SALMONID
HABITAT LIMITING FACTORS

WATER RESOURCE INVENTORY AREA 15 (East)
FINAL REPORT

WASHINGTON STATE
CONSERVATION COMMISSION

Donald Haring

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ACKNOWLEDGEMENTS

Completion of this report would not have been possible without the support and cooperation of the Technical Advisory Group (TAG), who contributed an extensive amount of their valuable time and were the source of the majority of information included in this report. Their expertise and familiarity with the sub-watersheds within East Water Resource Inventory Area (WRIA) 15, and their interest and willingness to share their knowledge, allowed us to complete this report. There were actually three TAGs involved in the development of this report, one for Pierce County streams in East WRIA 15, one for Kitsap County Streams in East WRIA 15, and one for marine/nearshore habitats. Several participants were involved with more than one of the TAGs. Following is an alphabetized list of TAG participants and other consulted individuals:

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Completion of this report was truly a collaborative effort. Unfortunately, the extent and variety of contributions cannot be adequately captured in the authorship reference for this report.

ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

The following list provides a guide to acronyms or abbreviations used in this report:

cfs	cubic feet per second (a measure of water flow)
CSO	Combined Sewer Overflow
CWA	Clean Water Act
EF	East Fork
ESA	Endangered Species Act
IFIM	Instream Flow Incremental Methodology
KGI	Key Peninsula/Gig Harbor/Islands Watershed Area
LWD	Large Woody Debris
m	Meter
mg/L	milligrams/Liter
mi	mile
mi^2	square miles
MF	Middle Fork
NF	North Fork
NWIFC	Northwest Indian Fisheries Commission
PSCRBT	Puget Sound Cooperative River Basin Team
PSNS	Puget Sound Naval Shipyard
RM	River Mile
SASSI	Salmon and Steelhead Stock Inventory
SF	South Fork
SSHIAP	Salmon and Steelhead Habitat Inventory Assessment Project
SSI	Salmonid Stock Inventory
TAG	Technical Advisory Group
WDF	Washington Department of Fisheries
WDFW	Washington Department of Fish and Wildlife
WF	West Fork
WRIA	Water Resource Inventory Area
WWTIT	Western Washington Treaty Indian Tribes
yr	year

TABLE OF CONTENTS

ACKNOWLEDGEMENTS 2
ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT 4
TABLE OF CONTENTS 5
LIST OF TABLES 10
LIST OF FIGURES 11
LIST OF MAPS INCLUDED IN SEPARATE MAPS FILE INCLUDED WITH THIS REPORT 13
EXECUTIVE SUMMARY 14
BACKGROUND 20
THE RELATIVE ROLE OF HABITAT IN HEALTHY POPULATIONS OF NATURAL SPAWNING SALMON 21
INTRODUCTION 27
Discussion of Habitat Limiting Factor Elements 27
WATERSHED DESCRIPTION 34
Geologic History (modified from PSCRBT 1994) 34
Key Peninsula, Gig Harbor, and Islands Subwatershed (modified from KGI Draft 1999) 35
Colvos Passage/Rich Passage Subwatershed 36
Sinclair Inlet Subwatershed (from PSCRBT 1990) 36
Dyes Inlet Watershed (from PSCRBT 1989) 37
Port Orchard Subwatershed 38
Liberty Bay/Miller Bay Subwatershed (from PSCRBT 1994) 38
Port Madison to Foulweather Bluff Area 40
Bainbridge Island Subwatershed (modified from PSCRBT 1995) 40
DISTRIBUTION AND CONDITION OF SALMON, STEELHEAD, AND CUTTHROAT STOCKS 41
General 41
Chinook 42
Summer Chum 45
Fall Chum 45
Coho 49
Pink 50
Sockeye 51
Steelhead 51
Cutthroat Trout 51
Char (Bull Trout/DollyVarden) 52
Other Species 52
HABITAT LIMITING FACTORS BY SUB-BASIN 53
Categories of Habitat Limiting Factors used by the Washington State Conservation Commission: 53
Subwatershed or Subbasin Discussions 55
Spring Creek 15.0001 55
Coulter Creek 15.0002 and Unnamed Tributaries 15.0003-0010 56
Unnamed (Sisson) Creek 15.0012 61
Unnamed 15.0014 62
Rocky Creek 15.0015, Fork Muck Creek 15.0016, Winter Creek 15.0017, and Unnamed Tributaries 15.0017A - 15.0021 62

Unnamed 15.002X (WRIA index number is incomplete, as no unassigned stream number exists between the uppermost Rocky Creek tributary and 15.0022 to the south) 66
Unnamed 15.0022 67
Unnamed 15.0023 67
Vaughn Creek 15.0023A 68
Dutcher Creek 15.0026 and Unnamed Tributary 15.0027 70
Unnamed 15.0028 70
Herron (Knackstedt) Creek 15.0029 and Unnamed 15.0029A 71
Unnamed (outlet to Herron Lake) 15.0030 71
Unnamed (Kingmans) Creek 15.0031 72
Unnamed 15.0031X 72
Whiteman Creek 15.0032 73
Taylor Bay Creek 15.0034 73
Unnamed 15.0035 74
Unnamed 15.0036 74
Schoolhouse Creek 15.0039 74
Unnamed 15.0039X 75
Unnamed 15.0040 75
Unnamed 15.0041 76
Unnamed 15.0041A 76
Mayo Creek 15.0042 77
Unnamed 15.0042A 77
Unnamed 15.0043 78
Unnamed 15.0044 78
Lackey Creek 15.0046 79
Minter Creek 15.0048, Little Minter Creek 15.0051, Huge Creek 15.0052 81
Unnamed 15.0053 85
Unnamed 15.0054 86
Burley Creek 15.0056, Little Bear Creek 15.0057, and Unnamed Creeks 15.0056A-0059A ... 86
Purdy Creek 15.0060 and Unnamed 15.0061 90
Goodnough (Gooch) Creek 15.0063 and Unnamed (Wilderness) 15.0064 93
McCormick Creek 15.0065 and Unnamed 15.0066 95
Lay (Nelyaly) Creek 15.0068 99
Meyer (Rosedale) Creek 15.0069A 100
Mark Dickson (Ray Nash) Creek 15.0070 and Lake Sylvia Creek 15.0070A 101
Unnamed 15.0071 104
Warren Creek 15.0072 104
Muri Creek 15.0074 105
Artondale Creek 15.0075 and East Branch Artondale Creek 15.0076 106
Wollochet (Bitter) Creek 15.0080/0081, Garr Creek 15.0080, and tributaries 108
Murphy Creek 15.008X 111
Sullivan Gulch Creek 15.0087 and Unnamed 15.0087A 111
Schoolhouse Creek 15.0090 112
Unnamed 15.009X 113
“Doc Weathers” Creek 15.0096 113
North (Donkey) Creek 15.0097 and Unnamed 15.0098 114
Crescent Creek 15.0099 116
Sunrise (Sunnycove, “Ed’s”) Creek 15.0105 120
Olalla Creek 15.0107 and Unnamed 15.0108-0113 121

Fragaria (Big Phinney) Creek 15.0115 and Unnamed (Little Phinney) 15.0116 123
Wilson Creek 15.0178 and Unnamed 15.0180 124
Unnamed 15.0181 124
Unnamed 15.0183 125
Curley Creek 15.0185, Salmonberry Creek 15.0188, and Unnamed 15.0186-0190 125
Duncan Creek 15.0191 130
Beaver Creek 15.0192 131
Unnamed 15.0193 133
Unnamed 15.0194 133
Unnamed 15.0195 134
Duncan (Sullivan, Sacco) Creek 15.0196 134
Sullivan (Karch, Karcher) Creek 15.0200 135
Olney, Retsil (Wilson, Karcher, Annapolis) Creek 15.0201 135
Annapolis Creek 15.0202 137
Blackjack Creek 15.0203, continued as Square Creek, Ruby Creek 15.0205, and Unnamed 15.0206-0207 139
Unnamed 15.0208 144
Ross Creek 15.0209 and Unnamed 15.0210 145
Anderson Creek 15.0211 and EF Anderson 15.0212 148
Unnamed 15.0215 151
Gorst Creek 15.0216 and extension as 15.0224, Unnamed (Bailey's) Creek 15.0217, Jarstad Creek 15.0218, Parish Creek 15.0220, and Heins Creek 15.0221 151
Wright Creek 15.0225 159
City of Bremerton Streams and Marine Shoreline 160
Unnamed 15.0226 and Unnamed 15.0227 161
Unnamed 15.0228 161
Chico Creek continued as Wildcat Creek 15.0229, Kitsap Creek 15.0230, Dickerson Creek 15.0231, Lost Creek 15.0234, Unnamed 15.0233, and additional Unnamed Unnumbered Tributaries 162
Koch (Knapp) Creek 15.0245, Unnamed (Crystal) Creek 15.0243, Unnamed (Woods) Creek 15.0244, and Unnamed Creeks 15.0242A, 15.0242B, 15.0241 168
Strawberry (Crystal, Koch's) Creek 15.0246, WF Strawberry 15.0247 168
Unnamed 15.0248 171
Clear Creek 15.0249, WF Clear Creek 15.0250, and Unnamed 15.0251-0254 172
Barker Creek 15.0255 and Hoot Creek 15.0255A 177
Unnamed 15.0257 182
Pahrmann (Peterman, Stampede) Creek 15.0258 182
Mosher Creek 15.0259 183
Unnamed 15.0260 186
Unnamed 15.0262 186
Dee (Enetai) Creek 15.0264 186
Illahee Springs Creek 15.0265 188
Illahee (Schutt) Creek 15.0266 and Unnamed 15.0267-0267A 188
Unnamed (Gilberton) Creek 15.0269 190
Unnamed 15.0272 191
Steele (Crouch) Creek 15.0273, SF Steele Creek 15.0274, and EF Steele 15.0275 191
Unnamed 15.0275A 195
Keyport Creek 15.0276 195
Unnamed 15.0277 196

Daniels Creek 15.0278 197
Little Scandia Creek 15.0279 197
Big Scandia Creek 15.0280 199
Unnamed 15.0281 201
MF Johnson Creek 15.0283, Johnson Creek Tributary 15.0282, and NF Johnson Creek 15.0284 202
Dogfish (WF Dogfish) Creek 15.0285, SF Dogfish (Wilderness, Harding) 15.0285A, NF (EF) Dogfish 15.0286, and Unnamed 15.0285B-0287 205
Unnamed 15.0288 210
Bjorgen Creek (identified as Deer Creek in headwaters) 15.0290 210
Unnamed 15.0291 and Unnamed 15.0292 212
Sam Snyder (Firecracker) Creek 15.0293 213
Unnamed 15.0295 214
Klaebel (Thompson) Creek 15.0296 and Unnamed 15.0297 214
Cowling Creek 15.0298 and Unnamed 15.0298A 216
Grovers Creek 15.0299 and Unnamed 15.0300-0304 217
Unnamed 15.0305, Independent Streams Immediately North and South of 15.0305 221
Kitsap Creek 15.0305X 222
Indianola Creek 15.0305X 223
Unnamed 15.0305X 225
Unnamed 15.0306 225
Unnamed 15.0307 226
Unnamed 15.0308-0308A 226
Carpenter Creek 15.0309 227
Silver Creek 15.0310 229
Eglon Creek 15.0311 and Silver Creek 15.0312 229
Unnamed 15.0316 230
Unnamed 15.0318 230
Unnamed 15.0319A 231
Dripping Water Creek 15.0320 232
Murden Cove Creek 15.0321, and Unnamed Tributaries 15.0322 and .0323 232
Ravine (Canyon, Winslow) Creek 15.0324 233
Unnamed 15.0324A 234
Sportsmen's Club Pond Creek 15.0325 234
Head of Bay Creek 15.0326 235
Blakely Falls Creek 15.0330X 235
Macs Dam Creek 15.0331 235
Unnamed 15.0332 236
Schel-chelb Creek 15.0028X and Unnamed Tributary 236
Fletcher (Springbrook) Creek 15.0340 and Unnamed 15.0341-0343 237
Mosquito Bay (Big Manzanita) Creek 15.0344 and Tributaries 238
MARINE/NEARSHORE HABITAT LIMITING FACTORS 240
Documented Use of Near-Shore Marine Areas by Juvenile Salmonids and Baitfish 240
Shoreline Armoring 241
Dredging and Conversion of Nearshore Habitat to Deepwater Habitat 243
Alteration of Intertidal/Shallow Subtidal Vegetated Habitat 244
Loss/Lack of Shoreline Riparian Vegetation 244
Marine Sediment/Water Quality 245
Oil and Toxic Spills 246

General Marine Nearshore/Marine Action Recommendations 246
Habitat Factors Limiting Nearshore/Marine Salmonid Productivity 247
ASSESSMENT OF HABITAT LIMITING FACTORS 272
Salmonid Habitat Concerns 272
Habitat Condition Rating 274
Habitat Restoration Potential 275
HABITAT IN NEED OF PROTECTION 284
DATA GAPS 291
Data Gaps by Habitat Element 291
LITERATURE CITED 295
Additional East WRIA 15 Reports not Directly Referenced in This Report 300
APPENDICES 302
APPENDIX A 303
APPENDIX B 330
SALMONID HABITAT CONDITION RATING STANDARDS FOR IDENTIFYING LIMITING FACTORS 330
APPENDIX C 337
WDF Stream Catalog (Williams et al. 1975) 337

LIST OF TABLES

Table 1: East WRIA 15 Salmon and Steelhead Stock Designations and Associated Status 17
Table 2: Observations of spawning adult Chinook and estimates of total numbers of spawning chinook for streams in East WRIA 15 44
Table 3: Reach specific habitat assessment data for Coulter Creek and tributaries (source, Phinney 1997) 58
Table 4: Streamflow data for Burley Creek (from Kitsap Public Utility District 2000)..... 89
Table 5: Channel condition ratings for Goodnough Creek (Pierce County Water Programs 2000) 94
Table 6: Channel condition ratings for McCormick Creek (Pierce County Water Programs 2000) 97
Table 7: Streamflow data for Sullivan Creek (from Kitsap Public Utility District 2000) 137
Table 8: Streamflow data for Blackjack Creek (from Kitsap Public Utility District 2000) 142
Table 9: Streamflow data for Anderson Creek (from Kitsap Public Utility District 2000)..... 150
Table 10: Streamflow data for Gorst Creek (from Kitsap Public Utility District 2000)..... 157
Table 11: Streamflow data for Chico Creek (from Kitsap Public Utility District 2000)..... 166
Table 12: Streamflow data for Strawberry Creek (from Kitsap Public Utility District 2000).... 170
Table 13: LWD sampling data in the Clear Creek Watershed (courtesy of Chris May) 173
Table 14: Pool/riffle sampling data in the Clear Creek Watershed (courtesy of Chris May)..... 173
Table 15: Streamflow data for Clear Creek (from Kitsap Public Utility District 2000)..... 175
Table 16: Habitat data for Barker Creek (Source: Chris May) 178
Table 17: Streamflow data for Barker Creek (from Kitsap Public Utility District 2000)..... 180
Table 18: Streamflow data for Johnson Creek (from Kitsap Public Utility District 2000) 204
Table 19: Streamflow data for Dogfish Creek (from Kitsap Public Utility District 2000)..... 208
Table 20: Clean Water Act Section 303(d) Water Quality Listings for Marine Waters in East WRIA 15 (from Dept. of Ecology 303(d) list) 246
Table 21: Assessment of Habitat Limiting Factor Severity for Salmonid-Bearing Watersheds within East WRIA 15..... 276
Table 22: East Kitsap Refugia (from CTC 2000) 285

LIST OF FIGURES

Figure 1: Location of East WRIA 15 in Washington State 15
Figure 2: Juvenile chinook releases into Clear Creek (graph courtesy of Paul Dorn, Suquamish Tribe) 43
Figure 3: Juvenile chinook releases from the Gorst Creek Hatchery (data courtesy of Paul Dorn, Suquamish Tribe)..... 43
Figure 4: Juvenile chinook releases from the Dogfish Creek Hatchery (data courtesy of Paul Dorn, Suquamish Tribe) 43
Figure 5: Juvenile chinook releases and adult chinook returns to the Grovers Creek Hatchery (graph courtesy of Paul Dorn, Suquamish Tribe) 45
Figure 6: Number of spawning adult chum salmon for Misc. Carr Inlet/Minter Creek tributaries (from WDFW run-reconstruction database) 46
Figure 7: Number of spawning adult chum salmon in Curley, North, Crescent, and Olalla Creeks (data courtesy of Jay Zischke, Suquamish Tribe)..... 47
Figure 8: Number of spawning adult chum salmon in Blackjack Creek and Gorst creeks (data courtesy of Jay Zischke, Suquamish Tribe)..... 47
Figure 9: Number of spawning adult chum salmon in the Chico Creek watershed (data courtesy of Jay Zischke, Suquamish Tribe)..... 48
Figure 10: Number of spawning adult chum salmon in several Dyes Inlet/Liberty Bay streams (data courtesy of Jay Zischke, Suquamish Tribe)..... 48
Figure 11: Cowling Creek chum plants (data courtesy of Paul Dorn, Suquamish Tribe) 49
Figure 12: Number of spawning adult coho salmon in Coulter and Rocky creeks (data courtesy of Chuck Baranski, WDFW)..... 50
Figure 13: Number of spawning adult coho salmon in several streams in East WRIA 15 in Kitsap County (data courtesy of Chuck Baranski, WDFW) 50
Figure 14: Coulter Creek estuary (note diking in intertidal area to direct streamflow) (photo courtesy of Department of Ecology)..... 60
Figure 15: Rocky Creek estuary (photo courtesy of Department of Ecology) 66
Figure 16: Burley Lagoon at the head of Henderson Bay (photo courtesy of Dept. of Ecology).. 89
Figure 17: North Creek estuary in Gig Harbor (photo courtesy of Dept. of Ecology) 115
Figure 18: Crescent Creek estuary in Gig Harbor (photo courtesy of Dept. of Ecology)..... 119
Figure 19: Olalla Creek estuary (photo courtesy of Dept. of Ecology) 123
Figure 20: Commercial development and road impacts to historic intertidal area in the Blackjack Creek estuary (photo courtesy of Department of Ecology) 143
Figure 21: Channelized portion of Gorst Creek immediately downstream of the old water diversion at Jarstad Park (2000 photo by Don Haring)..... 153
Figure 22: Gorst Creek habitat upstream of old water diversion at Jarstad Park (2000 photo by Don Haring)..... 154
Figure 23: Gorst Creek estuary at the west end of Sinclair Inlet (1992, photo courtesy of Department of Ecology)..... 157
Figure 24: Altered marine shoreline at Bremerton Naval Shipyard (photo courtesy of Dept. of Ecology)..... 160
Figure 25:Chico Creek estuary (1992 photo courtesy of Dept. of Ecology) 166
Figure 26: Extensive commercial development in Silverdale at the mouth of Clear Creek (photo courtesy of Dept. of Ecology)..... 175
Figure 27: Clear Creek estuary (photo courtesy of Dept. of Ecology) 176
Figure 28: Styles Lagoon at the mouth of Keyport Creek (photo courtesy of Dept. of Ecology)195
Figure 29: Land Use Adjacent to Little Scandia Creek (from PSCRBT 1994)..... 197

Figure 30: Land Use Adjacent to Big Scandia Creek (from PSCRBT 1994) 199
Figure 31: Land Use Adjacent to Dogfish Creek (from PSCRBT 1994) 205
Figure 32: Dogfish Creek estuary (photo courtesy of Dept. of Ecology) 209
Figure 33: Land Use Adjacent to Grovers Creek (from PSCRBT 1994) 217
Figure 34: Carpenter Creek estuary (photo courtesy of Dept. of Ecology) 228
Figure 35: Altered estuarine/nearshore habitat in Hidden Cove, near the north end of Bainbridge Island (1992 photo courtesy of Dept. of Ecology) 231
Figure 36: Marine shoreline development and habitat modifications in Carr Inlet at the unincorporated settlement of Home (1992 photo courtesy of Dept. of Ecology) 251
Figure 37: Development impacts to nearshore habitat in Wollochet Bay (1992 photo courtesy of Dept. of Ecology) 253
Figure 38: Marine shoreline at Pt. Fosdick showing development impacts to shoreline habitat west of Pt. Fosdick and natural steep bank shoreline to the northeast (1992 photo courtesy of Dept. of Ecology) 254
Figure 39: Prospect Pt. Development immediately below active feeder bluff (1992 photo courtesy of Dept. of Ecology) 255
Figure 40: Harper Estuary, site of planned estuarine restoration project (1992 photo courtesy of Dept. of Ecology) 256
Figure 41: Aerial photo of portion of the PSNS shoreline (1992 photo courtesy of Dept. of Ecology) 258
Figure 42: Massive fish kill in Puget Sound Naval Shipyard drydock (white color on bottom of drydock is dead fish, Official U.S. Navy Photograph, circa 1949) 258
Figure 43: CSO outfall at Evergreen Park and nearby old fill of intertidal area (1992 photo courtesy of Dept. of Ecology) 259
Figure 44: Marinas located on northeast shore of Liberty Bay (three adjoining photos); creosote piling breakwater on northern marina (1992 photos courtesy of Dept. of Ecology) 263
Figure 45: Shoreline armoring and presence of docks on spit on southern shoreline of Miller Bay (1992 photo courtesy of Dept. of Ecology) 264
Figure 46: Functional natural shoreline and estuary east of Indianola at mouth of 15.0305X (1992 photo courtesy of Dept. of Ecology) 265
Figure 47: Lost historic intertidal wetland at Presidents Pt. (1992 photo courtesy of Dept. of Ecology) 265
Figure 48: U.S Coast Survey (1872) of Apple Cove Pt. wetland (photo courtesy of Ted Labbe, NWIFC) 266
Figure 49: Remnant of historic intertidal wetland at Apple Cove Pt. (1992 photo courtesy of Dept. of Ecology) 266
Figure 50: U.S. Coast Survey (1872) depicting large intertidal wetland at Pt. No Pt. (photo courtesy of Ted Labbe, NWIFC) 267
Figure 51: Current configuration of historic Pt. No Pt. intertidal wetland; note ditches to drain historic wetland area (1992 photo courtesy of Dept. of Ecology) 267
Figure 52: Salmon netpen installation northwest of Beans Pt. (1992 photo courtesy of Dept. of Ecology) 269
Figure 53: Old log pond at the inner end of Blakely Harbor (1992 photo courtesy of Dept. of Ecology) 270

LIST OF MAPS INCLUDED IN SEPARATE MAPS FILE INCLUDED WITH THIS REPORT

Map 1: East WRIA 15 Salmonid Distribution
Map 2: East WRIA 15 Chinook Distribution
Map 3: East WRIA 15 Chum Distribution
Map 4: East WRIA 15 Coho Distribution
Map 5: East WRIA 15 Steelhead Distribution
Map 6: East WRIA 15 Cutthroat Distribution
Map 7: East WRIA 15 Fish Passage Barriers

Documented Baitfish Maps

T19R01E	Southern East WRIA 15 Islands
T19R01W	Southern East WRIA 15 Islands
T20R02E	Pt. Fosdick
T20R01E	McNeil Island
T20R01W	Longbranch Peninsula
T21R02E	Wollochet/Gig Harbor
T21R01E	South Carr Inlet
T21R01W	South Case Inlet
T22R02E	Southern Colvos
T22R01E	Henderson Bay/Burley Lagoon
T22R01W	North Case Inlet
T23R02E	Central Colvos Passage
T23R01E	North Colvos Passage
T24R02E	Manchester/ S. Bainbridge
T24R01E	Sinclair Inlet/S. Dyes Inlet
T25R02E	Central Bainbridge Island
T25R01E	N. Dyes Inlet
T26R02E	Port Madison
T26R01E	Liberty Bay
T27R02E	Apple Cove Point
T28R02E	Foulweather Bluff

EXECUTIVE SUMMARY

Section 10 of Engrossed Substitute House Bill 2496 (Salmon Recovery Act of 1998), directs the Washington State Conservation Commission, in consultation with local government and treaty tribes to invite private, federal, state, tribal, and local government personnel with appropriate expertise to convene as a Technical Advisory Group (TAG). The purpose of the TAG is to identify limiting factors for salmonids. Limiting factors are defined as "conditions that limit the ability of habitat to fully sustain populations of salmon, including all species of the family Salmonidae." It is important to note that the charge to the Conservation Commission in ESHB 2496 does not constitute a full limiting factors analysis. A full habitat limiting factors analysis would require extensive additional scientific studies for each of the subwatersheds in East Water Resource Inventory Area (WRIA) 15 (see location in Figure 1). Analysis of hatchery, hydro, and harvest impacts would also be part of a comprehensive limiting factors analysis, but these elements will be considered in other forums.

East WRIA 15 includes the streams and marine waters on the Puget Sound side of Key Peninsula, Gig Harbor Peninsula, South Puget Sound Islands, and Kitsap Peninsula. There are numerous low-elevation, low-gradient streams throughout East WRIA 15. There are 125 separate streams entering saltwater in East WRIA 15 that are known to support salmonids, with an estimated 215 miles of known anadromous salmonid utilization. Total length of utilized habitat rivals that of most large river basins, and the production potential of the streams is very high due to the low-gradient nature of the streams, the lack of natural anadromous fish passage barriers, and the extensive wetland complexes in many of the drainages. Individual drainage lengths range from single channels less than 1 mile in length to larger drainages with numerous tributaries (the Chico Creek watershed includes almost 68 miles of streams and tributaries, of which approximately 17 miles are accessible to anadromous salmonids (PSCRBT 1989)). Although the upper portions of some watersheds may not be accessible to anadromous salmonids, many support resident salmonid populations, and all warrant protection as "critical contributing areas" to downstream salmonid habitat (water quantity and quality). The larger drainages in East WRIA 15 include Coulter Creek, Rocky Creek, Minter Creek, Burley Creek, Crescent Creek, Curley Creek, Blackjack Creek, Gorst Creek, Chico Creek, Clear Creek, Dogfish Creek, and Grovers Creek. Most of the streams in East WRIA 15 are low gradient and highly productive, particularly for chum, coho, and cutthroat. In addition, there are 320 miles of marine shoreline and nearshore habitat in East WRIA 15, which provide juvenile rearing and migration habitat for local salmonid stocks as well as stocks originating from other Puget Sound WRIAs, and spawning habitat for baitfish stocks.

The soils throughout much of East WRIA 15 are comprised of a thin veneer of pervious topsoil over a deep deposit of densely compacted glacial till. This allows precipitation to be retained, held in wetlands, and naturally metered out to the streams to provide surface flows even through the dry summer months. The wetlands also provide excellent rearing habitat for juvenile coho salmon and cutthroat trout. Many streams do not have year-round surface flows, but provide excellent spawning and rearing habitat for chum salmon, which are only present during the wet winter months. The retention of natural stream hydrology is imperative to maintaining suitable habitat for salmonids.

WRIA 15 is quite unique in comparison to other western Washington watersheds. As noted above, the entirety of the WRIA is low-elevation and low-gradient. The drainages are relatively

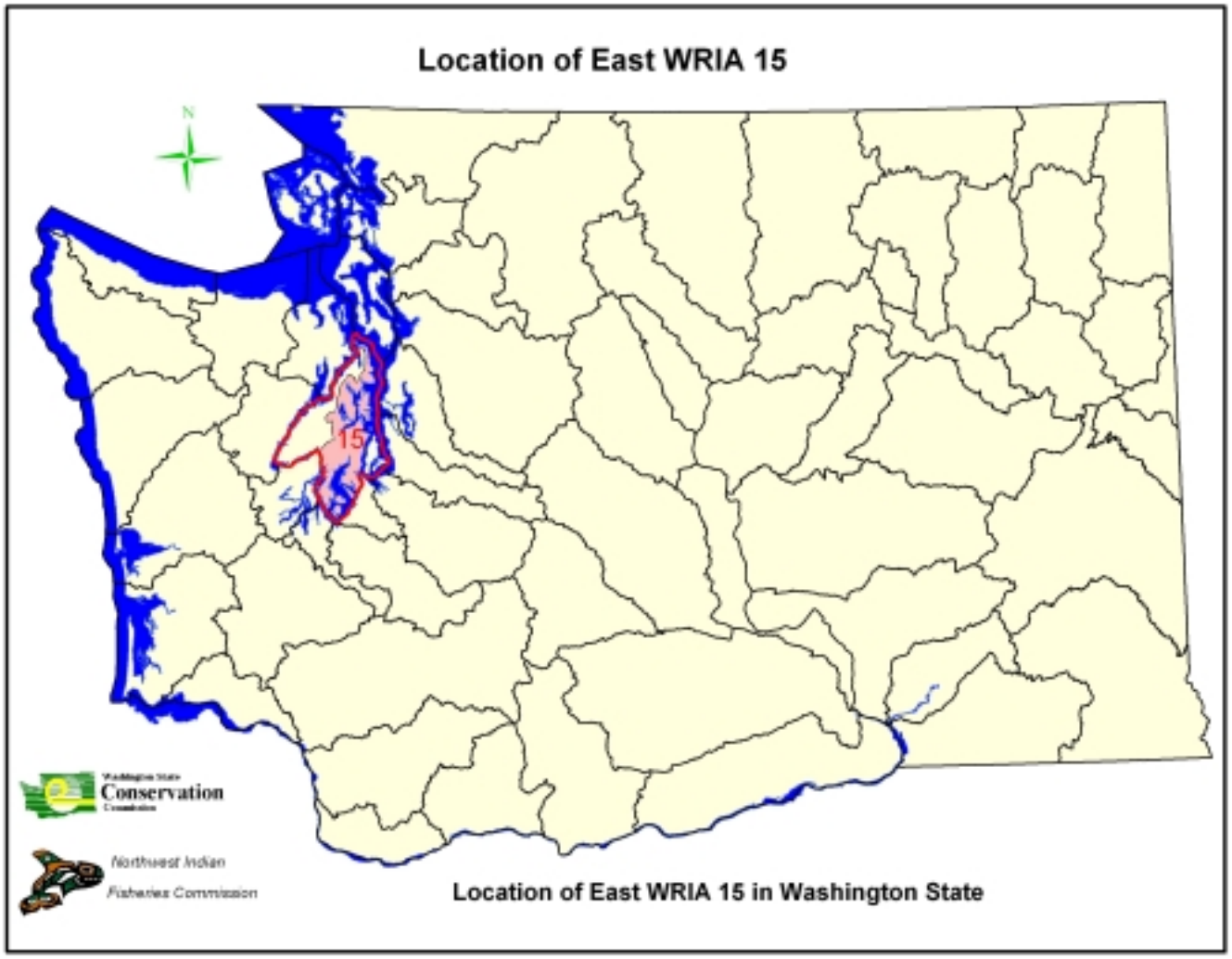


Figure 1: Location of East WRIA 15 in Washington State

small in comparison to larger river systems, and flows are dependent on precipitation and groundwater contribution, as the drainages do not receive snowmelt runoff from either the Olympic or Cascade mountains. Low-elevation snowmelt or rain-on-snow events during winter months are infrequent, and of much lower magnitude than events in the larger river systems that originate in the mountains. As a result, the natural hydrology and salmonid habitat conditions in streams in undisturbed areas tend to be very stable. However, the salmonid habitat in the streams in East WRIA 15 appears to be highly susceptible to changes in hydrology resulting from stormwater runoff from development in the watersheds. The increase in impervious surfaces, associated with conversion of forestland to residential and commercial development, decreases the infiltration of precipitation into the soils and wetlands, and increases the frequency and magnitude of peak stream flows. The result is less water being available to sustain flows through the dry months, and the increased peak flows result in increased bank and streambed instability, channel scour and downcutting, and loss of instream habitat diversity, all of which adversely affect salmonid production.

This report addresses habitat conditions that support anadromous salmon and steelhead, based on the stock status designations identified in the Salmon and Steelhead Stock Inventory (SASSI (WDF et al. 1993)). In addition, cutthroat trout utilization is identified where known and presumed elsewhere to the upper extent of other known salmonid utilization. There is no known bulltrout (char) presence in the low elevation streams or marine areas of East WRIA 15, however little sampling for bulltrout has occurred in marine areas. This report attempts to compile the best available information on the current distribution and condition of salmonid stocks, for use in determining potential benefits of salmonid habitat protection and restoration efforts.
Table 1 provides a summary of salmon stocks identified in SASSI, identified SASSI stock status, and ESA listing status. Distributions of individual salmon and steelhead species are shown on the maps in the separate Maps appendix included with this report, with supporting tabular data in Appendix A.

Data included in this report include formal habitat inventories or studies specifically directed at evaluating fish habitat, other watershed data not specifically associated with fish habitat evaluation, and personal experience and observations of the watershed experts involved in the TAG. These data provide an analysis of the salmonid habitat limiting factors in East WRIA 15. Although many of the habitat data/observations in this report may not meet the highest scientific standard of peer reviewed literature, they should nevertheless be considered as valid, as they are based on the collective experience of the watershed experts that are actively working in these freshwater drainages and marine nearshore habitats. Although there are a significant number of past studies and reports on these watersheds, a large number of salmonid habitat “data gaps” remain, which will require additional specific watershed research or evaluation. The available data indicate several common habitat themes across watersheds within East WRIA 15, including:

- natural stream ecological processes have been significantly altered due to adjacent land management practices and direct actions within the stream corridor,
- substantial increases in peak flow frequency and magnitude due to channelization and increased stormwater runoff from lands that have been converted to non-forest status; many of the less developed streams are facing similar threats from growth and further conversion of forestland to non-forest status,
- salmonid habitat quality and quantity has been adversely impacted by the cumulative effects of poor agricultural practices, timber harvest that exceeds sustainable levels,
- insufficient erosion controls during construction operations, and ineffective stormwater controls (water quality and quantity),

Table 1: East WRIA 15 Salmon and Steelhead Stock Designations and Associated Status		
Stock	**SASSI Status**	**ESA Listing Status**
South Sound Tribs. Summer/Fall Chinook	Healthy	Threatened
Case Inlet Summer Chum	Healthy	Not Warranted
Blackjack Creek Summer Chum	Healthy	Not Warranted
Case Inlet Fall Chum	Healthy	Not Warranted
Carr Inlet Fall Chum	Healthy	Not Warranted
Gig Harbor/Olalla Fall Chum	Healthy	Not Warranted
Dyes Inlet/Liberty Bay Fall Chum	Healthy	Not Warranted
Sinclair Inlet Fall Chum	Healthy	Not Warranted
Port Madison/Foulweather Bluff Fall Chum	Not Identified as Distinct Stock	Not Warranted
Bainbridge Island Fall Chum	Not Identified as Distinct Stock	Not Warranted
Deep South Sound Tribs. Coho	Healthy	Candidate
East Kitsap Coho	Healthy	Candidate
Bainbridge Island Coho	Not Identified as Distinct Stock	Candidate
Case/Carr Inlets Winter Steelhead	Unknown	Not Warranted
East Kitsap Winter Steelhead	Unknown	Not Warranted
Western South Sound Coastal Cutthroat	Unknown	Not Warranted
East Kitsap/Bainbridge Coastal Cutthroat	Not Identified as Distinct Stock	Not Warranted

- loss/impairment of instream flows during dry periods due to degradation and loss of headwater and floodplain wetlands, that store water during wet periods and meter flows to the streams during dry periods,
- substrate sediment stability and composition has been affected in a number of freshwater drainages due to lack of effective stormwater runoff controls,
- fine sediment (<.85 mm) levels in the gravels of several streams are identified as likely being high enough to adversely affect spawning success and benthic invertebrate production,
- lack of adequate large woody debris (LWD) in streams, particularly larger key pieces that are critical to developing pools, log jams, and other habitat diversity important to salmonids,
- lack of adequate pool frequency, or large deep pools that are important to rearing juvenile salmonids and adult salmonids on their upstream migration,
- loss of natural floodplain processes, due to dredging, bank armoring, and channelization, including the loss of functional off-channel habitat,

- loss of freshwater riparian function due to removal/alteration of natural riparian vegetation, which affects water quality, lateral erosion, bank stability, instream habitat conditions, LWD recruitment, etc.,
- the presence of a large number of culverts/screens/dams/etc. that preclude unrestricted upstream or downstream access to juvenile and adult salmonids,
- estuarine/marine nearshore function is substantially impacted by physical alteration of natural estuaries, by alteration of nearshore ecological function due to extensive shoreline armoring, by loss of shoreline LWD, by loss of shoreline riparian shade, and by poor water/sediment quality

Although there are varying extents of habitat impacts throughout East WRIA 15, the freshwater and marine nearshore salmonid habitat conditions are generally better in the northern and southern portions of East WRIA 15 than in the more heavily developed central portion. This does not appear to be the result of better land use regulation differences between Kitsap and Pierce counties, but rather the result of greater development interest and pressure in southern Kitsap County than in Pierce County or northern Kitsap County. However, the entirety of East WRIA 15 is experiencing rapid population growth, and all freshwater and marine nearshore salmonid habitats are at risk of adverse impacts.

Prioritized habitat action recommendations are provided for each stream in which salmonid presence has been identified, and for each marine area, following the discussion of identified salmonid habitat concerns. Those action recommendations at the top of the list are considered to provide greater restoration potential than those towards the bottom of the list, or those on the top of the list may need to be done first to better ensure the effectiveness of those further down the list. The TAG discussed at length whether it was practicable to prioritize or rank streams in East WRIA 15 on the basis of salmonid productivity potential resulting from habitat restoration. They determined that prioritization/ranking of streams was not feasible and may preclude consideration of high benefit restoration projects in certain watersheds. The TAG consensus was that proposed habitat restoration projects should be reviewed on their own merits, and the projects prioritized/ranked on the basis of their anticipated benefit to protecting/restoring salmonid production. Habitat protection/restoration project proposal ranking should consider whether the project addresses an identified habitat limiting factor, where the project type ranks in the prioritized action recommendations list for that stream or marine area, how the project complements other protection/restoration actions, and how the project complements with identified habitats needing protection (e.g., CTC 2000). Project ranking should also consider projects where willing landowners and partnerships can increase the effectiveness/efficiency of the restoration project. Habitat conditions also vary between different reaches of a stream; restoration proposals should consider the potential benefits of the proposal in relation to habitat conditions likely to be encountered elsewhere in the stream. In addition, restoration of the marine nearshore should be considered a high priority, based on benefits to all salmonid stocks including stocks originating outside East WRIA 15.

Protection/restoration of salmonid resources cannot be accomplished by watershed restoration projects alone. It is unlikely that we will be able to resolve the salmon predicament using the same land management approaches that got us into it. We will need to look at the watershed with a clear new vision. Salmonid recovery will require a combination of efforts, including:

- improved resource stewardship by landowners; regulations alone will not be effective without landowner commitment to resource protection and stewardship

- revision, implementation, and enforcement of land use ordinances that provide protection for natural ecological processes in the marine, instream, and riparian corridors, including measures to limit impervious surfaces to levels, and in a manner, that will maintain natural hydrology,
- protection of marine, instream, and riparian habitat that is currently functioning, particularly key habitat areas, and
- restoration of natural marine, instream, and riparian ecological processes where they have been impaired.

This report provides information that can and should be used in the development of salmonid habitat protection and restoration strategies. It should be considered a living document, with additional habitat assessment data and habitat restoration successes incorporated as information becomes available.

BACKGROUND

The successful recovery of naturally spawning salmon populations depends upon directing actions simultaneously at harvest, hatcheries, habitat and hydroelectric dams, the 4-H's. The 1998 state Legislature produced a number of bills aimed at salmon recovery. Engrossed Substitute House Bill (ESHB) 2496 is a key piece of the Legislature's salmon recovery effort, with the focus directed at salmon habitat issues.

Engrossed Substitute House Bill (ESHB) 2496 in part:

- directs the Conservation Commission in consultation with local government and the tribes to invite private, federal, state, tribal and local government personnel with appropriate expertise to act as a technical advisory group;
- directs the technical advisory group to identify limiting factors for salmonids;
- defines limiting factors as "conditions that limit the ability of habitat to fully sustain populations of salmon;"
- defines salmon as all members of the family salmonidae, which are capable of self-sustaining, natural production.

The overall goal of the Conservation Commission's limiting factors project is to identify habitat factors limiting production of salmon in the state. In waters shared by salmon, steelhead trout and bull trout we will include all three. Later, we will add bull trout only waters as well as cutthroat trout.

It is important to note that the responsibilities given to the Conservation Commission in ESHB 2496 do not constitute a full limiting factors analysis. The hatchery, hydropower, and harvest limiting factors are being dealt with in other forums.

THE RELATIVE ROLE OF HABITAT IN HEALTHY POPULATIONS OF NATURAL SPAWNING SALMON

(Chapter Author – Carol Smith, PHD)

During the last 10,000 years, Washington State anadromous salmonid populations have evolved in their specific habitats (Miller 1965). Water chemistry, flow, and the physical stream components unique to each stream have helped shaped the characteristics of every salmon population. These unique physical attributes have resulted in a wide variety of distinct salmon stocks for each salmon species throughout the State. Within a given species, stocks are population units that do not extensively interbreed because returning adults rely on a stream's unique chemical and physical characteristics to guide them to their natal grounds to spawn. This maintains the separation of stocks during reproduction, thus preserving the distinctiveness of each stock.

Throughout the salmon's life cycle, the dependence between the stream and a stock continues. Adults spawn in areas near their own origin because survival favors those that do. The timing of juveniles leaving the river and entering the estuary is tied to high natural river flows. It has been theorized that the faster speed during out-migration reduces predation on the young salmon and perhaps is coincident to favorable feeding conditions in the estuary (Wetherall 1971). These are a few examples that illustrate how a salmon stock and its environment are intertwined throughout the entire life cycle.

Salmon habitat includes the physical, chemical and biological components of the environment that support salmon. Within freshwater and estuarine environments, these components include water quality, water quantity or flows, stream and river physical features, riparian zones, upland terrestrial conditions, and ecosystem interactions as they pertain to habitat. However, these components closely intertwine. Low stream flows can alter water quality by increasing temperatures and decreasing the amount of available dissolved oxygen, while concentrating toxic materials. Water quality can impact stream conditions through heavy sediment loads, which result in a corresponding increase in channel instability and decrease in spawning success. The riparian zone interacts with the stream environment, providing nutrients and a food web base, woody debris for habitat and flow control (stream features), filtering runoff prior to surface water entry (water quality), and providing shade to aid in water temperature control.

Salmon habitat includes clean, cool, well-oxygenated water flowing at a normal (natural) rate for all stages of freshwater life. In addition, salmon survival depends upon specific habitat needs for egg incubation, juvenile rearing, migration of juveniles to saltwater, estuary rearing, ocean rearing, adult migration to spawning areas, and spawning. These specific needs can vary by species and even by stock.

When adults return to spawn, they not only need adequate flows and water quality, but also unimpeded passage to their natal grounds. They need deep pools with vegetative cover and instream structures such as root wads for resting and shelter from predators. Successful spawning and incubation depend on sufficient gravel of the right size for that particular population, in addition to the constant need of adequate flows and water quality, all in unison at the necessary location. Also, delayed upstream migration can be critical. After entering freshwater, most salmon have a limited time to migrate and spawn, in some cases, as little as 2-3 weeks. Delays can results in pre-spawning mortality, or spawning in a sub-optimum location.

After spawning, the eggs need stable gravel that is not choked with sediment. River channel stability is vital at this life history stage. Floods have their greatest impact to salmon populations during incubation, and flood impacts are worsened by human activities. In a natural river system, the upland areas are forested, and the trees and their roots store precipitation, which slows the rate of storm water into the stream. The natural, healthy river is sinuous and contains large pieces of wood contributed by an intact, mature riparian zone. Both slow the speed of water downstream. Natural systems have floodplains that are connected directly to the river at many points, allowing wetlands to store flood water and later discharge this storage back to the river during lower flows. In a healthy river, erosion or sediment input is great enough to provide new gravel for spawning and incubation, but does not overwhelm the system, raising the riverbed and increasing channel instability. A stable incubation environment is essential for salmon, but is a complex function of nearly all habitat components contained within that river ecosystem.

Once the young fry emerge from the gravel nests, certain species such as chum, pink, and some chinook salmon quickly migrate downstream to the estuary. Other species, such as coho, steelhead, bulltrout, and chinook, will search for suitable rearing habitat within the side sloughs and channels, tributaries, and spring-fed "seep" areas, as well as the outer edges of the stream. These quiet-water side margin and off channel slough areas are vital for early juvenile habitat. The presence of woody debris and overhead cover aid in food and nutrient inputs as well as provide protection from predators. For most of these species, juveniles use this type of habitat in the spring. Most sockeye populations migrate from their gravel nests quickly to larger lake environments where they have unique habitat requirements. These include water quality sufficient to produce the necessary complex food web to support one to three years of salmon growth in that lake habitat prior to outmigration to the estuary.

As growth continues, the juvenile salmon (parr) move away from the quiet shallow areas to deeper, faster areas of the stream. These include coho, steelhead, bulltrout, and certain chinook. For some of these species, this movement is coincident with the summer low flows. Low flows constrain salmon production for stocks that rear within the stream. In non-glacial streams, summer flows are maintained by precipitation, connectivity to wetland discharges, and groundwater inputs. Reductions in these inputs will reduce that amount of habitat; hence the number of salmon dependent on adequate summer flows.

In the fall, juvenile salmon that remain in freshwater begin to move out of the mainstems, and again, off-channel habitat becomes important. During the winter, coho, steelhead, bulltrout, and remaining chinook parr require habitat to sustain their growth and protect them from predators and winter flows. Wetlands, stream habitat protected from the effects of high flows, and pools with overhead are important habitat components during this time.

Except for bulltrout and resident steelhead, juvenile parr convert to smolts as they migrate downstream towards the estuary. Again, flows are critical, and food and shelter are necessary. The natural flow regime in each river is unique, and has shaped the population's characteristics through adaptation over the last 10,000 years. Because of the close inter-relationship between a salmon stock and its stream, survival of the stock depends heavily on natural flow patterns.

The estuary provides an ideal area for rapid growth, and some salmon species are heavily dependent on estuaries, particularly chinook, chum, and to a lesser extent, pink salmon. Estuaries contain new food sources to support the rapid growth of salmon smolts, but adequate natural habitat must exist to support the detritus-based food web, such as eelgrass beds, mudflats, and salt

marshes. Also, the processes that contribute nutrients and woody debris to these environments must be maintained to provide cover from predators and to sustain the food web. Common disruptions to these habitats include dikes, bulkheads, dredging and filling activities, pollution, and alteration of downstream components such as lack of woody debris and sediment transport.

All salmonid species need adequate flow and water quality, spawning riffles and pools, a functional riparian zone, and upland conditions that favor stability, but some of these specific needs vary by species, such as preferred spawning areas and gravel. Although some overlap occurs, different salmon species within a river are often staggered in their use of a particular type of habitat. Some are staggered in time, and others are separated by distance.

Chum and pink salmon use the streams the least amount of time. Washington adult pink salmon typically begin to enter the rivers in August and spawn in September and October, although Dungeness summer pinks enter and spawn a month earlier (WDFW and WWTIT 1994). During these times, low flows and associated high temperatures and low dissolved oxygen can be problems. Other disrupted habitat components, such as less frequent and shallow pools from sediment inputs and lack of canopy from an altered riparian zone or widened river channel, can worsen these flow and water quality problems because there are fewer refuges for the adults to hold prior to spawning.

Pink salmon fry emerge from their gravel nests around March and migrate downstream to the estuary within a month. After a limited rearing time in the estuary, pink salmon migrate to the ocean for a little over a year, until the next spawning cycle. Most pink salmon stocks in Washington return to the rivers only in odd years. The exception is the Snohomish Basin, which supports both even- and odd-year pink salmon stocks.

In Washington, adult chum salmon (3-5 years old) have three major run types. Summer chum adults enter the rivers in August and September, and spawn in September and October. Fall chum adults enter the rivers in late October through November, and spawn in November and December. Winter chum adults enter from December through January and spawn from January through February. Chum salmon fry emerge from the nests in March and April, and quickly outmigrate to the estuary for rearing. In the estuary, juvenile chum follow prey availability. In Hood Canal, juveniles that arrive in the estuary in February and March migrate rapidly offshore. This migration rate decreases in May and June as levels of zooplankton increase. Later as the food supply dwindles, chum move offshore and switch diets (Simenstad and Salo 1982). Both chum and pink salmon have similar habitat needs such as unimpeded access to spawning habitat, a stable incubation environment, favorable downstream migration conditions (adequate flows in the spring), and because they rely heavily on the estuary for growth, good estuary habitat is essential.

Chinook salmon have three major run types in Washington State. Spring chinook are generally in their natal rivers throughout the calendar year. Adults begin river entry as early as February in the Chehalis, but in Puget Sound, entry doesn't begin until April or May. Spring chinook spawn from July through September and typically spawn in the headwater areas where higher gradient habitat exists. Incubation continues throughout the autumn and winter, and generally requires more time for the eggs to develop into fry because of the colder temperatures in the headwater areas. Fry begin to leave the gravel nests in February through early March. After a short rearing period in the shallow side margins and sloughs, all Puget Sound and coastal spring chinook stocks have juveniles that begin to leave the rivers to the estuary throughout spring and into summer (August). Within a given Puget Sound stock, it is not uncommon for other chinook

juveniles to remain in the river for another year before leaving as yearlings, so that a wide variety of outmigration strategies are used by these stocks. Spring chinook salmon juveniles in the Columbia Basin exhibit some distinct life history characteristics. Generally, these stocks remain in the basin for a full year. However, some stocks migrate downstream from their natal tributaries in the fall and early winter into larger rivers, including the Columbia River, where they are believed to over-winter prior to outmigration the next spring as yearling smolts.

Adult summer chinook begin river entry as early as June in the Columbia, but not until August in Puget Sound. They generally spawn in September and/or October. Fall chinook stocks range in spawn timing from late September through December. All Washington summer and fall chinook stocks have juveniles that incubate in the gravel until January through early March, and outmigration downstream to the estuaries occurs over a broad time period (January through August). A few of these stocks have a component of juveniles that remain in freshwater for a full year after emerging from the gravel nests.

While some emerging chinook salmon fry outmigrate quickly, most inhabit the shallow side margins and side sloughs for up to two months. Then, some gradually move into the faster water areas of the stream to rear, while others outmigrate to the estuary. Most summer and fall chinook outmigrate within their first year of life, but a few stocks (Snohomish summer chinook, Snohomish fall chinook, and upper Columbia summer chinook) have juveniles that remain in the river for an additional year, similar to many spring chinook (Marshall et al. 1995). However, those in the upper Columbia, have scale patterns that suggest that they rear in a reservoir-like environment (mainstem Columbia upstream from a dam) rather than in their natal streams and it is unknown whether this is a result of dam influence or whether it is a natural pattern.

The onset of coho salmon spawning is tied to the first significant fall freshet. They typically enter freshwater from September to early December, but has been observed as early as late July and as late as mid-January (WDF et al. 1993). They often mill near the river mouths or in lower river pools until freshets occur. Spawning usually occurs between November and early February, but is sometimes as early as mid-October and can extend into March. Spawning typically occurs in tributaries and sedimentation in these tributaries can be a problem, suffocating eggs. As chinook salmon fry exit the shallow low-velocity rearing areas, coho fry enter the same areas for the same purpose. As they grow, juveniles move into faster water and disperse into tributaries and areas which adults cannot access (Neave 1949). Pool habitat is important not only for returning adults, but for all stages of juvenile development. Preferred pool habitat includes deep pools with riparian cover and woody debris.

All coho juveniles remain in the river for a full year after leaving the gravel nests, but during the summer after early rearing, low flows can lead to problems such as a physical reduction of available habitat, increased stranding, decreased dissolved oxygen, increased temperature, and increased predation. Juvenile coho are highly territorial and can occupy the same area for a long period of time (Hoar 1958). The abundance of coho can be limited by the number of suitable territories available (Larkin 1977). Streams with more structure (logs, undercut banks, etc.) support more coho (Scrivener and Andersen 1982), not only because they provide more territories (useable habitat), but they also provide more food and cover. There is a positive correlation between their primary diet of insect material in stomachs and the extent the stream was overgrown with vegetation (Chapman 1965). In addition, the leaf litter in the fall contributes to aquatic insect production (Meehan et al. 1977).

In the autumn as the temperatures decrease, juvenile coho move into deeper pools, hide under logs, tree roots, and undercut banks (Hartman 1965). The fall freshets redistribute them (Scarlett and Cederholm 1984), and over-wintering generally occurs in available side channels, spring-fed ponds, and other off-channel sites to avoid winter floods (Peterson 1980). The lack of side channels and small tributaries may limit coho survival (Cederholm and Scarlett 1981). As coho juveniles grow into yearlings, they become more predatory on other salmonids. Coho begin to leave the river a full year after emerging from their gravel nests with the peak outmigration occurring in early May. Coho use estuaries primarily for interim food while they adjust physiologically to saltwater.

Sockeye salmon have a wide variety of life history patterns, including landlocked populations of kokanee, which never enter saltwater. Of the populations that migrate to sea, adult freshwater entry varies from spring for the Quinault stock, summer for Ozette, to summer for Columbia River stocks, and summer and fall for Puget Sound stocks. Spawning ranges from September through February, depending on the stock.

After fry emerge from the gravel, most migrate to a lake for rearing, although some types of fry migrate to the sea. Lake rearing ranges from 1-3 years. In the spring after lake rearing is completed, juveniles enter the ocean where more growth occurs prior to adult return for spawning.

Sockeye spawning habitat varies widely. Some populations spawn in rivers (Cedar River) while other populations spawn along the beaches of their natal lake (Ozette), typically in areas of upwelling groundwater. Sockeye also spawn in side channels and spring-fed ponds. The spawning beaches along lakes provide a unique habitat that is often altered by human activities, such as pier and dock construction, dredging, and weed control.

Steelhead have the most complex life history patterns of any Pacific salmonid species (Shapovalov and Taft 1954). In Washington, there are two major run types, winter and summer steelhead. Winter steelhead adults begin river entry in a mature reproductive state in December and generally spawn from February through May. Summer steelhead adults enter the river from about May through October with spawning from about February through April. They enter the river in an immature state and require several months to mature (Burgner et al 1992). Summer steelhead usually spawn farther upstream than winter stocks (Withler 1966) and dominate inland areas such as the Columbia Basin. However, the coastal streams support more winter steelhead populations.

Juvenile steelhead can either migrate to sea or remain in freshwater as rainbow or redband trout. In Washington, those that are anadromous usually spend 1-3 years in freshwater, with the greatest proportion spending two years (Busby et al. 1996). Because of this, steelhead rely heavily on the freshwater habitat and are present in streams all year long.

Bulltrout/Dolly Varden stocks are also very dependent on the freshwater environment, where they reproduce only in clean, cold, relatively pristine streams. Within a given stock, some adults remain in freshwater their entire lives, while others migrate to the estuary where they stay during the spring and summer. They then return upstream to spawn in late summer. Those that remain in freshwater either stay near their spawning areas as residents, or migrate upstream throughout the winter, spring, and early summer, residing in pools. They return to spawning areas in late summer. In some stocks juveniles migrate downstream in spring, over-winter in the lower river,

then enter the estuary and Puget Sound the following late winter to early spring (WDFW 1998). Because these life history types have different habitat characteristics and requirements, bulltrout are generally recognized as a sensitive species by natural resource management agencies. Reductions in their abundance or distribution are inferred to represent strong evidence of habitat degradation.

In addition to the above-described relationships between various salmon species and their habitats, there are also interactions between the species that have evolved over the last 10,000 years such that the survival of one species might be enhanced or impacted by the presence of another. Pink and chum salmon fry are frequently food items of coho smolts, Dolly Varden char, and steelhead (Hunter 1959). Chum fry have decreased feeding and growth rates when pink salmon juveniles are abundant (Ivankov and Andreyev 1971), probably the result of occupying the same habitat at the same time (competition). These are just a few examples.
Most streams in Washington are home to several salmonid species, which together, rely upon freshwater and estuary habitat the entire calendar year. As the habitat and salmon review indicated, there are complex interactions between different habitat components, between salmon and their habitat, and between different species of salmon. For just as habitat dictates salmon types and production, salmon contribute to habitat and to other species.

INTRODUCTION

The quantity and quality of aquatic habitat present in any stream, river, lake or estuary is a reflection of the existing physical habitat characteristics (e.g. depth, structure, gradient, etc) as well as the water quality (e.g. temperature and suspended sediment load). There are a number of processes that create and maintain these features of aquatic habitat. In general, the key processes regulating the condition of aquatic habitats are the delivery and routing of water (and its associated constituents such as nutrients), sediment, and large woody debris (LWD). These processes operate over the terrestrial and aquatic landscape. For example, climatic conditions operating over very large scales can drive many habitat forming processes while the position of a fish in the stream channel can depend upon delivery of wood from forest adjacent to the stream. In addition, ecological processes operate at various spatial and temporal scales and have components that are lateral (e.g., floodplain), longitudinal (e.g., landslides in upstream areas) and vertical (e.g., riparian forest).

The effect of each process on habitat characteristics is a function of variations in local geomorphology, climatic gradients, spatial and temporal scales of natural disturbance, and terrestrial and aquatic vegetation. For example, wood is a more critical component of stream habitat than in lakes, where it is primarily an element of littoral habitats. In stream systems, the routing of water is primarily via the stream channel and subsurface routes whereas in lakes, water is routed by circulation patterns resulting from inflow, outflow and climatic conditions.

Human activities degrade and eliminate aquatic habitats by altering the key natural processes described above. This can occur by disrupting the lateral, longitudinal, and vertical connections of system components as well as altering spatial and temporal variability of the components. In addition, humans have further altered habitats by creating new processes such as the actions of exotic species. The following sections identify and describe the major alterations of aquatic habitat that have occurred and why they have occurred. These alterations are discussed as limiting factors.

Discussion of Habitat Limiting Factor Elements

Fish Passage Barriers

Salmon are limited to certain spawning and rearing locations by natural features of the landscape. These features include channel gradient and the presence of physical features of the landscape (e.g. logjams). Flow can affect the ability of some landscape features to function as barriers. For example, some falls may be impassable at low flows, but then become passable at higher flows. In some cases flows themselves can present a barrier, such as when extreme low flows occur in some channels; at higher flows fish are not blocked. Flow conditions may also allow accessibility to some anadromous salmonid species, while precluding access to others.

Throughout Washington, barriers have been constructed that have restricted or prevented juvenile and adult fish from gaining access to formerly accessible habitat. The most obvious of these barriers are dams and diversions with no passage facilities that prevent adult salmon from accessing historically used spawning grounds. Culverts are often full or partial fish passage barriers; delayed fish passage during certain flow conditions can be equally as detrimental as a total fish passage barrier. In addition, in recent years it has become increasingly clear that we have also constructed barriers that prevent juveniles from accessing rearing habitat. For example,

in estuarine areas, dikes and levees have blocked off historically accessible estuarine areas such as tidal marshes, and poorly designed culverts in streams have impacted the ability of coho juveniles to move upstream into rearing areas. This chapter highlights known human-caused barriers to salmon and steelhead trout.

Functions of Floodplains

Floodplains are portions of a watershed that are periodically flooded by the lateral overflow of rivers and streams. In general, most floodplain areas are located in lowland areas of river basins and are associated with higher order streams. Floodplains are typically structurally complex, and are characterized by a great deal of lateral, aquatic connectivity by way of distributaries, sloughs, backwaters, side-channels, oxbows, and lakes. Often, floodplain channels can be highly braided (multiple parallel channels).

One of the functions of floodplains is to provide aquatic habitat. Aquatic habitats in floodplain areas can be very important for some species and life stages such as coho salmon juveniles that often use the sloughs and backwaters of floodplains to over-winter since this provides a refuge from high flows. Floodplains also help dissipate water energy during floods by allowing water to escape the channel and inundate the terrestrial landscape, lessening the impact of floods on incubating salmon eggs. Floodplains also provide coarse beds of alluvial sediments through which subsurface flow passes. This acts as a filter of nutrients and other chemicals to maintain high water quality. Floodplains also provide an area for sediment deposition and storage, particularly for fine sediment, outside of the river channel, reducing the effects of sediment deposition and instability in the river channel.

Impairment of Floodplains by Human Activities

Large portions of the floodplains of many Washington rivers, especially those in the western part of the state, have been converted to urban and agricultural land uses. Much of the urban areas of the state are located in lowland floodplains, while land used for agricultural purposes is often located in floodplains because of the flat topography and rich soils deposited by the flooding rivers.

There are two major types of human impacts to floodplain functions. First, channels are disconnected from their floodplain. This occurs both laterally as a result of the construction of dikes and levees, which often occur simultaneously with the construction of roads, and longitudinally as a result of the construction of road crossings. This has: 1) eliminated off-channel habitats such as sloughs and side channels; 2) increased flow velocity during flood events due to the constriction of the channel; 3) reduced subsurface flows and groundwater contribution to the stream; and 4) simplified channels since LWD is lost and channels are often straightened when levees are constructed. Channels can also become disconnected from their floodplains as a result of down-cutting and incision of the channel from losses of LWD, decreased sediment supplies, and increased high flow events.

The second major type of impact is loss of natural riparian and upland vegetation. The natural riparian and terrestrial vegetation in floodplain areas was historically coniferous forest. Conversion of these forested areas to impervious surfaces, deciduous forests, meadows, grasslands, and farmed fields has occurred as floodplains have been converted to urban and agricultural uses. Riparian forests are typically reduced or eliminated as levees and dikes are

constructed. Loss of vegetation on the floodplain reduces shading of water in floodplain channels, eliminates LWD contribution, reduces filtering of sediments, nutrients and toxics, and results in increased water energy during flood flows.

Elimination of off-channel habitats results in the loss of important habitats for juvenile salmonids. Sloughs and backwaters that are protected from flood flow impacts function as prime spawning habitat for chum, pink, and coho, and rearing and over-wintering habitat for coho juveniles. The loss of LWD from channels reduces the amount of rearing habitat available for chinook juveniles. Disconnection of the stream channels from their floodplain due to levee and dike construction increases water velocities, which in turn increases scour of the streambed. Salmon that spawn in these areas may have reduced egg to fry survival due to the scour. Removal of mature native vegetation from riparian zones can increase stream temperatures in channels, which can stress both adult and juvenile salmon. Sufficiently high temperatures can increase mortality.

Streambed Sediment

The sediments present in an ecologically healthy stream channel are naturally dynamic and are a function of a number of processes that input, store, and transport the materials. Processes naturally vary spatially and temporally and depend upon a number of features of the landscape such as stream order, gradient, stream size, basin size, geomorphic context, and hydrological regime. In forested mountain basins, sediment enters stream channels from natural mass wasting events (e.g. landslides and debris flows), channel bank erosion (particularly in glacial deposits), surface erosion, and soil creep. Natural input of sediment to stream channels in these types of basins occurs periodically during extreme climatic events such as floods (increasing erosion) and mass wasting. In lowland, or higher order streams, lateral erosion is the major natural sediment source. Inputs of sediment in these basins tend to be steadier in geologic time.

Once sediment enters a stream channel it can be stored or transported depending upon particle size, stream gradient, hydrological conditions, availability of storage sites, and channel type or morphology. Finer sediments tend to be transported through the system as wash load or suspended load, and have relatively little effect on channel morphology. Coarser sediments (>2 mm diameter) tend to travel as bedload, and can have larger effects on channel morphology as they move downstream, depositing through the channel network.

Some parts of the channel network are more effective at storing sediment, while other parts of the network are more effective at transporting material. There are also strong temporal components to sediment storage and transport, such as seasonal floods, which tend to transport more material. One channel segment may function as a storage site during one time of year and a transport reach at other times. In general, the coarsest sediments are found in upper watersheds while the finest materials are found in the lower reaches of a watershed. Storage sites include various types of channel bars, floodplain areas, and associated with LWD.

Effects of Human Actions on Sediment Processes

Changes in the supply, transport, and storage of sediments can occur as the direct result of human activities. Human actions can result in increases or decreases in the supply of sediments to a stream. Increases in sediment deposition in the channel result from increased erosion due to land use practices or isolation of the channel from the floodplain (due to presence of dikes or roads), which eliminate important off-channel storage areas for sediment and increases the sediment load

beyond the transport capacity of the stream. In addition, actions that destabilize the landscape in high slope areas such as logging or road construction increase the frequency and severity of mass wasting events. Finally, increases in the frequency and magnitude of flood flows, and/or loss of floodplain vegetation, increase erosion. Increased erosion fills pools and aggrades the channel, resulting in reduced habitat complexity and reduced rearing capacity for some salmonids. Increased total sediment supply to a channel increases the proportion of fine sediments in the bed, which can reduce the survival of incubating eggs in the gravel and change benthic invertebrate production.

Decreases in sediment supply occur in some streams, primarily as a result of disconnecting the channel from the floodplain. Dams typically block the supply of sediment from upper watershed areas while levees typically isolate the stream from natural upland sources of sediment. In addition, gravels are removed from streambeds to increase flow capacity (dredging) or for mineral extraction purposes. Reduction in sediment supply can alter the streambed composition, which can coarsen the substrate and reduce the amount of gravel substrate suitable for spawning.

In addition to affecting sediment supply, human activities can also affect the storage and movement of sediment in a stream. An understanding of how sediment moves through a system is important for determining where sediment will have the greatest effect on salmonid habitat and for determining which areas will have the greatest likelihood of altering habitats. In general, transport of sediment changes as a result of gradient, hydrology changes (water removal, increased peak flows, or altered timing and magnitude of peak flows), and isolation of the channel from its floodplain. This increases in the magnitude and frequency of flood flows. Larger and more frequent flood flows move larger and greater amounts of material more frequently. This can increase bed scour and bank erosion, alter channel morphology, and ultimately degrade the quality of spawning and rearing habitat. Unstable channels become very dynamic and unpredictable compared to the relatively stable channels characteristic of undeveloped areas. Additional reductions in the levels of instream LWD can greatly alter sediment storage and processing patterns, resulting in increased levels of fines in gravels and reduced organic material storage and nutrient cycling.

Riparian Zone Functions

Stream riparian zones include the area of living and dead vegetative material adjacent to a stream. They extend from the edge of the ordinary high water mark of the wetted channel, upland to a point where the zone ceases to have an influence on the stream channel. Riparian forest characteristics in ecologically healthy watersheds are strongly influenced by climate, channel geomorphology, and where the channel is located in the drainage network. Large-scale natural disturbances (fires, severe windstorms, and debris flows) can dramatically alter riparian characteristics. These natural events are typically infrequent, with recovery to healthy riparian conditions for extended periods of time following the disturbance event. The width of the riparian zone and the extent of the riparian zone's influence on the stream are strongly related to stream size and drainage basin morphology. In a basin un-impacted by humans, the riparian zone would exist as a mosaic of tree stands of different acreage, ages (e.g. sizes), and species.

Functions of riparian zones include providing hydraulic diversity, adding structural complexity, buffering the energy of runoff events and erosive forces, moderating temperatures, protecting water quality, and providing a source of food and nutrients. They are especially important as the source of LWD in streams, which directly influences several habitat attributes important to

anadromous species. In particular, LWD helps form and maintain the pool structure in streams, and provides a mechanism for sediment and organics sorting and storage upstream and adjacent to LWD formations. Pools provide a refuge from predators and high-flow events for juvenile salmon, especially coho that rear for extended periods in streams.

Effects of Human Activities on Riparian Zones

Riparian zones are impacted by all types of land use practices. In general, riparian forests can be completely removed, broken longitudinally by roads and laterally by bridges and culverts, and their widths can be reduced by land use practices. Further, species composition can be dramatically altered when native, coniferous trees are replaced by exotic species, shrubs, and deciduous species. Deciduous trees are typically of smaller diameter than coniferous trees and decompose faster than conifers, so they do not persist as long in streams and are vulnerable to washing out from lower magnitude floods. Once impacted, the recovery of a riparian zone can take many decades as the forest cover regrows, and coniferous species colonize.

Changes to riparian zones affect many attributes of stream ecosystems. For example, stream temperatures can increase due to the loss of shade, while streambanks become more prone to erosion due to elimination of the trees and their associated roots. Perhaps the most important impact of riparian alteration is a decline in the frequency, volume, and quantity of LWD due to reduced recruitment from forested areas. Loss of LWD results in a significant reduction in the complexity of stream channels including a decline of pool habitat, which reduces the number of rearing salmonids. Loss of LWD affects the amount of both over-wintering and low flow rearing habitat, as well as providing a variety of other ecological functions in the channel.

Water Quantity

The hydrologic regime of a drainage basin refers to how water is collected, moved and stored. The frequency and magnitude of floods are especially important since floods are the primary source of disturbance in streams and thus play a key role in how channels are structured and function. In ecologically healthy systems, the physical and biotic changes caused by natural disturbances are not usually sustained, and recovery is rapid to pre-disturbance levels. If the magnitude of change is sufficiently large, however, permanent impacts can occur.

Alterations in basin hydrology are caused by changes in soils, decreases in the amount of forest cover, increases in impervious surfaces, elimination of riparian and headwater wetlands, and changes in landscape context. Hydrologic impacts to stream channels occur even at low levels of development (<2% impervious area) and generally increase in severity as more of the landscape is converted to from natural forest cover to more developed land uses.

Salmonid production is profoundly affected by water withdrawals for irrigation, industrial, and domestic use, including water transfers between basins. Removal of water, either directly from the stream channel or from wells that are in hydraulic continuity with stream flows, reduces the amount of instream flow and useable wetted area remaining for support of adult salmonid spawning and juvenile rearing. Reduction of instream flows also typically results in increased water temperature, often to levels that impair salmonid productivity. The relationship between the useable wetted area of a stream and stream flow varies between species and life stages. For example, juvenile coho prefer quiet water in pools for rearing, whereas juvenile steelhead prefer areas of faster water (Hiss and Lichatowich 1990). Streamflow limitations are typically greatest

during the dry summer and early fall months when stream flows are lowest. In other instances stream flows may actually increase due to direct or indirect (irrigation ground water return flows) water transfers from other basins. In some instances peak flood flows may be transferred to basins that would otherwise not be affected by flood flows. These situations may increase the stream flow and useable wetted area for fish use, but the increased hydrology may cause channel bedload movement, bank erosion, loss of LWD, and other adverse habitat impacts that would not be experienced under the natural hydrology regime to which the channel is adapted.

Water Quality

Water quality affects productivity and survival of salmonids. There are several water quality parameters that affect salmonids, including water temperature, pH, dissolved oxygen, turbidity, nutrients, and toxics. Elevated water temperatures are typically associated with loss of mature riparian vegetation along the stream corridor, with reduced instream flows during late summer resulting from water withdrawals, or from increased solar exposure to water impounded behind dams. Egg incubation and rearing can be affected by increased icing due to loss of riparian vegetation and reduced instream flows during the dry winter months. Dissolved oxygen levels are directly associated with water temperature, with saturation being higher in colder water. Turbidity refers to the presence of suspended sediment in the water column that may affect survival of eggs or fish. Stormwater runoff (particularly from roads), surface erosion, and increased streambank erosion are the main contributors of turbidity. Natural stream nutrient regimes have been altered. Natural nutrient cycling has been affected by low numbers of salmon carcasses due to reduced numbers of spawners returning to streams; by removal or alteration of riparian vegetation that reduces the entry of litter fall and invertebrates; by the lack of LWD in streams that slows the loss of nutrient sources from the stream; and by stormwater flows that flush available nutrients from the streams. Increased levels of nutrients result from stormwater runoff that has high levels of nitrogen and phosphorous, and by failing septics and sewage treatment plant outfalls. Public health districts regularly monitor for presence of fecal coliform; presence of elevated levels of fecal coliform may result in closure of marine shellfish beds to harvest, but fecal coliform are not known to affect salmonid health or survival. However, elevated fecal coliform counts may be an indicator of other salmonid habitat problems (elevated nutrient levels, low dissolved oxygen, unrestricted cattle access to streams, etc.) in the watershed. There is far less water quality monitoring for presence of toxics. Sources of toxics of concern include toxic spills (e.g., oil, paint, pesticides, etc.) runoff from roads/parking lots, exposure of the stream or marine water to treated wood, leaching of pesticides, and leaching of heavy metals.

Estuarine Habitat

Worldwide, few other habitats are so valuable for fish production and yet are so imperiled as estuaries. Estuaries include the area from the uppermost extent of tidal influence within the stream to the upper intertidal line on the delta face. Their abundant food supply, wide salinity gradients, and diverse habitats make these areas particularly valuable to anadromous fish for rearing, feeding, and osmoregulatory acclimation during transition between fresh water and marine habitats (Macdonald et al 1987). The vital role estuaries play in chum salmon ecology is well documented (Walters et al. 1978; Healy 1980A, Levy and Northcote 1982). Other species of salmonids that also inhabit estuaries, sometimes in high densities, include coho (Tschaplinski 1982, Mason 1974, Miller and Simenstad 1997, Nielsen 1994, Hiss 1994), sockeye (Healy 1980A), pinks (Hiss 1994), and chinook (Levy and Northcote 1982, Healy 1980A, Healy 1980B, Congleton et al 1981, Shreffler et al 1992). According to Levy and Northcote (1982), significant

estuary rearing by chum and chinook fry on the Fraser River Delta extends even into tidal channels that are dewatered during normal low tides. In the Skagit River estuary, Beamer and LaRock (1998) found high densities of chinook, chum, and smelt inhabiting a salt marsh tidal channel (Browns Slough) that was not associated with any freshwater stream. Also found in Browns Slough were coho smolts and adult cutthroat trout engorged on smelt. Juvenile chinook have been documented in at least two Puget Sound estuarine salt marshes not associated with chinook spawning streams - Shine Creek on the Olympic Peninsula (Lichatowich 1993) and Seabeck Creek on the Kitsap Peninsula (Hirschi, personal communication). The spawning of Pacific herring, an important forage fish for salmonids, has been documented in Willapa Bay and Grays Harbor estuarine salt marshes, but the presence or importance of Pacific herring has not been assessed in Strait of Juan de Fuca estuaries.

WATERSHED DESCRIPTION

The Kitsap Peninsula and Bainbridge Island include many freshwater streams. These streams drain to inlets in southern Puget Sound (south of the Tacoma Narrows), the east side of central Puget Sound (Tacoma Narrows to the north end of Kitsap Peninsula), north and central Hood Canal, and southern Hood Canal (waters east of the Great Bend). For Habitat Limiting Factors description and discussion purposes, the Kitsap Peninsula will be divided into separate East Kitsap and West Kitsap reports. This division generally is represented by a separation down the middle of the peninsula from north to south. The streams on the east side flow to central or southern Puget Sound; the streams to the west flow to Hood Canal. This report focuses on the East Kitsap streams in WRIA 15.

The division of east and west Kitsap streams also reflects differences in HB2496 Lead Entity representation (Kitsap County is the Lead Entity for East Kitsap and the Hood Canal Coordinating Council is Lead Entity for West Kitsap), and primary tribal co-management (with WDFW) of fisheries. The Suquamish and Puyallup tribes have primary co-management emphasis in central and southern Puget Sound portions of WRIA 15; the Port Gamble and Skokomish tribes have primary co-management emphasis for West WRIA 15 streams flowing to Hood Canal.

The streams draining into Puget Sound from the east half of the Kitsap Peninsula are numerous, but rather small in comparison to those of the west half. They represent typical lowland type streams with generally moderate gradients. Considerable deciduous growth, interspersed with stands of conifers, farmland, and urban/suburban development is common on all streams. Many of the streams originate from lakes, ground water run-off, or swamp-like headwater wetlands (Williams et al. 1975), which in several instances drain to both Puget Sound and Hood Canal tributaries. None of the streams are supported by snow runoff, as the maximum elevation in WRIA 15 is <500m. Stream profile characteristics are, for the most part, pool-riffle in nature with water quality and aquatic insect production highly conducive to anadromous fish production (Williams et al. 1975).

The climate is characterized by mild, wet winters, and warm, dry summers. The average summer temperature range is 70-80°F during the day and 50-60°F at night. The average winter temperature is 40-50°F in the day and 30-40°F at night. Precipitation patterns are characterized by frequent rainfalls of low intensity. Precipitation varies from 39 inches at Bremerton to >50 inches near Alexander Lake/Green Mountain.

Geologic History (modified from PSCRBT 1994)

The Sinclair Inlet watershed is geologically and topographically similar to other regions in the Puget Sound region, reflecting the influences of mountain building and glacial activity. During the Eocene Epoch (approximately 38-55 million years ago), East WRIA 15 was located at the western edge of the North American continent. Sediments were deposited in the coastal environment to the west of North America. Plate tectonic movement of the oceanic plate under the North America plate caused ocean and continental shelf rocks and sediment to be scraped off. These attached onto North America approximately 7-12 million years ago. Continued eastward movement uplifted these rocks and formed the hills and mountains of the Olympic Peninsula and the underlying Kitsap Peninsula. The underlying volcanic bedrock is overlaid with several thousand feet of marine sedimentary rocks. Green and Gold mountains, located west of Bremerton, are composed of these ocean floor rocks.

The Pleistocene Epoch (or Ice Age), which began about 2 million years ago, formed most of the geologic features present in the watershed today. Cordilleran Ice Sheets, which originated in the coast and insular mountains of British Columbia, moved south to the southern end of the Puget Sound basin near Olympia. Up to 3,500 feet of glacial ice covered the Kitsap Peninsula. Geologic units from at least five major and several minor glacial advances have been identified in the Puget Sound basin, although only three are exposed (visible) in Kitsap County.

Each glacial advance is characterized by a similar set of geologic events. Advancing ice blocked rivers, which normally drained to the north and formed lakes in the southern portion of the Puget Sound basin. These lakes drained to the south. Widespread, fine-grained, lacustrine sediments were deposited by meltwater streams. Glacial till (a compact unsorted mix of clay, sand, and gravel, looking much like concrete) was then deposited directly under the glacier as it overrode the outwash sediments. Local recessional outwash sand and gravel deposits later formed from melt water as the front of the ice sheet receded to the north. Non-glacial intervals between the advances are characterized by fluvial (stream) sediments and peat.

The Fraser Glaciation, which occurred from 15,000 to 13,500 years ago, was the last glacial advance in the central Puget Sound basin (Deeter 1979). It eroded or covered much of the previous deposits. Deposits from the Fraser Glaciation in the area are characterized by silt and clay overlain by thick advance outwash sand, abundant till cover, and only local recessional outwash. Recessional meltwater outwash streams, much larger than present day streams, eroded and formed the larger valleys in the area. Valleys with "underfit" streams and estuaries or drowned river mouths were formed by the greater flow rates of outwash streams and a lower sea level during the Fraser Glaciation.

Following the final retreat of the Fraser Glaciation, erosional and depositional processes sculptured, and continue to shape, the landscape. Bluffs along the Puget Sound are being eroded and re-deposited as beaches and spits. Streams are eroding their banks and then depositing sediments in floodplains, wetlands, and bays. All of these natural processes are modified by planned activities, such as road building, and unplanned events. An example of an unplanned event is accelerated stormwater erosion and resulting sediment deposition caused by increased flow rates from paving over areas or filling wetlands.

Key Peninsula, Gig Harbor, and Islands Subwatershed (modified from KGI Draft 1999)

The Key Peninsula/Gig Harbor/Islands subwatershed includes the southern portion of East WRIA 15, straddling the boundary between Pierce and Kitsap counties (there is also an extremely minimal part of this watershed in the northeastern corner of Mason County). The watershed lies between the northern end of Case Inlet on the west and the Tacoma Narrows and Colvos Passage on the east, including several islands in the eastern portion of southern Puget Sound. The watershed contains approximately 101,000 acres (158 mi^2) of land and 144 miles of shoreline. It is composed of two large peninsulas and many islands. The three largest islands are Fox, McNeil, and Anderson. There are a number of smaller islands, including, Raft, Herron, Cutts, Eagle, Gertrude, Tanglewood, and Ketron. It includes the incorporated City of Gig Harbor, as well as a number of unincorporated communities.

The estimated population of the Key Peninsula/Gig Harbor/Islands (KGI) watershed in 1990 was ~54,000. This population is expected to increase to 65,000 in 2000, to 78,000 in 2010, and to 87,000 in 2020 (PSRC 1995, as referenced in KGI DRAFT 1999). Estimated populations for the KGI subwatersheds in 1994 were (KGI DRAFT 1999):

- Gig Harbor 22,000
- Burley/Minter 18,000
- Key Peninsula 9,000
- Rocky Bay 1,000
- Islands 3,700 (Excludes McNeil Island prisoners)

The largest population increases between 1990 and 2020 are expected in the Gig Harbor and Burley/Minter subwatersheds, which are both expected to double in population.

Colvos Passage/Rich Passage Subwatershed

This area lies between the KGI subwatershed to the south and the Sinclair Inlet subwatershed to the west, including streams flowing to the west side of Colvos Passage and Rich Passage. No existing descriptions of this watershed area were located.

Sinclair Inlet Subwatershed (from PSCRBT 1990)

The Sinclair Inlet watershed drains an area of 27,492 acres, including the creeks that flow into Sinclair Inlet (primarily along the southern shore) and the Beaver Creek watershed to the east. The watershed includes 57 miles of saltwater frontage, approximately 46 lakes with 9.7 miles of shoreline, and >62 miles of streams. The watershed is characterized by many small streams that drain relatively small areas. Gorst and Blackjack creeks are the main dischargers of freshwater into the Inlet (TetraTech 1988, as cited in PSCRBT 1990). Estimates of freshwater runoff into Sinclair Inlet have ranged from 335 cfs in January to 5 cfs in August. The contribution of groundwater flow to the inlet is unknown but thought to be substantial (Lincoln and Collias 1975, as cited in PSCRBT 1990).

Forest land covers 7,626 acres or about 28%of the watershed (20% is in public ownership, 68% in private woodlots, 12% in commercial forest land) (PSCRBT 1990). In 1990, >95% of the forest land was stands over 10 years of age. Rural/agricultural areas cover 10,627 acres, or about 37% of the watershed (35% covered with grass/shrubs, 65% covered with trees).

A management guideline for animal grazing is one animal unit (AU, defined as one 1000-pound cow and calf) per acre of pasture for a 7-month growing period. As rural lots become smaller, the number of AUs increases, which increases the potential for pollution. Pastures with high densities of livestock also tend to be in the worst condition. PSCRBT (1990) identified 76% of the farms and 75% of the pasture land acreage in the Sinclair Inlet watershed as being in poor or only fair condition, mostly the result of higher densities of grazing than the land can support. Another major problem associated with animal keeping activities is direct livestock access to streams. PSCRBT (1990) identified that 37% (54) of the farms as having streams of ditches on or adjacent to them, of which 80% still allowed livestock access to the streams. Animal access to streams results in direct discharge of wastes trampling of streambanks, and loss of riparian vegetation.

Bremerton and Port Orchard are the major urban areas with additional retail centers at Gorst, Manchester, and Annapolis. Kitsap County designates approximately 6,658 acres (24%) of this watershed as urban. The remainder of the watershed is characterized by large parcels of pasture, forest, single-family homes, small farms, and low-intensity commercial uses.

Most of the watershed consists of low, rolling hill topography. Slopes in the upper watershed are moderate, with some steep slopes (>50%) occurring in the City of Bremerton watershed.

Agricultural areas in the Blackjack creek drainage are gently rolling to nearly flat. Very steep bluffs dominate the shorelines of Port Orchard Narrows, and portions of Sinclair Inlet and Rich Passage. The highest point in the watershed is approximately 1,360 feet, about one mile west of Alexander Lake.

The USFWS has classified 5,012 acres of wetlands in the Sinclair Inlet watershed, with 17% being freshwater and 83% being marine. The PSCRBT identified an additional 57 acres of freshwater wetlands (ponded water and hydrophytic vegetation) using aerial photography, and an additional 1,560 acres of hydric soils using soils interpretation.

Sinclair Inlet and Rich Passage have a surface area of 4,668 acres. The main basin of Sinclair Inlet is deepest near the eastern end (130 feet) south of Point Herron, but the head of the bay is <10 feet deep. Tideflats present at the head of the inlet are exposed during low tides. The currents of Sinclair Inlet are relatively weak, at only 0.8 knots (Determan 1980, as cited in PSCRBT 1990). The estimated total flushing time is approximately 14 days for Sinclair Inlet (Lincoln and Collias 1975, as cited in PSCRBT 1990), assuming that none of the waters leaving the inlet on ebb tides returns on flood tides. In reality, some waters do return and waters from Sinclair and Dyes inlets mix in an area off Annapolis. The volume that mixes and returns on flood tides to Sinclair Inlet is unknown (TetraTech 1988, as cited in PSCRBT 1990).

Dyes Inlet Watershed (from PSCRBT 1989)

The Dyes Inlet subwatershed drains an area of 30,289 acres, including the creeks that flow into Dyes Inlet and Port Washington Narrows. Approximately 40% of the watershed is within the urban area (12,231 acres) designated by Kitsap County. Bremerton and Silverdale are the major urban areas, with smaller retail centers at Chico, Tracyton, and Kitsap Lake. The Jackson Park Navel Reservation, Camp Wesley Harris, and parts of the Bangor Naval Reservation are located within the watershed. The remainder of the watershed is characterized by large parcels of land used for pasture, forest, wetlands, single-family homes, small farms, and low-intensity commercial uses.

Most of the watershed consists of low, rolling-hill topography. Slopes in the upper watershed are moderate, with the steepest slopes (>60%) occurring in the Lost Creek drainage. The highest point in the watershed is on Green Mountain (1,500 feet). Agricultural areas in the Clear Creek drainage are nearly flat. Steep, sloping sea cliffs and bluffs dominate the Port Washington Narrows shoreline.

The Dyes Inlet watershed is characterized by many small streams that drain relatively small areas. Clear, Barker, and Chico creeks are the main dischargers of freshwater into Dyes Inlet. Freshwater runoff into Dyes Inlet varies considerably throughout the year. The contribution of groundwater flow to the inlet is unknown, but thought to be substantial (Lincoln and Collias 1975, as cited in PSCRBT 1990).

The Dyes Inlet watershed contains a diverse array of land uses. Land use in the watershed was estimated to be 25% forested, 29% rural/agricultural, 40% urban, and 6% other (lakes, wetlands, military, parks, etc.)(PSCRBT 1989). There has been extensive conversion of rural/agricultural/forest land to urban (residential and commercial) area since 1989, particularly in the Clear Creek and Barker Creek watersheds. The USFWS classified 5,785 acres of wetlands in the Dyes Inlet watershed, with 20% being freshwater and 80% being saltwater. Because of inventory methods, this does not constitute a complete list of existing wetlands. The PSCRBT

identified and additional 78 acres of freshwater wetlands, and an additional 1,207 acres of hydric soils.

Over 75% of the soils in the Dyes Inlet watershed are included in the Alderwood/Kapowsin/ Shelton soil classification. These soils are nearly level to rolling, formed in material weathered from glacial till. The subsurface layers are gravelly sandy loams over a cemented hardpan at a depth of 20-40 inches. Permeability is moderate to moderately rapid above the hardpan and very low through the hardpan. This results in a perched water table. Runoff is slow and erosion hazard is slight. On-site sewage disposal systems often fail or do not work properly during periods of high rainfall because of these limitations, resulting in runoff that can carry animal waste, nutrients and other pollutants. Approximately 15% of the soils in the Dyes Inlet watershed are in the Indianola/Dystric Xerorthents soil classification. These occur on broad uplands and along side slopes or river valleys, formed in glacial outwash. These soils are somewhat excessively drained with rapid permeability. Runoff is slow and erosion is slight on lower slopes; however, on slopes >45% there is a potential for runoff and erosion. These soils are also poor for on-site sewage treatment, as they provide poor filter material, with greater potential to pollute groundwater. Approximately 8% of the soils in the Dyes Inlet watershed are in the Kilchis/Schneider soil classification. These soils occur on the steep mountain slopes and crests found in the upper watershed, formed in material weathered from basalt. The surface layer is typically a very gravelly sandy loam, with a depth to bedrock of 20-40 inches. Runoff is rapid and erosion hazard is moderate to severe. These soils are also not suitable for on-site sewage disposal due to slope and depth to bedrock.

Dyes Inlet and the Port Washington Narrows have a surface area of 4,642 acres. The main basin of Dyes Inlet is deepest near the center (150 feet), but the adjacent bays are typically <35 feet deep (PSCRBT 1989). Tideflats present in the small bays and at the head of the inlet are exposed during low tides. The currents of Dyes inlet are relatively weak, but those of Port Washington Narrows are strong (4 knots)(NOAA 1988, as cited in PSCRBT 1989). The estimated total flushing time is approximately four days for Dyes Inlet (Lincoln and Colias 1975, as cited in PSCRBT 1989), assuming none of the waters leaving the Inlet on ebb tides returns on flood tides. In reality, some waters do return and waters from Sinclair and Dyes inlets mix in an area off Annapolis. The volume that mixes and returns on flood tides to Dyes Inlet is unknown (Tetra Tech 1988, as cited in PSCRBT 1989).

Port Orchard Subwatershed

The Port Orchard subwatershed lies between the Sinclair Inlet and Dyes Inlet subwatersheds (to the south and west) and the Liberty Bay/Miller Bay subwatershed to the north. It includes those streams that flow from the west to Port Orchard from the Kitsap peninsula, and those that flow from the west side of Bainbridge Island on the east side of Port Orchard. The Bainbridge Island streams are included in the Bainbridge Island subwatershed discussion. No existing descriptions of this subwatershed area were located.

Liberty Bay/Miller Bay Subwatershed (from PSCRBT 1994)

The Liberty Bay/Miller Bay watershed drains an area of 27,629 acres. Approximately 48% (13,224 acres) of the watershed was identified as residential land use in 1994, with parcels varying from <1 acre to 10 acres, with 52% of the platted residential area developed at that time. Poulsbo and the marine waterfront have the highest concentrations of residential use. Land use was estimated to be: 21% (5,654 acres) commercial forest land, 9% (2,587 acres) agricultural

land (mostly small non-commercial farms), 1% (325 acres) commercial/industrial land, 2% (466 acres) military land, and 2% (640 acres) miscellaneous land use. An additional 17% (4,733 acres) was identified as open land that is likely being held for recreational purposes or as future real estate investments. This watershed experienced rapid development from 1980 to 1990, with an increase in housing units and population of 29%. This rapid rate of development has continued through the 1990s.

Over 75% of the soils in the Liberty Bay/Miller Bay watershed are included in the Poulsbo/Alderwood soil classification. Soils in this group occur on slopes ranging from flat to moderately steep. Creeks draining this soil group generally have little or no floodplain. This group is characterized by a moderately permeable, uncompacted till layer, 20-40 inches deep, overlying very compacted till material (hardpan). The soils are well drained above the hardpan, with low permeability through the pan. As a result, precipitation drains quickly to the hardpan then flows laterally to an outlet in a depression, hillside seep, creek, or road cut. Water often collects above the hardpan creating a seasonal high water table during the winter months. Approximately 17% of the soils in the Liberty Bay/Miller Bay watershed are in the Ragnar/Indianola soil classification. The soils in this group formed in glacial outwash. These soils have rapid permeability. Runoff is slow and erosion is slight on lower slopes; however, where the Ragnar soil is mapped on slopes >6%, the hazard of water erosion is severe. These soils are also poor for on-site sewage treatment, as they provide poor filter material, with greater potential to pollute groundwater. Approximately 10% of the soils in the Liberty Bay/Miller Bay watershed are in the Norma/McKenna soil classification, formed in a variety of materials. Surface water saturates and ponds on these soils during winter months. Runoff is slow and the hazard of water erosion is slight, except for likely streambank erosion on alluvial soils, where vegetation is removed by livestock or residents. The Kitsap soil group covers 5% of the watershed, in concentrations in the Scandia area, around Poulsbo, and in uplands in the Big Valley and Grovers Creek area. This silt loam soil formed in sediment from glacial lakes. Permeability is low with a seasonal high water table. This soil has a high potential for slippage on slopes >8%. Soils in many of the creek corridors in the Liberty Bay/Miller Bay watershed are prone to slumps, slides, or severe water erosion.

Liberty Bay is a relatively narrow shallow embayment (<60 feet deep). The bay is considered to be poorly flushed, with a tendency to concentrate pollutants PSCRBT 1994). Miller Bay is the second largest embayment in the watershed area, and is also shallow and poorly flushed. Many homes are located near the shore zone of the watershed, increasing possible septic effluent loading and other nonpoint pollutants to marine waters.

Portions of Liberty Bay have been classified as a conditionally approved shellfish harvest area since 1967. In 1994, 681 acres of shellfish beds within Liberty Bay were classified as restricted, with an additional 610 acres classified by the Dept. of Health (1991) as prohibited due to animal wastes, nearby marinas, and other nonpoint sources. These restrictions are due primarily to elevated fecal coliform contamination. Five potentially significant sources of pollutants were identified in Liberty Bay (PSCRBT 1994), including:

- the Dogfish Creek watershed,
- the unsewered west shoreline of Liberty Bay,
- stormwater runoff from the eastern Liberty Bay shoreline,
- raw sewage from boats moored in four area marinas, and
- an EPA Superfund site on the Keyport Naval Undersea Warfare Engineering Station

Longshore drift, caused by oblique wave action causing currents parallel to the beach, causes sediment to move along the shore to a bay or river mouth where the sediment is deposited to form

a spit (PSCRBT 1994). Beach erosion results if the sediment normally transported by the drift is cut off. This scenario is likely in the Miller Bay spit-Indianola area if cliffs to the east, that naturally erode and provide the sediment, are protected by structures such as marine bulkheads. Building protective structures is only an expensive, short-term control measure, which usually results in the need to build additional protective structures. Restoring the natural sediment load is needed to stop beach erosion.

Port Madison to Foulweather Bluff Area

This area extends from Miller Bay, at the northwest corner of Port Madison, north to Foulweather Bluff. No existing descriptions of this area were located.

Bainbridge Island Subwatershed (modified from PSCRBT 1995)

Bainbridge Island lies on the eastern side of East WRIA 15, and is approximately 3.5 miles wide and 10.5 miles long, including approximately 17,607 acres. It is one of the largest islands in Puget Sound (City of Bainbridge Island 1994, as cited in PSCRBT 1995).

The rolling topography of Bainbridge Island contains several north to south oriented points and ridges. Low-lying valleys occur between many of the ridges. The elevation ranges from sea level to approximately 400 feet. There are numerous small, perennial and intermittent streams on the island. The average flow of most of the streams is thought to be less than 1 cfs. Freshwater wetlands, some extensive, occur throughout the island and along the shoreline.

Bainbridge Island experienced rapid growth from 1980 to 1990, with the population growing by 3,532 people (28.7%) to approximately 15,846 people. The population is projected to grow to nearly 22,000 by the year 2010. Residential development is concentrated in and around population centers and along the marine shoreline. In recent years, there has been a marked increase in the conversion of tree-covered and agricultural land to residential development. Urban development in the Winslow area has also increased.

The Island has about 50 miles of shoreline. The shoreline is irregular and forms bays, harbors, coves, and lagoons. Major sand spits form Point Monroe, Wing Point, and Battle Point. The shoreline topography varies form relatively flat or gently sloping to steep with nearly vertical bluffs. Much of the land near the shore has steep slopes with a narrow, flat area next to the shore.

DISTRIBUTION AND CONDITION OF SALMON, STEELHEAD, AND CUTTHROAT STOCKS

General

The numerous streams in East WRIA 15 primarily support chum and coho salmon, steelhead, and cutthroat trout. In addition, Williams et al. (1975) identified chinook use in some of the larger streams. Additional streams with known adult and juvenile chinook use were identified by the TAG. The only stream with consistent pink salmon returns in east Kitsap is Minter Creek (Williams et al. 1975). Sockeye are sporadically observed in several streams, but no established populations of sockeye have been observed in any WRIA 15 streams (Williams et al. 1975).

The streams in East WRIA 15 are generally small lowland streams. Many of the streams are short, but collectively the streams in East WRIA 15 provide over 215 miles of known salmonid use (West WRIA 15 (Hood Canal drainages) known salmonid use is even more extensive). Because of the low stream gradient and productive wetlands, the streams of East WRIA 15 rival the salmon productivity of many of the large river systems in Puget Sound.

East WRIA 15 known salmon, steelhead and cutthroat distribution (all species combined) is identified on Map 1 (in the separate Maps file included with this report). Supporting data for the fish species distribution represented on Map1 are included in the fish distribution reference data table included in Appendix A. Individual species distributions for chinook, chum, coho, steelhead, and cutthroat are represented in Maps 2-6 (in the separate Maps file included with this report). Adult and juvenile salmonid distribution is limited by natural and human-caused migration barriers, but may also be significantly influenced by decreased numbers of returning spawning adults (the extent of stream area utilized may decrease as adult or juvenile fish abundance declines), or by impaired habitat conditions that do not provide suitable spawning or rearing conditions. Most current distribution knowledge is based on contemporary stock assessment work (since 1965-1970), and likely represents a more confined distribution than occurred historically, when habitat and fish populations were healthier.

Anadromous salmonid distribution is limited in many East WRIA 15 streams by presence of natural (falls cascades) and human-induced (culverts, dams, tidegates, reduced instream flow, etc.) fish passage barriers. Due to the low-gradient nature of East WRIA 15 streams, few natural barriers have been identified; most of the known barriers are human induced. Known fish passage barriers, and known barriers that have been recently replaced/repaired are shown on Map 7 (in the separate Maps file included with this report). In addition, stream gradient breaks that are likely to be fish passage barriers have been interpreted from USGS 7 ½" topographic quads by the Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP) conducted by the Northwest Indian Fisheries Commission. These gradient breaks are also identified on Map 7, but fish distribution has not been extended to these gradient breaks in the absence of additional information from watershed specialists indicating fish presence to that point. SSHIAP presumes chum distribution to occur upstream to a sustained 8% gradient (where there are no known natural barriers downstream); other salmon and steelhead (SSHIAP is not mapping known or presumed cutthroat distribution at this time) are presumed by SSHIAP to occur upstream to a sustained 12% gradient (chinook distribution only likely in larger streams where chinook presence is identified).

Chinook

East WRIA 15 streams lack the typical riverine chinook habitat characterized by habitat found in larger Puget Sound mainstem rivers. However, low numbers of spawning adult chinook are observed on a regular basis in numerous East WRIA 15 streams. In this basin, fall chinook salmon utilize the larger drainages in addition to some of the smaller creeks; Coulter, Rocky, Minter, Burley, Gorst, Chico, and Dogfish creeks are noted by Williams et al. (1975) as supporting established summer/fall chinook populations. In addition, the TAG indicated observed presence of adult spawning chinook in McCormick, Crescent, Olalla , Curley, Blackjack, Clear, Barker, Steele, and Grovers creeks. Chinook tend to utilize lower mainstem areas with large quantities of gravel and greater flows. Use of other smaller independent drainages in WRIA 15 by chinook is minimal, since these streams exhibit very low flows during the normal chinook migration and spawning periods (Williams et al. 1975). Current returns of spawning adult chinook are thought to be primarily the result of returns from chinook enhancement programs (hatcheries, netpens, juvenile outplants). It is unknown whether, or to what extent, adult chinook returns are the result of natural spawning. Distribution of chinook (summer/fall stocks) for East WRIA 15 streams is shown on the chinook species map (see Map 2– East WRIA 15 Chinook Salmon Presence, in the separate Maps file included with this report) and in Appendix A.

Upstream migration of adult fall chinook in these lowland streams typically extends from mid-September to mid-November, depending on stream flows and water temperature. Peak spawning occurs between mid-October and mid-November, and is usually completed in all small streams by the end of November. Following incubation and subsequent fry emergence, the majority of chinook fry rear in these lowland systems for 3-4 months and enter the estuaries around May or early-June, depending on the spring runoff flows.

The Salmon and Steelhead Stock Inventory (SASSI)(WDFW and WWTIT 1994) identifies the South Sound Tributaries Summer/Fall Chinook stock as including chinook production from East Kitsap streams (Grovers and Gorst creeks not mapped in SASSI) and Case and Car Inlets tributaries (specifically Coulter, Minter, and Burley creeks) in WRIA 15, as well as other south Puget Sound streams. It also identified that there are no genetic stock identification data for naturally spawning South Sound chinook. The grouping of seemingly widely distributed chinook was based on a history of extensive stock transfers from basin to basin and considerable hatchery outplants and associated straying of hatchery–origin chinook in south Puget Sound. The stock origin is mixed hatchery and wild, with the stock status dependent upon hatchery production and escapement levels. Some of the fish may be part of a self-sustainable population of natural spawning chinook, but no data are available to quantify that portion. The stock status is identified in SASSI as Healthy. Puget Sound chinook (including this stock) have been listed as threatened under the endangered Species Act (ESA).

Observations of adult chinook and estimates of total returns of adult chinook for East WRIA 15 streams are shown in Table 2. Although Table 2 identifies chinook presence in 17 East WRIA 15 streams, consistent estimates of numbers of spawning adult chinook are only available for Coulter, Rocky, Burley, Gorst, and Dogfish creeks. Chinook escapement to each of these streams is likely heavily influenced by returns of hatchery origin chinook released directly into these watersheds or into adjacent watersheds. Hatchery chinook releases from the Coulter Creek hatchery likely influence adult chinook escapements to Coulter and Rocky creeks. Releases from

Figure 2: Juvenile chinook releases from the Gorst Creek Hatchery (data courtesy of Paul Dorn, Suquamish Tribe)

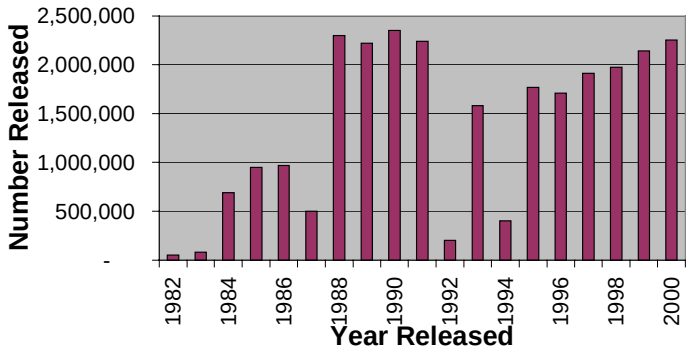


Figure 3: Juvenile chinook releases from the Dogfish Creek Hatchery (data courtesy of Paul Dorn, Suquamish Tribe)

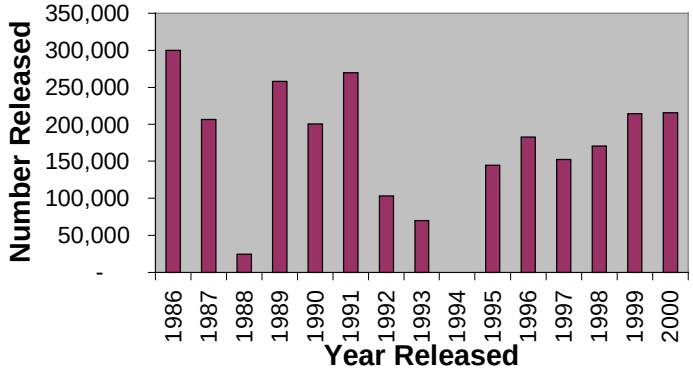
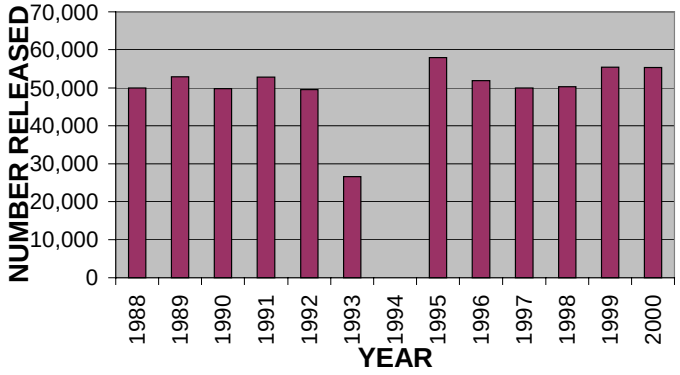


Figure 4: Juvenile chinook releases into Clear Creek (graph courtesy of Paul Dorn, Suquamish Tribe)



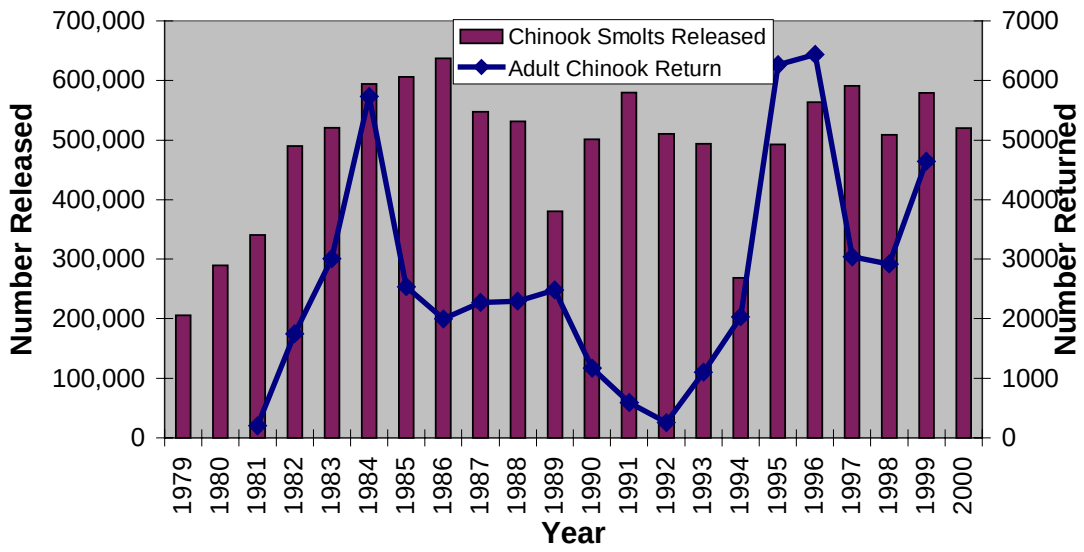
Minter Creek hatchery likely influence adult chinook escapements to Burley Creek. Releases from the tribal hatchery facilities on Gorst (Figure 2) and Dogfish creeks (Figure 3) likely influence adult escapements in those watersheds. Releases into Clear Creek (Figure 4) likely influence adult escapements in that watershed, although chinook escapement data have not been collected consistently over the years. In addition, hatchery return data are available for returns to the Minter Creek and Grovers Creek hatcheries. Hatchery releases and adult returns to the Grovers Creek Hatchery are presented in (Figure 5) (note that adult chinook return mostly as Age 3 or 4, therefore, juveniles released in 1990 would return as adults in 1993-1994).

Table 2: Observations of spawning adult Chinook and estimates of total numbers of spawning chinook for streams in East WRIA 15

WRIA Number	Stream Name	Year													
		1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986
	Coulter Cr.	5554	1517	444	886	76	1041	1465	1273	126	2141	224	246	139	227
	Rocky Cr.	214	365	35	0	9	2	9	39	23	116	21	34	13	3
	Burley Cr.	339	198	75	188	231	1063	672	1285	1155	999	210	591	52	100
	Crescent Cr.													2	
										2					
	Curley Cr.	8	6								15	3	4		
	Blackjack	4	21	15	11		1	1	2	1	6	1		1	1
	Gorst Cr.	2499	2164	1262	1604	700	751	211	161	144	544	268	362	754	443
	Parish Cr.	4													
	Chico Cr.	2	2												
	Clear Cr.	36	22	3	9		10	8	4	60	23				
	Unnamed	69	6							7					
	Barker Cr.	6	6												
	Steele Cr.	3													
	Unnamed	10													
	Dogfish Cr.	228	105	41	43	28	44	4	5	106	89	39	26	13	10
	Unnamed	73	39							1		14		0	0

Highlighted cells indicate reported chinook observations, usually peak live+dead counts, not total escapement estimates
Blanks indicate no recorded observations for those stream/year cells

Figure 5: Juvenile chinook releases and adult chinook returns to the Grovers Creek Hatchery (graph courtesy of Paul Dorn, Suquamish Tribe)



Summer Chum

SASSI identifies two distinct summer chum stocks as present in WRIA 15 streams: Case Inlet Summer Chum (this stock also includes summer chum spawning in several streams in WRIA 14) and South Sound-Blackjack Creek Summer Chum. Each of these stocks is identified as a separate stock because they are isolated from other Puget Sound stocks by geographic and temporal separation and are genetically distinct. Case Inlet summer chum spawn from September to late October; Blackjack Creek summer chum spawn during October. There are no directed fisheries on these stocks; however, these fish are impacted by mid-Puget Sound coho net fisheries (WDFW and WWTIT 1994). The status of both of these summer chum stocks is designated in SASSI as Healthy. The Coulter Creek hatchery was used to supplement wild summer chum spawning in Case Inlet streams, and is thought to have been a major contributor to large returns of wild summer chum into Coulter Creek. The supplementation project was discontinued in 1992 (WDFW and WWTIT 1994). Distribution of chum (summer and fall stocks combined) in East WRIA 15 streams is shown on the chum species map (see Map 3-East WRIA 15 Chum Salmon Presence, in the separate Maps file included with this report, and in Appendix A).

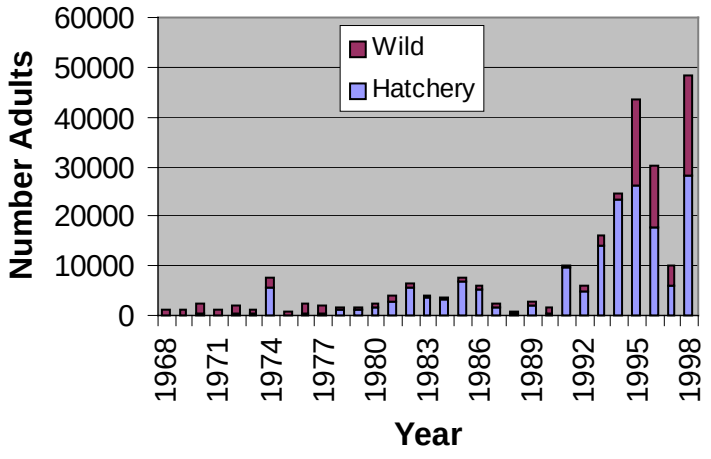
Fall Chum

SASSI designates five distinct fall chum stocks for East WRIA 15 streams. These include the Case Inlet and Carr Inlet fall chum stocks in South Sound, and the Gig Harbor/Olalla Creek, the Dyes Inlet/Liberty Bay, and the Sinclair Inlet fall chum stocks in South Sound/East Kitsap.

Case Inlet fall chum were identified as a distinct stock based on isolation from other Puget Sound stocks by geographic separation and run timing, and because they have distinct genetic characteristics. Returns of spawning adult wild fall chum to Coulter (WRIA15), Sherwood (WRIA 14), and Rocky (WRIA 14) creeks are specifically identified in SASSI. The TAG also identified chum escapement to numerous other creeks in Case Inlet (see Map 3 in separate Maps Appendix included with this report and Appendix A). Spawning occurs from early December to mid-January, reflecting a temporal separation from other Puget Sound stocks. Past hatchery releases have been made into most area streams. Juvenile chum plants to Sherwood Creek used local native brood stock, but non-local chum from Minter Creek were planted into Coulter Creek for at least two years. It is unknown to what extent the native stock may have been changed from its original form (SASSI). The stock status is identified in SASSI as being Healthy.

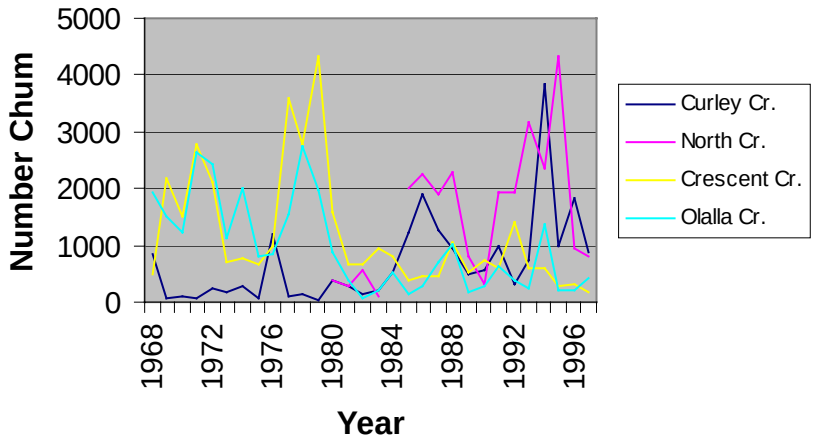
Carr Inlet fall chum are identified as a separate stock based on isolation from other Puget Sound stocks by geographic distribution (SASSI). Spawn timing is from mid-November to early January. SASSI specifically identifies Carr Inlet fall chum presence in Minter, Burley and Purdy creeks, but the TAG also identified fall chum presence in numerous other tributaries to Carr Inlet. In addition, the TAG identified several streams on the south side of the Gig Harbor peninsula and on Anderson Island that support chum, but that are not specifically included in any of the designated SASSI fall chum stocks. Heavy hatchery introductions and straying of Minter Creek hatchery origin chum (from various sources outside of Carr Inlet) has probably influenced the genetic makeup of wild spawning fish in most Carr Inlet streams. SASSI indicates that the stable fall chum escapement to Lackey Creek may represent the lone remaining fall chum native to Carr Inlet. The aggregate Carr Inlet fall chum stock should be considered to be either hybrid or an introduced hatchery stock (SASSI), with stock status designated as Healthy (but with a slight decreasing trend). Estimates of spawning adult chum salmon for Miscellaneous Carr Inlet/Minter Creek fall chum (from WDFW Run-reconstruction Database) are presented in Figure 6.

Figure 6: Number of spawning adult chum salmon for Misc. Carr Inlet/Minter Creek tributaries (from WDFW run-reconstruction database)



Gig Harbor/Olalla fall chum are identified as a stock based on isolation from other Puget Sound fall chum stocks by geographic and temporal distribution (SASSI). This stock spawns mainly from late-November through December, although Olalla fall chum may spawn as late as mid-January. SASSI specifically identifies presence of this stock in North, Crescent, Olalla, and Curley creeks. In addition, the TAG has identified fall chum presence in several other small

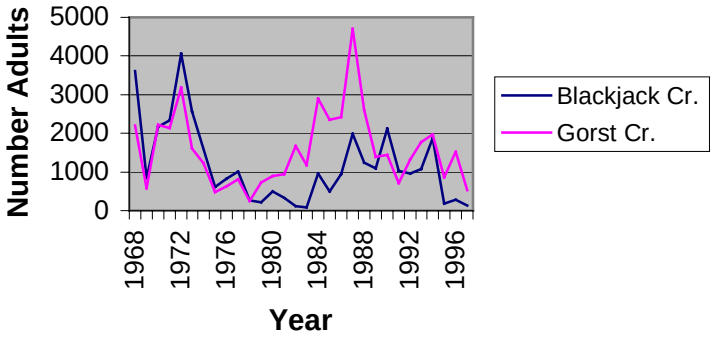
Figure 7: Number of spawning adult chum salmon in Curley, North, Crescent, and Olalla Creeks (data courtesy of Jay Zischke, Suquamish Tribe)



creeks in this geographic area (see Map 3-East WRIA 15 Chum Salmon Presence, in the separate Maps file included with this report), and in Appendix A. Adult spawning chum in these streams may also include fall chum strays from the Minter Creek Hatchery. The stock is considered to be a mixed-origin stock, and the stock status is designated as Healthy (SASSI). Estimates of spawning adult chum for Curley North, Crescent, and Olalla creeks are presented in Figure 7.

Sinclair Inlet fall chum are identified as a stock based on isolation from other Puget Sound stocks by geographic distribution, and similarity in spawn timing of individual Sinclair Inlet streams. Spawning occurs from December through early-January, creating a temporal separation from the earlier-spawning Dyes Inlet/Liberty Bay stock. SASSI identifies major spawning tributaries as including Gorst, Anderson, Ross, and Blackjack creeks. In addition, the TAG has identified fall chum presence in several other small creeks in this geographic area (see Map 3-East WRIA 15 Chum Salmon Presence, in the separate Maps file included with this report, and in Appendix A). The stock is considered to be of native origin, and the stock status is designated as Healthy (SASSI). Estimates of spawning adult chum salmon in Gorst and Blackjack creeks are presented in Figure 8.

Figure 8: Number of spawning adult chum salmon in Blackjack Creek and Gorst creeks (data courtesy of Jay Zischke, Suquamish Tribe)



Dyes Inlet/Liberty Bay fall chum were identified as a single stock because of similar spawn timing between the two inlets, and because of isolation from other Puget Sound stocks by geographic distribution and to some degree temporal separation (SASSI). SASSI identifies the major streams for this chum stock as Chico, Clear, Barker, Dogfish, and Grovers creeks. In addition, the TAG has identified fall chum presence in numerous other creeks in this geographic area (see Map 3-East WRIA 15 Chum Salmon Presence, in the separate Maps file included with this report, and in Appendix A). The stock spawns in November (peak in mid-November), which is somewhat early for fall chum. Estimates of numbers of spawning adult chum salmon in the Chico Creek watershed (Chico/Wildcat, Kitsap, Dickerson, and Lost creeks) are presented in Figure 9. Estimates of numbers of spawning adult chum salmon for several other Dyes Inlet/Liberty Bay streams are presented in Figure 10. The tributaries within this area have had significant hatchery plants from the Cowlings Creek tribal hatchery (Figure 11), with brood stock originating from Chico Creek (native stock in Dyes Inlet). [NOTE: Chum salmon typically return at age 3-4, so returns to Cowling Creek would be associated with releases 3-4 years prior.] The stock is considered to be of native origin, and the stock status is designated as Healthy (SASSI).

Figure 9: Number of spawning adult chum salmon in the Chico Creek watershed (data courtesy of Jay Zischke, Suquamish Tribe)

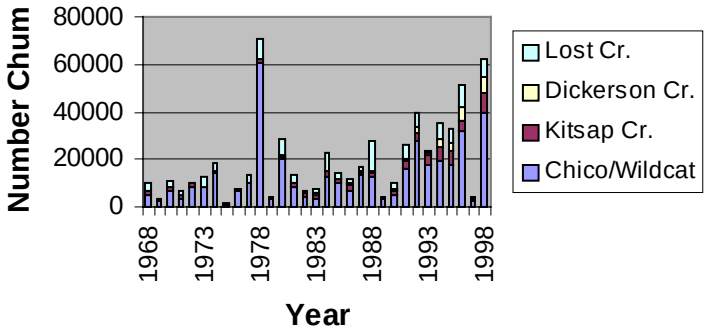
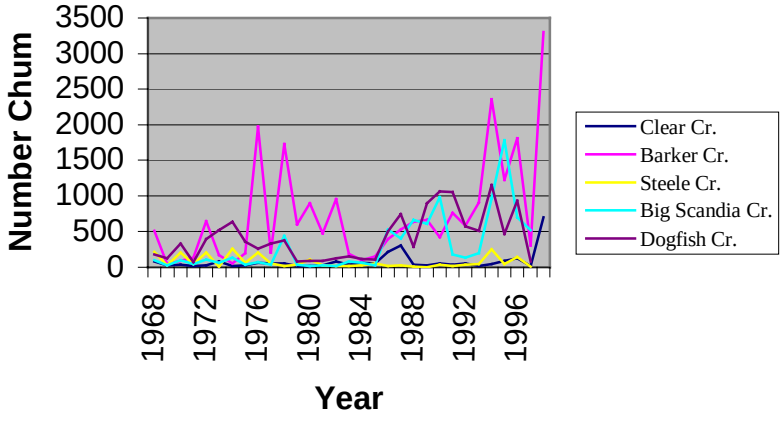
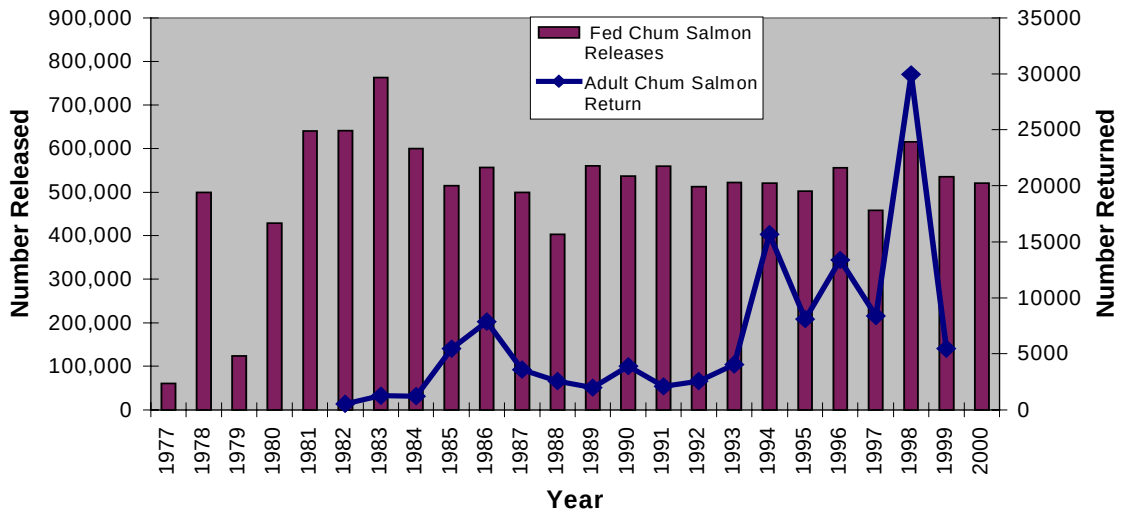


Figure 10: Number of spawning adult chum salmon in several Dyes Inlet/Liberty Bay streams (data courtesy of Jay Zischke, Suquamish Tribe)



Distribution of chum (summer and fall stocks combined) in East WRIA 15 streams is shown on the chum species map (see Map 3-WRIA 15 Chum Salmon Presence in the separate Maps file included with this report) and in Appendix A.

Figure 11: Cowling Creek chum plants (data courtesy of Paul Dorn, Suquamish Tribe)



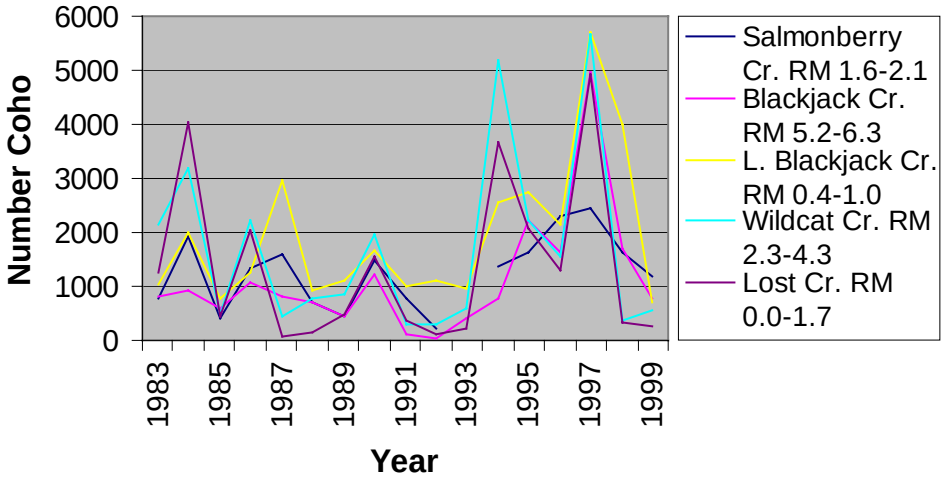
Coho

All of the accessible independent lowland streams of the Kitsap Peninsula are utilized by coho salmon. Spawning occurs in every independent stream and tributary where suitable conditions exist, particularly in the upper headwaters. Since coho are well adapted to the typical lowland-type streams found in this basin, they inhabit the most remote and extreme rivulets, as well as the springs, swamps, and marshes forming the upper headwaters and high water overflow areas on many of these drainages. Coho juveniles rear throughout the accessible lengths of these streams and in the associated estuaries and marine habitats (Williams et al. 1975).

SASSI designates two stocks of coho in East WRIA 15; Deep South Sound Tributaries Coho, and East Kitsap Coho. Each of these stocks is defined on the basis of geographic spawning distribution (SASSI). Neither stock exhibits any documented unique biological characteristics, and spawn timing is typical of coho stocks (most spawning occurring from late-October to mid-December. The primary harvest management focus for East WRIA 15 coho (both stocks) is harvest of hatchery surpluses, with secondary protection provided for remaining natural-origin coho in the extreme terminal bays (Chuck Baranski, WDFW). Efforts to evaluate and enumerate numbers of spawning adult coho have concentrated on other watersheds where the harvest management focus has been on wild coho production. Consequently, streams in East WRIA 15 have not been comprehensively and consistently evaluated for presence of adult spawning coho in recent years.

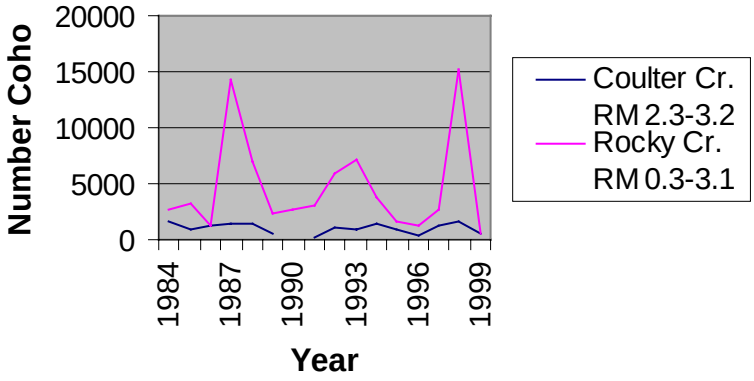
The Deep South Sound Tributaries coho stock includes all coho south of the Tacoma Narrows, excluding coho in the Chambers Creek (WRIA 12), Nisqually (WRIA 11), and Deschutes (portion of WRIA 13) basins. The stock includes coho in a portion of WRIA 13 (excluding the Deschutes), all of WRIA 14, and southern WRIA 15 drainages to southern Puget Sound. The SASSI map for this stock did not identify any coho presence on south Puget Sound islands, but coho spawning and rearing occurs in Schoolhouse Creek on Anderson Island (Todd Alsbury,

Figure 13: Number of spawning adult coho salmon in several streams in East WRIA 15 in Kitsap County (data courtesy of Chuck Baranski, WDFW)



SPSSEG). There have been substantial releases of hatchery-origin coho within this area, with significant off-station yearling plants from the early 1950s to the mid-1970s (SASSI). Off-station fingerling/fry plants occurred annually from the mid-1950s to the present. There are also annual on-station yearling releases from the Minter Creek Hatchery and from various pen-rearing programs throughout the basin. Straying rates from one net-pen facility study in the 1974-79 brood years estimated that 0.3-0.6% of the coho salmon released escaped annually to local streams, representing 10-20% of the average total escapement to these systems (Rensel et al. 1988, as cited in SASSI). The stock origin is considered to be mixed, and the stock status is designated as Healthy (SASSI). Estimates of numbers of spawning adult coho for several streams in the Kitsap County portion and for Coulter and Rocky creeks in the Pierce County portion of East WRIA 15 are presented in Figure 13 and Figure 12, respectively.

Figure 12: Number of spawning adult coho salmon in Coulter and Rocky creeks (data courtesy of Chuck Baranski, WDFW)



Pink

The typical lowland type streams of the East WRIA 15 are not normally inhabited by pink salmon, as they seem to prefer

drainages that are of glacial origin. Minter Creek is the only East WRIA 15 stream to record a meager return of pink salmon each odd year (Williams et al. 1975). Return of pink salmon to Minter Creek was not recognized in SASSI.

Sockeye

No persistent sockeye salmon stocks are identified in SASSI as present in East WRIA 15 streams, although periodic presence of low numbers of sockeye has been noted in several streams. Observed sockeye are likely stray adults originating from other river systems, or potentially the result of limited survival of riverine adult spawning sockeye.

Steelhead

No summer steelhead stocks are identified in East WRIA 15. Two distinct stocks of winter steelhead are identified in SASSI: Case/Carr Inlet steelhead and East Kitsap steelhead. Wild winter steelhead in each stock are of native origin. Run timing of these stocks is generally from December through mid-March, and spawn timing is generally from early-February to early-April. Each stock is comprised of a historically small number of steelhead, with insufficient information to classify its status as either Healthy, Depressed, or Critical. As small stocks, they could be especially vulnerable to any negative impacts. The stocks are identified as distinct stocks due to the geographical isolation of the spawning populations; there is little or no information available to indicate whether these are genetically distinct stocks (SASSI 1994).

Distribution of Case/Carr Inlet winter steelhead is identified in SASSI as including Sherwood (WRIA 14), Coulter, Rocky, Dutcher, Artondale, Jones, Minter, Burley, Purdy, McCormick, and Lackey creeks. The status of the stock is identified in SASSI as Unknown. The TAG generally supports this status designation.

Distribution of East Kitsap winter steelhead is identified in SASSI as including Olalla, Crescent, Curley, Gorst, Blackjack, Ross, Barker, Clear, Chico, Scandia, Dogfish, and Grovers creeks. The TAG identified winter steelhead distribution in several other creeks in this geographic area (see Map 5 in the separate Maps file included with this report, and Appendix A). The status of the stock is designated in SASSI as Unknown. The TAG generally supports this status designation.

Distribution of winter steelhead in East WRIA 15 streams is shown on the steelhead species map (see Map 5-East WRIA 15 Steelhead Presence in the separate Maps file included with this report) and in Appendix A.

Cutthroat Trout

Cutthroat trout are present throughout East WRIA 15 streams, with distribution typically extending further upstream than anadromous salmon, and presence in additional streams where anadromous salmon presence is not known. At this time, distribution differences between resident and sea-run cutthroat are not known, except upstream of anadromous barriers, and they have been considered as a composite stock for the purposes of this report. No stock assessment data are available with which to estimate cutthroat population size.

Fewer recorded observations exist for cutthroat than for other salmon species. Cutthroat are thought to be ubiquitous throughout the low gradient watersheds of East WRIA 15. However,

since so little is known regarding the extent of cutthroat presence, cutthroat presence is presumed at least to the uppermost extent of any other identified anadromous salmonid presence. Distribution of cutthroat in East WRIA 15 streams is shown on the cutthroat species map (see Map 6-East WRIA 15 Cutthroat Presence in the separate Maps file included with this report) and in Appendix A.

Char (Bull Trout/DollyVarden)

No char presence is identified for East WRIA 15. Streams in this area are all low elevation streams, which are not likely to meet the low water temperature spawning requirements of char. No bull trout use of the East WRIA 15 marine nearshore is known.

Other Species

Resident trout species, other than cutthroat, are not specifically considered or referenced in this report. These species are present throughout these same watersheds and should also be considered whenever habitat or fish production modifications are considered.

HABITAT LIMITING FACTORS BY SUB-BASIN

Categories of Habitat Limiting Factors used by the Washington State Conservation Commission:

The habitat elements considered in the East Water Resource Inventory Area (WRIA) 15 salmonid habitat limiting factors report include:

Loss of Access to Spawning and Rearing Habitat

This category includes culverts, tide gates, levees, dams, water diversion screening, and other artificial structures that restrict access to spawning habitat for adult salmonids or rearing habitat for juveniles. Additional factors considered are low stream flow or temperature conditions that function as barriers during certain times of the year.

Floodplain Conditions

Floodplains are relatively flat areas adjacent to larger streams and rivers that are periodically inundated during high flows. In a natural state, they allow for the lateral movement of the main channel and provide storage for flood waters, sediment, and large woody debris. Floodplains generally contain numerous sloughs, side channels, and other features that provide important spawning habitat, rearing habitat, and refugia during high flows. This category includes direct loss of aquatic habitat from human activities in floodplains (such as filling) and disconnection of main channels from floodplains with dikes, levees and revetments. Disconnection can also result from channel incision caused by changes in hydrology or sediment inputs.

Channel Conditions

This category addresses instream habitat characteristics that are not adequately captured by another category, such as bank stability, pools, and large woody debris. Changes in these characteristics are often symptoms of impacts elsewhere in the watershed, which should also be identified in the appropriate category (sediment, riparian, etc.).

Streambed Sediment Conditions

Changes in the input of fine and coarse sediment to stream channels can have a broad range of effects on salmonid habitat. Increases in coarse sediment can create channel instability and reduce the frequency and volume of pools, while decreases can limit the availability of spawning gravel. Increases in fine sediment can fill in pools, decrease the survival rate of eggs deposited in the gravel, and lower the production of benthic invertebrates. This category addresses these and other sediment-related habitat impacts caused by human activities throughout a watershed. This includes increases in sediment input from landslides, roads, agricultural practices, construction activities, and bank erosion; decreases in gravel availability caused by dams and floodplain constrictions; and changes in sediment transport brought about by altered hydrology and reduction of large woody debris.

Riparian Conditions

Riparian areas include the land adjacent to streams, rivers, and nearshore environments that interacts with the aquatic environment. This category addresses factors that limit the ability of native riparian vegetation to provide shade, nutrients, bank stability, and a source for large woody debris. Riparian impacts include timber harvest, clearing for agriculture or development, construction of roads, dikes, or other structures, and direct access of livestock to creek channels.

Water Quality

Water quality factors addressed by this category include temperature, dissolved oxygen, and toxics that directly affect salmonid production. Turbidity is also included, although the sources of sediment problems are addressed in the streambed sediment category. In some cases, fecal coliform problems are identified because they may serve as indicators of other impacts in a watershed, such as direct animal access to streams.

Water Quantity

Changes in flow conditions can have a variety of effects on salmonid habitat. Decreased low flows can reduce the availability of summer rearing habitat and contribute to temperature and access problems, while increased peak flows can scour or bury spawning nests. Other alterations to seasonal hydrology can strand fish or limit the availability of habitat at various life stages. Stormwater runoff from impervious surfaces, or increased exposure to rain-on-snow events, increase the frequency and magnitude of peak flow events, affecting the stability of the creek and associated habitat. All types of hydrologic changes can alter channel and floodplain complexity. This category addresses changes in flow conditions brought about by water withdrawals, the presence of roads and impervious surfaces, the operation of dams and diversions, alteration of floodplains and wetlands, stormwater runoff from impervious surfaces, and a variety of land use practices.

Estuarine and Nearshore Habitat

This category addresses habitat impacts that are unique to estuarine and nearshore environments. Estuarine habitat includes areas in and around the mouths of streams extending throughout the area of tidal influence. These areas provide especially important rearing habitat and an opportunity for transition between fresh and salt water. Impacts include loss of habitat complexity due to filling, dikes, and channelization; and loss of tidal connectivity caused by tidegates. Nearshore habitat includes intertidal and shallow subtidal saltwater areas adjacent to land that provide transportation and rearing habitat for adult and juvenile fish. Important features of these areas include eelgrass, kelp beds, cover, large woody debris, spawning habitat for baitfish, and the availability of prey species. Impacts include bulkheads, overwater structures, filling, dredging, and alteration of longshore sediment processes.

Lake Habitat

Lakes can provide important spawning and rearing habitat for salmonids. This category includes impacts that are unique to lake environments, such as the construction of docks and piers, increases in aquatic vegetation, and the application of herbicides to control plant growth.

Biological Processes

This category addresses impacts to fish brought about by the introduction of exotic plants and animals, and also from the loss of ocean-derived nutrients caused by a reduction in the amount of available salmon carcasses. The intent is to restore ocean-derived nutrients to freshwater streams through the restoration of healthy viable natural spawning populations of anadromous salmonids. Freshwater streams may be currently deficient in marine derived nutrients due to low spawning returns or habitat problems that limit fish utilization or productivity. There are few specific locations where there is information as to the extent that lack of marine derived nutrients is a limiting factor for salmonid productivity. The Biological Processes habitat element and associated Action Recommendations are only included for streams where there is specific information available.

Subwatershed or Subbasin Discussions

Watershed discussions for the streams in East WRIA 15 generally follow the marine shoreline, beginning with the north Case Inlet tributaries and proceeding to Foulweather Bluff at the north end of East WRIA 15. This is consistent with the stream index numbering sequence presented in Williams et al. (1975, East WRIA 15 portion of report is included in Appendix C of this report for reference); these stream index numbers are also referenced (where they exist) for further consistency and clarity. Streams without index numbers in Williams et al. (1975) are either assigned uncommitted numbers or are assigned an alpha extension, generally ascending from downstream to upstream. Location clarification for streams with assigned alpha extensions are noted in the Comments field in the fish distribution summary table in Appendix A or in the text. Additional location information for the larger streams in East WRIA 15 is available on the fish species distribution maps (see separate Maps file included with this report).

Spring Creek 15.0001

General

Spring Creek is approximately 1.2 mile long and enters the upper northwest end of North Bay at the north end of Case Inlet. The creek supports chum and coho upstream at least to a water diversion structure that supplies water to private trout ponds approximately 400-feet upstream of the North Bay Road culvert. The South Puget Sound Salmon Enhancement Group (SPSSEG) replaced the prior water diversion structure, which was a total fish passage barrier, with concrete step weirs in September 1999. The culvert under North Bay Road is a partial barrier to fish passage (WDFW SSHEAR fish passage barrier database identifies a culvert barrier at Hwy 302 (SITEID 991559) that appears to be the culvert under North Bay Road).

No information is available regarding habitat conditions in Spring Creek.

Action Recommendations

The following salmonid habitat restoration actions are recommended for Spring Creek:

- **Correct fish passage barrier at North Bay Road**

- **Assess salmonid habitat conditions in Spring Creek watershed; correct identified salmonid habitat limiting factors**

Coulter Creek 15.0002 and Unnamed Tributaries 15.0003-0010

General

The Coulter Creek watershed is one of the largest drainages in East WRIA 15, located on the northeast end of Case Inlet. The mainstem is approximately 8 miles long, with several tributaries contributing an additional 10-12 miles of channel length. There are a large number of wetlands in this watershed, both on the mainstem and tributaries. The upper portions of many of the tributaries are seasonal, but may support salmonid spawning and rearing during wet seasons when surface flows allow access. Land use in the watershed is almost entirely commercial forestry.

Most of this drainage (from just downstream of the West Branch (15.0004) to the vicinity of Lake Flora Road (RM 5.9)) is located within the privately owned Overton Tree Farm. As a result, limited habitat assessment work has been done by WDFW or the tribes on Coulter Creek or tributaries. Phinneyfish Consulting (under contract to the Overton family) conducted a habitat evaluation at several mainstem and tributary locations in the watershed in 1997. Much of the following habitat information is from the study report (Phinney 1997).

WDFW has operated a salmon hatchery (no egg incubation) at the mouth of Coulter Creek since 1979. Total salmon production has varied in recent years, but target release levels are approximately 1 million fall chinook fingerlings and 1 million chum fry annually (Phinney 1997).

Fish Access

The WDFW hatchery precluded upstream passage of salmonid adults at the instream weir for several years, with upstream passage being reintroduced in 1993-1994. However, operation of the weir for broodstock collection likely intercepts naturally produced fish and diverts them into the hatchery, and passes hatchery-origin adults into upper Coulter Creek where they spawn with the natural-origin stock.

Phinney (1997) indicates that all road crossings of mainstem Coulter Creek on the Overton Tree Farm are bridges, with no fish passage barriers. Although there are some culverts located on the tributaries, the only known fish passage barrier is the culvert on Unnamed 15.0003(?) at Coulter Creek Road (WDFW SSHEAR fish passage barrier database).

Floodplain Modifications

The natural floodplain of Coulter Creek and tributaries is generally intact and stable. The only identified (Phinney 1997) areas where the floodplain has been modified are at the powerline/pipeline crossing of the right-bank tributaries to Coulter Creek. The tributaries appear to be straightened and channelized through the 400-500 foot width of the powerline crossing.

Channel Condition/Substrate/Riparian

Table 3 provides a summary of the sites sampled by Phinney (1997), and associated habitat conditions.

The TAG indicates that riparian condition is in generally good condition on the Overton Tree Farm, even though Peter Overton (personal communication) indicates that buffer width is generally 35 feet on both sides of the creek. This is supported by Phinney (1997), who indicates that riparian buffer width is generally 35-75 feet on both sides of the creek, and that large alder and large conifer have been retained in the riparian buffers. However, much of the standing and down dead woody material has been removed from the riparian stands throughout the property for fire control. Removal of this material compromises near-term recruitment of new LWD to the creek over the next several decades. The only areas with poor riparian vegetation are on streams previously identified as Types 4 or 5 (non-fish bearing). These are primarily intermittent streams with no summer rearing potential. Riparian vegetation has been actively removed at powerline/pipeline crossings of Coulter Creek tributaries. Although the general impression is that riparian condition is good, riparian condition would be considered poor using the habitat rating standards in Appendix B, as most of the riparian buffers are <75 feet wide on each side of the stream. Existing riparian buffers currently provide good canopy cover, bank stability, and future LWD recruitment potential, although potential is somewhat limited due to current riparian buffer width (Phinney). Recent revisions to the Forest Practice Rules, including both increased riparian buffer widths and better identification of fish producing waters, will increase riparian protection on future forest practices. Since buffers have been provided with the prior forest practices on this property, a better baseline habitat condition exists on Coulter Creek than in many other watersheds with commercial forestry.

Most of the reaches, where habitat conditions were assessed, have good LWD presence (including presence of large key pieces) and associated pools. Substrate gravels are generally in good condition. Reaches where presence of sands and silts are noted are typically in areas with seasonal flows or beaver ponds. There are few road encroachments on Coulter Creek or tributaries. The only road that was assessed as contributing sediment is tributary 15.0002A, where periodic road washout may occur. Additional sediment contribution may occur from the powerline/pipeline crossings, where the Bonneville Power Authority (BPA) has actively removed riparian vegetation. Streambanks were assessed as being generally stable, except for an isolated area where Coulter Creek is cutting sharply into the bank, approximately 0.2 mile upstream from the lower bridge on Overton property (at the Archer residence)(Phinney 1997). Bank stabilization was conducted in 1999 at this site, using bioengineering techniques, which are beneficial to retaining the creek in its current course, avoiding the possibility of cutting off a major spawning area, and reducing downstream erosion.

Water Quality

The Bremerton-Kitsap Health District has been collecting water quality information at four locations in the Coulter Creek watershed since 1996. Identified water quality concerns include low dissolved oxygen (Mean=6.9 mg/l, Min.=0.7 mg/l downstream of the weir at the hatchery rearing pond). There were also several occurrences of stream temperatures exceeding 15°C.

Water temperatures have been collected at the WDFW hatchery and upstream. Daily maximum and minimum temperatures have been recorded at Coulter Creek Hatchery (Phinney 1997). The

Table 3: Reach specific habitat assessment data for Coulter Creek and tributaries (source, Phinney 1997)

Site Ref # (see map)	**Site Location**	**Reach Length (RM)**	**LWD Status**	**% Pool**	**Stream Canopy Cover**	**Substrate Condition**	**Riparian Status (most riparian buffers 35-75' in width)**	**Overall Habitat Quality**
1	Coulter Creek upstream of confluence of West Branch	0.5	Moderate amounts, good future potential	60%, to 4' deep	60%	<3" gravel	Old conifers and large alder and maple	Good
2	Coulter Creek downstream of confluence of 15.0002A	0.2	Abundant, future potential	60%, to 4.5' deep	70%	NA	Number of large cedar	Good
3	Coulter Creek downstream of confluence of 15.0008	0.25	Large amounts in and adjacent to channel	80%, to 3.5' deep	50%	<3" gravel	Alders with few older conifers	Good
4	Coulter Creek downstream of confluence of 15.0009	~0.3	Moderate amounts in and adjacent to channel	75%, to 3' deep	80%	<3" gravel	Alders with some older conifers	Good
5	Coulter Creek from confluence of 15.0009 to confluence of 15.0010	0.2	Moderate amounts of LWD, future potential	75%, to 3' deep	80%	<3" gravel, recent indications of substrate movement	Primarily alders, some older conifers and other deciduous	Good
6	Coulter Creek from confluence of 15.0010 to Lake Flora Road	0.2	Adequate in stream channel with a lot of recruitable material	75%, to 4' deep	75%	<3" gravel, with some sand	Maturing conifers and large alder, lots of deciduous brush	Good
7	Coulter Creek downstream of Sunnyside Road	0.1	Moderate amounts of LWD, additional recruitment potential	75%. to 2.5' deep	75%	Primarily small gravel (<2")	Maturing timber with some deciduous trees	Good
8	West Branch (15.0004) upstream of powerline crossing	0.25	Moderate amounts of LWD in and adjacent to channel, large trees for future potential	60%, to 2.5' deep	80%	Mostly small gravel (<1.5")	Riparian zone cleared under powerline crossing and along pipeline, upstream is mixed alder and conifers	Good
9	West Branch (15.0004) from mouth to lower bridge	0.25	Abundant LWD in and adjacent to channel, future recruitment potential	75%, to 4' deep	80%	Mostly gravel <3"	Area adjacent to channel has not been logged in recent years, large conifers and alder	Good
10	Mouth of tributary 15.0005	0.2	Small amounts of LWD in channel	30%, to 2' deep	90%	Mostly small gravel (<2") and sand	Small alders with some large conifers	Fair
11	Tributary 15.0007 in vicinity of powerline crossing		LWD placed in channel in area disturbed by pipeline crossing	50%	NA	Primarily small gravel and placed boulders	Riparian area impacted by powerline and pipeline, downstream riparian zone on right bank is maturing timber, while left bank is recently harvested	Fair below powerline, no fish use upstream of powerline

Table 3: Reach specific habitat assessment data for Coulter Creek and tributaries (source, Phinney 1997)

Site Ref # (see map)	**Site Location**	**Reach Length (RM)**	**LWD Status**	**% Pool**	**Stream Canopy Cover**	**Substrate Condition**	**Riparian Status (most riparian buffers 35-75' in width)**	**Overall Habitat Quality**
12	Tributary 15.0007 in vicinity RM 0.7	0.25	Abundance of LWD in and available to channel	75%, to 2' deep	89%	Mostly small gravel (<1.5")	Mixed timber including numerous large cedar	Good
13	Tributary 15.0007 upstream of Lake Flora Rd.	0.25	Little LWD in stream, mature timber on right bank is future source	NA, shallow pools	20%	Mostly small silty gravel (<1.5")	Small alder and few small firs on left bank, alder interspersed with mature conifers on right bank	Unlikely fish use
14	Tributary 15.0007 downstream of Lake Flora Rd.	0.25	LWD scattered through channel	NA	50%	Mostly sand and small gravel	Maturing conifers with some alders and a lot of brush	Unlikely fish use
15	Mouth of tributary 15.0002A	~0.15	LWD abundant in and adjacent to channel	50%, to 2.5" deep	80%	80% gravel >3", 20% gravel <3"	Mature conifers (cedar) interspersed with alder and small brush	Good
16	Mouth of tributary 15.0008	0.2	Moderate LWD in and adjacent to channel, future potential	50%, to 3' deep	60%	Primarily small gravel (<1") and sand	Alder and large maturing conifers	Good
17	Tributary 15.0009 downstream of Lake Flora Rd.	0.25	Abundance of small woody debris, some LWD, limited future potential	50%, to 2" deep	Exc.	Mostly small gravel (<1.5") and sand	Dense brush and small deciduous trees	Fair
18	Mouth of 15.0009	~0.25	LWD abundant in and adjacent to channel, future potential	75%	80%	Mostly small gravel (<2") with some sand and silt	Maturing conifer and alder on both banks	Good
19	Mouth of tributary 15.0002C	0.05	None	50%, beaver pond to 1' deep	None	Mostly small gravel (<.75")	Brushy with no trees	Unknown, probably intermittent

thermometer is located at the lower end of the exposed rearing pond, possibly reflecting warming that would occur in the hatchery ponds, and not necessarily indicative of the natural stream temperature. The maximum daily water temperature in the ponds from 1980 to 1996 exceeded 60°F for varying periods of time on some years. However, mean daily temperatures would likely rarely exceed 60°F.

In addition, Phinney (1997) installed water temperature recorders in three locations in Coulter Creek and one in the West Branch (15.0004). Maximum daily temperatures at the Coulter Creek sites were less than 59°F, and were usually less than 58°F. However, West Branch records showed daily temperatures frequently exceeding 60°F during mid-August during warm weather periods. In 1998 and 1999 Phinney (unpublished) documented mean daily temperatures in the West Branch remaining below 55°F at all times except immediately below the powerline/pipeline crossing. Maximum daily temperatures exceeded 60°F occasionally, only immediately below the exposed area below the powerline/pipeline crossing.

Water Quantity

Data collected by Robinson and Noble (ground water and environmental geologists, as cited in Phinney 1997) indicate that approximately half of the surface flow at the mouth of Coulter Creek originates as surface flow from Coulter Creek at the southern boundary (RM 0.6) of Overton property. The remainder is contributed by tributary and ground water flow downstream of Overton property.

The Department of Ecology has determined that Coulter Creek and tributaries exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, no further water is available for consumptive appropriation from July 15 – November 15 (WAC 173-515-040). Applications for consumptive water appropriation at other times of the year are subject to minimum instream flows established in WAC 173-515-030.

Figure 14: Coulter Creek estuary (note diking in intertidal area to direct streamflow) (photo courtesy of Department of Ecology)

Estuarine

The natural character of the Coulter Creek estuary (Figure 14) has been altered by directing the freshwater outflow along the northern side of the natural estuary by placement of a dike in the intertidal area (see Marine chapter). This dike was constructed to prevent freshwater flow onto clam beds to the south of the mouth

of Coulter Creek. Although there are no identified adverse impacts to salmonids attributed to presence of this dike, the dike likely alters the ability of the natural estuary to discharge the natural sediment load from the creek (e.g., Dungeness River, Quilcene River), and may result in impairment of estuarine habitat in the future.

Action Recommendations

The following salmonid habitat restoration actions are recommended for Coulter Creek and tributaries:

- **Future development in the Coulter Creek watershed should incorporate low-impact development principles and incorporate state-of-the-art stormwater BMPs to minimize potential water quantity/quality impacts**
- **Retain standing and down dead woody material in riparian zones for rear-term recruitment of LWD to creek channels**
- **Identify and correct sources of low dissolved oxygen, identified in Bremerton-Kitsap Health Department water quality sampling**
- **Restore functional riparian areas at the powerline/pipeline crossings of the streams in this watershed**
- **Assess road stability and sedimentation impacts on tributary 15.0002A, and relocate or abandon road, if warranted**
- **Restore natural outflow across the estuary**
- **Evaluate riparian condition on West Branch (15.0004) to determine if riparian restoration would be beneficial in reducing summer water temperatures**
- **If bank stabilization is required at the Archer property, utilize bio-engineering techniques that will maintain salmonid habitat function and diversity**

Unnamed (Sisson) Creek 15.0012

General

This small independent creek is approximately 1.2 miles long, entering Case Inlet approximately 0.75 mile north of Rocky Point. The TAG had no knowledge of fish utilization or habitat conditions in this stream. There is no available water quality or habitat assessment data, and surrounding land uses need to be confirmed (KGI DRAFT 1999).

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0012:

- **Assess salmonid utilization and habitat conditions in this watershed; correct identified salmonid habitat limiting factors**

Unnamed 15.0014

General

This small independent creek is approximately 1.3 miles long, entering Case Inlet approximately 0.6 mile north of Rocky Point. The culvert under SR 302 (RM 0.05) is reported to be a barrier to fish passage (WDFW SSHEAR fish passage barrier database SITEID 991523, database indicates that correction of the barrier culvert will yield no significant gain in habitat). The drainage has a significant beaver dam complex in the headwaters. The TAG had no knowledge of fish utilization or other habitat conditions in this stream.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0014:

- **Correct identified fish passage barrier at SR 302, as warranted**
- **Assess salmonid utilization and habitat conditions in this watershed; correct identified salmonid habitat limiting factors**

Rocky Creek 15.0015, Fork Muck Creek 15.0016, Winter Creek 15.0017, and Unnamed Tributaries 15.0017A - 15.0021

General

The Rocky Creek watershed is one of the larger drainages in East WRIA 15, entering the northern end of Rocky Bay on Case Inlet. The mainstem is approximately 5 miles long, with tributaries contributing an additional 10-12 miles of channel length. The Rocky Creek drainage contains >12,000 acres of land (KGI DRAFT 1999). The Rocky Bay drainage is, for the most part, low density residential and rural in character, with more concentrated residential development near the shoreline (KGI DRAFT 1999). In 1994, the Pierce County Council limited any new development in this drainage to one dwelling per 10-acres, to protect the rural setting and preserve its natural resources. In 1995, the Council passed an amendment to further limit development to one dwelling unit per 20-acres (KGI DRAFT 1999). Habitat information is also provided for the tributaries, where available, except for Unnamed tributary 15.0021, for which no information is available other than there is a large wetland 1.5 miles upstream (KGI DRAFT 1999).

Stream Team volunteers have noted that poaching of salmon has been occurring near the mouth of the creek (KGI DRAFT 1999), which likely affects the return of spawners and overall productivity of the system.

In 1998, 240-acres along Fork Muck Creek (East Fork Rocky) were transferred to the Peninsula Park Board (KGI DRAFT 1999). The area, now known as the “Rocky Creek Natural Area” will be protected from future development.

Fish Access

The dam at the outlet of Fern Lake on mainstem Rocky Creek was likely a previous total barrier to fish passage, precluding access to approximately 1.5 miles upstream. Visits by both Pierce Conservation District staff and Kalinowski in spring 2000 indicate very little of the dam remains intact, and the remaining structure is no longer a barrier to fish passage. The TAG indicates that the culvert on Rocky Creek located at 144th is a passage barrier. Tacoma Public Utilities has indicated an interest in correcting the barrier, but the project has yet to be scheduled.

The culvert at Wright –Bliss Road (RM 1.4) on Fork Muck Creek (15.0016) was a long-standing total barrier to fish passage (WDFW SSHEAR fish passage barrier database SITEID 15.0016 1.00). Volunteers had been assisting adult coho spawners past the barrier, allowing them to access to the headwaters. The barrier has been corrected with installation of a bridge, which should provide unrestricted fish passage upstream to the headwaters. There is what appears to be an old beaver dam that has been "repaired" with sand/concrete bags, just upstream (east) of the intersection of Lake Helena Drive and JM Dickenson Road (Pierce Conservation District (PCD)). The sand/concrete dam is a barrier to fish passage.

The TAG indicates that the lower passable cascade on Winter (Snow) Creek (15.0017) identified in Williams et al. (1975) does not exist. A prior culvert passage barrier on Winter Creek at RM 0.5 was repaired in 1998 (summer). The concrete box culvert at the 132nd KPN crossing of Winter Creek (~RM 0.7) has failed, likely from unauthorized instream work downstream of the culvert (see Floodplain Modifications section below), which has caused channel downcutting and associated fish passage problems (PCD).

Floodplain Modifications

The Rocky Creek natural floodplain is generally intact. The PCD has had reports that a landowner has done extensive unauthorized instream work with a caterpillar downstream of 132nd KPN on Winter Creek. WDFW should visit the site and determine whether habitat mitigation/restoration is warranted. The powerline access road on Fork Muck Creek at 144th KPN, managed by Tacoma Public Utilities (TPU), has resulted in continued stream and floodplain disturbance and erosion of fine sediments to the stream. Prior attempts to block access by installing a gate and a tank trap have been unsuccessful. The site is used by 4-wheel drive vehicles to drive in and across the stream, and is the site of illegal dumping of old vehicles and garbage. TPU should actively pursue excluding vehicle access at this site.

Channel Condition

The TAG indicates that Fork Muck Creek has good presence of deep pools. Recent significant landslides have been identified 0.25-0.5 mile upstream of SR 302, but the TAG indicates the cause of the slides is unknown. The Pierce County Stream Team identified creek conditions as "good" at 144th in June, 1995, but noted garbage and junk adjacent to the creek and collapsing banks as impacting the creek (KGI DRAFT 1999). Occasional LWD is also noted in this reach. The volunteers also noted unpaved roads as affecting the creek and that the natural streamside cover was degraded. An assessment at the same site in December 1995 rated as "poor". Differences in the assessments result from a dramatic reduction in the estimation of canopy, no notice of pools or riffles, and even lower ratings for bank conditions and land use. In addition to the impacts noted in June, the volunteers also noted mud/silt/sand in the stream, garbage/junk in

the stream, and the degradation of the streamside cover as severely impacting the stream. Land uses clearly affecting the creek included the unpaved roads again, but also logging and recreation as well. Multi-family residences were also noted. Stream Team monitoring of the second of the lower tributaries to Fork Muck Creek at the end of 132nd Street has noted cloudy water, a dramatic reduction in the riparian width, and the absence of riffles (KGI DRAFT 1999). In addition, the banks were collapsed and eroded, unpaved roads and recreation were impacting the stream, there was degradation of the natural streamside cover, and logging was clearly affecting the stream. More recent reports have noted higher sediment and algae levels in the creek as well as loss of cover to forestry operations.

Substrate

Macroinvertebrate samplings on Rocky Creek by Pierce County Water Programs have resulted in ratings ranging between "moderate" and "excellent" (KGI DRAFT 1999).

The TAG indicates that the substrate condition in Fork Muck Creek is generally good. Since the replacement of the culvert on Fork Muck Creek at Wright Bliss Road in 1999 the creek bed has head cut upstream about 300 feet and will probably continue to regrade for an additional 200 to 300 feet (Kalinowski). Conditions within this reach of the creek will remain unstable for several years until the channel sets its new configuration. The creek is reported to have a good population of freshwater mussels and a good macroinvertebrate population. However, macro-invertebrate samples taken in June and November 1996, on the second of the lower tributaries to Fork Muck Creek, had moderate and poor ratings, respectively, indicating that the creek does not have a strong macroinvertebrate population (KGI DRAFT 1999).

Riparian Condition

Rocky Creek is located in a vegetated ravine through much of its length. However, there are several reaches where the riparian vegetation is limited, particularly through agricultural areas. The Pierce County Stream Team has been monitoring a site less than a mile upstream of the mouth (KGI DRAFT 1999). Riparian assessment at this site indicates riparian width of 300-400 feet and good canopy cover.

There has been significant past logging of riparian vegetation on Fork Muck Creek. There is also a recent large forest harvest in the headwaters of Fork Muck Creek, but the TAG had no information on resulting riparian condition. Riparian condition is reported to be poor just downstream of Wright –Bliss Road, with associated bank erosion problems.

Riparian condition on Winter (Snow) Creek has been impacted by past timber harvest, but the TAG indicates that riparian condition is recovering. Riparian condition was observed to be excellent just downstream of the mouth of tributary 15.0017 in the summer of 1998.

Water Quality

The Pierce County Stream Team has been monitoring a site on Rocky Creek less than a mile upstream of the mouth (KGI DRAFT 1999). Every data sheet assessed the clarity of water at this site as clear. A sampling site located on Rocky Creek is monitored by Pierce County Water Programs, Storm Drainage and Surface Water Management (SWM) for the purpose of identifying sources of fecal coliform into Rocky Bay (KGI DRAFT 1999). Samples taken since 1995 have

all found the creek well within state water quality standards. Water quality samples taken by Stream Team volunteers and Pierce County Water Programs have generally found the creek to be in very good condition (KGI DRAFT 1999). Temperatures have ranged between 5°C and 14°C and the average pH is 7. Dissolved oxygen (DO) readings have ranged between 7 and 14.88 mg/l (the state water quality standard for minimum DO is 8mg/l for Class A waters, indicating a potential problem, at least during portions of the year). More recently, Stream Team volunteers have noticed more algae in the creek and a mild reduction in clarity. Anecdotal information from adjacent property owners has noted heavy sediment loads entering the creek after improperly performed timber harvest practices.

Water quality testing on the second of the lower two tributaries on Fork Muck Creek revealed pH levels between 6 and 6.5 and dissolved oxygen levels ranging between 5 and 11 mg/l (KGI DRAFT 1999). Two out of four readings violated state standards for dissolved oxygen even though the temperature of the water was good. One flow rate has been measured at the site, in June 1996, and the rate was less than 0.2 cubic feet per second.

Water Quantity

The Department of Ecology has determined that Rocky Creek and tributaries exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, no further water is available for consumptive appropriation from June 1 – October 31 (WAC 173-515-040). Applications for consumptive water appropriation at other times of the year are subject to minimum instream flows established in WAC 173-515-030.

Instream flows in Rocky Creek were likely previously impaired during the dry summer and early fall period by the dam at the outlet to Fern Lake (TAG). The dam appears to date back to the 1950s, when it was installed to impound water in Fern Lake for fish studies being conducted by WDF and/or the University of Washington. There is no indication that the dam received active maintenance for many years, and recent visits by PCD and Kalinowski indicate that the dam has basically washed out, and does not appear to be limiting natural outflow from Fern Lake. Flow data for Rocky Creek shows a low flow of four cubic feet per second on June 10, 1995, to a high of 9.4 cubic feet per second on October 29, 1996 (KGI DRAFT 1999). A flow survey performed by Pierce County Water Programs on September 12, 1997 calculated a total quantity of 9.8 cubic feet per second with a velocity of 1.58 feet per second.

The many large wetlands associated with the upper reaches of Fork Muck Creek may explain why the creek has seasonal flows (KGI DRAFT 1999). During times of low rainfall, these wetlands help recharge groundwater and have no surface water flow.

Estuarine

Much of the natural habitat integrity of the Rocky Bay estuary (Figure 15) has been retained, and estuarine function is generally good. Rocky Bay has been downgraded to “prohibited” status for commercial shellfish harvest, based on fecal coliform contamination.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Rocky Creek and tributaries:

Figure 15: Rocky Creek estuary (photo courtesy of Department of Ecology)

- **Protect integrity of large wetlands in headwaters of watershed**
- **Correct identified fish passage barriers at the 144th crossing of Rocky Creek, and at the 132nd KPN crossing of Winter Creek**
- **Prevent vehicle access at powerline access road on Fork Muck Creek at 144th KPN**
- **Evaluate impacts of unauthorized instream work on Winter Creek downstream of 132nd KPN, enforce and restore habitat as warranted**
- **Ensure that Pierce County Roads Dept. maintains roadside ditches in a manner that does not result in fine sedimentation to creeks**
- **Assess the cause of landslides in the lower 0.5 mile of Fork Muck Creek; implement remedial measures, as warranted**
- **Assess habitat conditions upstream of the sand/concrete bag dam east of the intersection of Lake Helena Drive and JM Dickenson Road, prioritize and correct barrier as warranted**
- **Assess channel condition (LWD presence, presence of pools, bank erosion) throughout watershed; remediate identified salmonid habitat limiting factors**
- **Restore full riparian function throughout watershed, with particular emphasis on agricultural areas and downstream of Wright-Bliss Road on Fork Muck Creek**
- **Evaluate specific areas found to not be in compliance with State water quality standards for dissolved oxygen or water temperature; identify causes of non-compliance and correct**
- **WDFW should actively enforce against poaching of adult salmon near the mouth of the creek, as reported by Stream Team volunteers**

Unnamed 15.002X (WRIA index number is incomplete, as no unassigned stream number exists between the uppermost Rocky Creek tributary and 15.0022 to the south)

General

This unnamed independent creek is approximately 0.5 mile long and enters approximately midway up the southern/eastern shore of Rocky Bay. It supports coho and chum upstream to the culvert fish passage barrier at 186th Avenue (RM 0.01)(PCD). There is potential habitat upstream of the culvert to at least Bliss-Cochran Road (which is also a fish passage barrier)(PCD), although the flow is low and habitat conditions are poor (primarily associated with adjacent agricultural land use). The TAG indicates there is little habitat potential upstream of Bliss-Cochran Road. Downstream of 186th, the creek flows through a mature conifer stand. This creek is seasonal,

with flows generally limited to late October through late May. The creek channel is ditched upstream of 186th Avenue for about 200 feet to a second blocking culvert under a private driveway (Kalinowski). Channel condition is generally poor with few pools and little LWD. Because of seasonal flows, salmonid production is currently limited to chum in the lower 0.01 mile, or slightly above if the blocking culvert at 186th Avenue is replaced.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.002X:

- **Correct identified fish passage barrier at 186th Avenue**
- **Assess fish passage status at the private driveway upstream of 186th Avenue, and at Bliss-Cochran Road; prioritize and correct as warranted**
- **Restore natural channel configuration and functional habitat conditions throughout watershed; particularly in reaches affected by adjacent agricultural land use**

Unnamed 15.0022

General

This independent creek is approximately 0.9 mile long and enters Case Inlet just outside Vaughn Bay on the north shore at Vaughn. Anadromous salmonid use of this creek is unknown.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0022:

- **Assess salmonid use and habitat conditions; correct identified salmonid habitat limiting factors, as warranted**

Unnamed 15.0023

General

This independent creek is approximately 1.0 mile long, entering the northeast corner of Vaughn Bay on Case Inlet. Coho and cutthroat presence has been observed upstream to the Hall Road crossing (Small), but the quality of the habitat is generally poor. An old dam in the headwaters (to create a private lake) washed out, but was rebuilt in 1991. The dam remains a total barrier to upstream fish passage (PCD). The creek has incised approximately 6 feet deep for most of its length. From the dam downstream to Hall Road the creek is seasonal; riparian condition in this reach is generally good, but overall habitat condition is poor. The culvert at the Hall Road crossing was blocked by accumulated debris on the upstream side, when visited by PCD in spring 2000. The culvert should be replaced and/or regularly maintained by Pierce County (using methods that do not impair downstream habitat) to ensure unrestricted fish passage.

Action Recommendations

The following salmonid habitat restoration actions are recommended for Unnamed 15.0023:

- **Replace the culvert at Hall Road crossing, or actively maintain the culvert in a manner that does not impair downstream habitat**
- **Assess salmonid use and habitat conditions; correct identified salmonid habitat limiting factors, as warranted**
- **Identify and correct cause of channel incision**

Vaughn Creek 15.0023A

General

This independent creek is approximately 1.0 mile long, with several additional small tributaries. It enters the east end of Vaughn Bay immediately south of Unnamed 15.0023. Its headwaters include two fairly large wetlands that drain to this creek (KGI DRAFT 1999). The creek supports coho and chum upstream to the forks. Land uses noted on stream walks include single-family residences, paved and unpaved roads, and recreation (KGI DRAFT 1999). The primary land use in the drainage is agriculture, with associated removal of riparian vegetation and heavy silt load in the stream.

Fish Access

There have been reports of several private driveways that may be potential partial barriers to anadromous fish passage (Kalinowski). These culverts should be assessed to determine the extent of fish passage impact. In addition, there has been a recent report of unpermitted work being done in Vaughn Creek behind the Vaughn Post Office and that this work may have created a fish blockage, which would isolate fish access to the entire creek (Kalinowski).

Floodplain Modifications/Channel Condition/Substrate/Riparian Condition

Local residents and stream team volunteers have indicated concerns about one property owner in the middle of the creek reach who is creating ponds, diverting creek water, and dredging the creek. These activities are believed to be contributing to the high sediment levels and the lack of fish in the stream. Steve Kalinowski and Doris Small have both visited the site of concern and indicate that all pond construction appears to be occurring in wetlands adjacent to the stream, but outside the floodplain of Vaughn Creek. Other than this one area, riparian cover over the creek is good.

Vaughn Creek's stream walk habitat assessment rating has been "Good" the last three surveys. The first rating was "Medium"; the major difference in this assessment was that pools and riffles in the creek were not noted. Bank conditions were noted as a severe impact from mud/silt/sand entering the stream. Other impacts noted were artificial modifications to the banks, and algae/scum floating or coating the rocks (which may be attributed to the tidal influence at the mouth). These concerns, for the most part, are on each of the assessments, with the first being the only one to show the mud/silt/sand as severely impacting the stream. Macroinvertebrate samples

taken on this creek have generated one rating of "Poor", and two ratings of "Moderate" (KGI DRAFT 1999).

Water Quality/Water Quantity

Water quality data shows temperature, pH, and dissolved oxygen easily meeting state standards (KGI DRAFT 1999). There is no data for fecal coliform or turbidity. Vaughn Creek's discharge rate is low: 1.13 cubic feet per second on November 11, 1996. The stream flows from a series of wetlands, and macroinvertebrate sampling rated the site as moderate. Temperature data, taken during a summer of 1998 survey, ranged between 12.8 and 14.4°C. During the survey there was no water in the creek at the DNR road that crosses the creek. Nitrate levels, while not regulated by state standards, seem to be noticeably higher in this creek than in other creeks in the area. A sample taken on June 11, 1997 recorded a level of 12 mg/l.

The total natural flow of Vaughn Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further water appropriation (WAC 173-515-040).

Estuarine

Physical habitat conditions in Vaughn Bay are generally in good condition (Steve Kalinowski). There are a large number of shoreline bulkheads within the bay, in relatively low energy areas with few signs of shoreline erosion (Small).

Vaughn Bay remains closed to commercial shellfish harvesting due to high fecal coliform counts. Vaughn Creek is most likely not the source of the pollution causing Vaughn Bay's closure because its discharge is so low.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Vaughn Creek:

- **Assess impacts of reported work behind Vaughn Post Office; ensure that fish passage to Vaughn Creek is maintained; implement mitigation/restoration actions as warranted**
- **Assess fish passage status of driveways off 92nd Street; prioritize and correct identified fish passage barriers**
- **Identify and correct sources of fine sedimentation to the creek**
- **Reduce presence of bulkheads on low energy marine shoreline areas in Vaughn Bay**
- **Assess bank stability through watershed; restore natural bank stability where problems are noted**
- **Identify and correct sources contributing to high nitrate levels in the creek**
- **Identify and correct sources of fecal coliform that have resulted in closure of Vaughn Bay to commercial shellfish harvest**

Dutcher Creek 15.0026 and Unnamed Tributary 15.0027

General

Dutcher Creek is approximately 2.5 miles long, including tributary 15.0027 and an unnumbered tributary. It enters Dutcher Cove on the east side of Case Inlet. The creek supports coho to the headwaters and to an impassable culvert on tributary 15.0027; chum use is unknown. SASSI also indicates presence of steelhead in Dutcher Creek, although presence was not identified in the SASSI steelhead distribution map. The culvert at the Lackey Road crossing of Dutcher Creek is failing and is a fish passage barrier (PCD). The lower end of the culvert has fallen off and the culvert has a 0.5 m drop at the outlet. Coho passage was previously precluded upstream of a dam at RM 1.0. Construction of a fish ladder at the dam now provides adult fish passage to the headwaters. Downstream of the dam, habitat condition is characterized as generally good, with good LWD, good substrate, with dense vegetation, although riparian status is unknown. Upstream of the dam, riparian condition has been impacted through agricultural areas. Gravel condition was observed to be good in the vicinity of Lackey Road. A South Sound Salmon Enhancement volunteer, who rears coho eggs annually, reports habitat is very good, with good canopy cover and not an inordinate amount of stormwater runoff (Manning and Manning, personal communication 1996, as referenced in KGI DRAFT 1999). No water quality data or habitat assessment data are available (KGI DRAFT 1999).

Dutcher Creek and tributaries have been closed to further consumptive water appropriation since 1954 (WAC 173-515-040).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Dutcher Creek and tributaries:

- **Correct identified fish passage barrier culverts at Lackey Road and on Unnamed tributary 15.0027**
- **Ensure continued effective operation of fish ladder at dam at RM 1.0**
- **Restore riparian function through agricultural area upstream of dam at RM 1.0**

Unnamed 15.0028

General

This independent creek is approximately 1.2 miles long with additional small tributaries, entering Case Inlet at the southern end of Dutcher Cove. A 1990-91 flood removed a previously impassable dam at the mouth. There was no anadromous utilization of the creek until after the dam washed out. The creek supports coho (Williams, landowner) and presumed cutthroat in the mainstem upstream to the instream pond located downstream of Lackey Road (~RM 0.7, an excavated 2.5 acre open-water wetland)(Kalinowski). The TAG indicates that habitat conditions are generally good, with good LWD, substrate gravels, and riparian vegetation. The estuary of the creek is also reported to be in good condition. No water quality data or habitat assessment data are available (KGI DRAFT 1999).

Action Recommendations

No habitat restoration actions are recommended for Unnamed 15.0028 at this time.

Herron (Knackstedt) Creek 15.0029 and Unnamed 15.0029A

General

This independent creek is approximately 1.7 miles long, entering Case Inlet east of the north end of Herron Island. The creek supports coho and chum to at least RM 0.4. In recent years, five-acre large lot residential housing has increased around the upper reaches of the creek and wetlands, but surrounding land uses need to be confirmed. No water quality data or habitat assessment data are available (KGI DRAFT 1999).

There is also a right-bank tributary that connects to Herron creek just upstream of the mouth. A previous culvert at the mouth of the tributary, just south of the Herron Beach Community Club, was thought to be a total barrier to fish passage, precluding access to habitat upstream (TAG). The culvert was replaced in 1999, but was evaluated in 2000 as still being a barrier to fish passage (PCD). Coho and chum use has been previously observed downstream of the culvert (note that this limited area is not designated on the species distribution maps, but is noted in the supporting species distribution table). Habitat immediately upstream of the culvert appears to be good, with good LWD presence, good canopy, and good substrate gravel. Extent of salmonid use should be evaluated upstream of the replaced culvert. The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert on Herron Creek at RM 0.1 (SITEID 15.0029 0.10). This culvert was replaced by PCD and SPSSEG in 1999.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Herron Creek:

- **Assess salmonid utilization in this watershed, particularly upstream of the culverts replaced in 1999**
- **Assess habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Unnamed (outlet to Herron Lake) 15.0030

General

This independent creek is approximately 0.75 mile long, originating from Herron Lake, entering Case Inlet just opposite the southern end of Herron Island. Fish use in this creek is unknown, although the TAG indicates the creek is of adequate size for anadromous salmonids. There are two parallel culverts under the road at the mouth that are thought to at least be partial barriers to fish passage.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0030:

- **Assess salmonid utilization and salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**
- **Assess fish passage status of parallel culverts under the road at the mouth of the stream; correct identified fish passage barriers, as warranted**

Unnamed (Kingmans) Creek 15.0031

General

This independent creek is approximately 0.8 mile long, entering Case Inlet southeast of the southern end of Herron Island. The creek supports coho and chum in the lower 0.05 mile. In addition, 10,000 chinook are released annually. Surface flows in this creek are seasonal. The headwaters of this drainage were clearcut in 1991-92, and subsequently converted to 250 acres of housing and 250 acres of open space. The TAG indicates that the clearcut and subsequent conversion resulted in significant erosion of fine sediments to the creek and a significant increase in landslides in the headwaters. Substrate in the upper portion of the drainage is a mix of fines, small gravels, and cobble. Riparian condition throughout the creek is severely impaired; the upper section of the creek is platted and subdivided, and the lower section of the creek has been logged to the edge of the stream. LWD status is indicated as poor in the upper portion of the drainage. The TAG indicates there is restoration potential, but significant riparian management would be required.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0031:

- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore riparian function throughout watershed**
- **Remediate any existing stormwater impacts to the channel resulting from development in the headwaters; ensure that stormwater from future development is fully addressed at the time of construction**
- **Identify and correct current sources of fine sedimentation to the creek**

Unnamed 15.0031X

General

This independent creek is approximately 0.8 mile long, with two additional small tributaries. It enters Case Inlet approximately 1 mile south of Unnamed (Kingmans Creek) 15.0031. No information is available on fish utilization or habitat conditions.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0031X:

- **Assess salmonid utilization and salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Whiteman Creek 15.0032

General

This small independent creek is >1.0 mile long, with an additional tributary, and enters Whiteman Cove on Case Inlet, just south of Joemma State Beach. There is a history of WDFW chinook releases from a pond at the mouth of Whiteman Cove. The outlet of Whiteman Cove is regulated by two weir-flow structures (constructed by WDF (Small)), each regulating flow through a culvert that passes under a road that spans the cove, precluding upstream anadromous fish passage (PCD). Natural estuarine function in Whiteman Cove has been precluded by the conversion to a freshwater lake. The TAG had no knowledge of habitat conditions in Whiteman Creek.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0032:

- **Assess feasibility of restoring natural estuarine function in Whiteman Cove, and restoring anadromous fish passage into Whiteman Creek**
- **Assess salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Taylor Bay Creek 15.0034

General

This small independent creek is approximately 0.5 mile long, entering Taylor Bay. A local landowner (White) reports coho presence to RM 0.25; status of chum and cutthroat is unknown. Adjacent land use is primarily agriculture, but habitat status is unknown.

Action Recommendations

The following salmonid habitat restoration action is recommended for Taylor Creek:

- **Assess salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Unnamed 15.0035

General

This small independent creek is approximately 0.5 mile long, entering the Nisqually Reach approximately 0.5 mile northwest of Devils Head. No information is available on fish utilization or habitat conditions.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0035:

- **Assess salmonid utilization and salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Unnamed 15.0036

General

This small independent creek enters the northwest arm of Filucy Bay. Williams et al. (1975) indicate creek length as 1.1 miles plus tributaries, but there is some question regarding the connectivity with large wetlands north of Erickson Road (KGI DRAFT 1999). The culvert at Erickson Road (just upstream of the mouth) is impassable (Kalinowski), and there is a dam just upstream that is also impassable (PCD). There appears to be at least 0.25 mile of potential coho/chum/cutthroat habitat upstream of the culvert and dam, with small gravels. Adjacent land use is agriculture, with total removal of riparian vegetation. Filucy Bay is closed to commercial shellfishing because of high fecal coliform counts. There have been reports of direct dumping of manure into the stream at an unconfirmed location (Smolko)(may be in Schoolhouse Creek 15.0039).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0036:

- **Correct identified fish passage barrier at Erickson Road and dam just upstream**
- **Restore riparian function throughout watershed, particularly on agricultural lands**
- **Identify and correct sources of fecal coliform contamination of Filucy Bay**

Schoolhouse Creek 15.0039

General

This small independent creek is approximately 1.0 mile long, and enters the northernmost end of Filucy Bay. The creek supports chum to Reeves Road, coho to the ostrich farm, and cutthroat to the headwaters. The culvert under Reeves Road is a partial barrier. SPSSEG and WDFW have built and rebuilt a series of three weirs that provide passage past this point (KGI DRAFT 1999), but the weirs have not provided dependable fish passage (the downstream weir has a drop of

0.6m, with only a small pool below). It is recommended the culvert be replaced (PCD, Kalinowski). Habitat conditions range from good to poor to approximately 500 feet upstream of Reeves Road (Iverson), where an ostrich farmer has severely altered the creek channel. The creek through the ostrich farm has been dredged, channelized, and all riparian vegetation removed. Ponds have been excavated and in-channel islands constructed, all without necessary permits. No farm plan is in place for the ostrich farm. The TAG expressed concern that the natural hydrology of the stream has been modified due to channelization and development in the watershed, although data are unavailable to support this concern. There have been reports of direct dumping of manure into the stream at an unconfirmed location (Smolko)(may be in Unnamed 15.0036).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Schoolhouse Creek:

- **Restore natural channel configuration and floodplain function through the ostrich farm, and upstream of Reeves Road; develop and implement farm plan for the ostrich farm**
- **Replace culvert at Reeves Road**
- **Identify and correct sources of fecal coliform contamination of Filucy Bay**

Unnamed 15.0039X

General

This small independent creek enters the north end of Filucy Bay immediately east of Schoolhouse Creek. Chum and coho presence is known in the lower 1,000 feet; cutthroat status is unknown, but presumed at least to the extent of other salmonid use. The culvert at Mahncke Road is a fish passage barrier (PCD). The TAG had no additional knowledge of habitat conditions in this creek.

Action Recommendations

The following salmonid habitat restoration actions are recommended for Unnamed 15.0039X:

- **Correct identified fish passage barrier at Mahncke Road**
- **Assess salmonid utilization and salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Unnamed 15.0040

General

This small independent creek is approximately 0.5 mile long, and enters midway up the northeast shore of Filucy Bay. Fish passage was totally precluded by an impassable culvert at the mouth until 1994, when the culvert was replaced and LWD was placed in the stream. This provided access to approximately 0.5 mile of habitat, although the condition of the habitat was generally

poor. The culvert at Mahncke Road is a fish passage barrier (PCD), although the TAG indicates that habitat potential appears to be limited upstream of the culvert. The TAG indicates that substrate in this drainage is primarily soft silt/sand, that LWD condition is poor (except for where LWD was placed concurrent with the barrier correction), and that riparian condition is fair, although riparian vegetation is composed primarily of hardwoods. No evaluation of fish presence has been done since the work in 1994.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0040:

- **Assess salmonid distribution in the watershed; verify whether salmonids are effectively passing upstream of the replaced culvert at the mouth**
- **Prioritize and correct identified fish passage barrier at Mahncke Road, as warranted**
- **Identify and correct sources of fine sediment delivery to the creek**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore riparian function throughout watershed; encourage conifer regeneration in deciduous stands that historically had a conifer component**

Unnamed 15.0041

General

This small independent creek is approximately 0.4 mile long and enters the west side of Pitt Passage across from the north end of McNeil Island. No information is available on fish utilization or habitat conditions.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0041:

- **Assess salmonid utilization and salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Unnamed 15.0041A

General

This small independent creek enters the small cove at the eastern end of the southern shore of Mayo Cove in Carr Inlet. The creek is known to support coho; cutthroat status is unknown, but presumed at least to the extent of other salmonid use. No information is available regarding habitat conditions in this stream.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0041A:

- **Assess salmonid utilization and salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Mayo Creek 15.0042

General

This small independent creek is approximately 0.4 mile long and enters Mayo Cove on Carr Inlet. No information is available on fish utilization or habitat conditions. Williams et al. (1975) identifies an impassable dam at the outlet of Bay Lake, and the TAG estimates creek gradient to be 5-7%.

Mayo Creek is on the CWA 303(d) list for exceedance of pH, temperature, and fecal coliform standards. In addition, several other tributaries to Mayo Cove are on the CWA 303(d) list, including Unnamed 15.00XX (fecal coliform and pH), Ravine Creek (fecal coliform), Private Creek (fecal coliform and pH), Lagoon Creek (pH), and Picnic Creek (fecal coliform and pH) (KGI Draft 1999).

Mayo Cove is estimated to contribute 20% of the average fecal coliform load into Minter Bay and only about 10% of the average fecal coliform loading into Burley Lagoon (data from Bremerton – Kitsap County Health Department 1990, as cited in Determan and Hoyle 1992).

Nearly 100% of the shoreline in Mayo Cove is bulkheaded; habitat impacts have not been evaluated (Kalinowski).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Mayo Creek:

- **Evaluate habitat impacts of extensive shoreline bulkheading of Mayo Cove; remediate impacts where possible**
- **Assess salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**
- **Prioritize and correct identified fish passage barrier at dam at outlet of Bay Lake**
- **Identify and correct sources of known water quality problems in Mayo Creek and other tributaries to Mayo Cove**

Unnamed 15.0042A

General

This small independent creek enters Van Geldern Cove near the eastern end of the southern shore. The creek is known to support coho; cutthroat status is unknown, but presumed at least to the extent of other salmonid use. No information is available regarding habitat conditions in this stream.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0042A:

- **Assess salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Unnamed 15.0043

General

This small independent creek is approximately 1.2 miles long, and enters the southern shore of Van Geldern Cove on Carr Inlet. The creek is seasonal, with isolated pools but no surface flow during the dry summer and early fall periods (Kalinowski). The creek supports coho and chum to Hoff Road and cutthroat to the headwaters. The culvert under Hoff Road was thought to be a total anadromous fish passage barrier, preventing access to an estimated 1.0 mile of habitat upstream. The Hoff Road culvert, and a private culvert 50-feet upstream, were repaired in September 1999; gravel was also added to the creek as part of the project. The TAG indicated a concern with ditch drainage off Hoff Road, which contributes fine sediment to the stream. Downstream of the culvert, the creek has been channelized, with a previous instream dam and pond that have since blown out. The TAG indicates no riparian vegetation is present from the upper end of the agricultural field (400-feet upstream of Hoff Road) to the mouth, and that LWD is generally absent.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0043:

- **Modify ditch drainage from Hoff Road to eliminate fine sediment delivery and excess stormwater flows to the creek**
- **Restore natural channel configuration and floodplain function downstream of Hoff Road**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore riparian function from the mouth to the upper end of the agricultural field upstream of Hoff Road**

Unnamed 15.0044

General

This independent creek is approximately 0.75 mile long, with an additional left bank tributary that is of similar length. The creek enters the western end of Van Geldern Cove in Carr Inlet. The creek supports coho to approximately RM 0.5 (Kalinowski); status of other species is unknown. A partial fish passage barrier caused by the culvert at Herron Road may limit upstream distribution (PCD). The creek channel appears to be incised, although the cause is unknown.

An additional left bank tributary, entering 15.0044 just upstream of saltwater, flows to the north and may have fish presence. The tributary flows through the town of Home; Second Street is the lowest crossing that is a fish passage barrier, with at least one additional barrier culvert upstream (PCD).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0044:

- **Assess salmonid utilization and salmonid habitat conditions (particularly identified channel incision) in this watershed; correct identified salmonid habitat limiting factors, as warranted**
- **Assess fish passage status of culverts at Herron Road, and at crossings of left bank tributary through Home; prioritize and correct as warranted**

Lackey Creek 15.0046

General

Lackey Creek is approximately 2.5 miles long and enters the north end of Glen Cove on the western shore of Carr Inlet. It is a very good chum creek (spawning at least to RM 0.75). Coho have been sampled in the lower reaches (John Iverson has caught adults at mouth, Steve Kalinowski has shocked juveniles), and coho presence is estimated at least to SR 302 (Small), but the uppermost extent of coho distribution is unknown.

Fish Access

The natural cascade at SR 302 may be impassable, as noted in Williams et al. (1975).

Floodplain Modifications

The lower mile of the creek is located in a naturally confined valley.

Channel Condition/Substrate/Riparian Condition

The TAG indicates that habitat conditions are generally good downstream of SR 302, with good gravel substrate (4-inch minus with few fines), good second-growth conifer riparian buffers mixed with alder (although they are interrupted by yarding corridors), and good LWD in the channel (Kalinowski).

A “Stream walk” conducted on March 16, 1996 gave the creek an “Excellent” rating. A macroinvertebrate sample was taken on June 1, 1996 and the creek was also rated as “Excellent”. Thirteen distinct taxa were found totaling 181 organisms. The percentage of organisms needing higher levels of DO (i.e., the EPT species, which are mayflies, stoneflies, and caddisflies) was 92 %. Clearly, there is enough dissolved oxygen in the water for these important macro-invertebrates (KGI DRAFT 1999). However, observations in lower Lackey Creek in June 2000

found very few macroinvertebrates (Smolko). The creek is currently in very good condition but the headwaters of the creek may be at risk for development in the near future.

Water Quality

Water quality data shows state standards being met for those tests administered except for dissolved oxygen (DO); results show levels hovering at or just below the minimum state standard for "Class A" waters of 8.0 milligrams per liter. Description of the streambed coating has ranged from greenish and yellowish to brown. A reported possible explanation for low DO levels and the coated streambed may be that the site is downstream too far and is getting interference from tidal action and saltwater. Nitrates have been at undetectable levels in all samples taken (KGI DRAFT 1999).

Water Quantity

The Department of Ecology has determined that Lackey Creek and tributaries exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, no further water is available for consumptive appropriation from June 1 through November 15 (WAC 173-515-040). Applications for consumptive water appropriation at other times of the year are subject to minimum instream flows established in WAC 173-515-030.

The creek is seasonal upstream of SR 302. Streamteam volunteers have been monitoring a site below the confluence of the streams for almost a year and report good flow even in the summer months. The discharge rate on July 7, 1996 was 6 cfs, while the rate was 10 cfs on September 7, 1996, generally considered the low-flow time of year. Interestingly, a lower flow rate of 3.5 cfs was recorded on November 21, 1996 (KGI DRAFT 1999).

Estuarine

Most of the north shore and approximately 50% of the south shore of Glen Cove, at the mouth of Lackey Creek, has been extensively bulkheaded (Smolko). There is a large eelgrass bed off the Camp Seymore dock, but there are reports of increasing presence of *Ulva* (spp.) in this area (Smolko).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Lackey Creek:

- **Protect integrity of channel and riparian habitat that is currently rated as good**
- **Evaluate habitat impacts of extensive shoreline bulkheading of Glen Cove; remediate impacts where possible**
- **Assess salmonid utilization in this watershed**
- **Assess potential conversion of eelgrass beds to Ulva (spp.); identify and correct increased nutrient sources that may be causing this conversion**

Minter Creek 15.0048, Little Minter Creek 15.0051, Huge Creek 15.0052

General

The Minter Creek watershed is the largest of the East WRIA 15 drainages to southern Puget Sound. Mainstem Minter Creek is 6.3 miles long. The Minter Creek watershed is approximately 10,000 acres in size (Dickes and Patterson 1994). There are two major tributaries; Little Minter Creek (15.0051) is approximately 3 miles long, and Huge Creek (15.0052) is approximately 3.7 miles long. In addition, there are several small tributaries in the watershed. Minter Creek flows to Minter Bay midway up the western shore of Henderson Bay. Minter Creek supports chinook, chum, coho, steelhead, and cutthroat; Little Minter Creek supports chum, coho and cutthroat; Huge Creek supports coho, steelhead and cutthroat.

PCPNRP (1988) indicated that the Minter watershed was approximately one-third developed and two-thirds forested, with approximately 9% agricultural and 11% residential. Parametrix (1991) indicates that population growth in the Minter watershed was increasing at the rate of 2-3% per year, and that the total number of agricultural properties located near streams more than doubled from 1984-1991.

Fish Access

There are numerous road crossings of Minter Creek, several of which occur in a one-mile stretch where the Minter–Kitsap Road crosses the creek several times. Chum and chinook distribution occurs downstream of these road crossings. Coho, steelhead, and cutthroat distribution extends upstream to Pine Road, where the culvert is a barrier to fish passage (PCD). WDFW hatchery operations have presented a historic barrier to upstream fish migration. The hatchery is removing the upstream water diversion structure (WDFW SSHEAR fish passage barrier database SITEID 15.0048 4.7) and is correcting the downstream hatchery rack barrier (WDFW SSHEAR fish passage barrier database SITEID 15.0048 0.4(?)) to provide unobstructed upstream passage of the hatchery. The uppermost crossing of 118th Avenue is a partial (velocity) fish passage barrier, and there is a reported driveway culvert just downstream that is reported to also be a partial barrier (PCD).

The culvert on Little Minter Creek at 118th and SR 302 is failing (bottom is rusted out and flow is being lost through the bottom of the culvert) and is a barrier (PCD). The WDFW SSHEAR fish passage barrier database lists a culvert barrier on Huge Creek (SITEID 15.0052 1.4) at 160th Street (RM 1.4); PCD indicates this to be a partial (velocity) barrier.

Floodplain Modifications

There are about 8 beaver dams located in the Minter Creek drainage and significant wetlands are associated with the creek (KGI DRAFT 1999). Minter Creek is constrained for a one-mile stretch where it flows immediately adjacent to and crosses under the 118th Avenue; this area is also heavily channelized. The floodplain and channel are also constricted through the WDFW hatchery and along the road upstream to previous water intake site (Small).

Channel Condition

TAG participants had no specific knowledge of habitat conditions in Huge Creek. In Minter Creek, downstream of the mouth of Huge Creek, there is a significant amount of LWD, but it is mostly hardwood. Pool condition on Minter Creek is indicated as good upstream of Pine Road, but pools and channel complexity is notably lacking where Minter Creek flows along 118th Avenue; this area is a continuous glide. There is significant bank cutting and bank armoring on Minter Creek upstream of Pine Road for 0.75-1.0 mile, where the creek flows through a residential development. The only TAG observation on LWD condition in Little Minter Creek was in the reach upstream of the County line, where little LWD presence was noted.

Substrate

Dennis Popochock (Manager of the Minter Creek Hatchery) has noticed an increase in the amount of sediment in Minter Creek in the last three years as compared with the previous 17 years. The increase has ranged from what was formerly five to 10-cubic yards of organic muck-type sediment annually accumulating in the settling ponds at the intakes to the hatchery to 25 to 30 and up to 650-cubic yards of sandy material each year currently. The source is unclear but several sources are suspected, including, failure of an upstream gravel pit's stormwater system (since corrected), run-off from three gravel pits, increased development resulting in more stormwater erosion and more debris in stormwater, removal of streamside vegetation, channelization, and road development on Huge Creek, a major tributary (Small 1996, Popochock 1996, as referenced in KGI DRAFT 1999). The change in the type of sediment from finer grained organics to coarser sand may be due to the maturing of the development in the basin. Twenty years ago more timber cutting and land clearing was occurring. Now there may be greater amounts of run-off due to increased impervious surface resulting in more erosion.

The Pierce County Stream Team rated macroinvertebrates in the creek as “Moderate” in 1996, and “Excellent” in 1997 (KGI DRAFT 1999). Stoneflies in the creek seem to be particularly robust. They rated the creek as “good to excellent” on the streamwalks conducted in a 200-foot site located 1/4 mile above the hatchery. Bank conditions noted were artificial modifications and silt in the stream, although silt was not in excessive amounts when the streamwalk was conducted. Minter Creek's gravel streambeds are excellent habitat for spawning and the riparian zone is excellent. Land uses were single-family residences and unpaved roads. A second site monitored on 118th Ave KPN almost to County Line Road was found to be healthy also with an excellent riparian zone and good spawning gravels. Water quality parameters measured (pH, dissolved oxygen, temperature, and average nitrate) were reported as good. Low pH problems have occurred in the spring. Problems identified by Stream Team include unpaved roads and bank modifications. A foam or sheen has been seen on the surface of the water just upstream of Minter Hatchery. Mud and silt also seem to be entering the stream. Temperatures taken during a summer of 1998 survey found levels between 12 and 14°C.

The TAG indicates that although Little Minter Creek is a small system with channel width <3 feet, that gravel condition is generally good. The reach upstream of the County line was noted as having good gravel composition, with few fines. The Pierce County Stream Team noted some siltation but for the most part, the creek runs swift, clean, and cold.

Riparian Condition

The TAG indicates that riparian condition on Minter Creek is poor to non-existent where the creek runs adjacent to 118th Avenue (~RM 1.5-2.7). From the County line to Pine Road, riparian trees are present, although dominated by mature hardwoods. Upstream of Pine Road, for 0.75-1.0 mile, riparian vegetation is sporadic through a residential development.

Riparian vegetation along Little Minter Creek is regularly removed along SR 302 in the lower 1.2 miles of creek to keep the powerlines clear. The Pierce County Stream Team found the creek to have good riparian cover on a streamwalk in back of the Harvestime Store off the Key Peninsula Highway.

Water Quality

Dickes and Patterson (1994) indicate that approximately 50% of the soils in the Minter watershed are unsuitable for on-site sewage treatment and disposal. Parametrix (1991) indicates that sanitary surveys of on-site sewage disposal systems typically finds that approximately 5% are failing, regardless of when the survey is performed. Water quality sampling performed in 1992-93 found violations of the "Class AA" fecal coliform standard at all five locations tested along the creek (KGI DRAFT 1999). Water quality declined in upper Minter Creek in the reach between the uppermost and next stations. Then it improved at each station downstream toward the mouth. Both parts of the water quality standard were exceeded at the second and third uppermost stations while just the second part of the "Class AA" criterion was exceeded at the other stations. Minter Creek is on the CWA 303(d) list for exceedance of fecal coliform standards.

The Kitsap County Conservation District reports that "Best Management Practices" have been focused along Minter Creek between the second and third upstream stations and may be the cause for the lower concentrations at the downstream site. However, the Conservation District has not yet addressed problem areas identified between the two uppermost stations. Flow-adjusted mean fecal coliform levels were significantly higher in 1992-93 compared with baseline data from 1983 at both the mouth site and an upper watershed site (Dickes and Patterson 1994, as referenced in KGI DRAFT 1999).

Water quality in Little Minter Creek is not as good as that found in other area streams (KGI DRAFT 1999). Elevated levels of fecal coliform were found during rain events, and Little Minter Creek is on the CWA 303(d) list for exceedance of fecal coliform standards. The highest fecal coliform count found in the most recent Department of Ecology study of the Burley-Minter Creek Subwatershed was collected at the upper Little Minter Creek site. Mean bacteria levels were higher in the upper watershed than in the lower watershed, unlike other creeks in the study (Dickes and Patterson 1994). This pattern on Little Minter Creek has also been documented in other studies (Determan et al. 1985, Struck 1990, TPCHD 1990, all as referenced in Dickes and Patterson 1994), with the source of the bacteria identified as poor livestock management. There were concentrated efforts to improve implementation of agricultural BMPs from 1983-1993, but no significant water quality improvements resulted (Dickes and Patterson 1994). Parametrix (1991) identified that 9 of 19 farms on Minter Creek, 4 of 6 farms on Huge Creek, and 2 of 5 farms on Little Minter Creek had installed agricultural BMPs, with those with installed BMPs representing approximately 50% of the agricultural stream footage. Although 2,000-3,000 feet of livestock stream frontage was being fenced annually in the Burley/Minter watersheds during the period 1984-1990, the percentage of total livestock frontage fenced was reduced from 59% of

26,600 frontage feet in 1985 to 49% of 46,700 frontage feet in 1991. Dickes and Patterson (1994) identify the reach from the mouth of Huge Creek to Pine Road as the area that would benefit from special focus on implementation of agricultural BMPs.

Temperature readings taken during a summer of 1998 survey found levels ranging between 11.5 and 14.5°C. Water quality parameters measured and macroinvertebrate counts were adequate. However, nitrate levels were higher than typically found in the Key Peninsula area. Rensel and Associates has been monitoring the water quality of both ground and surface waters in the area surrounding Horseshoe Lake Golf Course since at least 1994. Minter Creek flows through the golf course. There appears to be a strong potential for the golf course to impact water quality in the creek through groundwater infiltration since the soils in the area are gravelly, which allows rapid movement of water while providing minimal filtration. In addition, there is a horse camp on Horseshoe Lake that may be contributing nutrients to the lake, and downstream to Little Minter Creek (Smolko). Possible pollutants include nutrients and pesticides depending on what products are used and how carefully they are applied. Stream Team volunteers noted concerns about commercial impacts from existing businesses as well as new development. They are also concerned about proposed residential developments impacting water quality.

The Bremerton-Kitsap Health District has been collecting water quality information at five locations on Minter and Huge creeks since 1996. There were no consistent water quality concerns identified.

Minter Creek and Little Minter Creek are on the CWA 303(d) list for impaired use of aquaculture due to fecal coliform and other pathogens. Huge Creek is on the CWA 303(d) list for exceedance of fecal coliform standards.

Water Quantity

Minter Creek and tributaries have been closed to further consumptive water appropriation since 1973 (WAC 173-515-040). Incubation and rearing water at Minter Creek Hatchery has been recently converted from a surface water diversion to well water.

Estuarine

The TAG indicates that natural estuarine conditions are generally intact in the inner portion of Minter Bay. Both shores of outer Minter Bay have heavy housing development, with associated heavy shoreline armoring.

Nearshore/Marine

Minter Bay is designated as Class AA marine waters. Shellfish harvest in Minter Bay was downgraded from approved to prohibited in 1982, based on increased fecal coliform contamination (Dickes and Patterson 1994). Freshwater tributaries were considered to be the primary source of fecal coliform entering the estuaries, primarily from failing septics, livestock access from small farms, and stormwater runoff (Determan 1993, as cited in Dickes and Patterson 1994).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Minter Creek and tributaries:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Modify the Minter Creek Hatchery water intake structure and correct the hatchery rack operation to provide unobstructed upstream fish passage**
- **Restore natural channel configuration, floodplain function, and riparian function in the channelized/constrained one-mile stretch along and under 118th Avenue**
- **Prioritize and correct identified fish passage barriers in the Minter Creek watershed**
- **Implement a comprehensive program to prevent unrestricted livestock access to Minter Creek and tributaries (the reach on Minter Creek from Huge Creek to Pine Road is identified as one area that would particularly benefit from implementation of agricultural BMPs)**
- **Identify and correct sources of fine sediment delivery to the watershed**
- **Develop and implement a short-term LWD strategy in Minter Creek along 118th Avenue and in Little Minter Creek upstream of the County line, to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore riparian function on Minter Creek upstream of Pine Road, where the creek flows through a residential development; encourage conifer regeneration in deciduous stands that historically had a conifer component (particularly from the County line to Pine Road**
- **Evaluate habitat impacts of shoreline bulkheading of outer Minter Bay; remediate impacts where possible**
- **Assess salmonid habitat conditions in Huge Creek; correct identified salmonid habitat limiting factors, as warranted**
- **Continue to monitor water quality downstream of Horseshoe Lake; implement corrective measures if warranted**

Unnamed 15.0053

General

This small independent creek is approximately 0.75 mile long, entering Henderson Bay approximately 0.5 mile north of Minter Bay. The TAG has no information on fish distribution or habitat conditions in this stream.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0053:

- **Assess salmonid utilization and salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Unnamed 15.0054

General

This small independent creek is approximately 1.0 mile long, entering Henderson Bay approximately 1.0 mile north of Minter Bay. The culvert at the 128th Street crossing is a barrier to upstream fish passage (PCD). The TAG has no additional information on fish distribution or habitat conditions in this stream.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0054:

- **Assess salmonid utilization and salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Burley Creek 15.0056, Little Bear Creek 15.0057, and Unnamed Creeks 15.0056A-0059A

General

Burley Creek enters the north end of Burley Lagoon at the north end of Henderson Inlet. Burley Creek is >5 miles long, with an additional 4 miles of tributary, of which Little Bear Creek (W. Fork Burley) 15.0057 is the largest at >2 miles long. The Burley/Purdy Creek watershed is approximately 10,000 acres in size (Dickes and Patterson 1994). The drainage supports chinook, chum, coho, steelhead and cutthroat, with a few sockeye also observed on occasion.

PCPNRP (1988) indicated that the Burley watershed was approximately 27% developed, with approximately 6% agricultural and 17% residential/light agriculture. Parametrix (1991) indicates that population growth in the Burley watershed was increasing at the rate of 2-3% per year, and that the total number of agricultural properties located near streams more than doubled from 1984-1991.

Fish Access

The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert (SITEID 15.0056 3.7) on Burley Creek at RM 3.7 (Holman Road). The culvert is likely only a partial barrier, as Kalinowski observed juvenile coho just upstream of the Holman Road culvert in April 2000. The culvert under Mullenix Road is reported to be a velocity barrier to fish passage, although coho, steelhead and cutthroat are reported upstream. The TAG indicates there is limited habitat upstream of Mullenix. There is also a culvert that is a partial barrier to fish

passage at either the Bethel/Burley or Oak Street crossings (possibly both) of the right bank tributary to Burley Creek that enters approximately 0.75 mile upstream of the mouth of Little Bear.

There are five previous fish passage barriers located on Little Bear Creek. The culvert at Bethel-Burley Road (previous partial barrier, WDFW SSHEAR fish passage barrier database SITEID 15.0057 0.1) was replaced by the County in 1999. The remaining 4 barriers, located on private driveways, have also been repaired, allowing unrestricted fish passage to the headwaters. Two additional partial barriers near Madrona Road have recently been identified and plans are currently being developed by Kitsap County Conservation District to repair them (Kalinowski). The WDFW SSHEAR fish passage barrier database also indicates presence of a fish passage barrier culvert (SITEID 15.0057A 0.0) on a driveway on an Unnamed/Unnumbered tributary to Little Bear Creek. The TAG was unfamiliar with the current passage status of this culvert.

There are two anadromous fish passage barriers located on Unnamed 15.0059. The instream pond (RM 0.3) downstream of SR 16, and the SR 16 crossing of the creek are both barriers.

The WDFW SSHEAR fish passage barrier database lists additional culvert barriers on 15.0058 at SR 16 (SITEID 991516) and one on another left bank tributary to Burley Creek at SR 16 (SITEID 991866).

Floodplain Modifications

The TAG indicates a significant amount of channelization of Burley Creek, although functional floodplain characteristics remain. Little Bear Creek is confined in places by yards encroaching on the stream, but there are no significant modifications to floodplain function.

Channel Condition

Channel condition in Burley Creek is generally poor. Pool conditions in the lower 2 miles of Burley Creek are poor (TAG). LWD condition throughout Burley Creek is generally poor; there is limited LWD present at sporadic locations, but the LWD is primarily deciduous.

The TAG indicates that channel habitat conditions are generally good in Little Bear Creek.

Substrate

Substrate condition in Burley Creek is poor (heavy fine sediment presence) from the mouth to Oak Street (TAG). Gravel quality is indicated to be generally good elsewhere in the watershed.

Riparian Condition

The TAG indicates that riparian condition in Burley Creek is generally poor through the high-density rural area from the mouth to RM 0.75, fair with hardwood dominated riparian zone from RM 0.75-2.0, and poor to non-existent in the agricultural area upstream of RM 2.0.

The TAG indicates that riparian buffers on Little Bear Creek are generally intact except for lawn areas and driveways; riparian vegetation is mixed, but is mostly hardwood.

Water Quality

Dickes and Patterson (1994) indicate that approximately 75% of the soils in the Burley/Purdy watershed are unsuitable for on-site sewage treatment and disposal. Parametrix (1991) indicates that sanitary surveys of on-site sewage disposal systems typically finds that approximately 5% are failing, regardless of when the survey is performed. More specific inspection programs targeting Burley Lagoon were performed in 1994 and 1995. Bremerton-Kitsap County Health Dept. surveyed 484 systems and found a 9% failure rate. Tacoma-Pierce County Health Dept. dye-tested 93% of 121 systems near freshwater and marine shorelines and found an overall failure rate of 12% (Determan 1999, as cited in KGI DRAFT 1999). In the lower reach of Burley Creek, both parts of the fecal coliform standard were violated in the most recent Department of Ecology Study (KGI DRAFT 1999). The report suggests that poor water quality in this reach could be due to the transition into poorer soils, lack of focused best management practices, and increased proximity to the town of Burley where septic failures may be a problem. In general, the upper watershed had low fecal coliform bacteria levels except during rain events, when the standard was violated. Livestock from small farms have been sighted in the creek.

The Kitsap Conservation District (KCD) has been the main entity working with agricultural sources in the watershed. KCD has worked with small farmers in the watershed for the last 11 years. In 1995, they report there were 73 active small farms in the Burley watershed. Of these, 66 were between 1 and 20 acres in size. Approximately 86% of these have been contacted by KCD and offered technical assistance to implement agricultural BMPs (Garitone 1996, as referenced in KGI DRAFT 1999).

There were concentrated efforts to improve implementation of agricultural BMPs from 1983-1993, but no significant water quality improvements resulted (Dickes and Patterson 1994). Parametrix (1991) identified that 9 of 32 farms on Burley Creek, and 4 of 8 farms on Little Bear Creek had installed agricultural BMPs, with those with installed BMPs representing approximately 50% of the agricultural stream footage. Although 2,000-3,000 feet of livestock stream frontage was being fenced annually in the Burley/Minter watersheds during the period 1984-1990, the percentage of total livestock frontage fenced was reduced from 59% of 26,600 frontage feet in 1985 to 49% of 46,700 frontage feet in 1991. Dickes and Patterson (1994) identify the reach from Spruce Road to Oak Road as the area that would benefit from special focus on implementation of agricultural BMPs.

The water quality standard for fecal coliform was exceeded on Little Bear Creek during the most recent Department of Ecology study (KGI DRAFT 1999). The small tributary did not exceed the standard. During the study, routine dredging of roadside ditches by Kitsap County resulted in a total suspended solid concentration of 160 mg/L, and the water turned opaque brown with sediment. A total suspended solid concentration of similar magnitude was also found a month later during a rain event. This most likely resulted from the re-suspension of sediment deposited during earlier dredging activities (Dickes and Patterson 1994).

The Bremerton-Kitsap Health District has been collecting water quality information at nine locations in the Burley Creek watershed since 1996. Exceedance of the state water quality standard for fecal coliform has been regularly observed at the station downstream of the Spruce Road bridge, on Bear Creek just north of Pine Road, and periodically at the station downstream of the Spring Creek Road culvert. The other identified water quality parameter of concern is

dissolved oxygen, which averaged 9.3 mg/l downstream of the Spring Creek Road culvert, with individual sample values as low as 7.4 mg/l.

Burley Creek and Little Bear Creek are on the CWA 303(d) list for impaired use of aquaculture due to fecal coliform and other pathogens.

Water Quantity

Significant wetlands are associated with the Burley Creek (KGI DRAFT 1999).

Burley Creek and tributaries have been closed to further consumptive water appropriation since 1951 (WAC 173-515-040). Instream flows for water years 1991-1999 ranged from a minimum flow of 8.2 cfs to a maximum flow of 308 cfs. Of particular note is the increase in peak flows beginning in 1996, potentially the result of increased stormwater runoff in the basin.

Stream flow data for Burley Creek (as measured at Spruce Road) are presented in Table 4.

Table 4: Streamflow data for Burley Creek (from Kitsap Public Utility District 2000)

Water Year	Mean Discharge (cfs)	Max. Discharge (cfs)	Min. Discharge (cfs)
1991	34.6	250	15
1992	24.9	103	11
1993	15.3	38	11
1994	20.5	73	11
1995	17.5	79	8.2
1996	30.6	281	11
1997	37.0	308	13
1998	35.7	179	16
1999	42.7	281	16

Figure 16: Burley Lagoon at the head of Henderson Bay (photo courtesy of Dept. of Ecology)

Estuarine

The upper third of Burley Lagoon (Figure 16) is largely undeveloped, with presence of significant amounts of salt marsh. The outer two-thirds of Burley Lagoon has significant shoreline development, with associated shoreline armoring.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Burley Creek and tributaries:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**

- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Protect natural habitat characteristics of upper Burley Lagoon; evaluate habitat impacts of shoreline bulkheading of outer Burley Lagoon, remediate impacts where possible**
- **Prioritize and correct identified fish passage barrier throughout watershed**
- **Restore natural channel configuration in channelized portions of Burley Creek**
- **Implement a comprehensive program to prevent unrestricted livestock access to Burley Creek and tributaries (the reaches on Burley Creek from Spruce Road to Oak Road, and upstream of Oak Road (Iverson), are identified as areas that would particularly benefit from implementation of agricultural BMPs)**
- **Develop and implement a short-term LWD strategy in the lower 2 miles of Burley Creek, to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore riparian presence and function on Burley Creek from the mouth-RM 0.75 and upstream of RM 2.0; encourage conifer regeneration in deciduous stands from RM 0.75-2.0 that historically had a conifer component**
- **Restore riparian function through residential areas on Little Bear Creek; encourage conifer regeneration in deciduous stands that historically had a conifer component**
- **Ensure that County Roads Departments maintain roadside ditches in a manner that does not result in fine sedimentation to creeks**
- **Identify and correct sources of fecal coliform contamination of freshwater and marine waters**

Purdy Creek 15.0060 and Unnamed 15.0061

General

Purdy Creek is approximately 3.5 miles long, with a tributary (15.0061-0062) providing an additional 1.6 miles, and tributary 15.0060A (small tributary south of 15.0061) providing an additional 0.1mile of creek channel. It enters the southeast corner of Burley Lagoon at the north end of Purdy. The mainstem supports chum, coho, steelhead, and cutthroat, and the tributary supports coho and cutthroat. Tributary 15.0061 supports coho to Bandix Road with cutthroat extending farther upstream. Fish presence in tributary 15.0060A is unknown. In addition, fall chinook strays are regularly seen in Purdy Creek, but the TAG indicates that Purdy Creek does not have the habitat characteristics of a traditional fall chinook stream. Land use is varied and includes rural areas, SR 16, a trailer park, a park and ride lot, and Peninsula High School (KGI DRAFT 1999).

Fish Access

The creek channel is braided through the estuary, resulting in impaired passage at low tide. There are numerous barriers in this watershed. The culvert at SR 16 is thought to be a partial barrier,

but adult fish are known to regularly get upstream. There is a complex culvert arrangement at the Chevron station at the corner of 144th and Purdy Drive that is a partial fish passage barrier (PCD). The culvert is very long, entering two steel pipes at the upstream end, which then dump into a concrete box culvert. The culverts at the 160th Street crossing (undersized pipe with outfall), at the Nelson Road crossing, and at the Burley-Olalla Road crossing are all fish passage barriers (PCD). The culvert under Bandix Road is a partial barrier (PCD, headwall collapsing/debris on upstream end).

Shortly upstream of Bandix Road on 15.0060, there is a farm with an instream dam and farm ponds that would also be passage barriers; the TAG indicates approximately 200 yards of coho habitat upstream of the farm dam. There is an 18-inch culvert just upstream of the mouth of the 4-foot wide tributary 15.0060A that is likely a barrier to upstream fish passage.

Channel Condition

The lower 0.5 mile of Purdy Creek has abundant hardwood LWD and good associated pool complexity. LWD and pool condition is unknown through the rest of the channel. The Pierce County Stream Team rated the creek on the streamwalks conducted in the vicinity of 15501 62nd Ave NW as "Good" on five different occasions and "Excellent" once.

Substrate

The TAG indicates that substrate in tributary 15.0061 is composed primarily of small gravels with sand. Substrate condition is unknown through the rest of the watershed.

Riparian Condition

The TAG indicates that from 144th to 160th, Purdy Creek has a wide hardwood dominated riparian zone; from 160th to Nelson Road the riparian zone is generally narrow and dominated by mature hardwood, interrupted by sporadic farms that have removed much of the riparian vegetation. From Nelson Road upstream, the creek has a mature hardwood riparian zone. Riparian vegetation in tributary 15.0061 is primarily hardwood, but buffer width is "pretty sizable". Riparian vegetation is removed upstream of Bandix Road for approximately 200 feet, but upstream the tributary goes into a steep ravine.

Water Quality

The Pierce County Stream Team sampled Macroinvertebrates on four different occasions (KGI DRAFT 1999). It received "Poor" ratings twice, a "Moderate" rating once, and an "Excellent" rating once. Dissolved oxygen and nitrate tests both showed healthy levels. A temperature survey performed on August 19, 1998 found temperatures ranging from 11.5 to 14°C, which were generally lower than many other area streams sampled on the same day. Stream Team water quality sampling results have generally found the creek to be in fairly good condition.

According to a Department of Ecology study (1993), fecal coliform levels were relatively low in Purdy Creek except during rain events, when peak values led to standard violations (KGI DRAFT 1999). The upper reach did not violate the standard; however, fecal coliform bacteria levels increased during rain events. Total suspended solids were comparatively high in upper Purdy

Creek even during low rainfall. Upper Purdy Creek was the only location where a significant decrease in fecal coliform levels was detected relative to earlier years. The reason is unclear, since nonpoint source controls have not been focused in this area. The source of the total suspended solids is unclear, although tree-thinning operations had been occurring in the upper drainage basin (Dickes and Patterson 1994, as referenced in KGI DRAFT 1999). The Stream Team also noted silt in the creek in 1996. The creek is on the CWA 303(d) list for impaired use of aquaculture due to fecal coliform and other pathogens.

The Bremerton-Kitsap Health District has been collecting water quality information at three locations on Purdy Creek since 1996. There were no consistent water quality concerns identified.

Parametrix (1991) identified that only 4 of 12 farms on Purdy Creek had installed agricultural BMPs.

Water Quantity

The Department of Ecology has determined that Purdy Creek and tributaries exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, no further water is available for consumptive appropriation from June 1 – October 31 (WAC 173-515-040). Applications for consumptive water appropriation at other times of the year are subject to minimum instream flows established in WAC 173-515-030.

Adjacent property owners have installed at least one “duck pond” near the creek and have diverted creek water.

Estuarine/ Nearshore/Marine

Purdy Creek flows into the southern end of Burley Lagoon. It is likely that juvenile and adult salmonids would utilize estuarine habitat throughout Burley Lagoon, although estuarine habitat conditions at the southern end of the lagoon are impacted to a greater degree by bulkheading and shoreline armoring than near the mouth of Burley Creek, at the north end of the lagoon.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Purdy Creek and tributaries:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Prioritize and correct identified fish passage barriers throughout watershed**

- **The Dept. of Ecology should review ponds created near the creek to ensure that surface water diversions are conducted pursuant to necessary permits**
- **Protect natural habitat characteristics of upper Burley Lagoon; evaluate habitat impacts of shoreline bulkheading of outer Burley Lagoon, remediate impacts where possible**
- **Assess substrate composition throughout watershed; identify and correct sources of fine sedimentation to the creeks**
- **Assess LWD and pool condition throughout the watershed; correct habitat conditions in areas that are identified as deficient in LWD or pools**
- **Restore riparian presence and function throughout the watershed; encourage conifer regeneration in deciduous riparian stands that historically had a conifer component**
- **Identify and correct sources of fecal coliform contamination of freshwater and marine waters**

Goodnough (Gooch) Creek 15.0063 and Unnamed (Wilderness) 15.0064

General

Goodnough Creek is approximately 1.0 mile long, entering Henderson Bay just south of Purdy. The creek drains an area of about 2 square miles (1318 acres)(Pierce County Water Programs 2000). The creek supports coho and chum downstream of SR 302, and cutthroat. There is one small tributary known as SF Dogfish that flows into Goodnough at Canterwood Drive. Land uses represent a broad range from single-family residences to road construction. Those noted as clearly affecting water quality included single-family residences, heavy industry, residential construction, industrial construction, grazing, multi-family residences and construction, and road construction (KGI DRAFT 1999).

Fish Access

Anadromous salmonid access on Goodnough Creek is precluded by five culverts; SR 302 (partial barrier (PCD), WDFW SSHEAR fish passage barrier database SITEID 15.0063 0.10), Goodnough Drive (PCD), SR 16, and two private roads upstream of SR 16. Upstream fish passage is blocked by a golf course pond on the northern branch (Pierce County Water Programs 2000). The culvert at the 141st Avenue on SF Goodnough is also a fish passage barrier (PCD).

Floodplain Modifications

Goodnough Creek is naturally confined through much of its length in a deep ravine. However, the floodplain is confined within culverts in the lower quarter mile where it flows under SR 302 and SR 16, both of which are fish passage barriers.

Channel Condition

An assessment of habitat conditions was conducted in 2000 (Pierce County Water Programs 2000). Fish habitat was rated as poor downstream of SR 302, and fair in all reaches upstream of SR 302. Assessments of specific channel condition elements are presented in Table 5:

Table 5: Channel condition ratings for Goodnough Creek (Pierce County Water Programs 2000)					
Reach	**Bank Stability**	**Pool Frequency**	**Channel Pattern and Bedform**	**LWD Presence**	**Substrate Composition/ Embeddedness**
Downstream of SR 302	Poor	Poor	Poor	Poor	Fair/Poor
SR 302 – 54th Ave.	Good	Fair	Fair	Fair	Fair/Poor
54th Ave – 141st St. Ct.	Poor	Poor	Fair	Poor	Good/Fair

Data collected by Chris May (evaluation of segment upstream of Goodnough Drive) indicates the channel is confined with low sinuosity. Average bank full width is 2.5 m with average bank full depth of 0.37 m. Mean gradient is 2.5%. Bank stability is rated as 50-75% stable. Chris May rated the pool condition as poor, with 17% pool habitat, pool spacing of 8.0 bankfull widths/pool, and mean residual depth of 0.17 m. He rated riffle habitat as marginal, with 78% riffle habitat and 45% embeddedness.

Streamwalk ratings have ranged between "Poor" and "Good" with the majority being "Good". Among the bank conditions noted were artificial modifications, algae/scum floating or coating rocks, garbage in and adjacent to stream, creek artificially modified, and foam or sheen (KGI DRAFT 1999).

Substrate

TAG participants and the Pierce County Stream Team report excessive siltation in the substrate. Residential housing construction, Purdy Topsoil, and the Pierce County Public Works shop are suspected as possible sources of sediment (KGI DRAFT 1999). TAG participants have not observed excessive siltation in the lower watershed as reported by the Stream Team, and indicate that downstream of 144th, the substrate is composed of good gravels with few fines. Pierce County Water Programs (2000) rates substrate composition as fair, and substrate embeddedness as poor (Table 5).

Riparian Condition

The TAG indicates that riparian condition is good downstream of 144th Street.

Pierce County Water Programs (2000) rates riparian recruitment potential as poor downstream of SR 302 and good upstream. The lack of vegetative cover on the Canterwood Golf Course is identified as the potential cause of observed channel erosion and downcutting.

Water Quality/Water Quantity

The closed Purdy landfill is located in the drainage, potential impacts are unknown. The Pierce County Stream Team tested for macroinvertebrates and rated the creek as "Poor" on one occasion, "Moderate" on four other dates, and "Excellent" during two samples. Nitrate levels were higher than most of the other area streams so Pierce County Water Programs is investigating further. Possible sources of nitrates include Canterwood Golf Course and numerous homes.

Readings taken for temperature, pH, and dissolved oxygen generally found the creek to be in good condition (KGI DRAFT 1999).

Pierce County Water Programs (2000) estimates that 17% of the Goodnough Creek watershed is impervious surface; degraded channel conditions are typically evident when impervious surfaces exceed 10% of the watershed. Bank erosion and channel downcutting are likely the result of stormwater runoff from development in the upper watershed.

Estuarine/Nearshore/Marine

Goodnough Creek flows directly into Henderson Bay, and does not have any significant estuary at its mouth. The tidal reach runs along the back of the beach parallel to the shoreline of Henderson Bay for several hundred feet. The tidal reach of the creek is channelized and in poor condition; residential property owners may have routed the creek channel (Pierce County Water Programs 2000). However, the mouth of Goodnough Creek is at the base of Burley Lagoon, which provides good estuarine habitat.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Goodnough Creek and tributaries:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Prioritize and correct identified fish passage barriers throughout watershed**
- **Restore natural channel configuration and floodplain function downstream of SR 16**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity**
- **Assess extent of fine sediment delivery to creeks in the watershed; correct identified sources of fine sedimentation**
- **Identify and correct sources of high nitrates observed in Goodnough Creek**
- **Monitor water quality downstream of the closed Purdy landfill; remediate identified water quality impacts**

McCormick Creek 15.0065 and Unnamed 15.0066

General

Mainstem McCormick Creek is approximately 1.6 miles long, with a branched tributary representing an additional 2.0 miles of channel. The creek originates in a large wetland drains a catchment of 2.5 mi^2 (Pierce County Water Programs 2000), and flows northwest to Henderson Bay, entering approximately 0.75 mile south of Purdy. The creek supports chum, coho,

steelhead, and cutthroat. In addition, periodic chinook strays have been noted. A stretch of the creek near the correctional facility is owned by the parks department, whose intent is to protect the area from development (KGI DRAFT 1999).

Fish Access

There are six culverts located on mainstem McCormick Creek, three of which are located under SR 16 crossings (one of these is identified in the WDFW SSHEAR fish passage barrier database as SITEID 991942). The culvert at Woodhill Drive, located approximately 0.3 mile downstream of SR 16, is a barrier to fish passage (likely the same as SITEID 991943 in the WDFW SSHEAR culvert database). Part of the culvert problem may be associated with a water diversion structure for a remote site incubator (RSI) that has not been removed during adult migration (PCD). A private crossing (culvert) between Woodhill Drive and Sehmel Drive is a barrier to fish passage (PCD). The Rosedale culvert upstream of SR 16 is a large pipe and is not a barrier, but the pipe is about 90% plugged with silt and should be repositioned. One of the culverts under SR 16 is in similar condition, but only about 50% full of material. Steve Kalinowski has been working with WSDOT to replace culverts when other road work is done in the vicinity. Upstream of Canterwood Drive, a culvert under the access road for an electrical transmission line may also be a barrier (Pierce County Water Programs 2000).

Floodplain Modifications

McCormick Creek is naturally confined in a canyon from the upper end of tidal reach to Woodhill Drive (Pierce County Water Programs 2000). Upstream, the creek runs parallel to SR 16, and the natural floodplain is constrained somewhat by the extent of fill associated with the highway. However, the natural floodplain is generally still functional, except where the creek flows through the highway culverts. From the upstream SR 16 culvert to Canterwood Drive, the northern branch of the creek is little more than a roadside ditch; upstream of Canterwood Drive there is a 2,400-foot long, relatively undisturbed reach that is confined in a ravine (Pierce County Water Programs 2000).

Channel Condition

An assessment of habitat conditions was conducted in 2000 (Pierce County Water Programs 2000). Assessments of specific channel condition elements are presented in Table 6.

The lower quarter mile of McCormick Creek has a good mature riparian zone, abundant LWD and good habitat complexity.

Substrate

There are areas with good gravel presence McCormick Creek, but the substrate throughout the watershed is heavily impaired by silt embeddedness (Table 6). Past gravel pit operation on the east side of SR 16 is thought to be the primary contributor, with silt generated both from gravel washing and truck washing. The gravel pit on the east side of SR 16 has not been actively used in the last 3-4 years (Kalinowski). There is an active gravel pit (Active Construction) on Sehmel Drive, on the west side of SR 16, that likely contributed fines to the creek in the past, but current management of the gravel pit appears to be generally good. In addition, expansion construction

Table 6: Channel condition ratings for McCormick Creek (Pierce County Water Programs 2000)					
Reach	**Bank Stability**	**Pool Frequency**	**Channel Pattern and Bedform**	**LWD Presence**	**Substrate Composition/ Embeddedness**
Downstream of Woodhill	Fair	Good	Good	Good	Good/Poor
Woodhill – SR 16	Poor	Fair	Fair	Poor	Fair/Poor
SR 16 - Penitentiary	Good	Poor	Good	Good	Good/Fair
0066 SR 16-Canterwood	Fair	Poor	Poor	Poor	Poor/Poor
0066 Canterwood – Forks	Good	Good	Good	Good	Fair/Fair
0066 upstream of forks	Good	Good	Good	Good	Good/Fair
Lower 0067	Poor	Fair	Fair	Good	Fair/Poor
Upper 0067	Poor	Poor	Poor	Poor	Poor/ Poor

at the prison in the mid-1990s caused heavy siltation in the creek, some of which is still likely present (Small).

Gig Harbor High School has performed numerous data collection activities on McCormick Creek (KGI DRAFT 1999). Thirty macroinvertebrate samples taken from the creek have resulted in an average rating of "Excellent", but results have varied. Macro-invertebrate samples taken since March 1996 have generally fallen into the "Good" to "Moderate" range. They also performed two stream walks, one resulted in a "Good" rating and another in a "Poor" rating.

Riparian Condition

Riparian condition is rated as good, except in the estuary and from Woodhill Drive to SR 16, where riparian condition is poor (Pierce County Water Programs 2000).

Water Quality

The Gig Harbor High School has performed 30 water quality samples on the creek between 1994 and 1996 on two different sites (KGI DRAFT 1999). The average temperature was 9.33°C, the average pH was 6, and the average dissolved oxygen level was 8.23 mg/l. The unusually low pH readings are attributed to acidity coming from wetlands associated with the creek. Nitrate levels were extremely low, with most readings not reaching detectable levels. Average discharge was 9.81 cfs but discharge ranged between 1.6 and 17.5 cfs. Temperature readings taken during August of 1998 ranged between 15 and 17°C.

Water Quantity

Pierce County Water Programs (2000) estimates that 16% of the McCormick Creek watershed is impervious surface; degraded channel conditions are typically evident when impervious surfaces exceed 10% of the watershed.

The creek is likely impacted by stormwater runoff from the County Road, SR 16, Canterwood golf course and residential community, and development in the headwaters, although the extent of impact has not been quantified. The drainage is slated for significant growth, with a large commercial center proposed for the headwaters. This growth has the potential to add new road crossings and result in additional stormwater input. Pierce County has adopted a stormwater manual, which may limit the extent of additional stormwater impacts.

Streamflow measurements were made by USGS near the mouth of the creek from February 1978 to January 1979 (Pierce County Water Programs 2000). Flows ranged from 4.64 cfs in May to 1.15 cfs in August. The 25-year recurrence interval storm flow under 1990 land use conditions was estimated to be 230 cfs.

Estuarine/Nearshore/Marine

McCormick Creek has no significant estuary, draining directly to Henderson Bay. Habitat condition in the limited tidal reach of McCormick Creek is rated as fair, but lacks adequate riparian buffer and streamside cover (Pierce County Water Programs 2000).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for McCormick Creek and tributaries:

- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Correct identified fish passage barrier at Woodhill Drive, 0.3 mile downstream of SR 16; evaluate fish passage status at private crossing between Woodhill and Sehmel, and at other identified passage barrier sites, correct as warranted**
- **Identify and correct sources of fine sedimentation to the creeks; monitor gravel operations to ensure they do not contribute fine sediment to the channel**
- **Develop and implement a short-term LWD strategy upstream of the county road at RM 0.25, to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore riparian function upstream of the county road at RM 0.25**

- **Reposition culverts at Rosedale and at one of the SR 16 crossings to reduce clogging with bedload (incorporate with other road work in the vicinity)**

Lay (Nelyaly) Creek 15.0068

General

Lay Creek is approximately 1.5 miles long and flows to Lay Inlet near Rosedale (north of the east end of Raft Island in Henderson Bay). Lay Creek drains a catchment of 1.5 mi^2 (Pierce County Water Programs 2000). Coho and chum have been planted by volunteers for a number of years, with a reported high rate of hatching and success with returning fish (Olsen, personal communication, as referenced in KGI DRAFT 1999). An increase in siltation of the substrate has been noted in recent years, as well as a decrease in stream flow associated with construction of private ponds. There is no record of instream project permitting in this creek in recent years (Kalinowski). Some gravel and LWD have been placed by volunteers in an attempt to restore salmonid habitat (KGI DRAFT 1999).

Recent watershed assessment (Pierce County Water Programs 2000) indicates that riparian conditions are good/fair, and fish habitat is fair downstream of 82nd Avenue. Both riparian condition and fish habitat are rated as good from 82nd Avenue upstream to the forks. The northern branch is approximately 2,500 feet long; riparian condition in this reach is rated as narrow but fair, fish habitat condition is poor. Fish habitat and riparian condition in the northern branch and tributaries are rated as fair and good, respectively, except just downstream of 92nd Street, where both fish habitat and riparian condition are rated as poor. Composite stream survey summary habitat ratings for Lay Creek, identified by Pierce County Water Programs (2000) are:

Riparian Condition	Fair
Substrate Composition in Spawning Areas	Poor/Fair
Substrate Embeddedness	Poor
Bank Condition	Good
Pool Frequency	Poor/Good
Large Woody Debris	Poor/Good

No water quality sampling information is available for Lay Creek (KGI DRAFT 1999). Lay Creek has good estuarine habitat for approximately 100 yards upstream of 86th Avenue.

The culvert at the 82nd Avenue crossing is a fish passage barrier (culvert is installed at a 2% slope)(PCD). Kalinowski indicates the culvert is a barrier at low tide, but is passable at high tide. The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert on Lay Creek at 7725 92nd Street (WDFW SSHEAR SITEID 15.0068 0.00). Other barriers exist on the southern tributary near 92nd Street, and on the tributary that enters from the east (Pierce County Water Programs 2000).

Pierce County Water Programs (2000) estimates that 6% of the Lay Creek watershed is impervious surface; land use planning should attempt to ensure that impervious surfaces are kept to <10%, the threshold above which significant degraded channel conditions are typically evident. The peak flow for the 25-year recurrence interval storm, under 1990 land use conditions, has been estimated at 105 cfs (Pierce County Water Programs 2000). In May 2000, surveyors estimated the flow downstream of 82nd Avenue to be 2 cfs.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Lay Creek:

- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; ensure that future impervious surfaces are limited to <10% of the watershed area**
- **Protect integrity of estuarine habitat extending upstream of road at mouth of creek**
- **Prioritize and correct identified fish passage barriers**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Assess the watershed for floodplain modifications, including presence of private ponds that may affect fish passage and instream flow; correct identified problems**
- **Restore functional riparian habitat throughout the watershed**

Meyer (Rosedale) Creek 15.0069A

General

Rosedale Creek is approximately 0.75 mile long and enters Henderson Bay directly east of Raft Island, at the town of Rosedale. The creek drains a catchment of 0.6 mi^2 (Pierce County Water Programs 2000). Channel gradient is moderate. The creek supports coho, chum, and cutthroat upstream to the site of the future Holy Family School. Chinook have also been raised in the pond upstream of the dam at the Holy Family school site (RM 0.5), but the success of adult returns is unknown. The dam located on the Holy Family School grounds is identified as a fish passage barrier, but is scheduled to be replaced with a bridge when the school is constructed. There are a large number of wetlands associated with the stream. Riparian vegetation is nearly 100% hardwoods, primarily associated with wetland conditions adjacent to the creek (Kalinowski). Substrate gravel condition is characterized as generally good (<11% fines). No floodplain modification concerns are known (Kalinowski). The culvert at the mouth of the creek has a 3-foot drop at low tide, and probably does not meet the WDFW criteria for fish passage (PCD).

The Pierce County Water Programs (2000) stream assessment indicates that the short estuarine reach to Rosedale Street is in poor condition. From Rosedale Street to a private driveway (200 feet), conditions improve somewhat and are rated as fair. From the private driveway to an instream pond (500 feet) the riparian corridor is in fairly good condition, but fish habitat is only in fair condition, with little LWD present. Water is diverted form the in-stream pond to an off-stream hatchery pond; pond level is controlled with removable weir boards, which are removed during adult salmon migration. Upstream of the in-stream pond, the creek extends another 4,000 feet; the riparian condition is fair, with good streamside and canopy cover. Fish habitat condition in this reach was rated as fair, with poor frequency of pools. A water sample was taken from

Rosedale Creek as part of the assessment, just upstream of the estuarine reach. Water temperature, pH, and dissolved oxygen were in compliance with standards, but fecal coliform concentration was eight times higher than the standard. No records of measured discharge are available; surveyors estimated the flow in May 2000 to be 3 cfs.

Pierce County Water Programs (2000) estimates that 8% of the Rosedale Creek watershed is impervious surface; land use planning should attempt to ensure that impervious surfaces are kept to <10%, the threshold above which significant degraded channel conditions are typically evident.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Rosedale Creek:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff, particularly from the Holy Family School, when constructed; ensure that future impervious surfaces are limited to <10% of the watershed area**
- **Correct identified fish passage barrier at site of Holy Family School (RM 0.5), and at the mouth of the creek**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Substrate characterizations differ; evaluate substrate conditions throughout the creek, correct sources of fine sedimentation**
- **Restore full riparian function by encouraging conifer regeneration in deciduous stands that historically had a conifer component**
- **Determine whether the water diversion at the in-stream pond is permitted**
- **Identify and correct sources of fecal coliform contamination**

Mark Dickson (Ray Nash) Creek 15.0070 and Lake Sylvia Creek 15.0070A

General

This independent creek is approximately 1 mile long and enters Henderson Inlet immediately south of the east end of Raft Island. It drains a catchment of 2.2 mi2 (1,421 acres)(Pierce County Water Programs 2000). It also includes a tributary draining Lake Sylvia. The streams support coho, chum, and cutthroat.

Fish Access

Coho and chum are precluded from migrating upstream of a culvert at the outlet of Olufson's Pond (approximately RM 0.75). The Department of Ecology Dam Safety section proceeded with an emergency removal of the rapidly failing dam three years ago. However, the estate replaced the dam with a culvert (unpermitted), which remains impassable, but there is no significant habitat upstream (Small). The WDFW SSHEAR fish passage barrier database indicates presence of three fish passage barrier culverts and a dam on Mark Dickson Creek at RM 0.35, 0.4, 0.43, and 0.3, respectively. River miles in the database do not agree with mapped locations; it may be

possible that the dam at Olsen's pond is the same as identified in the database at RM 0.3. The TAG was unfamiliar with the current passage status of the identified barriers in the database. Further evaluation of the status of the barriers identified in the database is warranted. PCD identified two private driveway culverts downstream of the dam off Ray Nash Drive that are fish passage barriers, but again it is unclear whether these may be sites identified in the WDFW SSHEAR fish passage barrier database.

The dam at the outlet to Lake Sylvia is a total barrier to anadromous fish passage; chum presence only extends to the first driveway culvert downstream of the lake (Tom Burns), which is also identified as a fish passage barrier (PCD). The database also identifies two barrier culverts on a tributary to Mark Dickson Creek at RM 0.0 and 0.1, which likely correspond with the barriers identified by PCD on Lake Sylvia Creek at Ray Nash Road and Whitmore Road.

Floodplain Modifications

The lower 0.5 mile of Mark Dickson Creek is located in a small confined ravine, with houses encroaching to the edge of the ravine. The upper 0.5 mile is primarily agriculture, with the floodplain constrained by Ray Nash Road on the east side and houses on the other. There are significant wetlands in the headwaters.

There are two inlet streams to Lake Sylvia that may have provided historic habitat; one has been placed in a concrete-lined channel, the other has been placed in a culvert.

Channel Condition

LWD is absent throughout Mark Dickson Creek (Kalinowski); Pierce County Water Programs (2000) rated LWD condition as poor in both Mark Dickson and Lake Sylvia creeks. Bank stability is generally good (confirmed by Pierce County Water Programs (2000) assessments, except in lower Lake Sylvia Creek and a short reach of Mark Dickson Creek); past bank erosion at the estuary has been eliminated by rocking the bank.

URS Corp. (2000) rated pool frequency as good in Mark Dickson Creek (20% of pools <1 ft., and 80% 1-2 ft.), with an absence of pools in Lake Sylvia Creek. Instream habitat cover was rated as good in Mark Dickson Creek and poor in Lake Sylvia Creek. The Scouts have installed several log weirs in Lake Sylvia Creek (Small).

Substrate

The TAG indicates that there are suitable spawning gravels within the anadromous fish distribution zone, and that the substrate tends to be unstable. The TAG rated gravel composition in Mark Dickson Creek as fair (11-20% fines), and good (<11% fines) in Lake Sylvia Creek (Kalinowski). Pierce County Water Programs (2000) rated substrate composition in spawning areas as good in Mark Dickson Creek; substrate embeddedness was rated as fair.

Riparian Condition

Riparian condition on Mark Dickson Creek is poor with the road on one side of the creek and housing immediately adjacent to the creek on the other side. In addition, any trees that do fall into the creek are immediately removed for firewood. Lake Sylvia Creek riparian condition is

poor, with a lack of riparian vegetation. Pierce County Water Programs (2000) rated riparian condition in Mark Dickson Creek as fair, and poor in lower Lake Sylvia Creek, and good in the upper section.

Water Quality

Copper compounds have been used for control of algae in Lake Sylvia, a shallow 10-acre man-made lake, with an average depth of 6 feet. Further use was precluded by Department of Ecology in 1994 due to copper presence in lake sediments, and concern of potential toxic effects on salmonids and other aquatic life in the creek downstream of the lake. It is unknown what effects these copper compounds have had on downstream waters. A survey of water quality in Lake Sylvia was conducted in the summer of 1996 (Pierce County Water Programs (2000). The upper layers of the lake were consistently at a temperature of 20°C, whereas water on the bottom of the lake was ~15°C. Dissolve oxygen ranged from 9.5 mg/L to about 3.0 mg/L, with dissolve oxygen usually lowest at the outlet of the lake. The pH of the lake ranged between 6 and 8.5.

A water sample was taken from Mark Dickson Creek as part of the Pierce County Water Programs (2000) assessment, just upstream of the estuarine reach. Water temperature, pH, dissolved oxygen, and fecal coliform were in compliance with state water quality standards.

Water Quantity

Pierce County Water Programs (2000) estimates that 7% of the Mark Dickson Creek watershed is impervious surface; land use planning should attempt to ensure that impervious surfaces are kept to <10%, the threshold above which significant degraded channel conditions are typically evident. No records of measured discharge were found (Pierce County Water Programs 2000). The peak flow of the 25-year recurrence interval storm, under 12990 land use conditions, was estimated to be 90 cfs. In May 2000, surveyors estimated the flow downstream of 67th Street Court to be 6 cfs.

The total natural flow of Mark Dickson Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further consumptive water appropriation (WAC 173-515-040).

Estuarine

There is a defined mud flat estuarine area at the mouth of the creek, with good tidal exchange and small amount of saltmarsh. Estuarine conditions are generally natural, except for those areas affected by road-associated bank hardening and limited bulkheading. However, Pierce County Water Programs (2000) rates estuarine condition as poor/fair.

Lakes

Lake Sylvia is a completely artificial 10-acre lake with an average depth of 6 feet (Pierce County Water Programs 2000), created by a 12-15 foot high dam. The lake has a history of treatment with copper sulphate to control filamentous algae. Residents on the lake have expressed concerns of increased sediments and nutrients entering the lake from inlet streams.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Mark Dickson Creek and tributaries:

- **Ensure that future impervious surfaces are limited to <10% of the watershed area**
- **Protect integrity of natural estuarine habitat**
- **Restore fish passage upstream of the dam at Lake Sylvia**
- **Prioritize and correct identified fish passage barriers throughout the watershed**
- **Identify and correct sources of fine sedimentation to the creeks**
- **Restore natural channel configuration and floodplain function, where possible, in the upper 0.5 mile of Mark Dickson Creek**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore riparian function in the upper 0.5 mile of Mark Dickson Creek and on Lake Sylvia Creek**
- **Evaluate potential downstream water quality and sediment effects of use of copper compounds to control algae in Lake Sylvia; remediate identified impacts**

Unnamed 15.0071

General

This independent creek is <1 mile long, entering Henderson Bay midway between Raft Island and the northern outer end of Horsehead Bay. Steve Kalinowski indicates that the impassable cascade at the road, identified by Williams et al. (1975), is actually an impassable culvert. TAG members had no additional knowledge of salmonid utilization or habitat condition, although the area downstream of the road is thought to probably be too steep for anadromous access.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0071:

- **Assess salmonid utilization and salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Warren Creek 15.0072

General

This small independent creek enters the north shore of Hale Passage directly opposite the north end of Fox Island. It drains a catchment of 0.9 mi^2 (Pierce County Water Programs 2000). The drainage currently supports coho and cutthroat to Warren Drive (~RM 0.25), which is a barrier to anadromous fish. Estuarine habitat extends almost to Warren Drive. There is approximately 0.5 mile of potential spring-fed habitat for coho and cutthroat upstream of the culvert, but the culvert would be expensive to replace (Iverson).

Pierce County Water Programs (2000) indicates that conditions in all reaches of Warren Creek are good. The riparian corridor is intact and in excellent condition. Fish habitat is in generally good condition, except for approximately 500 feet downstream of Warren Drive, where it is rated as fair. Substrate conditions are indicated as less than ideal, with a high degree of embeddedenss and too much sand.

No records of measured discharge for Warren Creek were located (Pierce County Water Programs 2000). In May 2000, surveyors estimated the flow downstream of Warren Drive to be 0.6 cfs.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0072:

- **Correct identified fish passage barrier at Warren Drive**
- **Assess salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Muri Creek 15.0074

General

This small independent creek enters Hale Passage approximately 0.75 mile east of the Fox Island Bridge. Travis Nelson (Puyallup Tribe) has shocked cutthroat in the lower reaches. Vernon Young (prior landowner) also indicated cutthroat presence in the stream. The uppermost extent of distribution isn't known, but probably is <RM 0.1. A house is constructed at the mouth of the creek right at the marine shoreline, with the garage actually constructed over the channel. Fish passage was restored upstream of the garage for several years, but recent removal of the baffles inside the culverts under the garage likely precludes fish passage. The TAG participants had no direct knowledge of habitat conditions in the stream.

Pierce County Water Programs (2000) examined a representative reach of Muri Creek, but a survey of the entire creek was not done. The channel was high gradient, and confined within a ravine. Condition of fish habitat in the reach was rated as generally fair, with a lack of pool habitat and desirable channel form (probably the result of steep channel gradient).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Muri Creek:

- **Restore fish passage upstream of the culverts at the garage built over the stream**
- **Develop and implement a short-term LWD strategy to provide LWD presence, increase frequency and depth of pools, and provide habitat diversity until full riparian function is restored**
- **Assess salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Artondale Creek 15.0075 and East Branch Artondale Creek 15.0076

General

This creek is 2.2 miles long and drains to the northwest end of Wollochet Bay, and includes two primary tributaries (> 1 mile long) and an additional small tributary. It drains a catchment of 3.2 mi2 (Pierce County Water Programs 2000). The drainage supports chum, coho, and cutthroat, to 58th Avenue on the mainstem and to at least Hunt Street on the East Branch. There is potential for steelhead use, based on creek size and habitat, but steelhead presence is unknown (TAG). [NOTE: SASSI identified steelhead presence in Artondale Creek, but no presence is identified on the SASSI steelhead distribution map] Significant wetlands form the headwaters and the creek flows through a golf course, under roads, and by homes and hobby farms (KGI DRAFT 1999).

The drainage is currently experiencing a large amount of residential development. The Gig Harbor Golf and Country Club was constructed on wetlands (Small) and habitat within the boundaries is severely degraded. The creek has been dredged and channelized; riparian vegetation has been removed, resulting in dense growth of reed canary grass; and the golf course is proposing to further dredge the channel to prevent flooding of the golf course. The ditch along the road through the golf course is actually a tributary. The ditch has always had juvenile salmonids present when checked, but is actively dredged by the County. Downstream of the golf course, the creek generally has good substrate, although the gravel size is small. Riparian condition from the mouth to the golf course is rated as fair on the south side of the creek and poor on the north side. There are a number of associated wetlands along the creek, and the Peninsula Heritage Land Trust is acquiring rights to shorelines in the estuary to provide additional protection.

The culvert at the Hunt street crossing of the East Branch is a total fish passage barrier (PCD), but no flow was observed upstream of the culvert during the Pierce County Water Programs assessment. There is severe bank erosion for approximately 1,200 feet downstream of Hunt Street, thought to be associated with unrestricted livestock access to the channel. The Pierce County Capital Improvement Plan identifies two alternatives to address the problem. One alternative would be to riprap the entire section, and the other would be to use bioengineering techniques to stabilize the channel. Only the latter would be consistent with attempting to maintain salmonid habitat (KGI DRAFT 1999).

There is a pending multi-phase development (Chelsea Park) north of the Gig Harbor Golf and Country Club that has significant potential to alter habitat and flows in Artondale Creek.

Pierce County Water Programs (2000) conducted an assessment of stream conditions. They identified that the mouth of the creek is generally undisturbed, and conditions in the lower estuary are generally good. Upstream of the Wollochet Drive bridge, conditions deteriorate rapidly. The upper part of the estuary is channelized and both fish habitat and riparian corridor are in poor condition. Upstream of the estuary, there is a 1,000-foot stream reach where both fish habitat and the riparian corridor are in good condition. From Artondale Drive through much of the Gig Harbor Golf and Country Club (1,800 feet), conditions are poor. The reach in the golf course has less value as fish and wildlife habitat than any other stream reach examined in this study. The creek has been channelized and riparian vegetation has been completely removed, causing a dense growth of reed canary grass." From the golf course to a large wetland upstream of the

bridge (3,100 feet), fish habitat and riparian condition are rated as fair and good, respectively. The mainstem was not surveyed upstream of the wetland.

On East Branch Artondale, there are several wetlands in the reach from the confluence to the beginning of a narrow canyon, with fish habitat and riparian condition rated as good. From the mouth of the canyon to Hunt Road, riparian condition is good, but fish habitat is only fair, because of eroding banks and lack of pools. Upstream of Hunt Road, riparian condition is good, but fish habitat was not surveyed because no flow was observed, and the Hunt Road culvert is clearly impassable.

Water temperature was measured at several stations in Artondale Creek, as part of a stream survey conducted by volunteers in 1998 (Pierce County Water Programs 2000). Water temperature was in compliance with standards. A water sample was taken from Artondale Creek, near the mouth, as part of the Pierce County Water Programs (2000) stream assessment. Water temperature, pH, and dissolved oxygen were in compliance with standards. Fecal coliform concentration was approximately 7 times higher than the standard.

Pierce County Water Programs (2000) estimates that 7% of the Artondale Creek watershed is impervious surface; land use planning should attempt to ensure that impervious surfaces are kept to <10%, the threshold above which significant degraded channel conditions are typically evident. Streamflow measurements were made by USGS near the mouth of the creek from February 1978 to January 1979 (Pierce County Water Programs 2000). Flows ranged from a high of 4.8 cfs in May to a low of 0.85 cfs in August. In May 2000, surveyors estimated the flow upstream of the estuary to be 4.5 cfs. The peak flow from the 25-year recurrence interval storm, under 1990 land use conditions, was estimated to be 350 cfs.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Artondale Creek and tributaries:

- **Ensure that stormwater from ongoing and future development is fully addressed at the time of construction; ensure that future impervious surfaces are limited to <10% of the watershed area**
- **Restore natural channel configuration and floodplain function through Artondale Golf Course**
- **Restore riparian function throughout the watershed, particularly through the Artondale Golf Course; encourage conifer regeneration in deciduous stands that historically had a conifer component**
- **Reconfigure entrance road to golf course and/or tributary that runs in the road ditch in a manner that eliminates the need for regular maintenance dredging of the tributary by the county; in the interim, ensure that the county does not perform any dredging activities during spawning or incubation periods, dredging at other times should be isolated from flowing water to prevent the release of fines to downstream areas**
- **Prevent unrestricted livestock access to the creek, particularly on the East Branch downstream of Hunt Street; if necessary, use bioengineering techniques to stabilize eroding banks**

Wollochet (Bitter) Creek 15.0080/0081, Garr Creek 15.0080, and tributaries

General

Wollochet Creek flows into the northern end of Wollochet Bay. Wollochet Creek flows southward from its headwaters near Rosedale Street. Garr Creek, the main tributary to Wollochet Creek, enters Wollochet Creek from the east near the intersection of Wollochet Drive and Fillmore Drive. Wollochet (Bitter) Creek is 1.7 miles long; the Garr Creek system includes several tributaries, with a channel length of approximately 3.5 miles. The Wollochet Creek watershed drains a catchment area of 2.6 mi^2 (Pierce County Water Programs 2000). There are a number of small ponds, lakes, and wetlands in the drainage basin, some of which are being protected by efforts by the Peninsula Heritage Land Trust (KGI DRAFT 1999). Land use in the Wollochet Creek basin is mostly rural, with large lot residences in a natural setting. Wollochet Creek supports chum, coho, and cutthroat. Anadromous salmonid presence is unlikely in Garr Creek upstream of Spruce Lane, although cutthroat are likely present throughout the drainage.

Fish Access

There are numerous fish passage barriers in the Wollochet Creek watershed. A debris dam with no water passing over it, located between East Bay Drive and Wollochet Drive, is a barrier to fish passage, at least at low flows (Pierce County Water Programs 2000). A driveway culvert just upstream of the Wollochet Drive crossing is a partial barrier (PCD). Further upstream, a private driveway across the street from the nursery at the intersection of Wollochet Drive (west side) and Fillmore Drive is a total fish passage barrier (Kalinowski, PCD). The culvert has separated and the driveway has collapsed into the culvert. Another culvert approximately 100 yards upstream is a partial fish passage barrier. There are a number of additional culverts beneath driveways adjacent to Wollochet Drive that should be evaluated to determine if they are barriers to fish passage. The culvert at the Hunt Street crossing is a fish passage barrier (1.2 foot outfall drop, PCD). In addition, there is a dam and associated instream pond (2.5 foot drop) north of Hunt Street that is a barrier (PCD), and a 4-foot drop at the outlet of another pond immediately south of Hunt Street (Kalinowski). There are two additional culverts in the vicinity of Conte Drive that have drops of >1 foot, that may also be fish passage barriers (Pierce County Water Programs 2000).

A culvert on Garr Creek at Spruce Lane (WDFW SSHEAR SITEID 15.0080 0.24), a short distance upstream of the confluence with Wollochet Creek, has a 6-foot drop at the outlet and is a total barrier to anadromous fish passage into the Garr Creek watershed. A short distance upstream, a private driveway off 54th Avenue is also a fish passage barrier (PCD).

On Unnamed 15.0083, the culverts at the Fillmore Drive and Wollochet Drive crossings are both fish passage barriers (PCD). Similarly, the culverts on Unnamed 15.0086 at the Fillmore Drive and Gustafson Drive crossings are both fish passage barriers (PCD).

Floodplain Modifications

Much of Wollochet Creek is located in a narrow ravine, with few alterations of the naturally confined floodplain.

Channel Condition

LWD condition downstream of the Wollochet Drive/Fillmore Drive intersection is fair, and poor upstream (Iverson). Pierce County Water Programs (2000) indicates that from East Bay Drive to Wollochet drive, fish habitat condition is rated as good (with particularly good substrate condition), and riparian condition of limited width, but also rated as good. From the Wollochet Drive crossing to just upstream of the Wollochet/Fillmore intersection, fish habitat and riparian condition are rated as good (although pool frequency and channel form are not as good as downstream). Upstream to just upstream of 68th Street, fish habitat is fair (with a lack of pools and LWD, and areas of poor substrate), and riparian condition is fair/good. The assessment included the channel for 5,000 feet upstream of 68th Street, where fish habitat was rated as fair/good, and riparian condition was rated as fair. The stream assessment included the lower 1,500 feet of Garr Creek to a dam that forms a lake near Spruce Lane. Fish habitat in this reach was rated as fair; riparian condition was rated as good. Additional habitat assessment is needed for the remainder of the Garr Creek watershed.

Economic and Engineering Services (1995, as cited in KGI DRAFT 1999) reported bank erosion problems at the entrance to Wollochet Bay and below Park Lake. Installation of a large culvert beneath Wollochet Drive and the installation of streambank erosion control measures, including rock armoring, have addressed the bank erosion at the entrance to the bay. Bank stability was rated as good by URS Corp (John Davis).

Substrate

The TAG indicates that substrate quality is generally good, with nice pool tailouts in the lower sinuous section. Limited benthic macroinvertebrate sampling conducted by Stream Team volunteers indicate the benthic community in Wollochet Creek as being less vigorous than other streams in the area (KGI DRAFT 1999). Pierce County Water Programs (2000) identifies substrate condition as good in lower Wollochet Creek, and fair/poor upstream, with areas of high embeddedness.

There are numerous driveway fills across Wollochet Creek; although the streambanks are generally stable, several of the driveway fills are unstable, contributing fine sediment to the creek.

Riparian Condition

The TAG indicates that riparian condition is generally good; this was confirmed by Pierce County Water Programs (2000), although there are areas where presence or width of riparian buffers should be increased. Homeowners adjacent to Wollochet Drive are reported to be removing the riparian vegetation along the creek (KGI DRAFT 1999).

Water Quality/Water Quantity

The only water quality sampling information available are water quality readings taken in August 1998, which ranged between 14.6 and 16.8^{o}C (KGI DRAFT 1999). Further evaluation of summer water temperatures is advised, as observed elevated water temperatures appear to be inconsistent with the reported good riparian condition. Elevated water temperatures may be related to effects of ponds in the watershed. A water sample taken as part of the Pierce County Water Programs (2000) assessment identified water temperature, pH, dissolved oxygen, and fecal

coliform as in compliance with standards. They found no records of measured discharge for Wollochet Creek, but surveyors estimated flow to be approximately 7 cfs in August 2000.

The upper Garr Creek drainage contains several manmade stormwater detention ponds, as well as natural depressions that provide storage (KGI DRAFT 1999). Economic and Engineering Services (1995, as cited in KGI DRAFT 1999) reported that the series of interconnected wetlands, streams, and lakes provide an excellent level of flood control and water quality treatment for most drainages within the watershed. They also reported stormwater runoff quality in the basin to be acceptable under current conditions, although no chemical testing was performed.

Pierce County Water Programs (2000) estimates that 12% of the Wollochet Creek watershed is impervious surface; which exceeds the 10% threshold above which significant degraded channel conditions are typically evident.

Estuarine

A local land trust has been targeting acquisition of estuarine areas at the mouth of Wollochet Creek. The northern portion of the Wollochet Bay estuary is in generally good condition, with few bulkheads or docks. The southern portion of the estuary has higher presence of bulkheads and docks.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Wollochet/Garr Creek and tributaries:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**
- **Evaluate habitat impacts of shoreline bulkheading and docks in the southern portion of Wollochet Bay; remediate impacts where possible**
- **Assess fish passage status of driveway culverts adjacent to Wollochet Drive; correct identified fish passage barriers**
- **Prevent fine sediment entry to the creek from unstable driveway fills that cross the creek**
- **Prioritize and correct identified fish passage barriers in the Wollochet Creek and Garr Creek drainages**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity, particularly upstream of the intersection of Wollochet Drive and Fillmore Drive; encourage conifer regeneration in deciduous stands that historically had a conifer component**

- **Work with landowners along Wollochet Drive to encourage protection of existing riparian vegetation, and encourage riparian restoration in areas where riparian vegetation has been removed**
- **Assess water temperatures throughout the watershed during summer months; identify and correct problem areas contributing to observed high summer water temperatures**

Murphy Creek 15.008X

General

Murphy Creek flows into Wollochet Bay just east of Picnic Point. The mouth of the creek is contained in a 275-foot culvert (PCD) that is likely a velocity barrier to effective fish passage at all flows. Pierce County water Programs (2000) surveyed a single 100-foot long reach upstream of the culvert under East Bay Drive. Riparian condition was rated as good; fish habitat condition was rated as fair/poor. There was no surface flow observed upstream of the survey reach in August 2000.

There is approximately 1000 feet of creek at the base of Murphy Drive that has been ditched and channelized. The Stream Team has conducted some restoration activities on a small portion of the impacted area.

Pierce County Water Programs (2000) estimates that 23% of the Murphy Creek watershed is impervious surface; which exceeds the 10% threshold above which significant degraded channel conditions are typically evident.

Action Recommendations

There is little salmonid production potential for Murphy Creek in its current condition. The stream could potentially provide limited coho, chum, and cutthroat spawning if the culvert were to be removed at the mouth of the creek, and alterations to natural hydrology addressed.

Sullivan Gulch Creek 15.0087 and Unnamed 15.0087A

General

This independent creek is 1.2 miles long and enters Wollochet Bay midway up the eastern shore. It drains a catchment area of 2 mi^2 (Pierce County Water Programs 2000). The creek has a moderate gradient, and is located throughout much of its length in a very confined steep-sided ravine. Coho and chum utilize the lower several hundred feet of the stream, with cutthroat extending upstream to approximately RM 0.75. The primary habitat concerns in this drainage are stormwater impacts from the severely undersized stormwater detention pond for Quail run (Smolko believes this has been addressed), and additional potential stormwater impacts from development of a driving range and a mini-storage facility proposed for the headwaters.

There is a set of double culverts at the Wollochet Drive crossing in which sediment tends to accumulate (Small). These culverts should be evaluated to determine if they should be replaced. Past maintenance using a hydrojet has caused sedimentation downstream.

Sullivan Gulch Creek is located in a steep ravine for most of its length, except for the upper headwaters. The culvert at the 25th Street crossing is blocked by debris accumulation, which likely creates a fish passage barrier (PCD). Upstream of 25th Street, the creek is primarily wetland with mud substrate. The TAG indicates that the riparian condition is good in the lower portion of the drainage. This creek offers little opportunity for salmon restoration, due to the confined nature of the creek and hydrology impacts from development in the headwaters.

Pierce County Water Programs (2000) indicates that downstream of a point about 1,300 feet south of 36th Street, the creek condition is good, with the riparian corridor intact and in very good condition. Fish habitat in this reach is indicated as good, except for substrate embeddedness, which is rated as fair. Upstream, both fish habitat and riparian condition are rated as fair. A small tributary enters the mainstem of Sullivan Gulch Creek from the east, just upstream of East Bay Drive. The riparian corridor on the tributary is intact and in very good condition, but the creek channel is quite incised and scour has created a gravel bar at the confluence with the mainstem. Fish habitat condition in the tributary is rated as fair.

Pierce County Water Programs (2000) estimates that 28% of the Sullivan Gulch Creek watershed is impervious surface; which exceeds the 10% threshold above which significant degraded channel conditions are typically evident.

Action Recommendations

The following salmonid habitat restoration action is recommended for Sullivan Gulch Creek and tributaries:

- **Identify and remediate existing stormwater impacts to the channel; ensure that stormwater from future development is fully addressed at the time of construction**
- **Evaluate culverts at Wollochet Drive crossing; replace if warranted, or maintain in a manner that does not impair habitat downstream**
- **Identify and correct cause of channel incision on right bank tributary**

Schoolhouse Creek 15.0090

General

Schoolhouse Creek is <1 mile long and is the only creek on Anderson Island known to support anadromous salmonids. The creek enters Oro Bay on the southeast side of Anderson Island. Schoolhouse Creek supports chum and coho upstream to the Powerline Road culvert (~RM 0.5), and cutthroat upstream to ~RM 0.75 (SPSSEG). Presence of steelhead is unknown, but not likely (Todd Alsbury).

There are six culverts located on Schoolhouse Creek, which were assessed by SPSSEG. The lower crossing of Eckenstem/Johnson Road is in the tidally influenced portion of the creek, and the culvert is a potential fish passage barrier during outgoing tides. The next upstream crossing of Eckenstem/Johnson Road has two small (0.44m) culverts, which are assessed to be passable

except potentially at high flows. The culverts at the Oro Road crossing are likely fish passage barriers for juvenile salmonids, although adults can probably pass at most flows. Local residents have reported creek flows over Oro Road during high water events. The culvert at the Powerline Road crossing is a complete barrier to upstream anadromous fish passage. Stream gradient downstream of the Powerline Road is <2%, and this gradient continues for 189m upstream of Powerline Road. Suitable habitat for coho and cutthroat extends from this point to 378m upstream of the upper crossing of Eckenstem/Johnson Road. Upstream of this point, there are a number of seeps and wetlands without defined surface water channels. There are an estimated 796m^2 of spawning habitat and 1566m^2 of rearing habitat upstream of the Powerline Road culvert. No information is available on habitat conditions for Schoolhouse Creek.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Schoolhouse Creek:

- **Prioritize and correct identified fish passage barriers**
- **Assess salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

Unnamed 15.009X

General

This small independent creek enters the northwestern end of the second small bay on the north shore from the east end of Fox Island. The creek supports cutthroat.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.009X:

- **Assess salmonid habitat conditions in this watershed; correct identified salmonid habitat limiting factors, as warranted**

"Doc Weathers" Creek 15.0096

General

This very small independent drainage enters south Puget Sound approximately 0.25 mile south of the Tacoma Narrows Bridge, at the County Park. The TAG indicates it is not currently a salmon stream, but offers good sea-run cutthroat potential. There is a fish passage barrier at the mouth. Immediately upstream, the creek is buried within a 30-inch culvert in a lawn area for approximately 330 feet, set at a 6-7% grade. The culverted reach of the creek may provide habitat for chum at winter flows, if restored. The gradient upstream is 5-8%. Pierce County Water Programs (2000) surveyors estimated discharge in May 2000 to be 0.3 cfs.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Doc Weathers Creek:

- **Correct the fish passage barrier at the mouth of the creek**
- **Restore surface flow and natural channel configuration through lawn area where creek is contained in a culvert**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore riparian function**

North (Donkey) Creek 15.0097 and Unnamed 15.0098

General

The small independent drainage is one of the two primary tributaries to Gig Harbor, entering on the southwest end. North Creek drains a catchment area of 1.9 mi^2 (Pierce County Water Programs 2000). The drainage supports chum, coho, and steelhead, with presumed cutthroat presence at least to the extent of other anadromous salmonids. A small tributary (Unnamed 15.0098) has insufficient flow and too high a gradient to support anadromous salmonids, although chum are known to spawn in the mouth of the tributary. A volunteer group has been raising and releasing approximately 1.0 million chum in this drainage on an annual basis in the North Creek watershed since the late 1970s.

Fish Access

An impassable natural cascade at RM 0.75 limits anadromous salmonid access. The culvert at the Harborview Drive/Austin Street intersection is a fish passage barrier when diversion boards are in place to divert flows to the RSI incubator; even when the boards are removed, the site is at least a partial barrier (there is a 0.32m outfall onto a shallow apron that is only 0.3m deep)(PCD). A private driveway culvert off Burnham Drive is also a fish passage barrier (PCD). The culvert at the 96th Street crossing, in the vicinity of the Harbor Business Park, is perched and undersized, creating a total fish passage barrier.

Floodplain Modifications

Natural channel and floodplain characteristics are altered downstream of the culvert at the Harborview Drive crossing. The creek is channelized for 300 feet downstream of the road crossing, and the lower 600 feet of the creek are contained in a culvert. Upstream, the creek is located in a ravine to approximately 96th Street. Further upstream the topography flattens out, although fish are unable to access this upper portion of the watershed.

Channel Condition/ Riparian Condition

The Pierce County Water Programs (2000) stream assessment rated fish habitat conditions as generally fair (with embeddedness, channel form, and bank erosion as poor) in the short 300-foot open reach downstream of the Harborview Drive crossing. The riparian corridor in the reach is

Figure 17: North Creek estuary in Gig Harbor (photo courtesy of Dept. of Ecology)

rated as fair, but with less than desired buffer width and canopy cover. Upstream to 96th Street, fish habitat was rated as fair, and riparian condition was rated as good. Upstream of 96th Street, there is a 1,300-foot long palustrine reach, with fish habitat and riparian condition rated as good.

The TAG indicated concern that riparian vegetation is generally limited to 100% hardwood, and buffers are confined to within the ravine only, upstream to 96th Street. Riparian cover has been completely cleared at several home sites along the drainage.

Substrate

The TAG indicates the gravel substrate is in generally good condition, although at risk due to development and fine sedimentation from stormwater runoff in the drainage. This is consistent with the URS Corp. (John Davis) ratings in their stream survey reach as good substrate composition in spawning areas, and fair substrate embeddedness.

Water Quality/Water Quantity

Streamflow measurements were made by USGS from February 1978 to January 1979 (Pierce County Water Programs 2000). Flows ranged from a high of 2.86 cfs in May to a low of 1.01 cfs in October. The peak flow for the 25-year recurrence interval storm, under 1990 land use conditions, was estimated to be 215 cfs. In May 2000, surveyors estimated discharge upstream of Harborview Drive to be 0.4 cfs.

This watershed is experiencing a high rate of development, with associated stormwater runoff concerns. Flooding has been experienced upstream of 96th Street, but the severity of flooding impacts was unknown by TAG participants. Pierce County Water Programs (2000) estimates that 19% of the North Creek watershed is impervious surface; which exceeds the 10% threshold above which significant degraded channel conditions are typically evident. The total natural flow of North Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further consumptive water appropriation (WAC 173-515-040).

Estuarine

The lower 600 feet of North Creek are contained in a culvert. This culvert likely is in historic intertidal area. There is a mud flat estuary at the mouth of North Creek (Figure 17). The City of Gig Harbor has acquired a small parcel of property at the mouth of North Creek, although the interest and benefits of this acquisition were mostly wildlife focused.

Nearshore/Marine

Nearshore habitat function in Gig Harbor has been severely impaired. There is generally heavy boat use and boat moorage throughout the harbor. The Gig Harbor Yacht Club, located on the southwestern shore of Gig Harbor, has indicated an interest in dredging the nearshore harbor area because of sedimentation from North Creek, but there are concerns of potential sediment contamination associated with the marina. The shoreline of Gig Harbor is approximately 95% bulkheaded, likely altering the natural sediment contribution from adjacent uplands, and altering the nearshore substrate composition. In addition, there are numerous commercial and private docks and overwater structures throughout Gig Harbor.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for North Creek and tributaries:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Correct the identified fish passage barrier at the 96th Street crossing, in the vicinity of Harbor Business Park; prioritize and correct other identified barriers, as warranted**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore functional riparian zones throughout watershed; encourage conifer regeneration in deciduous stands that historically had a conifer component**
- **Restore estuarine function in the lower portion of North Creek**
- **Assess the impacts of existing alterations to marine nearshore habitat in Gig Harbor; remediate impacts where possible**

Crescent Creek 15.0099

General

The small independent drainage is one of the two primary tributaries to Gig Harbor, entering on the northern end. Crescent Creek drains a catchment area of about 5 mi^2 (Pierce County Water Programs 2000). The drainage supports chum, coho, steelhead, and cutthroat, with chinook also observed (likely returns from annual planting of chinook by Larry Oathout (Iverson)). This drainage had a historic wild chinook run (Steve Kalinowski), as indicated by fish entry timing records on a previously existing barn at RM 2.8; the last native chinook were recorded in the late-1940s with indications of the first chinook returning in August. Land use is mostly rural and

agricultural in the lower 2.0 miles of the drainage. There are several small unmapped streams that enter the west side of Crescent Creek from the Peacock Hill area; fish use in these streams is unknown.

Fish Access

A culvert just downstream of the outlet of Crescent Lake was previously identified as a fish passage barrier, but was replaced in 1999. There is an additional driveway culvert just downstream that is a partial fish passage barrier (PCD).

Floodplain Modifications

The TAG indicates that Crescent Drive constrains the natural channel and floodplain for its full length. In addition, there has been extensive dredging and channelization in the agricultural area from the mouth to Crescent Lake. The TAG indicates that the best restoration option for the reach constrained by the road is to acquire all possible riparian zone, as the road can't be effectively relocated.

Channel Condition

Data presented by Chris May (evaluation of 0.1 km segment of creek just upstream of Crescent Valley Road bridge) indicates the channel is moderately confined with moderate sinuosity. Average bank full width is 4.8 m with average bank full depth of 0.33 m. Mean gradient is 0.5%. Bank stability is rated as 50-75% stable. Chris May rated the pool condition as marginal, with 35% pool habitat, pool spacing of 3.5 bankfull widths/pool, and mean residual depth of 0.26 m. He also rated riffle habitat as marginal, with 28% riffle habitat and 50% embeddedness. Pierce County Water Programs (2000) rated pool frequency as ranging from poor to good, depending on the reach.

The TAG indicates an almost total absence of LWD in the stream. However, in the segment surveyed by Chris May, LWD rated as marginal, with an estimate of 240 pieces/km, with 67% within the bankfull width, 25% conifer, and only 13% >0.5 m diameter. Pierce County Water Programs (2000) rated LWD presence as ranging from poor to good, depending on reach.

Substrate

The TAG indicates creek gravels to be pretty good throughout the drainage. Data from the segment sampled by Chris May indicates an intergravel dissolved oxygen/dissolved oxygen ratio of 77%, which is slightly worse than the 80% threshold indicative of good flow and dissolved oxygen in the spawning gravels. The Benthic Index of Biotic Integrity (B-IBI) benthic invertebrate sampling data in the surveyed segment indicates a score of 31, which would likely indicate some impairment of substrate quality. URS Corp. (John Davis) rated substrate composition in spawning areas as good in lower Crescent, although embeddedness was rated as poor.

The TAG indicates a concern of potential fine sedimentation from Salmonberry Creek (a non-salmonid bearing right bank tributary just downstream of Crescent Lake) due to development occurring along Crescent Lake. The concern of fine sediment presence is substantiated by Pierce

County Water Programs (2000), who indicate presence of gravels, but with embeddedness rated as poor though almost the entire drainage.

Riparian Condition

The lower 2.0 miles of the drainage are in agriculture, with no remaining functional riparian vegetation. There is greater presence of riparian trees upstream of RM 2.0, although riparian condition remains poor. The riparian areas are narrow and primarily deciduous, with few conifers. Riparian condition just upstream of Crescent Valley Road Bridge (segment sampled by Chris May) rated as sub-optimal, with a 50-foot average buffer width, composed of mature mixed woody vegetation, providing 73% canopy cover. Riparian ratings by Pierce County Water Programs (2000) varied from poor to good, depending on reach.

Water Quality

A water sample taken from near the mouth as part of the Pierce County Water Programs (2000) assessment identified water temperature, pH, and dissolved oxygen as in compliance with standards. Fecal coliform concentration was approximately 4 times higher than the standards. Measurements with a continuous-recording thermograph from May 10 to August 18, 2000 were in compliance with standards, with the average daily maximum temperature in June and July being 15°C (maximum temperature observed was 15.1^{o}C on May 10 and August 18), and declining in the first half of August.

Livestock are generally fenced away from the stream, although the fences are typically located very near the creek (Kalinowski, Smolko). Water temperatures taken in August 1998 ranged between 13 and 20°C, although the high temperature was taken from a stagnant pool in open sun (KGI 1999 Draft).

Water Quantity

The Department of Ecology has determined that Crescent Creek and tributaries exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, no further water is available for consumptive appropriation from June 1 – October 15 (WAC 173-515-040). Applications for consumptive water appropriation at other times of the year are subject to minimum instream flows established in WAC 173-515-030. Pierce County has recently installed an instream flow gauge.

Streamflow measurements made by USGS near the mouth from February 1978 to January 1979 ranged from a high of 9.89 cfs in May to a low of 2.28 cfs in August (Pierce County Water Programs 2000). Measurements made just downstream of Crescent Lake indicated no flow in September 1969, and 0.29 cfs in October 1970. Peak flow for the 25-year recurrence interval storm, under 1990 land use conditions, was estimated to be 450 cfs.

Chris May estimated the total impervious surface in the Crescent Creek drainage at 6.7%. [NOTE: Pierce County Water Programs (2000) estimates that 19% of the North Creek watershed is impervious surface.] Although some hydrology impacts from stormwater runoff would be expected at this level, it remains within the range of functional watersheds. Special effort should be made to prevent further stormwater impacts to this drainage, in order to protect the integrity of the watershed. There are two large developments anticipated in the upper watershed that may

affect habitat and flows in Crescent Lake and upper Crescent Creek. Stormwater runoff from Crescent Drive, which runs immediately adjacent to much of the length of Crescent Creek, likely adversely affects the natural hydrology and water quality in Crescent Creek. Additional stormwater quantity/quality control measures applied to Crescent Drive would likely benefit instream resources in Crescent Creek.

There are natural springs on the opposite side of the creek from Crescent Drive that have been detached from the creek. Reattaching these springs would enhance the flow and water quality in Crescent Creek.

Estuarine/ Nearshore/Marine

The upper end of the Crescent Creek estuary is generally undeveloped natural shoreline except for the armored bank of the city park (Figure 18).

The nearshore condition for Crescent Creek is the same as for North Creek, as both flow into Gig Harbor. There is greater presence of private docks and fewer commercial shoreline structures on the north shore of Gig Harbor.

Figure 18: Crescent Creek estuary in Gig Harbor (photo courtesy of Dept. of Ecology)

Lakes

The shoreline of Crescent Lake is heavily developed, with a high number of docks and other private overwater structures. There are additional developments anticipated in the upper watershed that may affect water quality in Crescent Lake.

Bruce Bolding (WDFW, personal communication) has recently completed collection of numerous stomach samples from several warmwater species (largemouth bass, smallmouth bass, bluegill, etc.) that have been introduced into Crescent Lake. Although the data have yet to be analyzed, the population of warmwater species in Crescent Lake is abundant, and juvenile salmonids were found in the stomach samples. The data may yield an estimate of the level of predation on juvenile salmonids in Crescent Lake.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Crescent Creek:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**
- **Restore natural channel configuration and floodplain function, where possible, through the agricultural area from the mouth to Crescent Lake**
- **Acquire and restore all possible riparian area in the reach constrained by Crescent Drive**
- **Implement state-of-the-art stormwater quality/quantity BMPs to Crescent Drive**
- **Reconnect natural springs (on opposite side of creek from Crescent Drive) with Crescent Creek to enhance creek flow and water quality**
- **Evaluate potential removal of bank armoring at city park in Crescent Creek estuary**
- **Assess fish passage status of driveway culvert just downstream of the outlet of Crescent Lake; correct if determined to be a barrier to fish passage**
- **Assess the extent of fine sedimentation to Salmonberry Creek from development; correct identified problems**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore riparian function throughout watershed; encourage conifer regeneration in deciduous stands that historically had a conifer component**
- **Assess the impacts of existing alterations to marine nearshore habitat in Gig Harbor; remediate impacts where possible**

Sunrise (Sunnycove, "Ed's") Creek 15.0105

General

This small independent creek enters Colvos Passage approximately 0.75 mile south of the town of Olalla. The creek currently supports coho to the forks at approximately RM 0.5, and also has chum recolonization potential (chum were present in the recent past (Small)). Fish passage into this creek is impaired. A previous 125-foot culvert at the mouth (WDFW SSHEAR fish passage barrier database SITEID 15.0105 0.0) started washing out in approximately 1992 (Small). Sections have fallen off and collapsed, creating a total fish passage barrier. In addition, another small culvert approximately 200 yards upstream is a likely fish passage barrier at high flows. Kitsap Conservation District is working to remove this barrier. There is potential for chum to recolonize at least the lower extent of the creek now that the barrier culvert at the mouth is no longer present. There is an old road grade that parallels the channel, and that continues to

contribute a heavy fine sediment load to the channel. There is woody riparian vegetation along much of the channel, composed primarily of hardwoods.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Sunrise Creek:

- **Ensure that fish passage at the site of the washed out culvert is maintained; correct identified fish passage barrier just upstream**
- **Abandon and remove the old road grade that parallels the channel**
- **Restore riparian function by encouraging conifer regeneration in deciduous stands that historically had a conifer component**

Olalla Creek 15.0107 and Unnamed 15.0108-0113

General

The Olalla Creek drainage is of medium size, including >4 miles of mainstem and several small tributaries. Olalla Creek enters Colvos Passage at the town of Olalla. The drainage supports periodic chinook (likely hatchery strays only), chum (mainstem and lower portion of Unnamed 15.0108), coho (mainstem and several tributaries), steelhead, and cutthroat (observed in pond at headwater (Small)). Steve Kalinowski has walked Unnamed tributaries 15.0111 and 15.0112 and indicates no fish observed. Agriculture is the predominant land use in the drainage.

Fish Access

No fish passage barriers are identified in mainstem Olalla Creek to the headwaters (upstream of RM 4.0). A culvert at the Olalla Road crossing of Unnamed 15.0108 (just upstream of the mouth) is a total barrier to coho and chum, precluding access to nearly 2.0 miles of potential habitat upstream. [Note: Kalinowski and Small have walked Unnamed 15.0108 and have not seen the impassable cascade noted in Williams et al. (1975).]

Floodplain Modifications

Olalla Creek is located within a naturally confined ravine from RM 0.25-2.0. Upstream, the creek channel has been ditched and straightened through the agriculture lands that cover much of the drainage. From RM 2.0-3.0, the natural floodplain remains accessible to the creek at high flows, but this is not of benefit to salmonids, because high water tends to filter through dense stands of reed canarygrass located in the floodplain. Reestablishment of native forested riparian buffer is needed to reestablish a natural channel.

Channel Condition

The TAG indicates that although some LWD is present in the ravine (RM 0.25-2.0), LWD condition would rate as poor due to lack of key piece LWD. Available LWD is generally small and mostly alder, with few conifer remnants. There is little habitat diversity from RM 2.0-3.0;

with this reach being generally a glide. Bank stability in this reach is poor, estimated to be <80% stable.

Substrate

The TAG indicates that the substrate in Olalla Creek is fair in the ravine section, with fines likely in the 11-20% range. The channelized section from RM 2.0-3.0 would rate as poor, with gravel generally lacking and high presence of fines.

Riparian Condition

There is some good riparian vegetation from the mouth to the upstream end of the ravine at RM 2.0. From RM 2.0-3.0, adjacent land use is agriculture, with active removal of riparian vegetation, although there are some limited areas of willow and alder.

Water Quality

The Bremerton-Kitsap Health District has been collecting water quality information at four locations in the Olalla Creek watershed since 1996. Identified water quality concerns include high fecal coliform levels (Mean=74 fc/100ml at upstream of Forsman Road, 73 fc/100ml upstream of Hovgaard Road), and turbidity (Mean=14.7 NTU upstream of Hovgaard Road, 19.7 downstream of Olalla Valley Road (both stations were affected by large single events).

Water Quantity

No reliable gauge data are available for Olalla Creek. The Department of Ecology has determined that Olalla Creek and tributaries exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, no further water is available for consumptive appropriation from June 1 – October 15 (WAC 173-515-040). Applications for consumptive water appropriation at other times of the year are subject to minimum instream flows established in WAC 173-515-030.

Estuarine

A house, at the upstream end of the estuary, is constructed immediately adjacent to the channel (Figure 19), constricting the natural channel and constraining tidal interchange. Attempts have been made to buy the site (using IAC funds) to restore estuarine function, but the owner is not willing to sell. The lower portion of Unnamed 15.0108 has been ditched through the natural intertidal area.

Road fill and fill at the boat launch (immediately upstream of the highway), at the mouth of Olalla Creek, may constrain tidal interchange at higher tidal levels, but there is still good tidal flushing of the estuary and no apparent impact to sediment transfer to and from the estuary.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Olalla Creek and tributaries:

Figure 19: Olalla Creek estuary (photo courtesy of Dept. of Ecology)

- **Correct culvert fish passage barrier at the Olalla Valley Road crossing**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore creek functions**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff**
- **Restore natural channel configuration and function, including historic floodplain wetlands and off-channel habitat (where possible), upstream of RM 2.0**
- **Restore functional riparian condition through agricultural lands from RM 2.0-3.0; this will also help restore bank stability, and channel and floodplain function in areas severely choked by reed canary grass**
- **Restore riparian function through the ravine from the mouth to RM 2.0, by encouraging conifer regeneration in deciduous stands that historically had a conifer component**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Pursue acquisition of house and property at upper end of estuary that constricts tidal interchange in the Olalla Creek channel and in Unnamed 15.0108; reconfigure to restore estuarine and channel function**
- **Remove riprap fill on the estuary at the boat ramp**

Fragaria (Big Phinney) Creek 15.0115 and Unnamed (Little Phinney) 15.0116

General

Fragaria Creek is a small independent creek (<1 mile long) entering Colvos Passage approximately 2.5 miles north of Olalla Creek. Fragaria Creek and its tributary support coho and cutthroat. The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert (SITEID 15.0116 0.0) at the mouth of Fragaria Creek; this culvert has

recently been replaced. There is a natural waterfall, which is a total barrier to anadromous salmonids, located approximately 0.25 mile upstream of the mouth. The culvert at the Banner Road crossing (upstream of the natural waterfall) is a fish passage barrier for resident fish in Fragaria Creek. Gravel condition is good in the lower 0.25 mile; riparian condition is good, except in the lowermost 150-feet of the stream, which is developed. LWD condition is thought to be fair/poor.

Action Recommendations

The following salmonid habitat restoration actions are recommended for Fragaria Creek:

- **Prioritize and correct fish passage barrier at Banner Road, as warranted**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**

Wilson Creek 15.0178 and Unnamed 15.0180

General

Wilson Creek is a small independent creek (~1 mile), which enters Driftwood Cove on Colvos Passage. Wilson Creek supports chum, coho, and cutthroat; Unnamed 15.0180 supports cutthroat. Wilson Creek is located in a steep ravine with good riparian tree cover (primarily deciduous). LWD condition is thought to be fair/poor. A previous culvert fish passage barrier under a logging road approximately 0.25-0.5 mile upstream has since washed out, allowing upstream fish passage.

Action Recommendations

The following salmonid habitat restoration actions are recommended for Wilson Creek:

- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore riparian function by encouraging conifer regeneration in deciduous stands that historically had a conifer component**

Unnamed 15.0181

General

Unnamed 15.0181 is a small independent creek (<1 mile) entering Yukon Harbor northwest of Point Southworth. The creek supports cutthroat. The culvert at the Olympiad Drive crossing is undersized, and has eliminated historic estuarine function in Harper estuary upstream of the culvert. The culvert is also a potential anadromous fish passage barrier, and should be replaced with a bridge or larger culvert of sufficient size to restore tidal influence upstream of the crossing. Habitat conditions in the estuary have also been adversely impacted by the old brick factory. TAG participants had no knowledge of specific habitat conditions upstream of the estuary.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0181:

- **Replace culvert at Olympiad Drive crossing in a manner that restores estuarine function upstream of the culvert and that is passable to salmonids**
- **Evaluate habitat conditions in watershed, correct identified habitat limiting factors**

Unnamed 15.0183

General

Unnamed 15.0183 is a small independent creek (~1 mile) entering Yukon Harbor approximately 0.5 mile east of the mouth of Curley Creek. The creek supports coho and cutthroat. TAG participants had no knowledge of habitat conditions in this creek.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0183:

- **Evaluate habitat conditions in watershed, correct identified habitat limiting factors**

Curley Creek 15.0185, Salmonberry Creek 15.0188, and Unnamed 15.0186-0190

General

The Curley Creek watershed is one of the largest in East WRIA 15, with approximately 5.0 miles of mainstem and several tributaries (of which Salmonberry Creek is the largest) contributing an additional 8 miles. Long Lake, a two-mile long natural large shallow lake, is located approximately 2.5 miles upstream of the mouth of Curley Creek. All salmonids originating from or returning to the upper two-thirds of the watershed must pass through Long Lake. The drainage supports chinook, chum, coho, steelhead, and cutthroat. TAG participants have also had several reports of Atlantic salmon observed near the mouth, likely influenced by proximity to commercial Atlantic salmon rearing netpens. Tributaries to Long Lake, other than Salmonberry Creek, are very small, low gradient creeks that potentially support cutthroat, but probably not salmon. Kitsap County has recently purchased a reach of the Salmonberry Creek corridor downstream of Mile Hill Road, and habitat restoration in this reach may occur in conjunction with other development in the area (Kalinowski).

Fish Access

The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert at the Sedgwick Road crossing of Unnamed 15.0186 (SITEIDs 991567 and 15.0186 0.6). The TAG participants indicated it is questionable whether anadromous passage extends that far upstream.

Fish passage in Unnamed tributary 15.0187 is impaired by weir with a flow notch that is located at the mouth. Adult coho have been observed upstream, but the weir is considered a partial barrier. In addition, there is an instream pond on Unnamed 15.0187 downstream of Locker Road, with a fish ladder at the outlet. On past occasions, the flow to the ladder has been cut off in the interest of maintaining the level of the pond, resulting in fish kills inside the ladder. The best options to address this concern would be to either relocate the pond to outside the channel, or restore natural channel characteristics through the pond, potentially eliminating the pond. The culvert under Locker Road, previously identified as a fish passage barrier (WDFW SSHEAR fish passage barrier database SITEID 15.0187 0.2), has been replaced; Chris Byrnes (WDFW) has since observed adult coho upstream of Locker Road.

The TAG indicates the culvert at the Phillips Road SE crossing of Unnamed 15.0189 (Cool Cr.) is marginally passable.

Floodplain Modifications/Channel Condition

Curley Creek is located within a steep-walled unconfined ravine from the mouth to RM 1.0; upstream the floodplain flattens out. The floodplain of Curley Creek is generally intact except where property owners have constructed close to the channel within the floodplain. The TAG indicates that LWD presence in Curley Creek is good downstream of Sedgwick Road, with presence of large key pieces. There has been recent recruitment of LWD to the lower end of Curley Creek (RM 0.7-Sedgwick Road), and also in the reach from Sedgwick Road to Long Lake, but LWD presence remains spotty and condition is generally poor upstream of Sedgwick Road.

The lower 500-600 feet of Salmonberry Creek, just upstream of Long Lake, is an area of high quality wetlands, including several small tributaries and good gravels, with good gravels extending upstream to Baker Road. The reaches along Long Lake Road, from Sedgwick Road to Salmonberry Road and from Sedgwick downstream to the upper end of the golf course, are also reported to be a high quality habitat, with fair gravel and mixed riparian buffers. The reach of Salmonberry Creek along Long Lake Road from Salmonberry Road to Mile Hill Road is a broad floodplain that is heavily impacted by past agriculture, with a lack of riparian vegetation and extensive channelization. Salmonids are stranded during peak flows, as they are unable to move through the reed canarygrass back to the channel on receding flows.

A habitat restoration project was conducted by NRCS and WDFW on the Childers property to recreate wetlands and off-channel rearing areas. In addition, habitat restoration improvements have been made on the Jones and Howe properties, which are improving over time. Although some improvement in habitat complexity resulted, the reach remains heavily channelized with poor riparian condition. The creation of open off-channel rearing areas with no riparian cover also has the potential to result in increased water temperature and bird predation of rearing salmonids. Salmonberry Creek generally lacks LWD and pool complexity, except in the restored areas. Upstream of Mile Hill Road on Salmonberry Creek, reed canarygrass is less of a problem, although the natural riparian zone has been replaced by a broad expanse of lawn. Approximately 2000 feet of creek channel through the Clover Valley Golf Club has been channelized and straightened with removal of all riparian vegetation.

Little is known regarding habitat conditions in Unnamed tributary 15.0186. The TAG indicates it is a small creek with coarse substrate in the lower end. Riparian vegetation is mixed; instream cover is considered to be fair.

Habitat conditions in Unnamed tributary 15.0187 are impacted by stormwater from extensive development in the drainage. The creek has incised into a deep gully with limited riparian vegetation, mostly comprised of alder. The TAG indicates that any trees that do recruit to the creek are actively removed to supply a private sawmill. The TAG reports presence of large amounts of garbage and debris throughout the channel.

On Unnamed 15.0189 (Cool Cr.), the creek channel is ditched straight and narrow through the Grows Vineyards (previously Clover Valley) Golf Course. The current golf course owners have indicated some interest in enhancing habitat within the golf course. In addition, Kitsap County Surface Water Management is planning to replace the culvert on Phillips Road. Habitat conditions are generally better upstream of the golf course. Substrate in this tributary drainage is adversely affected by development in the headwaters (upstream of Ashby farm), which is contributing a significant silt load to the creek. In addition, some small side tributaries have yet to be fenced to prevent unrestricted animal access to the channel.

Substrate

Substrate in Curley Creek downstream of RM 1.0 (in the confined ravine) is mainly cobble from 5-6-inches in size. Most of the spawning gravels are located from RM 1.0 (the upper end of the ravine) to RM 1.9 (approximately 0.1 mile upstream of Sedgwick Road). Gravels in this area are generally stable, although fines may exceed 11%; gravel quality may improve with greater spawning salmonid presence, which would help to clean the gravels during spawning. Substrate is generally natural sand/silt wetland condition from 0.1 mile upstream of Sedgwick Road to Long Lake.

The reach of Salmonberry Creek from the golf course upstream to Salmonberry Road is noted as having high presence of substrate algae, even in areas with good riparian vegetation, possibly indicative of excessive nutrient inputs to the creek.

Significant levels of fines have been noted in Unnamed 15.0187, which seems to be aggravated by an instream weir/step (with notch) at the mouth of the creek that appears to trap sediments. High presence of fines has been noted downstream of the game farm, although it is unknown whether the fines are from the game farm or upstream land uses. The headwaters of Unnamed 15.0187 have been heavily developed, and there is some indication of channel incision, likely from stormwater runoff (May). High contribution of fines is also identified for Unnamed 15.0189, primarily from development in the headwaters.

Riparian Condition

The TAG indicates that riparian condition in the reach of Curley Creek from Long Lake downstream to Sedgwick Road is heavily affected by agriculture, with high abundance of invasive blackberry, lack of riparian buffers, and presence of only a few alders. Downstream of Sedgwick Road, the TAG indicates presence of generally good mixed riparian buffers.

Riparian condition on Salmonberry Creek is fair from the upstream end of the Grows Vineyards Golf Club to Salmonberry Road, but poor to non-existent elsewhere. Of particular concern are those areas within the golf club, and from Salmonberry Road to upstream of Mile Hill Road.

Riparian condition on Unnamed 15.0187 and Unnamed 15.0189 is generally poor. The landowner at the Game Farm has recently removed numerous trees on both banks to the edge of the creek, apparently to allow for an extension of a trail system along and across the creek. Additionally, the landowner directly downstream of the game farm (~RM 0.7) has also repeatedly removed key pieces of LWD in order to supply a private sawmill (Oleyar).

Water Quality

The Bremerton-Kitsap Health District has been collecting water quality information at three locations in Curley Creek and four stations in Salmonberry Creek since 1996. Identified water quality concerns include high fecal coliform levels (Mean=51 fc/100 ml upstream of Sedgwick Road, several high readings were noted downstream of Clover Valley Road on Salmonberry Creek), and dissolved oxygen (Mean=9.2 mg/l, Min.=7.4 mg/l). There were also several occurrences of stream temperatures in the range of 15-19.3^{o}C.

Water Quantity

Long Lake acts as a hydrologic buffer during peak flows, moderating the effects of peak flows on habitat downstream of the lake.

The Department of Ecology has determined that Curley Creek and tributaries exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, no further water is available for consumptive appropriation from June 15 – October 15 (WAC 173-515-040). Applications for consumptive water appropriation at other times of the year are subject to minimum instream flows established in WAC 173-515-030. Salmonberry Creek and tributaries have been closed to further consumptive water appropriation since 1948 (WAC 173-515-040).

A landowner on the Unnamed/unnumbered right bank tributary entering Salmonberry Creek at RM 3.0 has indicated a desire to divert the creek flow to created ponds, contrary to the closure to further consumptive water rights. This tributary provides rearing for salmonids; spawning use is unknown.

Estuarine

The TAG indicates the shoreline in the estuary is generally in natural condition, with estuarine conditions extending upstream of the bridge on Southworth Drive. The TAG indicates that Yukon Harbor, at the mouth of Curley Creek, has some areas of natural hard shoreline, but that there is a significant amount of shoreline bulkheading, including fill of the nearshore area.

Lakes

Long Lake is a natural large shallow lake (<12-feet deep) that is in the late stages of eutrophication. The lake acts as a hydrologic buffer during peak flows, moderating the effects of peak flows on habitat downstream of the lake. High nutrient (nitrogen and phosphorous) levels

have been identified in the lake, which appear to be associated with re-suspension from lake sediments (Welch et al. 1988, Welch and Kelly 1990, Welch et al. 1994); available studies have not indicated potential impacts to juvenile or adult salmonids. Large populations of introduced warmwater game fish (bass, crappie, bluegill, etc.) exist in the lake and may pose a predation problem for juvenile salmonids migrating through the lake, although no information on potential effects is available.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Curley/Salmonberry Creeks:

- **Protect integrity of natural estuary**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff. Remediate existing stormwater impacts to Salmonberry Creek and Unnamed 15.0187; ensure that stormwater from future development throughout the watershed is fully addressed at the time of construction.**
- **Manage water chemistry and aquatic vegetation in Long Lake in a manner that protects salmonid habitat conditions in the lake and downstream**
- **Restore natural channel configuration and function through the Grows Vineyards Golf Course, and through channelized agricultural areas in the watershed**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored, particularly upstream of Sedgwick Road; this strategy also needs to address active removal of standing trees and LWD in the vicinity of RM 0.7-0.8 at the Game Farm (mainstem and Unnamed 15.0187) to supply a private sawmill**
- **Remove instream pond and associated fish ladder in Unnamed tributary 15.0187 downstream of Locker Road to provide unrestricted fish passage and reliable instream flows downstream of the pond**
- **Eliminate unrestricted livestock access to channels in the watershed, and identify and correct sources of fine sedimentation (development in the headwaters of Unnamed 15.0187 and Unnamed 15.0189 (upstream of Ashby farm) are specifically noted as contributing a significant silt loads)**
- **Restore functional riparian zones throughout watershed, particularly in disturbed areas upstream of Sedgwick Road; restore historic wetlands and off-channel habitat, where possible**
- **Evaluate fish passage status (at all flows) of weir with flow notch just upstream of mouth of Unnamed 15.0187; implement corrective actions as warranted**
- **Evaluate fish passage status of culvert at Phillips Road crossing of Unnamed 15.0189; implement corrective actions as warranted**
- **Evaluate habitat conditions in Unnamed 15.0186, correct identified habitat limiting factors**

- **Recruit local watershed group to remove large amounts of garbage and debris from the channel in Unnamed 15.0187**
- **Assess benefits to anadromous and resident salmonids of correcting identified fish passage barrier at Sedgwick Road crossing of 15.0186 (WDFW SSHEAR SITEID 991567)**

Duncan Creek 15.0191

General

Duncan Creek is approximately 0.7 mile long, entering Puget Sound at Manchester. The creek supports coho and cutthroat. The culvert at Colchester Drive is thought to be a partial barrier to coho, and possibly a complete barrier to chum. Dave Kimball (local citizen) has observed juvenile coho upstream to the culvert at Colchester Drive, and has observed adult coho passing both directions through the same culvert.

The creek is located in a ravine upstream of Colchester Drive, the watershed is heavily developed, and the TAG indicates the channel is used for stormwater conveyance, resulting in a deeply incised channel. Kitsap County has acquired property in the headwaters of Duncan Creek to develop a regional stormwater facility. Dave Kimball indicates the intent is to locate the stormwater detention pond in the headwaters outside of the stream channel. There is potential that habitat conditions may improve after construction of the regional stormwater facility, compared to the impacted habitat conditions resulting from current stormwater runoff. There is an active citizens group on Duncan Creek, and a landowner is implementing a habitat restoration project at the mouth of the creek, which will likely be completed by the time this report is released (Small).

LWD and pool presence is unknown, but likely poor due to stormwater conveyance impacts to the channel. Riparian condition is generally good throughout the drainage.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Duncan Creek:

- **Remediate existing stormwater impacts to the channel; ensure that the stormwater plan currently under design review supports salmonid habitat downstream**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity, and to provide additional channel roughness to retain gravels in the currently incising channel**
- **Evaluate fish passage and habitat conditions upstream of the culvert fish passage barrier at Colchester Drive, prioritize and correct as warranted**

Beaver Creek 15.0192

General

Beaver Creek originates west of Manchester and flows in a northeasterly direction, emptying into Clam Bay (PSCRBT 1990). There are 2.8 miles of creeks and tributaries in the Beaver Creek watershed. Beaver Creek supports chum, coho, and cutthroat. PSCRBT 1990 indicates steelhead presence in Beaver Creek, although none of the TAG participants could verify steelhead presence. Land use adjacent to the creek corridor is primarily private woodlots (75%) and pasture/grassland (18%) (PSCRBT 1990). With the exception of one pasture in the lower section of the mainstem, most of the pasture/grassland areas are along the tributaries.

Little Clam Bay, an adjacent embayment, is isolated from saltwater by a causeway and tidegate at the outer end of the bay, creating a 20-30 acre impoundment. The impoundment is brackish, with salt water entry at higher tidal elevations (Small). This pond was initially constructed by Washington Department of Fisheries in the 1960s to create a fish farm (Small), and has since been used by WDFW and NMFS as a salmon rearing and release facility. Although it is questionable whether the small seep-fed creek that enters Little Clam Bay would support salmonids, the damming of this embayment prevents access to 23 acres of historic intertidal/nearshore area.

Fish Access

A dam, fitted with a fish ladder, is located at the mouth of Beaver Creek. The dam creates a pond (~3 acres) that is used for the water supply for fish studies at the NMFS labs. This ladder has a history of poor maintenance in recent years (Small). In addition, there is a second fish ladder on Navy property just upstream of the NMFS pond. The culvert under Beach Drive, which was previously a fish passage barrier, has been replaced. The culvert under Beaver Creek Road was repaired by Kitsap County Public Works in 1999.

Floodplain Modifications/Channel Condition

The lower portion of Beaver Creek has been altered by construction of two ponds; the lower pond that provides water to the NMFS facility is approximately 300 feet long, and the upper pond on Navy property is approximately 150 feet long. Both ponds provide poor habitat. Upstream, good habitat exists in most of the creek corridor, although a pasture in the lower portion of the creek has inadequate riparian vegetation canopy (PSCRBT 1990).

Substrate

Animal access occurs in the tributaries and the lower pasture area of the mainstem, and is a source of bacteria and sediment into the creek (PSCRBT 1990).

Riparian Condition

The reach from Beach Drive to Michigan Street is historic agricultural area that has been converted to residential. A riparian buffer of alder is growing in this reach; there appears to be little conifer in this riparian area, and width of the riparian buffer is undetermined.

Water Quality

There is a large goose farm in the vicinity of Collins Road; impacts to water quality are likely, but not identified at this time. Beaver Creek is on the CWA 303(d) list for exceedance of fecal coliform levels.

The Bremerton-Kitsap Health District has been collecting water quality information at two locations in the Beaver Creek watershed since 1996. Identified water quality concerns include consistent high fecal coliform counts (Mean=111 fc/100ml) downstream of the Ecology Lab Drive culvert.

Water Quantity

There are two water withdrawals from Beaver Creek in the vicinity of the NMFS Manchester facility. WDFW has a water right certificate at the site for the withdrawal of 5.0 cfs; NMFS has an application in for a water right certificate for a withdrawal of 0.95 cfs (Newman).

The total natural flow of Beaver Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further consumptive water appropriation (WAC 173-515-040).

Estuarine

A dam is located across the mouth of the estuary on the U.S. Naval Reserve. The dam severely limits the physical parameters of the estuary and eliminates intertidal exchange with the lower portion of Beaver Creek. Removal of the dam, which may involve removal of contaminated fill, is necessary to restore natural estuarine function at the mouth of Beaver Creek.

Little Clam Bay, an adjacent embayment, is isolated from saltwater by a causeway and tidegate at the outer end of the bay, creating a 23-acre brackish water impoundment. This pond was initially constructed by Washington Department of Fisheries in the 1960s to create a fish farm (Small), and has since been used by WDFW and NMFS as a salmon rearing and release facility. Although it is questionable whether the small seep-fed creek that enters Little Clam Bay would support salmonids, the damming of this embayment prevents access to 23 acres of historic intertidal/nearshore area.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Beaver Creek:

- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**

- **Evaluate feasibility of restoring historic estuary/nearshore in Little Clam Bay that is now a 23 acre brackish impoundment**
- **Work with NMFS and the U.S. Naval Reserve to determine the feasibility of restoring the natural estuary at the mouth of Beaver Creek; this would involve removal of the dam at the lake outlet and may involve removal of contaminated sediments**
- **Assess creek channel from Beach Drive to Michigan Street for existence of ponds within the floodplain and associated fish passage barriers**
- **Restore riparian function in the historic agricultural area from Beach Drive to Michigan Street, by encouraging conifer regeneration in deciduous stands that historically had a conifer component; ensure that riparian buffer width is sufficient to provide riparian functions**
- **Identify and correct areas in the watershed that have unrestricted livestock access**
- **Identify and correct sources of fecal coliform contamination**

Unnamed 15.0193

General

This small independent creek is 1.3 miles long, entering Sinclair Inlet 0.25 mile southwest of Point Glover. The creek supports coho and cutthroat, with potential of chum spawning at the mouth. The TAG indicated that habitat conditions have been impacted by development in the watershed and road construction and maintenance. They had no knowledge of specific habitat conditions in the creek, except that there is salt marsh estuarine habitat present immediately upstream of the culvert on Beach Drive.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0193:

- **Protect estuarine salt-marsh habitat; evaluate opportunities to increase estuary function upstream of Beach Drive**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Evaluate habitat conditions in this watershed, correct identified habitat limiting factors**

Unnamed 15.0194

General

This small independent creek is 0.75 mile long, entering Sinclair Inlet 0.25 mile southwest of Point Glover. The creek supports chum, coho, and cutthroat, and juvenile chum use has been observed around the saltwater marsh habitat at the mouth (Kalinowski). There are old instream

dam structures (likely installed by landowner) present near the mouth of the creek, which are not fish-friendly, but are likely passable. The creek is located in a fairly steep ravine for approximately ¾ of its length. Riparian vegetation in the ravine is mostly deciduous with some conifer presence. LWD condition through the ravine is fair.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0194:

- **Ensure effective fish passage at old instream dam structures near the mouth of the creek; remove structures if feasible**
- **Restore riparian function in ravine by encouraging conifer regeneration in deciduous stands that historically had a conifer component**

Unnamed 15.0195

General

This small independent creek is 0.75 mile long, entering Sinclair Inlet 2.5 miles east of Blackjack Creek. There is no known spawning in the creek, but juvenile chum use has been observed around the saltwater marsh habitat at the mouth (to RM 0.01, Kalinowski).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0195:

- **Protect existing estuarine salt-marsh habitat**
- **Evaluate habitat conditions in this watershed, correct identified habitat limiting factors**

Duncan (Sullivan, Sacco) Creek 15.0196

General

This small independent drainage is 1.2 miles long, with three additional short tributaries. Duncan Creek enters Sinclair Inlet 1.75 miles east of Blackjack Creek. The creek is known to support coho to the impassable cascade at RM 0.5, with presumed presence of cutthroat. The watershed is heavily urbanized, but little is known of specific habitat conditions.

The Bremerton-Kitsap Health District has been collecting water quality information at one location in Duncan (Sacco) Creek since 1996. Identified water quality concerns include consistent high fecal coliform counts downstream of Beach Drive (Mean=606 fc/100ml). A failing septic just upstream of the mouth has been corrected; updated sampling data will determine the extent to which this eliminates this concern (Jim Zimny, Bremerton-Kitsap Health District, personal communication).

Action Recommendations

The following salmonid habitat restoration action is recommended for Duncan Creek:

- **Evaluate habitat conditions in this watershed, correct identified habitat limiting factors**
- **Monitor water quality; identify and correct any remaining sources of fecal coliform contamination**

Sullivan (Karch, Karcher) Creek 15.0200

General

This small independent creek is approximately 0.5 mile long, entering Sinclair Inlet approximately 1.0 mile east of Blackjack Creek. The drainage area of Sullivan Creek is 0.20 mi^2 (PSCRBT 1990). The creek is a 100% urban drainage, and supports spawning for a few chum (Kalinowski) and cutthroat (Small) at the mouth. The culvert under Beach Drive is very small, constricting outflow during high flow events and restricting saltwater exchange into the lower end of Sullivan Creek. Sullivan Creek is experiencing sedimentation in the lower reach, most likely from increased stormwater from development in the upper watershed (PSCRBT 1990).

Sullivan Creek and tributaries have been closed to further consumptive water appropriation since 1975 (WAC 173-515-040).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Sullivan Creek:

- **Identify and remediate existing stormwater impacts to the channel; including stormwater water quantity control and water quality treatment for stormwater runoff**
- **Replace culvert at Beach Drive with bridge or larger culvert that will provide unrestricted outflow during high flows and which will restore saltwater exchange into the lower end of Sullivan Creek**
- **Identify and correct sources of fine sedimentation to the creek**

Olney, Retsil (Wilson, Karcher, Annapolis) Creek 15.0201

General

This small independent drainage is approximately 2 miles long, entering Sinclair Inlet approximately 0.75 mile east of Blackjack Creek. Locals most often refer to this creek as Olney Creek or Retsil Creek (Small), although Williams et al. (1975) identify the creek as Wilson Creek. The drainage area to Wilson Creek is 1.86 mi^2 (PSCRBT 1990). The creek supports chum, coho, and cutthroat. There is heavy urban development throughout most of the watershed.

Fish Access

The impassable cascade noted in Williams et al. (1975) is passable to anadromous salmonids. The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert (SITEID 15.0201 0.9) at Mile Hill Road (SR 166) crossing.

Floodplain Modifications/ Channel Condition

The floodplain is channelized and confined through the City of Port Orchard operated Sewage Treatment Plant upstream of the mouth. The plant was built over the previous channel, which was relocated, with associated mitigation features (boulder clusters, etc.)(Small). There are still bank erosion problems through the sewage treatment plant. The upper portion of the creek through Jackson Lund Park (South Kitsap Park) is relatively undisturbed, with good habitat (Small).

Riparian Condition

The riparian condition through the sewage treatment plant is poor. Upstream of the sewage treatment plant, riparian condition is fair, with housing development to the edge of the ravine. Interestingly, one of the only patches of old growth on the Kitsap Peninsula is located along the stream, upstream of the sewage treatment plant and below Mile Hill Drive (Small).

Water Quality

The creek flows through a sewage treatment plant at the mouth of the creek. The TAG indicates the sewage treatment plant has previously been cited/fined for water quality violations. The watershed is heavily urbanized, with much of the construction occurring prior to implementation of stormwater controls.

A fish kill occurred in approximately 1990, when the Annapolis Water District cleaned their storage tanks with chlorine (Small). The chlorine release resulted in a kill of everything, including the algae on the substrate.

The Bremerton-Kitsap Health District has been collecting water quality information at two locations in the Wilson Creek watershed since 1996. Identified water quality concerns include consistent high fecal coliform counts at the Wastewater Treatment Plant (Mean=137 fc/100ml), and periodic high counts downstream of Mile Hill Road. In addition, turbidity was identified as a concern at the Wastewater Treatment Plant (Mean=26.4 NTU).

Water Quantity

The bed of the creek is 5-7 feet wide, with evidence of bed scour. The Albertson's stormwater pond has blown out, with associated erosion and scour, several times in the 1980s (Small). The TAG indicates that most of the developments in the drainage do not have stormwater controls, and that stormwater impacts are evident through the drainage.

Stream flow data for Wilson (Karcher) Creek (as measured at 996 Olney Street NE) are presented in Table 7. Instream flows for water years 1997-1999 ranged from a minimum flow of 2.7 cfs to a maximum flow of 55 cfs.

Table 7: Streamflow data for Sullivan Creek (from Kitsap Public Utility District 2000)			
Water Year	**Mean Discharge (cfs)**	**Max. Discharge (cfs)**	**Min. Discharge (cfs)**
1997	4.07	13	3.0
1998	3.86	27	2.7
1999	6.62	55	3.0

Estuarine

An Eagle Scout restoration project was completed near the mouth, with limited riparian plantings from the sewage treatment plant to Beach Drive. Although benefit to anadromous salmonids is limited, the project represents an improvement over previous habitat condition.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Olney/Retsil Creek:

- **Restore natural channel configuration and riparian function through the City of Port Orchard Sewage Treatment Plant property**
- **Remediate existing stormwater impacts to the channel, including stormwater water quantity control and water quality treatment for stormwater runoff**
- **Assess and correct identified fish passage barrier at Mile Hill Road (SR 166) crossing**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Restore full riparian function in the ravine by encouraging conifer regeneration in deciduous stands that historically had a conifer component**
- **Identify and correct sources of fecal coliform contamination and elevated turbidity**

Annapolis Creek 15.0202

General

This small independent creek is approximately 1.2 miles long, entering Sinclair Inlet approximately 0.5 mile east of Blackjack Creek. Its headwaters originate above the South Kitsap Mall and flow in a northerly direction into a ravine near the South Kitsap High School; the headwaters of Annapolis Creek are buried in a culvert underneath South Kitsap Mall. Land use within the watershed is impacted by urban development, with 31% urban forested and 69% urban non-forested (PSCRBT 1990). The drainage supports coho and cutthroat. Although there are a significant number of salmonid habitat limiting factors, the location in an urban area may provide a habitat restoration educational opportunity.

Fish Access

There is a pond at the high school property that has a 3-6 foot falls at the outlet, which limits fish passage. TAG participants indicate the dam was constructed by the Corps of Engineers to create

a small-hydro facility to power the scoreboards at the high school. In addition, the TAG indicates there are numerous culvert fish passage barriers upstream.

Floodplain Modifications

The lower portion of the creek is channelized and constrained as it flows next to Arnold Avenue. The road is located directly next to the creek and the riparian zone lacks adequate vegetation (PSCRBT 1990). At the upstream end of the watershed, approximately 1000 feet of the channel is in a culvert under a mall. The creek subsequently daylights in a mini-storage lot, where there was a habitat mitigation project that failed, associated with a channel change (Small).

Channel Condition

The TAG indicates there is a lack of LWD, due primarily to wide-ranging stormwater flows.

Substrate

The TAG indicates the creek bed has evidence of significant scour (to bedrock in several places), due primarily to wide-ranging stormwater flows. Gravel condition is rated as fair to poor.

Riparian Condition

The riparian zone through the high school property is very poor, with lots of blackberry thickets. The school has been actively conducting riparian restoration.

Water Quality

An old Navy garbage dump is located on the high school property; impacts to water quality have not been assessed. The TAG participants indicate that Annapolis Creek is the #1 priority of the Kitsap Health Department. Annapolis Creek is on the CWA 303(d) list for exceedance of fecal coliform levels.

The Bremerton-Kitsap Health District has been collecting water quality information at two locations in the Annapolis Creek watershed since 1996. Identified water quality concerns include consistent high fecal coliform counts (Mean=251 fc/100ml downstream of Arnold Avenue culvert, and Mean=98 fc/100ml behind SK High School baseball fields). In addition, there were frequent observations of dissolved oxygen levels <10 mg/l at both sample sites.

Water Quantity

The creek currently has good summer low flow from springs. The drainage has a high amount of impervious surface; the South Kitsap Mall covers 15 acres of the headwaters. The creek is prone to flooding, and culverts in the lower reaches plug with debris during high rainfall events. Inadequate stormwater retention from developed areas is the most likely cause (PSCRBT 1990). A hydrologic analysis of the Annapolis Creek watershed was conducted (PSCRBT 1990), to estimate the stormwater runoff effects from existing development (1990) in the watershed. Four storm recurrence intervals were chosen to simulate storm events on the watershed, including the 2, 5, 25, and 100-year, 24-hour rainstorms. The conversion of mature forestland to residential or

developed use is a habitat limiting factor in this watershed, and has a dramatic impact on runoff. Increases in peak flows resulting from existing development (1990), as compared to the historic forested condition (1965), ranged from a 49% increase for the 2-year storm event to 18% for the 100-year storm event. Increase in total stormwater runoff volume ranged from 25.3% for the 2-year event to 10.9% for the 100-year event. These increases in peak flows significantly affect the stability and characteristics of the creek channel and associated habitat.

Estuarine

In 1989, a gas station was removed that was over the stream near the mouth, and that section was restored to an open channel and placed in public ownership (Small). There may be some possibility for further restoration at this site. However, the creek is in a culvert at the entry point to saltwater in Sinclair Inlet, limiting capability to provide a functional estuary.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Annapolis Creek:

- **Remediate existing stormwater impacts to the channel, including water quantity control and water quality treatment for stormwater runoff;**
- **Evaluate options to restore functional estuary a mouth of creek, including the potential of removing the culvert at the mouth of the creek; implement as warranted**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore functional riparian zones throughout the watershed, particularly through the high school property and along Arnold Avenue**
- **Remove small-hydro dam at the high school, and restore natural channel configuration and functional habitat conditions**
- **Assess, prioritize, and correct fish passage barriers upstream of the high school, as warranted**
- **Identify and correct sources of fecal coliform contamination**
- **Monitor dissolved oxygen levels, correct as warranted**
- **Assess water quality impacts, if any, from the old Navy garbage dump**

Blackjack Creek 15.0203, continued as Square Creek, Ruby Creek 15.0205, and Unnamed 15.0206-0207

General

The mainstem of Blackjack Creek flows northerly from a broad valley west to SR 16 into a steep ravine within Port Orchard city limits prior to entering Sinclair Inlet at the east side of the City of Port Orchard (PSCRBT 1990). The downstream portion of the creek within the city limits is generally developed, although the creek is located within a naturally forested ravine. Land use in the upper watershed is dominated by several small farms and agricultural land. There are over 17 miles of mainstem and tributaries with the Blackjack watershed with two dominant tributaries: Ruby Creek and Square Creek. The drainage area to Blackjack Creek is approximately 12.3 mi^2 (PSCRBT 1990). The primary land uses adjacent to the creeks are private woodlots (38%),

grassland/pasture (23%), forested urban (15%), and commercial timber (11%) (PSCRBT 1990). The forested urban land occurs within the lower three miles where the creek is in a steep wooded ravine. Upstream of Sidney Road (RM 5.2), Square Creek land use changes from agriculture to forest land. However, the forest land is destined for development. Much of the agricultural area in Unnamed tributary 15.0206 is also destined for development.

Blackjack Creek is one of the major fish producing streams in East Kitsap County, supporting chinook, coho, steelhead, cutthroat, and a unique run of summer chum. Blackjack Creek is the only creek in the area that has deliberately not been planted annually with coho fry. The Suquamish Tribe had a chum egg box program for several years (ended in ~1990) on Ruby Creek, using Gorst Creek chum stock (Dorn).

Blackjack Creek and tributaries are identified by the TAG as one of the best opportunities for habitat protection/restoration in WRIA 15. Several habitat protection/restoration actions have already been implemented in the headwaters in Square and Ruby Creeks, and the benefits of these actions would be complemented by additional restoration actions throughout the rest of the watershed.

Fish Access

There is a possible barrier culvert on Unnamed tributary 15.0204 at Bethel Road. There are potential fish passage concerns with 2 culverts in the Ruby Creek drainage, although they are known to be partially passable. The TAG indicates that the cascades identified in the WDF Steam Catalog (Williams et al. 1975) in upper Square Creek do not exist. The culvert at the Sidney Road crossing of Square Creek is undersized (May); the culvert may not currently be a fish passage barrier, but should be replaced with a larger culvert that will handle the 100-year flow and anticipated sediment and debris.

Floodplain Modifications

Along Sidney Road, Blackjack Creek was captured in a roadside ditch for approximately 600 feet, eliminating access to the floodplain on the road side of the creek. However, it was restored to its original channel away from the road in 1999 (Kalinowski). Upstream of Sedgwick Road, Blackjack Creek is extensively ditched through agricultural areas; however, floodplain function is still maintained through most of this area.

Ruby Creek 15.0205 has been ditched for most of its length for agricultural purposes, although there has been a wetland restoration effort at approximately RM 1.0. The Ruby Creek drainage upstream of Glenwood Road is in a land trust, with generally good habitat conditions (good riparian forest, fair LWD).

Channel Condition

There is a large amount of garbage in lower Blackjack Creek, especially under the Lund Street bridge (Oleyar). The presence of debris in the creek is likely the result of heavy development within the City of Port Orchard, which extends to the edge of the crest of the ravine (Dorn). The TAG indicates that LWD condition is fair/good in the lower 3 miles of Blackjack Creek, and poor throughout most of the upper Blackjack Creek drainage, where LWD presence is limited.

There have been several good wetland restoration projects and Kitsap Conservation District efforts to restore habitat in Ruby Creek 15.0205, a tributary to Blackjack Creek.

An evaluation of channel condition in lower Square Creek by Chris May indicates an unconfined channel with moderate sinuosity, a mean bankfull width of 5.3m, a mean bankfull depth of 0.42m, with 25-50% of the banks being stable. Pool spacing was 1 pool per 4.7 bankfull channel widths, a mean residual pool depth of 0.35m, and 21% of the sample area in pool habitat, yielding a quality rating of marginal (habitat rating of poor using the rating standards in Appendix B). Riffle habitat was 52% of the sample area, with the riffle gravel estimated to be 10% embedded, yielding a substrate quality rating of optimal. LWD density in the sample area was estimated at 166.2 m^3/km, with only 24% of the LWD being conifer, 40% >0.5 m diameter, and an LWD quality rating of marginal.

Substrate

The TAG indicates there is currently a lot of gravel moving through the upper watershed. This condition is likely to be exacerbated with additional increases in peak flows that may result from further stormwater input. Agriculture in the upper watershed has caused erosion and silt deposition downstream (PSCRBT 1990). There are also several stormwater outfalls from the Glenwood development on Square Creek (~RM 6.0-6.2), in addition to bank erosion resulting from development to the edge of the creek. Upstream of Glenwood Road, substrate and habitat conditions are generally good; however, this area is at risk, as it is zoned for residential development. The TAG participants indicated some observed problems with siltation from logging activities in the headwaters of Unnamed tributary 15.0207.

An intensive survey of the lower three miles of Blackjack Creek (Fishpro 1987, as cited in PSCRBT 1990) found a lack of suitable fish spawning habitat and excessive sedimentation in the creek. Possible sources cited were slides within the ravine and upper watershed erosion, likely the result of riparian vegetation removal and unrestricted livestock access. However, TAG participants indicated that substrate condition in the lower portion of Blackjack Creek is actually considered to be good, and that the Fishpro (1987) study may not be representative of current conditions. Although recent slides have been contributing gravels and fines, large numbers of spawning fish appear to be keeping the substrate clean (Oleyar).

An evaluation of benthic productivity in lower Square Creek by Chris May yielded a B-IBI score of 39.

Riparian Condition

The Suquamish Tribe has conducted surveys from the mouth to RM 3.0. Blackjack Creek is located in a steep ravine from just upstream of the mouth to Sedgwick Road; riparian condition is considered to be fair, with mixed woody vegetation and limited trail access through the ravine. Riparian condition is exceptionally good (near old growth) for approximately 1 km just upstream of the Sidney Road crossing; this riparian habitat warrants special protection consideration. Upstream of Sedgwick Road, most land use is agriculture with a lack of riparian vegetation, and a lack of fencing to exclude livestock. However, at RM 3.5, there has been some fencing and LWD placement by Kitsap Conservation District and WDFW. The TAG indicates there has been a fair amount of riparian vegetation removal on Unnamed tributary 15.0206 and on the agricultural area of upper Blackjack Creek.

Chris May evaluated riparian condition on Square Creek, indicating that 38.5% of the creek had riparian zones >30m, and 35.5% had riparian zones <10m, with 51.3% of the riparian zones in natural condition.

Water Quality

Blackjack Creek has good populations of freshwater mussels (some as large as 4-inches), typically an indicator of good water quality conditions (Steve Kalinowski). However, Blackjack Creek is on the CWA 303(d) list for exceedance of fecal coliform levels.

The Bremerton-Kitsap Health District has been collecting water quality information at eight (five Blackjack, one Ruby, two Square) locations in the Blackjack Creek watershed since 1996. No consistent water quality concerns were identified. However, periodic high fecal coliform counts were observed downstream of the Bay Street culvert, downstream of Sedgwick Road, upstream of Sidney Road, and on Ruby Creek downstream of Sidney Avenue. In addition, dissolved oxygen level observations <10 mg/l were common downstream of Sedgwick Road, and on Ruby Creek downstream of Sidney Avenue.

Water Quantity

From 1947 through 1950, the USGS maintained a continuous recording gage on Blackjack Creek 0.4 mile upstream of Sinclair Inlet, although the measurements were taken only during the summer and early fall (representing mainly low flow conditions) (PSCRBT 1990). During this period of record, the maximum flow was 285 cfs, the minimum was 6.7 cfs, and the mean annual flow ranged from 20-26 cfs.

Additional streamflow data for Blackjack Creek (as measured 0.5 mile upstream of Bay Street) collected by Kitsap Public Utility District are presented in Table 8. These periods of record are abbreviated, limiting the ability to compare the data. However, both mean discharge and minimum discharge are approximately 1/3 less than they were prior to significant development in the basin.

Table 8: Streamflow data for Blackjack Creek (from Kitsap Public Utility District 2000)

Water Year	**Mean Discharge (cfs)**	**Max. Discharge (cfs)**	**Min. Discharge (cfs)**
1993	14.9	74	4.5
1994	13.5	65	4.1

Blackjack Creek and tributaries have been closed to further consumptive water appropriation since 1960 (WAC 173-515-040).

Chris May estimates that 9.7% of the 10.0 km^2 drainage area of Square Creek is impervious surface. An estimated 39% of the Square Creek watershed is forested. There are several stormwater outfalls from the Glenwood development on Square Creek (~RM 6.0-6.2).

Water quality and quantity impacts are evident from stormwater in the Urban Growth Area (UGA) in the lower two miles of Blackjack Creek. Heavy development within the City of Port Orchard extends to the edge of the crest of the ravine, resulting in increased stormwater runoff

directly to the creek. Most of the development is single family domestic, which is exempt from local stormwater ordinances.

The TAG indicates that the hydrology in Unnamed tributary 15.0204 is quite variable, ranging from 0.5-0.75 cfs base flow to 60 cfs in winter (southeast of highway interchange). Much of this variability in flow is due to stormwater releases from undersized stormwater detention ponds in existing commercial developments. Additional heavy development is proposed in this drainage, which has significant potential to further exacerbate existing stormwater impacts in the lower Blackjack Creek drainage.

McCormick Woods discharges stormwater to wetlands in the headwaters of Unnamed tributary 15.0206, but the TAG participants indicate the stormwater is treated prior to entry into the wetlands, minimizing the impact to the wetlands and downstream areas.

Figure 20: Commercial development and road impacts to historic intertidal area in the Blackjack Creek estuary (photo courtesy of Department of Ecology)

Estuarine

The natural characteristics of the Blackjack Creek estuary have been highly altered (Figure 20). There has been significant fill (several acres) of historic intertidal estuary for shopping mall construction. Both banks of the estuary are heavily armored, and there is little natural remaining. Development has encroached to the water's edge near Bay Street, with associated lack of riparian vegetation on the shoreline. Although the Bay Street crossing of the estuary limits natural tidal exchange upstream of the culvert, the TAG participants indicate that there is sufficient tidal exchange to maintain some estuarine habitat upstream of Bay Street.

Nearshore/Marine

Bay Street runs along the shoreline of Port Orchard, with most of the shoreline armored to protect the roadway. In addition, there is little remaining riparian vegetation or woody debris along the marine shoreline through Port Orchard.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Blackjack/Square Creek and tributaries:

- **Reduce habitat impacts on agricultural lands upstream of SR 16, including development and implementation of farm plans that restore stream functions; identify and correct areas in the watershed that have unrestricted livestock access**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff,**

and increased fine sediment delivery from road surfaces and associated ditch maintenance

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; remediate existing stormwater impacts to the channel**
- **Protect high quality riparian habitat on Blackjack Creek just upstream of Sidney Road**
- **Protect/preserve/acquire as much of Square Creek upstream of Sidney Road as possible**
- **Protect as much of Ruby Creek upstream of Sidney Road as possible**
- **Protect and restore estuarine habitat (particularly upstream of Bay Street), including restoration of riparian function, and reduction of commercial encroachment, where feasible**
- **Evaluate fish passage status and upstream habitat the Bethel Road crossing of Unnamed 15.0204, two culverts in the Ruby Creek drainage, and at the Sidney Road crossing of Square Creek; prioritize and correct as warranted**
- **Restore natural channel configuration and floodplain function on Blackjack Creek through the channelized agricultural area upstream of Sedgwick Road, and through the agricultural area of Ruby Creek downstream of Glenwood Road**
- **Develop and implement a short-term LWD strategy for lower two miles of Blackjack Creek and Square Creek, to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore functional riparian zones throughout the watershed, with particular emphasis on Blackjack Creek upstream of Sedgwick Road, Unnamed 15.0206, and Square Creek**
- **Remove accumulated garbage and debris in Blackjack Creek through the City of Port Orchard**
- **Identify and correct sources of fecal coliform contamination**
- **Monitor dissolved oxygen levels downstream of Sedgwick Road, and on Ruby Creek downstream of Sidney Avenue, correct problems as warranted**

Unnamed 15.0208

General

This small independent drainage enters Sinclair Inlet approximately 0.5 mile west of the mouth of Blackjack Creek. The creek is approximately one mile in length, and historically probably supported cutthroat; historic potential for support of other salmonids is unknown. All potential salmonid habitat was eliminated with construction of Port Orchard Boulevard, which went right down the bottom of the ravine, displacing the creek (Kalinowski). The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert at the mouth of the creek at the Bay Street (SR 166) crossing (SITEID 15.0208 0.0), although there appears to be little potential habitat upstream.

Action Recommendations

This creek has little, if any, restoration potential unless Port Orchard Boulevard is abandoned and removed from the ravine (Kalinowski).

Ross Creek 15.0209 and Unnamed 15.0210

General

This independent drainage creek originates south of the SR 16/Tremont interchange in a large wetland system, flowing 1.5 miles to Sinclair Inlet just east of Ross Point. In addition, a small intermittent tributary enters the left bank at RM 0.5, originating approximately 2.5 miles to the southwest near North Lake (USGS 1981, as cited in NOAA 1992). The majority of the creek corridors in the Ross Creek watershed are forested (46% woodlots, 26% urban forested, 15% commercial forestland)(PSCRBT 1990). The drainage supports chum, coho, steelhead, and cutthroat. Chum spawning escapements from 1981-1991 averaged 722 adults (NOAA 1992).

Fish Access

A creek blockage, caused by falling riprap on the downstream side of the SR 166 crossing, should be removed to allow easier access by spawning fish and to more efficiently pass water during storm events (NOAA 1992). This culvert is also noted in the Estuarine discussion (below) as being of insufficient size to pass sediment and maintain saltwater estuarine characteristics upstream of the culvert. The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert on Ross Creek at the SR 16 crossing (SITEIDs 990357 and 15.0209 0.0), although the TAG indicated that coho are regularly observed upstream.

There are three potential barriers on Unnamed tributary 15.0210 (O'Keefe). A private driveway crossing downstream of SR 16 is likely a partial barrier, particularly at high flows. The culvert under SR 16 is likely a total barrier to chum and a partial/ complete barrier to coho and steelhead. At RM 0.6, the creek is encased for 500 feet in a culvert, which flows underneath a closed municipal landfill on which a business park has been constructed (owned by RV Associates). The culvert is a 36-inch plastic corrugated pipe with no substrate in the culvert, which was put in to replace a 24-inch corrugated metal pipe eight years ago. Although there is good quality habitat upstream of this culvert, and steelhead and cutthroat have been observed upstream of the closed landfill, it is likely that the culvert provides marginal passage conditions at best. [NOTE: The WDFW SSHEAR fish passage barrier database indicates presence of four fish passage barrier culverts on Unnamed 15.0210 at RM 0.14, 0.42, 0.51, and 1.84. The first three likely correspond to the barriers identified by the TAG above.] A prior fish passage barrier at Old Clifton Road (likely the same as WDFW SSHEAR SITEID 15.0210 1.84, see above) was replaced by Kitsap County in 1999.

Floodplain Modifications

Most all of the Ross Creek drainage is located within a deep confined ravine. There are areas where development has encroached to the edge of the ravine, resulting in blowdown of trees in the ravine and increased bank erosion and stormwater flows, but the natural floodplain of Ross Creek is within the ravine and generally intact.

Channel Condition

An inventory of natural habitat elements was conducted on the lower 0.6 mile (downstream of SR 16) of Ross Creek (NOAA 1992). The average channel width of lower Ross Creek is

approximately 10 feet. Although percentage of habitat that is pools was not identified, within the 0.6 mile, there were 38 pools (43 pools per mile) and 52 riffles, with 80% of the pools identified as scour pools. Ninety-five percent of all riffles were classified as low gradient riffles. Pools and riffles in the sample area may be too shallow to provide adequate rearing habitat for resident salmonids or salmonids that require a longer amount of freshwater rearing time. The constant influx of gravel to the creek from the slumped hillsides and anthropogenic activities appear to continually fill in pools as they form and create a rather shallow wide run of moderate velocity water. All LWD estimated to be large enough to provide hydraulic control or fish habitat was counted in the sample reach. The expanded LWD estimate was 220 pieces per mile on lower Ross Creek. There was little evidence of bank cutting throughout the watershed.

From North Lake to downstream of Old Clifton Road on Unnamed tributary 15.0210, channel condition is generally poor. LWD is almost completely lacking and pool:riffle ratio is 4-5:1, with few large deep pools.

Substrate

The amount of fine silts in the substrate of Ross Creek increases progressively upstream. From the mouth of Ross Creek to approximately RM 0.4, fines in the gravel were estimated to be <20% (NOAA 1992). A development is located above the east side of the Ross Creek ravine from RM 0.4-0.55. A small tributary at the downstream end of the development deposited silts into the creek. At the upstream end of the development, a culvert from the development causes bank erosion. In addition, several hillside slumps were observed on ether side of the creek from RM 0.4-0.55From this point to SR 16, fine sediments dominate the substrate. Upstream of the mouth of Unnamed tributary 15.0210, silt and fine sediments effectively inhibit spawning activities. Gravels migrating into the creek fill pools and have created a rather homogeneous shallow channel throughout the watershed, which offers very little habitat for resident fish.

NOAA (1992) references unsubstantiated reports that a sediment abatement pond east of Ross Creek and Tremont Avenue may overflow during storm events, contributing sediments to Ross Creek.

Riparian Condition

Riparian vegetation in the lower 0.6 mile of Ross Creek is well developed and provides adequate shading and bank stabilization for the creek (NOAA 1992). Riparian vegetation was dominated by trees with a diameter of 12-24 inches. The dominant tree species is red alder, with additional presence of Douglas fir, western red cedar, and western hemlock. A number of windthrown trees were noted on the east wall of the ravine below the development from RM 0.4-0.55.

Riparian vegetation is dominated by second growth forest from North Lake to downstream of Old Clifton Road on Unnamed tributary 15.0210.

Water Quality

The predominant soils within the lower watershed are not conducive to on-site treatment of sewage; all development within this area should be connected to sanitary sewer (NOAA 1992). In addition, soils forming steep slopes throughout the lower watershed are unstable and prone to slumping and slippage.

Water quality samples taken in January indicate that dissolved oxygen (DO) and creek temperatures are adequate to provide suitable habitat for aquatic life (NOAA 1992). They recommend that summer low flows should be monitored for DO and temperature. Total suspended solids (TSS) were 22 times higher directly below the landfill than they were at the next highest recorded site on the creek. Water samples below the landfill were darker in color as compared to other samples taken. Potential effects to fish or habitat were not identified. Fecal coliform measurements indicated elevated levels of fecal coliform present, both in the estuary and upstream, although point sources could not be fully identified.

The Bremerton-Kitsap Health District has been collecting water quality information at four locations in the Ross Creek watershed since 1996. No consistent water quality concerns were identified. However, high fecal coliform counts and dissolved oxygen levels <10 mg/l were frequently observed at the station off Cedar Ridge Court.

Water Quantity

In the Ross Creek watershed, there are a large number of wetlands in the vicinity of the SR 16/Tremont interchange. These wetlands store water and attenuate high flows (NOAA 1992).

Unnamed tributary 15.0210 is conveyed for 500 feet through a 36-inch culvert under a closed municipal landfill at RM 0.6 on which a business park has been constructed (owned by RV Associates). A 36-inch plastic corrugated pipe was installed eight years ago to replace a 24-inch corrugated metal pipe that had become insufficient to effectively handle storm water flows (O'Keefe).

The total natural flow of Ross Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further consumptive water appropriation (WAC 173-515-040).

Estuarine

SR 166 crosses the mouth of the Ross Creek estuary, with the culvert under the road limiting the amount of tidal influence upstream of the culvert. The estuary upstream of SR 166 is in fairly natural condition, with salt marsh habitat, although increasing siltation and channel braiding is occurring as a result of inability to flush the sediments through the undersized culvert under SR 166 (Oleyar, Small). The culvert should be replaced with a structure of sufficient size to restore tidal influence upstream of the culvert, and effectively pass sediments and debris to the outer estuary. Some development encroachment has occurred on adjacent uplands to near the water edge. Some of the encroachment areas are currently owned by the City of Port Orchard, potentially providing opportunities for habitat restoration that would otherwise not be available. Estuarine conditions upstream of the highway could be improved by replacing the culvert with a bridge or a much larger culvert.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Ross Creek and tributaries:

- **Replace culvert at the SR 166 crossing with bridge or a much larger culvert that will restore saltwater tidal influence upstream and flush accumulated sediments to Sinclair Inlet**
- **Restore functional estuarine habitat; eliminate or reduce encroachment from existing development and reestablish functional riparian buffers**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Evaluate three potential fish passage barriers on Unnamed tributary 15.0210; prioritize and correct fish passage problems as warranted**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Identify and correct sources of fecal coliform contamination**
- **Monitor dissolved oxygen levels, correct problems as warranted**
- **Evaluate water quality effects immediately downstream of the landfill on Unnamed tributary 15.0210; correct any identified problems**

Anderson Creek 15.0211 and EF Anderson 15.0212

General

Anderson Creek enters the south shore of Sinclair Inlet approximately 0.75 mile east of the town of Gorst, and also includes salmonid presence in East Fork Anderson 15.0212. The City of Bremerton's water supply area includes slightly less than half of the Anderson Creek drainage basin (Kathleen Cahall, City of Bremerton). The water supply area is managed for both municipal water supply and commercial forestry. The watershed supports chum, coho, and cutthroat, and possibly steelhead.

The City of Bremerton maintains the option of using Anderson Creek as an emergency water supply, although TAG participants indicate that no diversion of surface water from Anderson Creek has occurred during the last 10 years.

Fish Access

The culvert at the SR 16 crossing, just upstream of the mouth, is long and installed on a slight slope and is probably a passage barrier at low and high flows (Oleyar), but was assessed by WDFW SSHEAR staff (SITEID 990017) and was determined to not be a fish passage barrier.

Sheet flow through the City of Bremerton diversion flume, upstream of SR 16, inhibits fish passage at certain flows. There is an earthen dam on the west fork, approximately 0.2 mile upstream of the diversion flume, that is not a current fish passage barrier, but is a potential significant sediment source in the event of dam failure.

Floodplain Modifications

The natural floodplain is impaired by the presence of a 300-foot long concrete flume and pump station located approximately 0.25 mile upstream of SR 16. This flume severely constricts the channel and floodplain and eliminates all suitable habitat conditions within the flume. Sheet flow through the flume also inhibits fish passage during certain flows. The Suquamish Tribe and WDFW have jointly proposed to remove the fish ladder, sluice gate, and at least one side of the concrete flume, and revegetate the banks, allowing the creek to reestablish natural channel characteristics. The City of Bremerton indicates that removal of the concrete flume is not being considered, as it serves as an emergency drinking water supply (Kathleen Cahall). Ability to restore full floodplain function is also limited by the presence of City of Bremerton groundwater wellheads on both sides of the valley bottom in the vicinity of the diversion flume.

Channel Conditions

Natural channel characteristics have been eliminated at the water diversion flume reach upstream of SR 3. Removal of one side of the flume would allow the channel to reestablish improved natural channel characteristics and improve fish passage through this reach.

An evaluation of channel condition just upstream of the water diversion facility by Chris May indicates a moderately confined channel with moderate sinuosity, a mean bankfull width of 4.0m, a mean bankfull depth of 0.38m, with 50-75% of the banks being stable. Pool spacing was 1 pool per 12.5 bankfull channel widths, a mean residual pool depth of 0.41m, and 10% of the sample area in pool habitat, yielding a quality rating of marginal. Riffle habitat was 83% of the sample area, with the riffle gravel estimated to be 10% embedded, yielding a quality rating of optimal. LWD density in the sample area was estimated at 214 m^3/km, with 89% of the LWD being conifer, 67% >0.5 m diameter, and an LWD quality rating of sub-optimal.

Substrate

The TAG participants indicate that substrate condition is good upstream of the diversion flume. An evaluation of benthic productivity just upstream of the water diversion facility by Chris May yielded a B-IBI score of 35.

Riparian Condition

Chris May evaluated riparian condition on Anderson Creek, indicating that 72.7% of the creek had riparian zones >30m, and 9.9% had riparian zones <10m, with 83.2% of the riparian zones in natural condition.

Water Quality/Water Quantity

The total natural flow of Anderson Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further consumptive water appropriation (WAC 173-515-040).

Chris May estimates that 10.2% of the 5.8 km^2 Anderson Creek watershed is impervious surface. Sixty-two percent of the Anderson Creek watershed is estimated to be forested.

The Bremerton-Kitsap Health District has been collecting water quality information at three locations in the Anderson Creek watershed since 1996. No water quality concerns were identified.

A natural wetland complex in the headwaters of EF Anderson is being used for stormwater treatment from adjacent development. Although habitat conditions in EF Anderson remain generally good, increases in stormwater runoff entry into the creek may alter the hydrology to the extent that downstream channel conditions are altered. Further use of instream wetlands to treat and store stormwater runoff should be avoided.

Stream flow data for Anderson Creek (as measured behind Gorst RV) are presented in Table 9. Instream flow for water years 1995-1999 ranged from a minimum flow of 2.5 cfs to a maximum flow of 115 cfs. City of Bremerton indicates that precipitation in 1997, 1998, and 1999 are significantly higher than the average during the period of record (Kathleen Cahall).

Table 9: Streamflow data for Anderson Creek (from Kitsap Public Utility District 2000)

Water Year	Mean Discharge (cfs)	Max. Discharge (cfs)	Min. Discharge (cfs)
1995	7.48	46	3.2
1996	5.44	35	2.8
1997	6.65	115	2.8
1998	6.9	38	3.0
1999	7.75	70	2.5

Estuarine

Virtually all historic estuarine function at the mouth of Anderson Creek has been eliminated by the containment of Anderson Creek in culverts under the SR 16/166 crossings. Saltwater exchange into the estuary is impaired by the SR 166/16 crossing, which precludes any significant saltwater influence upstream of the highway. The streambed is also filling with sediment upstream of the highway due to limited flow through the culvert. The culvert may also be a velocity barrier at higher receding tides, as salmon have been observed milling downstream of the culvert until velocities are reduced at the later portions of receding tides. Estuarine restoration would likely require that the highway be put on piles. The historic estuary likely provided benefits for Anderson Creek origin salmonids as well as to salmonids originating from other streams in the area.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Anderson Creek and tributaries:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; remediate existing stormwater impacts to the channel**
- **Restore natural channel configuration, estuarine function, and natural sediment transport through the SR 166/16 corridor**

- **Restore natural channel configuration and floodplain function through the City of Bremerton water diversion property, including removal of the diversion flume or isolation of the creek from the flume**
- **Ensure that stormwater from future development is fully addressed at the time of construction, avoid use of headwater wetlands to treat and store stormwater runoff**
- **Evaluate potential of failure and associated impacts of the earthen dam on the west fork; pursue removal to restore functional channel habitat**

Unnamed 15.0215

General

This small independent creek enters the south shore Sinclair Inlet just east of Gorst. The creek is located in a steep ravine, and TAG participants had no knowledge of salmonid presence or habitat condition for this creek. The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert at the SR 16 crossing (SITEID 991670). The evaluation was done during a recent inventory of State highways, and should reflect current conditions.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0215:
- **Correct identified fish passage barrier at SR 16**
- **Evaluate habitat conditions in this drainage, determine salmonid utilization, and correct identified habitat limiting factors as warranted**

Gorst Creek 15.0216 and extension as 15.0224, Unnamed (Bailey's) Creek 15.0217, Jarstad Creek 15.0218, Parish Creek 15.0220, and Heins Creek 15.0221

General

The Gorst Creek watershed is one of the largest in the East Kitsap Area, entering the west end of Sinclair Inlet. Less than half of the Gorst Creek watershed lies within the City of Bremerton's water supply, with associated restricted entry and development. There are 17.3 miles of mainstem and tributaries in the Gorst Creek watershed, with Parish and Heins creeks being two of the larger tributaries (PSCRBT 1990). Other tributaries include Unnamed (15.0217), Jarstad Creek (15.0218), Unnamed (15.0222), Unnamed (15.0223). The drainage area to Gorst Creek is approximately 4.35 mi^2, including approximately 1.63 mi^2 of drainage area to Heins Creek and 1.66 mi^2 of drainage area to Parish Creek (PSCRBT 1990). TAG participants indicate there appears to be much higher black bear presence and predation on salmon in Gorst Creek (upstream of RM 0.8), Parish, Heins and Jarstad creek drainages than most any other drainage on Kitsap Peninsula. Bear predation is not identified as a limiting factor, but rather as one of the critical ecosystem linkages that must be considered when establishing desired spawning escapements.

The watershed supports chinook, chum, and coho salmon, steelhead, and cutthroat. Sockeye are also occasionally observed in Gorst Creek, although it is unknown whether they are of local origin. The Suquamish Tribe operates two chinook rearing ponds and two yearling fall chinook

raceways near RM 0.76. This program was established in 1981 as a cooperative effort with WDFW, the City of Bremerton, and the Poggie Club, to provide salmon for tribal and sport harvest. Returns of chinook spawners are observed annually in Gorst Creek. The TAG indicates that adult chinook returns are likely hatchery origin returns, rather than the result of natural production. Suquamish tribal fisheries data suggest that spawning hatchery chinook in East Kitsap streams are not reproducing sufficient offspring to survive to adulthood (Dorn). The Gorst Creek watershed is one of the largest current producers of anadromous salmonids and is also one of the best opportunities for habitat restoration success.

The City of Bremerton manages the land adjacent to 14.6 miles of creek corridor for commercial timber; the primary land use in the watershed (84%) is commercial timber (PSCRBT 1990). The greatest human impact on Gorst Creek occurs in the lower one mile, where the creek flows through a densely developed area. Additional land use concerns in the watershed include the expansion of the Gold Mountain Golf Course from 18 to 36 holes (2-3 years ago), stormwater and riparian impacts to Parish Creek from the Sunny Slope development, and pending future impacts associated with planned residential development of McCormick Woods. There are no currently identified problems associated with the Gold Mountain or McCormick Woods developments.

The City of Bremerton was awarded a $386,000 Salmon Recovery Funding Board (SRFB) grant in 1999 to remove 750 feet of concrete channel downstream of the old pumphouse station and restore over 1000 feet of meandering stream channel. This is the first SRFB project awarded to East WRIA 15. Former Bremerton Mayor Glenn Jarstad is promoting a long-term plan to purchase all the properties downstream of this project and restoring the entire lower 0.8 mile of Gorst Creek (Dorn).

Fish Access

A diversion dam on Gorst Creek at RM 0.8, operated by the City of Bremerton, was a total barrier to upstream anadromous fish passage for many years; the dam was removed in 1985 (Kathleen Cahall).

The culvert under the Old Belfair Highway at RM 2.3 (WDFW SSHEAR SITEID 15.0216 2.3) is undersized and presents a barrier to fish passage at high flows. The culvert at the Old Belfair Highway crossing at RM 0.5 also presents a barrier at low and high flows (Oleyar). The WDFW SSHEAR fish passage barrier database indicates that the culvert at the SR 3 crossing of Gorst Creek (SITEIDs 990168 and 15.0216 3.5) at RM 3.5 is a fish passage barrier; the TAG indicates that it is only a partial barrier, as salmon juveniles and adults have been observed upstream.

Approximately 600 feet of Gorst Creek is routed through an 18-24 inch culvert under a privately operated landfill just upstream of SR 3 (WDFW SSHEAR SITEID 15.0216 3.6); Steve Kalinowski indicates this culvert is a total fish passage barrier, blocking access to 0.5-1.0 mile of habitat upstream. The culvert is also corroding (Dorn) and in danger of failure, and can't be effectively maintained as it currently is (Small). In 1997, a slope failure of the landfill at the upper end of the culvert covered the mouth of the culvert (Grant Holcroft). This has since been corrected, and water quality monitoring is ongoing to evaluate whether there are leachate impacts to Gorst Creek from the landfill. Gorst Creek upstream of SR 3 usually has no surface flow from May to September, and City of Bremerton staff have only observed adult salmon as far upstream as SR 3 (Kathleen Cahall).

The culvert under SR 3 on Unnamed 15.0217 has a significant drop at the outlet, likely creating a total fish passage barrier (WDFW SSHEAR SITEID 991585); there are at least two additional barrier culverts upstream. The TAG indicates that Unnamed 15.0217 may present a good restoration opportunity for the Gorst Creek watershed. The WDFW SSHEAR fish passage barrier database also indicates presence of a concrete wall at RM 0.01 (WDFW SSHEAR SITEID 15.0217 0.01) that is a fish passage barrier. The TAG was unfamiliar with this site.

The culvert at the SR 3 crossing of Parish Creek (WDFW SSHEAR SITEID 990323) has been fitted with baffles, providing unrestricted fish passage (Burns).

The Navy railroad crossing of Jarstad Creek (WDFW SSHEAR SITEID 15.0218 0.1) is a fish passage barrier. There is approximately 0.2 mile of good habitat upstream of the railroad.

The Navy railroad trestle crossing of Heins Creek (WDFW SSHEAR SITEID 15.0221 0.3) creates a partial fish passage barrier. There is a 3-foot drop at the culvert outlet. There is a deep pool at the outlet that may allow limited numbers of coho to access the culvert (City of Bremerton staff report having seen adult salmon upstream of the railroad culvert during high flows (Kathleen Cahall)). The Navy has been working with Mid-Sound Regional Fisheries Enhancement Group (MSRFEG) and the Suquamish Tribe to look at potential of installing weirs downstream to provide fish passage upstream of the culvert (Dorn). The WDFW SSHEAR fish passage barrier database also indicates presence of a culvert at RM 0.1 (WDFW SSHEAR SITEID 15.0221 0.1) that is a fish passage barrier; Oleyar indicates this is not a fish passage barrier to any species at any life stage.

The Navy railroad crossing of Unnamed 15.0223 also impedes fish passage; the culvert under the railroad crossing has collapsed. Fish passage is currently limited to a vertical opening of approximately 10 inches on the downstream end of the culvert (Oleyar). Further collapse of the culvert or complete filling with sediments would totally prevent fish passage. In addition, there are some sections of old concrete piping just downstream of the culvert that may create a barrier to fish passage.

Figure 21: Channelized portion of Gorst Creek immediately downstream of the old water diversion at Jarstad Park (2000 photo by Don Haring)

Floodplain Modifications

The floodplain of the lower 0.8 mile of Gorst Creek is extensively hardened and confined. The floodplain is completely channelized from the old water diversion at RM 0.8 to the mouth (Figure 21). There are approximately six businesses, and 10-12 private properties that encroach into the floodplain in the lower 0.8 mile, including a building materials supply and a metal

recycling operation just upstream of SR 3.

Figure 22: Gorst Creek habitat upstream of old water diversion at Jarstad Park (2000 photo by Don Haring)

Channel Condition

Channel conditions in the lower 0.8 mile of Gorst Creek are highly altered. The creek banks are heavily armored and the creek is channelized (Figure 21). There is little LWD and few pools from the mouth of Gorst Creek to the second crossing of Old Belfair Highway (RM 2.3), and what little LWD is present is primarily alder. From Old Belfair Highway to SR 3, LWD presence and pool condition are reported to be fair/good (Figure 22).

The TAG indicated that Unnamed 15.0217 contains good substrate and rearing habitat conditions upstream of the SR 3 fish passage barrier.

Numerous landslides have contributed LWD to Parish Creek and downstream areas, although the primary impact of the landslides is contribution of sediment, particularly fine sediment.

LWD is generally lacking in Jarstad and Heins creeks (Oleyar). Alexander Lake, on Heins Creek, is a man-made lake where beavers have constructed dams in the outlet concrete spillway (Kalinowski). Beaver activity, or lack thereof, resulted in a failure of the outlet dam and associated blowout of Alexander Lake in the mid-1980s. Although there were significant effects to downstream channel conditions after the blowout, the habitat has generally recovered from the impacts of the blowout. The TAG indicates that habitat in the vicinity of the old beaver dam site is of very high quality. However, anadromous access to the lake is precluded by a combination of natural and man-made barriers.

The TAG had no knowledge of channel or habitat conditions in Unnamed 15.0223 other than riparian information indicated below.

Substrate

Less than half of the Gorst Creek watershed is within the City of Bremerton water supply. However, the City of Bremerton actively harvests timber within the watershed. Although City of Bremerton managed timber harvest is conducted with good protection for streams, there is concern that timber harvest rates within the watershed may exceed sustainable yield levels (Kalinowski), and that roads and harvest may be contributing fine sediments to the creeks (Oleyar).

The primary substrate effects in the watershed are from Parish Creek, where several major landslides occurred in approximately 1996. These landslides are considered to have been a

natural occurrence and have contributed a heavy fine silt load to downstream areas. Landslides in the Parish Creek drainage have likely been a long-standing problem, as evidenced by the fact that the City of Bremerton diverted Parish Creek waters around their diversion on Gorst Creek, likely to avoid high gravel and fine sediment loads in the Parish Creek waters during high flows. Proposed development in the Parish Creek drainage has the potential to accelerate the already high natural slide and erosion rates in the drainage. There is limited potential for significant salmon utilization (chum in the lower reaches, coho in the upper reaches) in Parish Creek due to high fine sediment levels in the substrate.

Substrate in mainstem Gorst Creek is rated as fair (11-20% fines) throughout, although the portion downstream of the mouth of Parish Creek is subjected to greater presence of fines. Spawning downstream of the Old Belfair Highway is likely helping to keep the gravel substrate clean. In addition, the city operated a dam upstream of Old Belfair Highway for many years. They regularly dredged fines from upstream of the dam (the majority of which was likely from Parish Creek), which helped protect the quality of substrate downstream.

There is naturally limited gravel availability in Jarstad Creek, due to the igneous bedrock formation exposed at the surface (Dorn). Gravel and bed control weirs were placed downstream of the railroad crossing by WDFW, and substrate conditions in this area are good. In addition, there are pockets of spawning gravels, intermixed with bedrock, for 0.2 mile upstream of the railroad.

Substrate in Heins Creek is good upstream to the railroad crossing (RM 0.3), although there is very little flow during dry periods. There are also good pockets of gravel upstream of the railroad to the impassable cascades at RM 0.5, although anadromous salmonid passage is not currently known upstream of the railroad.

Riparian Condition

Less than half of the Gorst Creek and Heins Creek drainages are owned and managed by the City of Bremerton for forestry and protection of the city water supply. As a result, significant riparian buffers have been retained and riparian condition is good. However, there is concern that timber harvest rates within the watershed may exceed sustainable yield levels (Kalinowski). Riparian condition is poor on mainstem Gorst from the mouth to the old diversion site at RM 0.8, with encroachment of businesses and backyards to near the streambank. From just upstream of the diversion to Old Belfair Highway, riparian buffer width is good, although made up of younger timber. Riparian condition on mainstem Gorst from Highway 3 to the landfill is good.

Riparian condition on Jarstad and Heins creeks is reported to be good. Riparian condition on Unnamed 15.0217 is poor from the mouth to approximately 0.2 mile upstream of SR 3; the upper 0.5 mile is in forested condition. The TAG had no specific knowledge of specific habitat conditions in Unnamed 15.0223, but indicated that the drainage was well vegetated, with assumed good riparian condition.

Water Quality

Gorst Creek is on the CWA 303(d) list for exceedance of fecal coliform levels, based on excursions from water quality standards observed near the SR 3/SR 16 intersection in 1992 and 1993. The Bremerton-Kitsap County Health District has performed a sanitary survey, and there

are plans to sewer the area near the mouth of Gorst Creek to prevent fecal contamination from failing on-site septics (Kathleen Cahall).

Water quality in lower Gorst Creek (downstream of the City of Bremerton water diversion) is likely impacted from drainage and stormwater runoff from light industrial and residential properties that encroach to the edge of the creek. Of particular concern is runoff from parking lots for the businesses and from the metal recycling business located just upstream of SR 3. Uncontrolled runoff from this area affects water quality in the lower portion of Gorst Creek and the estuary.

An old privately operated landfill (reported to contain primarily building materials, appliances, and medical waste) is located in the headwaters of Gorst Creek, just upstream of SR 3. The creek is culverted for approximately 600 feet under the dump. Considering the limited life expectancy of culverts, there is concern of the potential for culvert failure and contamination of the entire drainage downstream. Recent surface and groundwater samples indicate no current adverse effects to water quality from the landfill, but that would likely change in event of failure of the culvert (Larry Tucker, personal communication).

The Sunny Slope development, adjacent to Parish Creek and Unnamed 15.0217 was constructed without any stormwater controls. Other than the lower portion of Gorst Creek, this is one of the few sites in the Gorst Creek watershed that is impacted by stormwater. Impacts to water quality have not been assessed, but water quality may benefit from regional detention and treatment of stormwater prior to routing to the creeks. There are also hundreds of tires piled in a wetland complex in the headwaters of Parish Creek; specific effects to downstream water quality are not determined.

The Bremerton-Kitsap Health District has been collecting water quality information at nine locations in the Gorst Creek watershed (five Gorst, one Bailey's, one Jarstad, one Heinz, one Parish) since 1996. No consistent water quality concerns were identified. However, high fecal coliform counts were frequently observed downstream of the SR 3 culvert and upstream of the Sam Christopherson Road culvert. In addition, dissolved oxygen levels <10 mg/l were frequently observed downstream of Gold Mountain Golf Course, and on Jarstad Creek downstream of Bremerton Forest Road.

Water Quantity

The City of Bremerton maintains a surface water right in Gorst Creek. The water right is for 10 cfs for emergency use only, and has not been used for the last 10-12 years (May, Dorn). WDFW also maintains a surface water right to 10 cfs for fish rearing by the fisheries coop (Dorn). Average Gorst Creek low flow in late summer/early fall is <10 cfs. Any surface water diversion by the City of Bremerton or WDFW during this period has the potential to dewater the creek and preclude upstream fish passage. The headwaters of the Gorst Creek and Union River (Hood Canal) are in close proximity to one another, and TAG participants indicated a concern that Union River water may be transferred into the Gorst Creek system, increasing water availability in Gorst Creek, but impairing instream flows in Union River. City of Bremerton indicates that some surplus stored water, upstream of their dam on the Union River, is diverted to Twin Lakes, which are on the hydrologic boundary between the Union River and Gorst Creek watersheds (Kathleen Cahall). There are no surface drainage channels out of the Twin Lakes. Studies by the

City of Bremerton indicate that approximately half of the groundwater flow out of the Twin Lakes is to the Union River watershed and half to the Gorst Creek watershed.

Applications for consumptive water appropriation from Gorst Creek are subject to minimum instream flows established in WAC 173-515-030.

There is significant development in the upper reaches of Unnamed 15.0217, with numerous stormwater outfalls directly to the creek. No specific water quality or quantity concerns were identified by the TAG, but the Gorst Creek watershed is identified as a good restoration opportunity, and uncontrolled stormwater runoff has the potential to alter the hydrology and habitat conditions downstream.

Stream flow data for Gorst Creek (as measured at Sam Christopherson Way) are presented in Table 10. Instream flows for water years 1991-1996 ranged from a minimum flow of 1.6 cfs to a maximum flow of 238 cfs. City of Bremerton indicates that precipitation in 1997, 1998, and 1999 are significantly higher than the average during the period of record (Kathleen Cahall).

Table 10: Streamflow data for Gorst Creek (from Kitsap Public Utility District 2000)

Water Year	Mean Discharge (cfs)	Max. Discharge (cfs)	Min. Discharge (cfs)
1991	28.9	196	5.1
1992	25.4	238	1.6
1993	17.5	77	2.6
1994	31.1	138	2.9
1995	67.0	227	8.8
1996	24.8	154	4.7

Figure 23: Gorst Creek estuary at the west end of Sinclair Inlet (1992, photo courtesy of Department of Ecology)

Estuarine

The west end of Sinclair Inlet is very shallow, with excellent production of prey organisms for salmonids (Figure 23). Historic natural estuarine characteristics upstream of the highway have been eliminated due to channelization and confinement of the lower creek. Downstream of the highway, there are good estuarine conditions in the vicinity of the mouth of Gorst Creek, but the shoreline to the north of Gorst Creek is completely armored to protect the rail line and highway, and the shoreline on the south side is encroached upon by businesses. Due to the extent of existing shoreline armoring, further shoreline encroachment and armoring of the shorelines (particularly the southern shore) should be minimized, and remaining natural

conditions should be enhanced where possible. There is an opportunity to reconnect a portion of the estuary to the north that was cut off by the routing of the rail line.

Lakes

See Channel Condition section for discussion of habitat impacts associated with Alexander Lake.

Bruce Bolding (WDFW, personal communication) has recently completed collection of stomach samples from introduced largemouth bass taken from Wildcat Lake. Although the data have yet to be analyzed, juvenile salmonids were found in the stomach samples. The data may yield an estimate of the level of bass predation on juvenile salmonids.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Gorst Creek and tributaries:

- **Promote continued sustainable forestry throughout the watershed**
- **Restore estuarine function (will likely require acquisition of historic floodplain/estuary from the mouth to Jarstad Park)**
- **Restore natural channel configuration and floodplain function in the lower 0.8 mile of Gorst Creek; seek removal or relocation of approximately six businesses and 10-12 residences that encroach into the natural floodplain (see plan promoted by former Mayor Glenn Jarstad, in General Comments above)**
- **Restore functional riparian zones from the mouth of Gorst Creek to the old diversion site at RM 0.8**
- **Replace culverts at Old Belfair Highway crossings to provide unrestricted fish passage at all flows**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Implement low impact development throughout the watershed, particularly on Parish Creek, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed, particularly those areas located just upstream of SR 3 and the Sunny Slope development adjacent to Parish Creek**
- **Ensure that development in the Parish Creek watershed incorporates special protection measures to avoid potential of increasing the amount of slide activity or erosion of fine sediment to the watercourse; Parish Creek naturally contributes high levels of fine sedimentation to downstream areas, affecting sediment quality and fish production potential**
- **Surface water rights currently exceed the instream flow in late summer/early fall; Lead Entity should refer to the HB-2514 Watershed Planning Process for consideration and resolution**
- **Protect highly productive, shallow intertidal areas of Sinclair Inlet; avoid armoring of additional shorelines on Sinclair Inlet, remove shoreline armoring where practicable**

- **Reconnect estuarine component north of Gorst Creek that was cut off by construction of the rail line**
- **Prioritize and correct fish passage barriers at Navy railroad crossings (Jarstad Creek, Heins Creek, and Unnamed 15.0223), at SR3, and elsewhere in the watershed; correct man-made fish passage barriers downstream of Alexander Lake on Heins Creek**
- **Assess condition and life expectancy of 600-foot long culvert under landfill just upstream of SR 3; develop and implement remedial measures to prevent collapse of the culvert and to ensure continued fish passage**
- **Develop and implement a short-term LWD strategy for Gorst Creek, from the mouth to RM 2.3, to provide LWD presence and habitat diversity until full riparian function is restored**
- **Assess habitat conditions in Unnamed 15.0223; correct identified habitat limiting factors, as appropriate**
- **Identify and correct sources of fecal coliform contamination**
- **Remove large accumulation of tires from wetland complex in the headwaters of Parish Creek**
- **Monitor dissolved oxygen levels downstream of Gold Mountain Golf Course, and on Jarstad Creek downstream of Bremerton Forest Road; correct problems as warranted**

Wright Creek 15.0225

General

Wright Creek is 1.2 miles long entering the north shore of Sinclair Inlet approximately mid-way between Gorst and Bremerton. The creek supports chum spawning in the intertidal area to RM 0.01 (there is an impassable cascade 100-feet upstream of the head of the estuary) and cutthroat to the dam at RM 0.8.

There is a 300-acre development approved in the upper watershed of Wright Creek, with associated stormwater management concerns. In addition to support for chum and cutthroat, Wright Creek provides important estuarine habitat. It is currently the only natural estuary remaining on the north shore of Sinclair Inlet, with the estuary extending upstream of SR 3.

The Bremerton-Kitsap Health District has been collecting water quality information at one location in Wright Creek since 1996. No consistent water quality concerns were identified. There was one high fecal coliform count in 1998. Although all stream temperature observations were <13.9^{o}C, observed temperatures are regularly elevated.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Wright Creek:

- **Protect integrity of the only natural estuary remaining on the north shore of Sinclair Inlet, with possible replacement of culvert under SR 3 and the Navy railroad with bridges to allow more inter tidal mixing and daylight**

- **Retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed; ensure that stormwater from future development is fully addressed at the time of construction**
- **Evaluate causes of elevated stream temperature; implement corrective actions as warranted**

City of Bremerton Streams and Marine Shoreline

General

All of the streams from Wright Creek in Sinclair Inlet, through Bremerton (on the south side of Port Washington Narrows, to Oyster Bay (at the south side of Dyes Inlet) have been covered and contained in culverts, eliminating all surface water and estuarine habitat characteristics. This eliminated streams along >11 miles of shoreline in an area that likely had numerous natural streams. In addition, the City of Bremerton has a history of repeated ongoing combined sewer overflow (CSO) problems that affect estuarine and nearshore water quality (May, Davis). City of Bremerton indicates they have been implementing an aggressive CSO reduction program since 1992, which has drastically reduced CSOs and which will bring the City into compliance with state regulations (Kathleen Cahall).

Figure 24: Altered marine shoreline at Bremerton Naval Shipyard (photo courtesy of Dept. of Ecology)

Marine shoreline and nearshore areas have been highly altered through the Bremerton area, due to roads, railroads, shipyards (Figure 24), and commercial and residential development. Efforts should be made to restore nearshore and marine riparian habitats, where feasible. Tag participants indicated that Mud Bay and Oyster Bay, at the southern end of Dyes Inlet, may have once been connected, but later separated by the construction of Marine Drive. The City of Bremerton indicate they have no indication that these bays were once connected, and that maps back to 1909 show a land separation between these two bays (Kathleen Cahall).

Action Recommendations

There is little, if any, habitat restoration opportunity for Bremerton area streams, as they are covered and fully contained in culverts

The following salmonid habitat restoration action is recommended:

- **Restore functional nearshore and marine riparian conditions, where feasible**

- **Eliminate combined sewer overflows that affect estuarine and nearshore water quality**

Unnamed 15.0226 and Unnamed 15.0227

General

This small independent drainage has approximately 2 miles of creek length, entering the southern end of Ostrich Bay at the southern end of Dyes Inlet. The creek supports chum, coho, and cutthroat. Land use in the watershed is primarily residential. This creek is located in a ravine from Shorewood Drive upstream to SR 3 (RM 0.2), with a lateral riparian buffer of approximately 50 feet. Riparian condition upstream of SR 3 is poor/fair. Fish passage barriers exist at SR 3, Kitsap Way, and Price Road. The stream gradient is reported to be steep upstream of Kitsap Way. The watershed is mostly fully built out, with most of the development occurring without effective stormwater controls.

The Bremerton-Kitsap Health District has collected water quality monitoring data since 1996 upstream of Shorewood Drive. There have been several occasions of fecal coliform counts exceeding the threshold of concern of 100 fc/100ml.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0226 and tributaries:

- **Retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce impacts of road crossings, including identified fish passage barriers (SR 3), increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Restore functional riparian areas upstream of SR 3**
- **Identify and correct sources of fecal coliform contamination**

Unnamed 15.0228

General

This small creek (<1 mile long) enters the western shore of Ostrich Bay at the southern end of Dyes Inlet. Although the creek is not known to support salmonids, it provides important estuarine habitat along the shore of Ostrich Bay, likely providing support for shoreline associated juvenile salmonids.

Action Recommendations

No habitat action recommendations are recommended at this time.

Chico Creek continued as Wildcat Creek 15.0229, Kitsap Creek 15.0230, Dickerson Creek 15.0231, Lost Creek 15.0234, Unnamed 15.0233, and additional Unnamed Unnumbered Tributaries

General

The Chico Creek drainage is one of the largest and most productive in East WRIA 15. Almost 68 miles of streams and tributaries compose the Chico Creek watershed, of which approximately 17 miles are accessible to anadromous salmonids (PSCRBT 1989). The four major tributary streams to Chico Creek include Kitsap, Dickerson, Lost, and Wildcat creeks. There are also two major lakes in the watershed, Kitsap and Wildcat lakes. Chico Creek enters Chico Bay on the western shore of Dyes Inlet at the community of Chico. The drainage supports chinook, chum, coho, steelhead, and cutthroat. The Mountaineers have acquired approximately 300 acres of pristine habitat at the junction of Lost/Wildcat/Chico creeks that should provide essential long-term habitat protection; this acquisition includes one of the only remaining stands of old growth on the Kitsap Peninsula.

Chico Creek chum were used as a source of eggs for the Suquamish Tribe's Cowling Creek Hatchery from 1978 to 1981. The Cowling Creek Hatchery supports the tribe's East Kitsap chum eggbox program from 1981 to present (Dorn, Zischke). Also of interest, Suquamish tribal elders identify Chico Creek as the primary historic source of coho, probably due the availability of rearing habitat in the lakes and wetlands within the watershed.

Kitsap Creek consistently has the highest density of chum spawning observed within East Kitsap streams (Dorn). The effects of sedimentation/bed scour and stormwater runoff are moderated by the presence of Kitsap Lake.

Kitsap County will be completing a Watershed Analysis of the Chico Creek watershed (J. Davis). Data collected will be used to develop a Chico Creek Watershed Plan. The assessment will include action recommendations for land use planning, groundwater management, stormwater management technology, and habitat protection and restoration.

Fish Access

The concrete box culverts at the SR 3 crossing of Chico Creek and at the Kittyhawk Drive crossing immediately downstream from SR 3 are velocity barriers at high flows (Kalinowski, Oleyar, Suquamish Tribe). In addition, the Dept. of Transportation maintains a "trash rack" at RM 0.3 to intercept logs and other debris that might clog the SR 3 culvert downstream. The fence structure is 8-10 feet high and the full width of the channel. It is a partial to complete barrier to fish passage when clogged with accumulated debris. It also clogs with chum carcasses during spawning season, and needs frequent maintenance (Small). Replacement of the SR 3 culvert with a bridge would allow removal of the trash rack and allow passage of debris to the estuarine and nearshore areas in Sinclair Inlet.

The triple box culvert at the Golf Club Hill Road crossing may be a passage barrier at low flows or when the culverts are periodically blocked with debris. Kitsap County and WDFW added baffles and log weir substrate controls to these culverts in approximately 1992, which improved fish passage conditions (Small). Replacement of these culverts with a bridge would provide

natural substrate at the crossing and would pass debris, eliminating the need for regular maintenance.

Anadromous salmonid presence in Chico/Wildcat Creek was precluded for approximately three decades upstream of the outlet to Wildcat Lake by the WDFW fish screen (WDFW SSHEAR SITEID 15.0229 4.45), designed to keep planted trout in Wildcat Lake. A very limited number of coho and/or steelhead may have been able to jump over the screen into the lake. The screens were removed at the outlet of Wildcat Lake in the spring of 1999, and adult coho were documented in Wildcat Lake in the fall of 1999 (Oleyar). Fish screens at the outlet of Kitsap Lake also precluded anadromous fish passage upstream of the outlet of the lake. The screens at the outlet of Kitsap Lake were also removed in the spring of 1999, and adult coho were documented in the inlet creek to Kitsap Lake in the fall of 1999 (Baranski). Fish passage may still be impaired at the lake outlet by unauthorized manipulation of the lake level control boards at the outlet control structure. A prior fish passage barrier at the Northlake Way/Kitsap Way crossing was repaired in 1992, with installation of baffles in the culvert. However, the lower 20 feet of the culvert under Northlake Way (WDFW SSHEAR SITEID 15.0230 1.7 (note the river mile designation for SITEID is incorrect, should be ~RM 0.65)), has cracked off, creating a gradient fish passage barrier within the culvert and at certain flow regimes. A corrugated culvert has been placed across Kitsap Creek just downstream of Northlake Way, likely to act as a weir to stabilize gravel substrate, and may be a partial/total barrier to fish passage at low flows (there is some question as to whether this culvert is still present in the stream).
An impassable natural falls (RM 1.1) is the uppermost extent of distribution on Dickerson Creek. There is also an impassable dam located at the outlet to an instream pond at RM 1.2, but anadromous salmonids are not able to pass above the natural falls downstream. The culvert at the Taylor Road crossing of Dickerson Creek is likely a partial fish passage barrier, particularly at high and low flows. The TAG indicated that the upstream end of the culvert under the Navy railroad crossing at ~RM 0.5 was blocked by logs in March 1999, although the logs have since been cleared. In addition, the TAG indicated that the railroad culvert is a potential velocity barrier to fish passage at high flows. The TAG indicates that Unnamed tributary 15.0232 is dry most of the year until late fall, although chum were observed to RM 0.1 in 1998 (Oleyar).

Fish presence in Lost Creek extends upstream to a natural cascade at RM 1.9. Spawning steelhead and cutthroat were observed as far upstream as RM 1.4 in March 2000 (Oleyar). Logjams in Lost Creek may create difficulty to fish passage, but some do provide nice pools, and all are thought to be passable; the benefits associated with logjams typically outweigh those of removal.

Floodplain Modifications

Chico Creek is channelized and contained within riprap dikes from the mouth to the golf course at RM 0.8. Significant streambed and egg scour occurs in this channelized section. There are few resting areas in this reach for adult and juvenile fish during high flows (Oleyar).

Kitsap Creek is naturally constrained by topography from Kitsap Lake downstream for 0.3 mile. Further downstream, the Kitsap Creek floodplain is constrained on the west bank by the road and houses with associated bulkheads. The floodplain of Dickerson Creek is constrained by presence of houses downstream of the railroad crossing.

No floodplain concerns were identified for Lost or Wildcat creeks.

Channel Condition

Channel conditions in mainstem Chico Creek are generally poor (LWD poor, pools poor) in the channelized section from the mouth to the golf course at RM 0.8. The channel also lacks complexity (general lack of pools and LWD) from RM 0.8 to the railroad crossing at RM 2.0, but this area is heavily used by spawning chum (Small). Upstream, channel condition is generally good. LWD presence is good in Wildcat Creek downstream of Wildcat Lake, where the creek flows through several big logjams and some beaver dams.

LWD and pool presence in Kitsap Creek are poor, but the creek has good spawning densities, likely associated with peak flow moderation from Kitsap Lake. In Dickerson Creek, there is little LWD downstream of the railroad (RM 0.5). The Suquamish Tribe and WDFW are maintaining instream log weirs downstream of the railroad to provide fish passage and retain gravels. Upstream of the railroad, channel conditions are generally good except for sedimentation resulting from a slide at the powerline crossing. A 300-unit development on 400+ acres has been approved between Kitsap Creek and Dickerson Creek; the development is designed outside the creek ravines, but will increase presence of impervious surfaces and associated runoff in previously unsewered, unroaded areas.

Channel condition is generally good throughout the entire anadromous section of Lost Creek. LWD condition is generally good (Oleyar), with land use designated as long-term forestry.

Substrate

Chico Creek is channelized from the mouth to the golf course at RM 0.8, with presence of additional areas of bank hardening upstream to the Navy railroad crossing (RM 2.0). Substrate gravels are present, and appear to be compacted with fine sediment (Small). Even with the compacted substrate, significant streambed and egg scour occurs in this section. Substrate in Wildcat Creek, in the vicinity of RM 3.0-3.5, is impaired by surface erosion and landslides associated with past logging activities.

Kitsap Creek has generally good gravel conditions downstream of Kitsap Lake, with heavy spawning use.

Substrate condition in Dickerson Creek is reported to be good from the mouth to 0.2 mile upstream of the railroad crossing, with substrate consisting of larger cobble and bedrock further upstream.

Substrate in Lost Creek is affected by impacts from past logging. There are numerous slides off of logging roads adjacent to Lost Creek. Fine sediment has impacted the quality of gravels, but the TAG indicates that heavy chum spawning has helped to keep the gravels relatively loose and clean. There are also numerous small right bank tributaries to Lost Creek with fish use in the lower sections that are not noted on the fish distribution map. Chum and coho are both known to spawn in the lower reaches of these tributaries, although it is unknown how far upstream anadromous utilization occurs (Oleyar). Upstream of the falls on Lost Creek, a culvert at a DNR road crossing was removed, allowing the accumulated sediments upstream of the culvert to naturally regrade. This will likely pass significant sediment to downstream areas, possibly causing problems with excess sediment and channel instability.

Riparian Condition

Riparian status on Chico Creek from the mouth to the golf course (RM 0.8) is poor. Riparian vegetation is non-existent through the golf course on Chico Creek. From the golf course to the railroad crossing (RM 2.0) riparian condition is fair/poor. Upstream of the railroad crossing, riparian condition is good to excellent. Riparian condition on Wildcat creek is good upstream to Wildcat Lake. The shoreline of Wildcat Lake is moderately developed, with some remaining good riparian areas.

Riparian condition on Kitsap Creek is good on the east side of the creek from the mouth to Kitsap Way, and fair on the east side upstream to the lake. The west side of Kitsap Creek is heavily developed with homes, with riparian condition being poor to non-existent. The shoreline of Kitsap Lake is heavily developed with associated poor riparian condition.

Riparian condition on Dickerson Creek is poor downstream of the railroad crossing and good upstream.

Riparian condition on Lost Creek is primarily regrowth from logging that occurred 15 years ago, but riparian condition is reported to be good (Oleyar).

Water Quality

Kitsap Lake is on the CWA 303(d) list for exceedance of total phosphorous and fecal coliform standards.

The Bremerton-Kitsap Health District has been collecting water quality information at eight locations in the Chico Creek watershed since 1996. No consistent water quality concerns were identified, but there were several observations of high fecal coliform counts in Chico, Dickerson, and Kitsap creeks, low dissolved oxygen levels in Chico and Dickerson creeks (downstream of the Taylor Road crossings), and water temperatures exceeding 15°C in Chico downstream of Kittyhawk Drive and downstream of Taylor Road) and in Dickerson Creek (downstream of Taylor Road). Numerous occurrences of water temperatures exceeding 15°C (temperatures as high as 21.4^{o}C) were identified in Kitsap Creek (downstream of Northlake Way).

Water quality is likely affected by highway runoff to Kitsap Creek from Northlake Way, and to Chico Creek and the estuary from SR 3 and Chico Way. Concerns were also raised regarding potential stormwater impacts from development currently underway between Dickerson and Kitsap creeks. Existing plans are to route the stormwater to the Kitsap Creek side of the development, with potential impacts to both water quality and quantity in Kitsap Lake and the creek downstream. A general concern was identified regarding potential water quality effects from golf course management, but specific effects in this watershed are unknown.

Water Quantity

Kitsap Lake and Wildcat Lake act as hydrologic buffers during peak flows, moderating the effects of peak flows on habitat in Kitsap Creek and Wildcat Creek, respectively, downstream of the lakes. However, instream flows in Kitsap Creek during low flow periods may be impaired by unauthorized landowner manipulation of the lake level control boards at the outlet dam.

The Department of Ecology has determined that Chico Creek and tributaries downstream of the confluence of Dickerson Creek exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, no further water is available for consumptive appropriation year round (WAC 173-515-040). Chico Creek and tributaries upstream of the confluence of Dickerson Creek (excluding Wildcat Lake), Dickerson Creek and tributaries, Kitsap Creek and tributaries, and the Unnamed creek and tributaries to Kitsap Lake are also closed year round to further consumptive water appropriation, with closures dating as far back as 1942.

Instream flow in Dickerson Creek is impaired by diversion of flow from Dickerson Creek at RM 1.2 to Kitsap Lake, primarily for lawn irrigation on lakeside properties. This is of particular concern because the peak diversion is typically during the period of lowest instream flow (late summer – early fall) in Dickerson Creek. The TAG recommends that Ecology verify whether this diversion is permitted, and monitor the diversion to ensure that maximum instream flow in Dickerson Creek is retained.

Stream flow data for Chico Creek (as measured at Chico Golf and Country Club) are presented in Table 11. Instream flows for water years 1991-1996 ranged from a minimum flow of 1.9 cfs to a maximum flow of 500 cfs.

Table 11: Streamflow data for Chico Creek (from Kitsap Public Utility District 2000)

Water Year	Mean Discharge (cfs)	Max. Discharge (cfs)	Min. Discharge (cfs)
1991	8.59	165	4.1
1992	27.9	400	4.1
1993	25.9	103	8.5
1994	24.6	247	2.2
1995	54.6	500	3.5
1996	28.7	285	1.9

Figure 25:Chico Creek estuary (1992 photo courtesy of Dept. of Ecology)

Estuarine

Estuarine conditions downstream of the culvert at the mouth of Chico creek are generally good, although the extent of estuarine influence is limited by the routing of the creek through a confined culvert at the mouth (Figure 25). Review of historic aerial photos indicates the mouth of the creek may have historically moved across a broader estuarine interface. Estuarine function could be improved by increasing the number and/or width of openings under SR 3, which may also eliminate the need for Dept. of Transportation to maintain the

trash rack upstream.

Lakes

There are two major lakes in the Chico Creek watershed. Wildcat Lake is located on Wildcat Creek at RM 4.6. It is approximately 112 acres in size with a maximum depth of 33 feet, and provides a large rearing area for juvenile salmonids. Kitsap Lake is located on Kitsap Creek at RM 0.7. Anadromous fish access upstream of the lakes was precluded for several decades by the presence of fish screens (discussed in fish access section above), the purpose being to keep planted trout in the lakes.

The shorelines of both Kitsap Lake and Wildcat Lake are heavily developed with houses (Kalinowski). Much of the lakeside riparian vegetation has been replaced with lawns and landscape plants. Additionally, a significant amount of the shoreline of each lake has been hardened with bulkheads. In addition to planted trout, both lakes have populations of several species of warmwater game fish with Kitsap having the higher populations. Residents are concerned with aquatic weed growth particularly in Kitsap Lake and have been investigating options for control. Both lakes receive heavy use by recreational boaters and fishers.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Chico Creek and tributaries:

- **Replace the culverts at the SR 3 and Kittyhawk Drive crossings with bridges of sufficient size to allow unrestricted fish passage at all flows, as well as passing sediment and debris; this would allow removal of the upstream Dept. of Transportation trash rack, which is a fish passage barrier when clogged with accumulated debris**
- **Restore natural channel and floodplain configuration and integrity in Chico Creek from the mouth to the Navy railroad trestle; remove or relocate riprap dikes where feasible**
- **Restore stream utilization of historic estuarine delta**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed; ensure that state-of-the-art stormwater protection is provided for the pending development between Kitsap and Dickerson creeks**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance; develop and implement a forest road management plan in the Lost Creek drainage to reduce slide impacts from forest roads**
- **Evaluate potential of restoring natural channel and floodplain configuration in Kitsap Creek along Northlake Way**
- **Identify and correct cause of high water temperatures in Kitsap Creek (downstream of Northlake Way), as identified in the Bremerton-Kitsap Health District sampling**
- **Correct the culvert fish passage barrier at the Northlake Way crossing of Kitsap Creek**
- **Actively monitor the operation of the lake level control boards at the outlet of Kitsap Lake to ensure that unrestricted fish passage is maintained**

- **Correct the culvert partial fish passage barrier at the Taylor Road crossing of Dickerson Creek**
- **Develop and implement a short-term LWD strategy in Chico Creek (mouth to railroad crossing), in Kitsap Creek, and Dickerson Creek (mouth to railroad crossing)**
- **Replace the culverts at the Golf Club Hill Road with a bridge that will provide natural substrate and pass debris**
- **Assess the fish passage status at high flows of the culvert on Dickerson Creek at and downstream of the railroad crossing; correct if identified as a fish passage barrier**
- **Remove the dam, or provide unrestricted fish passage, at RM 1.2 on Dickerson Creek (would benefit resident salmonids only, as anadromous salmonids are unable to pass the natural falls downstream)**
- **Assess fish passage and habitat impacts of corrugated culvert downstream of Northlake Way (likely placed across the creek without HPA approval as a weir to stabilize gravel substrate); correct identified problems**

Koch (Knapp) Creek 15.0245, Unnamed (Crystal) Creek 15.0243, Unnamed (Woods) Creek 15.0244, and Unnamed Creeks 15.0242A, 15.0242B, 15.0241

General

Koch Creek is approximately 1.4 miles long; the other independent streams are each <1.0 mile long. They enter the western shore of Dyes Inlet between Silverdale and Chico Creek. Each of these streams is impassable at Silverdale Way (Koch Creek is WDFW SSHEAR SITEID 15.0245 0.1), which is located just upstream of the mouths, with additional impassable barriers at SR 3 and at the railroad crossings. Koch Creek, and Unnamed tributaries 15.0242A, 15.0242B, and 15.0241 support chum spawning in the short distance upstream to Silverdale Way; all of these streams support cutthroat, some extending upstream of Silverdale Way.

Action Recommendations

The following salmonid habitat restoration action is recommended for Koch Creek and additional independent tributaries south of Silverdale:

- **Prioritize and correct fish passage barriers at Silverdale Way, SR 3, and the railroad crossings, as warranted**

Strawberry (Crystal, Koch's) Creek 15.0246, WF Strawberry 15.0247

General

Strawberry Creek and associated tributaries comprise approximately 3.8 miles of creek length (PSCRBT 1989). Strawberry Creek enters the northwest end of Dyes Inlet in Silverdale. The drainage supports chum, coho, and cutthroat. Land use in the lower watershed is urban (45%), with upstream areas primarily rural residential (26%) or private woodlots (21%)(PSCRBT 1989).

Fish Access

There are three culverts in lower Strawberry Creek that are identified as fish passage barriers, located at Silverdale Way, Silverdale Loop (WDFW SSHEAR SITEID 15.0246 0.49), and Anderson Hill Road (WDFW SSHEAR SITEID 15.0246 0.83). The culvert at the SR 3 crossing (WDFW SSHEAR SITEID 990403) was evaluated in the recent WSDOT inventory to not be a barrier to fish passage. The culvert at Silverdale Way is a partial barrier at certain flows, and recent habitat projects just downstream of Silverdale Way should be monitored, as they may have added additional fish passage constraints (Oleyar). In addition, there is one culvert and one bridge upstream of Frontier Road, and two culverts on Hosman Circle that appear to be partial barriers (O'Keefe). There are also two impassable culverts at Ivy Lane, although the creek is very small at this point (O'Keefe). The WDFW SSHEAR fish passage barrier database indicated fish passage barrier culvert at RM 1.67 (WDFW SSHEAR SITEID 15.0246 1.67) likely corresponds to one of these latter culverts.

There is a dam and pond located on WF Strawberry just upstream of Provost Road (WDFW SSHEAR SITEID 15.0247 0.4) that has been in place since the early 1900s. The dam is a total barrier to fish passage. The landowner (Harshbarger) has a history of dredging the mud and silt from the pond and dumping it directly into the channel downstream of the dam. In addition, the WDFW SSHEAR fish passage barrier database indicates presence of fish passage barrier culverts on WF Strawberry Creek at Frontier Road (WDFW SSHEAR SITEID 15.0247 0.14) and SR 3 (WDFW SSHEAR SITEID 990708); the ends of these culverts are separated by a distance of only a few feet.

Floodplain Modifications

From the mouth of Strawberry Creek to Silverdale Way, the channel is contained between concrete walls and covered. Adult salmon actually spawn in this raceway configuration, but all of the spawned eggs or alevin likely get scoured out at high flows. Upstream of Silverdale Way, the channel is located in a steep/deep ravine with generally poor/fair habitat conditions. The streambanks are bulkheaded in several locations in the ravine to provide bank stability below structures that are built on the crest of the ravine. Most of WF Strawberry is located in a naturally confined ravine upstream of Provost Road.

Channel Condition

Strawberry Creek downstream of Silverdale Way is confined between concrete walls. Although some spawning occurs in this reach, there are no LWD, pools, or riffles, and all spawn is likely lost to mortality due to bed scour. Upstream of Silverdale Way, channel conditions are also generally poor, with heavy channel armoring both inside and outside the ravine.

Substrate

Channel substrate is very unstable downstream of Silverdale Way, in the concrete lined channel. Although some spawning occurs in this reach, there are no LWD, pools, or riffles, and all spawn is likely lost to mortality due to bed scour. PSCRBT (1989) indicted potential for fine sediment entry to the channel from a school playground area, which was devoid of vegetation , with bare exposed soil directly next to the stream. On WF Strawberry, the substrate from Provost Road to Dickey Road is reported to be orange in color (O'Keefe); the cause is unknown.

Riparian Condition

The only riparian vegetation on Strawberry Creek is what is left in the ravines. Development encroaches to the edge of the ravine in many locations. Riparian buffers are narrow and composed of mixed hardwoods with some conifers, and are rated fair to poor (Kalinowski). WF Strawberry Creek has mixed conifer/hardwood vegetation from Frontier Road upstream to the dam.

Water Quality

The lower portion of Strawberry Creek has a very high percentage of impervious surfaces. WF Strawberry is heavily developed, with most of the development occurring prior to implementation of stormwater controls. The water quality impacts of associated stormwater runoff are unknown.

The Bremerton-Kitsap Health District has been collecting water quality information at three locations in Strawberry Creek since 1996. Identified water quality concerns include periodic observations of high fecal coliform levels downstream of Washington Avenue.

Water Quantity

Streamflow data for Strawberry Creek (as measured at the Silverdale Water District Office) are presented in Table 12. Instream flow for water years 1992-1999 (note several years flow data not available) ranged from a minimum flow of 0.5 cfs to a maximum flow of 680 cfs. Of particular note are the extremely high peak flows observed since 1998.

Table 12: Streamflow data for Strawberry Creek (from Kitsap Public Utility District 2000)

Water Year	Mean Discharge (cfs)	Max. Discharge (cfs)	Min. Discharge (cfs)
1992	2.2	15	0.50
1993	2.0	9.6	0.6
1994	NA	NA	NA
1995	NA	NA	NA
1996	3.59	25	1.2
1997	NA	NA	NA
1998	10.5	680	0.9
1999	20.1	617	0.81

The Department of Ecology has determined that Strawberry Creek and WF Strawberry exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, no further water is available for consumptive appropriation from June 1 – October 31 (WAC 173-515-040). Applications for consumptive water appropriation at other times of the year are subject to minimum instream flows established in WAC 173-515-030.

High stormwater flows, likely the result of heavy development in lower Strawberry Creek and WF Strawberry, are resulting in a significant increase in bank erosion in this watershed.

Estuarine

There is no defined estuary associated with Strawberry Creek.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Strawberry Creek and tributaries:

- **Restore natural channel configuration and floodplain integrity downstream of Silverdale Way; in the interim, identify and implement a strategy that will realize production benefits from fish spawning in confined raceway channel configuration downstream of Silverdale Way**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Prioritize and correct numerous fish passage barriers in Strawberry Creek watershed**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity**
- **Restore functional riparian buffers both within and outside the ravine area**
- **Ensure that any future dredging of accumulated sediments from the pond on WF Strawberry (upstream of Provost Road) is done pursuant to necessary permits, and that sediments are not disposed of downstream of the dam, unless authorized**
- **Identify cause of orange coloration of substrate on WF Strawberry, from Provost Road to Dickey Road, correct identified water quality problems as warranted**

Unnamed 15.0248

General

This small independent creek is approximately 0.8 mile long, entering the northwest end of Dyes Inlet. The creek is thought to originate in the wetland behind Toys-R-Us. This creek has been entirely culverted to facilitate development in Silverdale. There is no remaining habitat available in this creek. The TAG reports that oil sheens are regularly observed at low flow off the mouth of the culvert. In addition, the creek likely carries stormwater runoff from dense roads and parking lots in the drainage. Water quality effects to Dyes Inlet should be investigated and effectively addressed.

Action Recommendations

There is little, if any, habitat restoration opportunity for this creek, as it is fully covered and fully contained in a culvert. However, it is important to retrofit state-of-the-art stormwater quality

best management practices to existing development in the watershed that affect water quality in Dyes Inlet.

Clear Creek 15.0249, WF Clear Creek 15.0250, and Unnamed 15.0251-0254

General

Clear Creek is a low gradient lowland stream, which flows through a broad valley, entering Dyes Inlet at Silverdale. There are 11.8 mile of streams and tributaries in the Clear Creek watershed (PSCRBT 1989). The Clear Creek drainage supports chinook, chum, coho, steelhead, and cutthroat. The Suquamish Tribe maintains a chinook rearing pond on Clear Creek, established in 1986 in cooperation with the Clear Creek Council and the Bremerton chapter of Trout Unlimited (Dorn). The TAG indicates that for the size of the Clear Creek drainage, it should be producing a lot more salmonids than it currently is.

In 1989, land use adjacent to the Clear Creek corridor was indicated as 39% rural residential, 19% private wood lots, and 18% urban land (PSCRBT 1989). Since that time significant development has occurred in the watershed.

Fish Access

The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert on Clear Creek at Mountain View Road (RM 3.1, SITEID 15.0249 3.1).

Historic wetlands in the headwaters of Unnamed tributary 15.0251, on the Bangor Base, were converted to stormwater treatment facilities. These stormwater ponds are sized adequately to prevent any surface outflow, although riprap at the outlets of these ponds prevents upstream passage coho into these historic wetland rearing areas, and the lake level is artificially maintained, eliminating surface outflow in dry summer months.

Fish passage barriers exist on Unnamed 15.0250 at the Sunde Road crossing (partial barrier) and at the Shadow Glen Boulevard crossing (gradient within culvert causing total fish passage barrier, this may be the same site as WDFW SSHEAR SITEID 15.0250 2.2).

Coho presence in Unnamed tributary 15.0254 is currently limited to downstream of an impassable culvert under Mountain View Road (WDFW SSHEAR SITEID 15.0254 0.5), but the TAG indicates there is little habitat upstream of the culvert.

PSCRBT (1989) indicated that a 200-foot section of Clear Creek was contained in a culvert (not a fish passage barrier) under an old railroad crossing just downstream of the confluence of the West Fork. This culvert was removed as mitigation for a wetland fill associated with the Myhre Road bridge (Small), approximately 10 years ago.

Floodplain Modifications

The Clear Creek floodplain is severely constrained on both sides of the creek at the mouth by commercial development. The amount of impervious surface in lower Clear Creek is extremely high (>30%), resulting in large amounts of stormwater runoff to the stream. Upstream of Kitsap

Mall, Clear Creek is ditched and channelized from Mountain View Road to Schold Road. The TAG indicates that there is a large wetland area west of Schold Road and east of WF Clear Creek that would provide excellent opportunities for restoration, and suggest that the area be acquired or otherwise committed into resource protection status.

Unnamed tributary 15.0250 is channelized and trenched from Shadow Glen Boulevard to the Bangor Base, and would benefit from fencing to exclude animal access.

Channel Condition

Streambank stability ratings were monitored at several sample sites throughout the Clear Creek watershed (Chris May). The specific streambank stability category ratings follow, but the reader should recognize that all of the rating categories designated by May fall within the poor category referenced in the habitat rating criteria in Appendix B of this report. Streambanks on Clear Creek were rated as 25-50% stable, except for the reach at RM 1.8 where bank stability was >75%. Streambank stability ratings for Unnamed tributary 15.0250 were 50-75% stable in the lower and middle sections, and 25-50% stable in the upper section of the creek. Streambank stability at one sample site on Unnamed 15.0251 was 25-50%.

LWD and pool/riffle sampling data collected by Chris May for Clear Creek and tributaries are presented in Table 13 and Table 14.

Table 13: LWD sampling data in the Clear Creek Watershed (courtesy of Chris May)

Location	**LWD Frequency (pieces/km)**	**%LWD Coniferous**	**%LWD >0.5m Diameter**	**LWD Recruitment Potential**
Clear Cr. (RM 0.3)	40	25	25	Poor
Clear Cr. (RM 1.0)	33	15	20	Poor
Clear Cr. (RM 1.8)	165	73	55	Good
Clear Cr. (RM 2.8)	6	70	50	Poor
Unnamed 15.0250 (RM 0.1)	78	40	30	Poor
Unnamed 15.0250 (RM 0.8)	200	80	90	Marginal
Unnamed 15.0250 (RM 1.4)	122	45	35	Poor
Unnamed 15.0250 (RM 2.1)	3	15	5	Marginal
Unnamed 15.0251 (RM 0.3)	5	10	5	Poor

Table 14: Pool/riffle sampling data in the Clear Creek Watershed (courtesy of Chris May)

Location	**% Pool Habitat**	**Pool Quality***	**% Riffle Habitat**	**% Glide Habitat**
Clear Cr. (RM 0.3)	22	Marginal	35	43
Clear Cr. (RM 1.0)	15	Poor	25	60
Clear Cr. (RM 1.8)	18	Sub-optimal	69	17
Clear Cr. (RM 2.8)	25	Marginal	55	20
Unnamed 15.0250 (RM 0.1)	20	Marginal	30	50
Unnamed 15.0250 (RM 0.8)	45	Sub-optimal	45	10
Unnamed 15.0250 (RM 1.4)	35	Marginal	45	20
Unnamed 15.0250 (RM 2.1)	20	Poor	40	40
Unnamed 15.0251 (RM 0.3)	10	Poor	35	55

[NOTE: Chris May pool quality rating of sub-optimal would translate to a rating of fair, and a rating of marginal would translate to fair/poor using the Habitat criteria in Appendix B.]

Substrate

The lower mile of the Clear Creek channel (downstream of the forks) is broad and deep; there are some suitable spawning gravels from RM 0.1-0.5 and from Waaga Way to Schold Road, but the gravels tend to be unstable during peak flows. Upstream of Schold road, the channel is deep with sandy substrate. Benthic Index of Biotic Integrity (B-IBI) sampling upstream of the Silverdale Way culvert scored 31 (Chris May). B-IBI sampling upstream of Clear Creek Road scored 35 (Chris May).

Good spawning gravels are present on Unnamed 15.0250 from the headwaters to 0.2-0.4 mile downstream of Clear Creek Road. Spawning habitat in Unnamed tributaries 15.0250 and 15.0251is composed of a thin layer of gravel over hard pan. Substrate conditions may benefit from placement of LWD or weirs to stabilize and retain gravels in this portion of the drainage.

Riparian Condition

The TAG indicates the riparian condition is fair (wide alder-dominated buffer) from the mouth of Clear Creek to the forks (RM 1.0), but that the riparian zone is subjected to frequent extensive flooding resulting from stormwater runoff. Riparian condition on Unnamed 15.0250 is poor (blackberries) from Schold Road to ~RM 0.3, good from RM 0.3 upstream to SR 3, poor from SR 3 to Clear Creek Road (in vicinity of Clear Creek Nursery), good from Clear Creek Road to Shadow Glen Boulevard, and poor in the agricultural area upstream of Shadow Glen Boulevard. The TAG indicated that overall riparian condition is poor in the watershed. This area offers good potential for riparian restoration and LWD placement.

Water Quality

The Bremerton-Kitsap Health District has been collecting water quality information at eleven locations in the Clear Creek watershed since 1996. Identified water quality concerns include high fecal coliform levels (Mean=119 fc/100 ml downstream of Ridgetop Boulevard, periodic high counts at several other sample sites). Periodic water temperatures exceeding 15°C were identified downstream of Schold Road.

Water quality in Unnamed tributary 15.0250 is affected by runoff from a stormwater pond in the headwaters. Chris May indicates that water quality could be improved by encouraging wetland plant growth in the stormwater pond.

Clear Creek is on the CWA 303(d) list for exceedance of fecal coliform standards. The most likely sources are the agricultural areas downstream of Bangor Base and stormwater from the densely developed area in the lower watershed (Chris May).

Water Quantity

Clear Creek and tributaries have been closed to further consumptive water appropriation since 1953 (WAC 173-515-040).

Figure 26: Extensive commercial development in Silverdale at the mouth of Clear Creek (photo courtesy of Dept. of Ecology)

Impervious surface in the Clear Creek drainage ranges between 15-30%, depending on location within the drainage (Chris May). Clear Creek is heavily impacted by stormwater runoff impacts from commercial development (Figure 26) and from Unnamed tributaries 15.0252 and 15.0253, particularly from the Ridgetop development. Much of the development was built prior to implementation of stormwater BMPs; stormwater detention and maintenance is non-existent in the lower watershed, resulting in frequent significant flooding downstream of Silverdale Way. The stormwater impacts include silt and sedimentation, increased frequency and magnitude of peak flows, and probably water quality impacts. Unnamed tributary 15.0252 is ditched and armored as a stormwater conduit, with very limited restoration potential. Stormwater impacts, existing and new, need to be addressed in order for other habitat protection and restoration efforts to be effective.

Stream flow data for Clear Creek (as measured at the intersection of Silverdale Way and Waaga Way) are presented in Table 15. Instream flow for water years 1994-1999 ranged from a minimum flow of 2.0 cfs to a maximum flow of 235 cfs. The TAG indicated that peak flows may not be adequately represented by this data, as they recall a large flood in 1998; review of the data indicates absence of flow records from January 16 to 27, 1998.

Table 15: Streamflow data for Clear Creek (from Kitsap Public Utility District 2000)

Water Year	Mean Discharge (cfs)	Max. Discharge (cfs)	Min. Discharge (cfs)
1994	6.75	100	2.0
1995	11.7	200	2.1
1996	10.9	127	2.8
1997	14.1	235	3.8
1998	12.6	107	4.6
1999	20.7	190	3.3

PSCRBT (1989) references a hydrologic analysis that was conducted for the Clear Creek watershed, to compare stormwater runoff from the land uses in 1989 to the original non-developed (forested, grasslands) land cover. The flow modeling indicated increases in peak flows for the 5-year, 25-year, and 100-year 24-hour storm events of 45%, 32%, and 22%, respectively. There has been significant development in the Clear Creek watershed since 1989, which would exacerbate the peak flow increases identified in the hydrologic modeling.

Historic wetlands in the headwaters of Unnamed tributary 15.0251, on the Bangor Base, were converted to stormwater treatment facilities. These stormwater ponds are sized adequately to prevent any surface outflow, although riprap at the outlets of these ponds prevents upstream passage coho into these historic wetland rearing areas.

Figure 27: Clear Creek estuary (photo courtesy of Dept. of Ecology)

Estuarine

The natural estuary is constrained on both sides of the mouth of Clear Creek by commercial development (Figure 27). In addition, the culvert under Bucklin Hill Road affects the natural sediment transport into Dyes Inlet. There are long-standing discussions of replacing the culvert with a bridge, but no formal action is planned at this time.

Kitsap County has purchased the Old Mill Site Park at the mouth of Clear Creek, and is planning some wetland and estuarine restoration.

Nearshore/Marine

Periodic fish kills have occurred in the small estuarine bay southeast of the mouth of Clear Creek. These are thought to be the result of warm summer temperatures. It is unclear whether these are associated in any way to altered freshwater conditions.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Clear Creek and tributaries:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed (particularly from Kitsap Mall and the Ridgetop development);**
- **Replace culvert at Bucklin Road crossing with a bridge of sufficient length to restore natural sediment transport from Clear Creek to Dyes Inlet**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Restore natural channel configuration and floodplain integrity on Clear Creek within the boundaries of Kitsap Mall and from Mountain View Road to Schold Road**

- **Reduce habitat impacts on agricultural lands on Clear Creek, including development and implementation of farm plans that restore stream functions**
- **Restore natural channel configuration and floodplain integrity on Unnamed 15.0254 from Shadow Glen Boulevard to Bangor Base; also prevent unrestricted livestock access to the channel in this area**
- **Acquire, if possible, existing wetlands west of Schold Road and east of WF Clear Creek**
- **Develop and implement a short-term LWD strategy to provide LWD presence, habitat diversity, substrate stability, and improved bank stability, until full riparian function is restored**
- **Restore functional riparian zones throughout watershed; identify and correct cause of high water temperatures downstream of Schold Road**
- **Prioritize and correct fish passage barriers at Sunde Road and Shadow Glen Boulevard (both on Unnamed 15.0250), and at Mountain View Road (Unnamed 15.0254), as warranted**
- **Assess whether periodic fish kills in the small estuarine bay southeast of the mouth of Clear Creek are influenced by human-induced impacts; correct any identified problems**
- **Evaluate water quality in headwater stormwater pond on Unnamed tributary 15.0251 (on Bangor Base); evaluate options to reestablish fish passage with tributary downstream to enhance rearing habitat**
- **Establish wetland plant growth in stormwater pond in headwaters of Unnamed 15.0250, to improve downstream water quality**
- **Identify and correct sources of fecal coliform contamination**

Barker Creek 15.0255 and Hoot Creek 15.0255A

General

Mainstem Barker Creek originates at Island Lake in Kitsap County, flowing over 3 miles to the east side of Dyes Inlet. In addition, Hoot Creek (E.F. Barker) is the major tributary (approximately 2.5 miles long), and there are several additional small tributaries. The watershed supports chinook in the lower mainstem, and chum, coho, steelhead, and cutthroat extending farther into the watershed. Chinook presence in Barker Creek was not documented until after initiation of the Clear Creek chinook enhancement program (Dorn).

Fish Access

There are several fish passage barriers identified in the Barker Creek drainage. The culverts under Barker Creek Lane (WDFW SSHEAR SITEID 15.0255 0.3) and Nels Nelson Road (WDFW SSHEAR SITEID 15.0255 0.85) were previously both identified as partial barriers, but have just been corrected. There are also two culverts identified as fish passage barriers near the mouth on Pinsch Creek (first left bank tributary to Barker Creek at ~RM 0.25). There were efforts to make the lowermost of these culverts passable in 1999, but the culvert is still considered to be a complete anadromous fish passage barrier (Oleyar). These appear to be different sites than those identified in the WDFW SSHEAR Fish Passage Barrier Database as SITEIDs 15.0255A 0.05 and 15.0255A 0.25, noted to be on Raven Creek. The TAG was unfamiliar with the sites identified on Raven Creek. There are numerous culverts on Hoot Creek upstream of

Waaga Way. The WDFW SSHEAR fish passage barrier database identifies fish passage barrier culverts on Hoot Creek at RM 0.69, 0.97, 1.04, 1.17, 1.38, 1.69, 1.75, 1.93, 2.08, 2.17, and 2.28.

Intermittent flows in Hoot Creek, upstream of Waaga Way, prevent fish passage during low flow conditions. In addition, fish passage in Hoot Creek would be impaired by the presence of numerous driveways with culverts that cross the creek; however, riparian restoration and floodplain confinement should be addressed prior to worrying about culvert impacts.

Floodplain Modifications

The floodplain on Barker Creek, upstream of Nels Nelson Road, is impacted by development including areas where the streambanks have been bulkheaded. This area historically was a broad wetland zone, and bulkheading has likely eliminated access to historic floodplain areas.

Hoot Creek (E.F. Barker) has been extensively ditched and channelized, including construction of a number of instream ponds. From Waaga Way to the headwaters, the land use adjacent to Hoot Creek is rural residential. The floodplain of Hoot Creek is also confined in the lower portion of the creek that flows adjacent to Central Valley Road.

Channel Condition

Surveys by Chris May and the Suquamish Tribe indicate a natural landslide occurred on Barker Creek, immediately downstream of the Barker Road crossing, recruiting LWD and sediment to the channel. Much of the sediments have moved downstream, although the culvert at the Tracyton Boulevard crossing has trapped sediments and slowed the natural rate of sediment flushing to the estuary (Oleyar). An identified beneficial habitat restoration project would be to revegetate the landslide area. LWD condition is good from the mouth to just upstream of Nels Nelson Road, with abundant instream wood. The TAG indicates that there is little LWD throughout the upper Barker Creek drainage. The west side of Barker Creek is heavily impacted by development, with numerous stormwater ponds and outfalls to the stream.

Chris May has measured habitat parameters 1 km upstream of Waaga Way (Barker 1) and just upstream of Nels Nelson Road (Barker 2). Summary data are provided in Table 16.

Table 16: Habitat data for Barker Creek (Source: Chris May)

Location	**Barker 1**	**Barker 2**
Mean Bankfull Width (m)	2.8	4.7
Mean Bankfull Depth (m)	0.25	0.58
Bank Stability Rating	50-75% stable	<25% stable
% Pool Habitat	26	24
Pool Quality	Marginal	Marginal
% Riffle Habitat	39	28
Riffle Embeddedness	30	35
Riffle Quality	Marginal	Marginal
LWD Frequency (pieces/km)	100	87
% LWD Coniferous	62	85
% LWD >0.5 m Diameter	54	69
LWD Quality	Marginal	Sub-optimal

The third left bank tributary (Waldo Creek, enters Barker Creek upstream of Nels Nelson Road) is fed by headwater springs that provide approximately 17% of the flow in lower Barker Creek. This tributary has good riparian conifer presence in the upper drainage, although the channel could use more LWD.

Substrate

The substrate from the first big bend upstream of the mouth to the forks is typical of wetland conditions, with very sandy substrate. The TAG also indicates there is a heavy silt load from stormwater runoff and erosion. Sampling of IGDO/DO upstream of Nels Nelson Road indicates a value of 84% (a value of 80% is identified as the lower end for effective egg incubation (May)). Sampling of IGDO/DO upstream of Waaga Way indicates a value of 66%, indicating poor oxygenation within the substrate.

There are some suitable spawning gravels in the lower portion of Hoot Creek, just upstream of the bend, with the remainder of Hoot Creek having sand/silt substrate more characteristic of wetlands.

Riparian Condition

Surveys by Chris May and the Suquamish Tribe indicate good riparian condition from the mouth to Nels Nelson Road, with good presence of mature firs and cedars. Riparian condition is indicated as fair/good from Nels Nelson Road to the Mormon Church (RM 1.1), and immediately upstream of Waaga Way. Upstream of Nels Nelson Road, there is more development near the stream, and several landowners have removed the riparian vegetation. Although remaining riparian buffers may be relatively broad, there is significant disturbance within the buffers for stormwater outfalls and trails. The Urban Growth Area boundary of Silverdale extends to the west side of Barker Creek. Riparian buffers on the east side of Barker Creek are primarily on rural residential/agricultural land, and are in generally good condition. A reach in the middle of the Barker Creek corridor has been placed in public ownership, and habitat conditions could be improved by replanting the riparian corridor.

The TAG and PSCRBT (1989) indicate that riparian condition in Hoot Creek is generally poor, with little woody vegetation adjacent to the stream.

Water Quality

The Bremerton-Kitsap Health District has been collecting water quality information at four locations in Barker Creek since 1996. Identified water quality concerns include high fecal coliform levels (Mean=97 fc/100 ml upstream of Barker Creek Road, 142 fc/100ml downstream of the culvert at 8600 Nels Nelson Road, and 77 fc/100ml upstream of culvert at 600 Bucklin Hill Road), with periodic dissolved oxygen levels as low as 7.6 mg/l upstream of culvert at 600 Bucklin Hill Road.

Barker Creek is on the CWA 303(d) list for exceedance of fecal coliform levels. Temperature is likely a concern in Hoot Creek, due to lack of riparian vegetation, although no data were available. PSCRBT (1989) indicates that animal access to the creek corridor is a much more common occurrence within the Barker Creek watershed than any of the other streams in the Dyes

Inlet watershed, with Hoot Creek having the highest degree of animal access. This may no longer be applicable, due to conversion of prior agricultural lands to residential development.

Water Quantity

Barker Creek and tributaries have been closed to further consumptive water appropriation since 1961 (WAC 173-515-040). Island Lake is also closed to further water appropriation (Newman). The presence of unauthorized water diversions is identified as a global problem for streams in east Kitsap County, but is of particular concern in the Barker Creek watershed.

Base flows in the lower mainstem are influenced by spring flows from Waldo/Pinsch Creek (third left bank tributary from the mouth). The upland adjacent to this spring was at risk of development (Three-Springs development proposal), but Kitsap county has recently acquired approximately a 10-acre site, which should ensure the integrity of current good riparian condition in the vicinity of the springs, and continued high quality base flow conditions in lower Barker Creek.

Flows to upper Barker Creek result from controlled releases from Island Lake, which are minimal during dry periods. No fish presence has been identified within 0.75 mile of the lake outlet, likely due to insufficient instream flows. Island Lake residents have been working on a MOU with the Kitsap County Health Department regarding lake level management for docks in the lake, but it is unclear to what extent the need for instream flows downstream of the lake are being considered.

Flows in lower Barker Creek are heavily influenced by stormwater runoff from development on the west side of the creek. There are numerous stormwater ponds and associated outfalls located in or near the floodplain on the west side of the creek. The TAG recommends that consideration be given to possibly connecting some of these small ponds and further addressing water quality and quantity impacts through a regional stormwater facility.

Stormwater contribution from the Bucklin Hill Road and Waaga Way were identified as significant concerns. There are apparently no stormwater controls for the runoff from Bucklin Hill Road, with all runoff routed directly through roadside ditches. Nearly all existing stormwater ponds, including those associated with Waaga Way, were built to older stormwater standards, resulting in ponds that are undersized to effectively address water quality and quantity.

Streamflow data for Barker Creek (at Barker Creek Road, 0.5 mile east of Tracyton Boulevard) are presented in Table 17. Instream flows for water years 1992-1997 ranged from a minimum flow of 1.3 cfs to a maximum flow of 86 cfs.

Table 17: Streamflow data for Barker Creek (from Kitsap Public Utility District 2000)

Water Year	Mean Discharge (cfs)	Max. Discharge (cfs)	Min. Discharge (cfs)
1992	7.25	64	3.4
1993	4.74	23	2.4
1994	4.34	47	1.6
1995	5.67	65	1.3
1996	7.00	79	2.9
1997	13.0	86	3.4

Estuarine/Nearshore/Marine

Barker Creek is contained within a deep canyon in the lower 0.5 mile of the creek. Tidal fluctuation into the mouth of the creek is impaired by the culvert under Tracyton Boulevard, which affects normal sediment transport to Dyes Inlet and estuarine productivity. Natural estuarine conditions would likely extend approximately 0.2 mile upstream of Tracyton Boulevard. Replacement of the culvert with a bridge would help restore natural estuarine function. In addition, there is a house and associated bulkhead that encroach into the north side of the estuary.

Lakes

Barker Creek originates at Island Lake. Flows to upper Barker Creek result from controlled releases from Island Lake, which are minimal during dry periods. The lake shoreline and adjacent uplands are heavily developed, with numerous docks located on the shoreline of the lake. Island Lake residents have been working on a MOU with the Kitsap County Health Department regarding lake level management for docks in the lake, but it is unclear whether the need for instream flows to support instream resources downstream of the lake is being considered. Groundwater has been pumped in past years to maintain the level of Island Lake, although this has not been done in recent years. The shallow groundwater aquifer surrounding the lake has not recharged in recent years, unlike groundwater aquifers elsewhere in Kitsap County. This may be due to the lack of infiltration of stormwater runoff from heavy residential development in the area.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Barker Creek and tributaries:

- **Replace the culvert at the Tracyton Boulevard crossing with a bridge of sufficient length to restore natural estuarine function upstream, to ensure unobstructed fish passage, and to restore natural sediment transport**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed; address water quantity, water quantity, and riparian impacts of the numerous stormwater ponds and outfalls located on the west side of Barker Creek**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters (Bucklin Hill Road and Waaga Way), water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Ensure that the need for instream flows is incorporated into the MOU regarding lake level management in Island Lake**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions; identify and correct areas in the watershed that have unrestricted livestock access**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored, particularly upstream of Nels Nelson Road**

- **Restore natural channel configuration and floodplain function upstream of Nels Nelson Road (including access to previously accessible floodplain wetlands) and on Hoot Creek**
- **Prioritize and correct identified fish passage barriers on Pinsch Creek, Raven Creek, and Hoot Creek, as warranted**
- **Restore functional riparian buffers, particularly upstream of Nels Nelson Road and on Hoot Creek**

Unnamed 15.0257

General

This small independent creek (~0.8 mile long) enters Dyes Inlet approximately 0.5 mile north of Mosher Creek. The creek originates from the stormwater pond at Olympic High School. The creek currently supports chum and presumed cutthroat to the blocking culvert at Tracyton Boulevard. The culvert is scheduled to be replaced by Kitsap County Public Works in 2000, coincident with other road maintenance work in the area. A landowner installed four log step weirs in 1999, just upstream of the mouth, to improve fish passage into the creek (Small). Even though the creek is influenced by stormwater runoff, there is no significant indication of channel incision. Substrate condition is fair, consisting of small gravels with moderate levels (11-20%) of fines. The creek is reported to be devoid of LWD, and there is a lack of any significant riparian vegetation.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0257:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Replace fish passage barrier culvert at Tracyton Boulevard (scheduled for replacement in 2000)**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore functional riparian zones throughout watershed**

Pahrmann (Peterman, Stampede) Creek 15.0258

General

This small independent creek (~1.0 mile long) enters Dyes Inlet approximately 0.25 mile north of Mosher Creek. This creek was previously known primarily as Peterman Creek, but has recently

been officially renamed by a group of Tracyton residents as Pharmann Creek (Okeefe). The creek is known to support cutthroat to Tracyton Boulevard; use by other salmonid species is unknown. The culvert at the Tracyton Boulevard crossing has a 4-foot drop at the outlet. It is scheduled to be replaced by County Roads in 2000, coincident with other road maintenance work in the area. The streambed below Tracyton Boulevard is incised approximately 6 feet, likely the result of lack of LWD in the channel and stormwater runoff from development upstream. There is currently a lack of suitable substrate because of the channel incision, although there are some pools developed in the hardpan. The creek is reported to be devoid of LWD, and there is a lack of any significant riparian vegetation.

The Bremerton-Kitsap Health District has collected water quality sampling data since 1996 (downstream of Tracyton Boulevard culvert). There have been several occurrences of fecal coliform counts exceeding the threshold of concern of 100 fc/100ml, and of dissolved oxygen <10 mg/l (as low as 6.3 mg/l).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Pahrmann Creek:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Replace fish passage barrier culvert at Tracyton Boulevard (scheduled for replacement in 2000)**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore functional riparian zones throughout watershed**
- **Identify and correct sources of fecal coliform contamination and causes of low dissolved oxygen levels**

Mosher Creek 15.0259

General

This small independent creek (~1.25 miles long) enters Dyes Inlet just north of Tracyton. The headwaters of the creek are located at the wetland near the mobile home park in the vicinity of McWilliams Road. The creek supports chum downstream of Tracyton Boulevard, and coho and cutthroat to the headwaters. There is a private chum hatchery located near the mouth of the creek (Dorn).

Fish Access

The culvert under Tracyton Boulevard (WDFW SSHEAR SITEID 15.0259 0.27) is a partial barrier (complete barrier to chum). The culvert under Central Valley Road (WDFW SSHEAR SITEID 15.0259 0.77), is also a partial barrier with approximately 0.3 mile of habitat upstream, although coho have been reported by residents to the headwaters, and have been observed to Saturn Lane. Additional fish passage barriers identified in the WDFW SSHEAR fish passage barrier database at Fairgrounds Road, the County easement at RM 1.91, and at Conifer Drive do not appear to be on Mosher Creek, as these roads do not cross Mosher Creek.

Floodplain Modifications

The creek is naturally confined in a ravine downstream of Central Valley Road, with a broad flat floodplain upstream.

Channel Condition

Until a couple of years ago, severe bank erosion occurred below Central Valley Road, due to flushing of a fire hydrant directly down the streambank and into the stream. This resulted in the input of chlorinated water to the stream, and resulted in streambank erosion and the main input of fine sediment.

Substrate

There are numerous trails within the ravine that are causing fine sediment erosion to the stream. Substrate condition is indicated as fair/good downstream of Central Valley Road (~RM 0.9) and poor/fair upstream.

Riparian Condition

Riparian condition is generally good within the ravine downstream of Central Valley Road. There is heavy development between Central Valley Road and McWilliams Road, but riparian buffers in this area are generally fair. However, there is a reach of agricultural area upstream of Central Valley Road (Lindbergh) with poor riparian condition that would benefit from planting riparian vegetation.

Water Quality

The Bremerton-Kitsap Health District has been collecting water quality information at two locations in Mosher Creek since 1996. No consistent water quality concerns were identified, but there were several observations of high fecal coliform counts upstream of Tracyton Boulevard.

There is a history of dumping chlorinated water into the stream, from the fire hydrant flushing at Central Valley Road, and from direct pumping of chlorinated water from a City of Bremerton well (located downstream of Central Valley Road) directly to the stream. TAG participants believe both of these impacts no longer occur.

Water Quantity

The total natural flow of Mosher Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further consumptive water appropriation (WAC 173-515-040).

The TAG indicates that flows in this creek are very flashy, but that the creek has good base flow through dry summer months. The channel in the ravine reach downstream of Central Valley Road is experiencing increased erosion and sedimentation, likely due to uncontrolled stormwater runoff to the stream. There has been significant development in the watershed in recent years, but the creek was reported to be flashy prior to the development, likely from road runoff. Most of the development in the vicinity of Central Valley Road was built without any stormwater controls. There are four developments with stormwater controls that have been built in the headwaters in the last seven years.

Estuarine

Mosher Creek has a small natural confined estuary, with little bulkheading or shoreline armoring. The marine shoreline near the mouth of Mosher Creek is mostly steep bank, and is in fairly natural condition, without much bulkheading.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Mosher Creek:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Protect existing natural integrity of estuarine area**
- **Prioritize and correct fish passage barriers at Tracyton Boulevard and Central Valley Road**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Ensure that local fire department (fire hydrant flushing) and City of Bremerton (direct pumping of well water) are aware that chlorinated water should not be allowed to directly flow into the creek**
- **Prevent fine sediment erosion from trails located in the ravine**
- **Restore functional riparian zones, particularly through the agricultural area upstream of Central Valley Road**
- **Identify and correct sources of fecal coliform contamination**

Unnamed 15.0260

General

This small independent creek (~1.0 mile long) enters Washington Narrows approximately 0.5 mile south of Tracyton. Fish passage may be blocked by a culvert at the mouth of the stream, with two more barrier culverts within the next several hundred feet. The creek is reported to have cutthroat, but no current anadromous salmonid presence.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0260:

- **Evaluate salmonid habitat conditions upstream of the blocking culverts near the mouth of the stream; prioritize and correct passage barriers as warranted**

Unnamed 15.0262

General

This small independent creek (~0.8 mile long) enters Washington Narrows approximately 0.75 mile south of Tracyton. The TAG indicates this creek has steep gradient and very flashy flows, with no anadromous salmonid potential.

Dee (Enetai) Creek 15.0264

General

This small independent creek enters Port Orchard Bay approximately 1.0 mile northeast of Point Heron. The creek currently supports chum, coho, and cutthroat in the lower reaches.

Fish Access

There are a number of fish passage barriers in this watershed (Dorn). Anadromous salmonids are currently able to pass upstream to the second culvert under Enetai Beach/Jacobsen Boulevard, which is a total fish passage barrier. Additional culverts under Trenton Avenue and Helm Street are also identified as fish passage barriers. These culverts should be removed and replaced with small bridges.

Floodplain Modifications

The natural floodplain of Dee Creek is constrained at several culvert crossings. Most of the culverts are undersized, creating sediment deposition areas upstream.

Channel Condition

From the mouth to Trenton Avenue, the channel is located in a steep ravine with good LWD presence. Upstream of Trenton Avenue, channel conditions are considered to be poor.

Substrate

The upper watershed is intensely developed with no stormwater protection. Habitat upstream of Trenton Avenue is generally poor, and the primary identified concern downstream of Trenton Avenue is gravel scour, likely resulting from altered creek hydrology in the headwaters.

Riparian Condition

Riparian condition upstream of Trenton Avenue is poor, with little remaining riparian vegetation due to intense development in the headwaters. Riparian condition in the steep ravine reach downstream of Trenton Avenue is considered to be generally good.

Water Quality/Water Quantity

Flows in Dee Creek are very flashy, likely the result of the intense development in the watershed with no stormwater controls. This increases surface flows during storm events, decreases base flows, and contributes to poor water quality conditions in the stream.

The Bremerton-Kitsap Health District has been collecting water quality information at one location in Dee Creek since 1996. Identified water quality concerns include consistent high fecal coliform counts (Mean=183 fc/100ml, three observations of 1600 fc/100ml). Although not identified as a water quality concern, there were some observations of dissolved oxygen levels <10 mg/l., and two observations of elevated turbidity.

Estuarine

Dee Creek has a small estuary; both banks are armored. Effects of bank armoring to estuarine function should be evaluated.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Dee Creek:

- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Evaluate estuarine condition and restore functions where possible; limit further shoreline armoring**

- **Replace fish passage barrier culverts and undersized culverts with bridges to restore sediment transport and floodplain function**
- **Restore LWD presence and riparian condition upstream of Trenton Avenue**
- **Identify and correct sources of fecal coliform contamination**

Although Dee (Enetai) Creek has habitat potential in the reach downstream of Trenton Avenue, it is not considered a high priority for habitat restoration due to the intense development and uncontrolled stormwater runoff from the headwaters. Prioritization of fish passage barrier correction and other habitat restoration actions should be predicated on first addressing the stormwater runoff issues in this drainage.

Illahee Springs Creek 15.0265

General

This small independent creek enters Port Orchard Bay at Illahee State Park. The creek is not known to support salmonids. The Bremerton-Kitsap Health District has been collecting water quality information at one location in Illahee Creek since 1999. Identified water quality concerns include high fecal coliform counts (Mean=58 fc/100ml).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Illahee Springs Creek:

- **Assess salmonid utilization of this creek**
- **Identify and correct sources of fecal coliform contamination**

Illahee (Schutt) Creek 15.0266 and Unnamed 15.0267-0267A

General

The Illahee Creek watershed includes mainstem Illahee Creek and two salmonid bearing tributaries. The basin enters the west shore of Port Orchard Bay approximately 1.0 mile north of Illahee State Park. The watershed supports chum, coho, and cutthroat. Much of the habitat in this drainage is under Department of Natural Resources (DNR) ownership. They have proposed to harvest timber in the watershed, but there is potential to transfer the land to protected status.

Fish Access

The culvert at the Illahee Road crossing (WDFW SSHEAR SITEID 15.0266 0.75) was previously identified as a partial fish passage barrier, but the culvert was replaced during the summer of 1999. A dam is present approximately 0.2 mile upstream of Illahee Road. The creek channel has cut around the side of the dam (currently covered with English Ivy), but there is concern that this site may become a fish passage barrier as the channel regrades through deposited sediment and gravel upstream of the dam (Irwin Krigsman, local resident). The site should be monitored and corrective actions implemented as warranted.

Floodplain Modifications

The channel is naturally confined in a ravine downstream of McWilliams Road. The channel is incised upstream of Illahee Road, and continues to further incise, primarily from stormwater runoff from development and the golf course in the north fork. A dam at the outlet of a pond on the south fork blocks normal instream flow, with the south fork going dry in summer months. There is a large wetland (~20 acres) on the north fork upstream of McWilliams Road that provides flow in the north fork during dry summer months.

Channel Condition

Channel condition is generally poor, with lack of LWD and pools.

Substrate

Serious erosion is occurring on the northwest fork downstream of the Rolling Hills Golf Course. This reach is steep with significant streambed scour, likely resulting from stormwater runoff from the golf course and development in the headwaters.

Riparian Condition

Riparian condition is reported by the TAG to be very poor for 300 feet along the northeast boundary of the Rolling Hills Golf Course. Efforts have been made to encourage the golf course to revegetate the riparian zones, but there is little interest by the golf course in increasing riparian vegetation.

Water Quality/Water Quantity

There are significant impacts to channel configuration and habitat quality due to stormwater runoff from the north fork. Stormwater runoff is causing bank erosion and channel incision. There is a regional stormwater detention pond currently in the planning stage for this drainage. It would be located on the golf course and adjacent lands in the north fork.

Hydrology is stabilized to some extent by the metering of flow from the ~20 acre wetland in the headwaters of north fork (15.0267 mainstem). The northeast fork (15.0267A) is characterized by very low flows, with salmonid potential likely only in the lower 0.25 mile. A dam, at the outlet of the pond on the south fork, blocks normal instream flow, with the south fork going dry in summer months.

The Bremerton-Kitsap Health District has been collecting water quality information at one location in Illahee Creek since 1996. No consistent water quality concerns were identified. However, there were several observations of high fecal coliform levels and several observations of dissolved oxygen levels <10 mg/l.

Estuarine

There is a large estuary at the mouth of Illahee Creek. The estuary has little shoreline armoring and there is saltmarsh vegetation at the outer end of the estuary. The shallow intertidal delta

likely produces high numbers of amphipods (Dorn). However, the estuarine channel has been regularly dredged to remove silt from the mouth of the creek, with the disposal of fill materials on both the north and south sides of the estuary. There is a current proposal to construct a residence on additional fill in the estuary on the south side of the creek.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Illahee Creek and tributaries:

- **Retrofit state-of-the-art stormwater quality and quantity best management practices to existing development (including the golf course) in the watershed**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Protect the integrity of the estuary, limit further bulkheading of the estuarine shoreline; limit dredging and disposal of dredge materials in the estuary**
- **Transfer critical resource segments of DNR ownership in this watershed to protected status**
- **Reestablish functional riparian buffers along the northeast boundary of the Rolling Hills Golf Course**

Unnamed (Gilberton) Creek 15.0269

General

This small independent creek enters Port Orchard Bay approximately 0.5 mile south of Burke Bay. Steve Kalinowski reports approximately 1.0 mile of suitable salmonid habitat, but access is currently precluded upstream of Illahee Road. The watershed is located in a deep ravine, the gradient is relatively steep, and the riparian condition is considered to be good. There are housing developments located on the headwaters of both forks, but the impacts to the creek have not been evaluated.

The culvert at the crossing of Illahee Road (WDFW SSHEAR SITEID 15.0269 0.1, west of Boundary Lane) has a standpipe on the upper side of the road that feeds to the culvert approximately 8-feet below. This is a total barrier to anadromous fish passage. There is an estimated 1.0 mile of suitable coho and cutthroat habitat upstream of this culvert.

The Bremerton-Kitsap Health District has a water quality sampling site downstream of the Illahee Road culvert. No data were presented indicating any water quality concern.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0269:

- **Retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**

- **Replace fish passage barrier culvert and standpipe at Illahee Road**
- **Evaluate habitat condition upstream of Illahee Road and develop and implement habitat restoration as appropriate**

Unnamed 15.0272

General

The TAG indicates the creek is thought to not be accessible to anadromous salmonids, due to the impassable culvert at Illahee Road, but the creek is thought to have potential for at least cutthroat. The marine shoreline from the mouth north to Steele Creek has recurrent slide activity. However, the recruitment of these bank materials to the nearshore environment is attenuated by the location of Illahee Road between the slides and the armored shoreline. The roadway fill extends into the historic intertidal area, and the roadfill prism is armored with large rock, eliminating natural shoreline configuration and processes.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0272:

- **Evaluate options for restoring natural marine shoreline processes from the mouth north to Steele Creek**
- **Replace fish passage barrier culvert at Illahee Road**
- **Evaluate habitat condition upstream of Illahee Road and develop and implement habitat restoration as appropriate**

Steele (Crouch) Creek 15.0273, SF Steele Creek 15.0274, and EF Steele 15.0275

General

Steele Creek flows into Burke Bay on the west shore of Port Orchard at Brownsville. This watershed also includes EF Steele Creek (15.0275) and SF Steele Creek (15.0274). The TAG indicated that mainstem Steele Creek was historically very productive, but productivity was eliminated by construction of a dam between Royal Valley and Paulson. Chum and coho are now able to move upstream of the old dam site. This system supports chinook (TAG indicates all are hatchery strays), chum, coho, steelhead, and cutthroat (see fish distribution table in Appendix A for details).

Fish Access

The culvert at the Paulson Road crossing (WDFW SSHEAR SITEID 15.0275 0.4) of EF Steele is identified as a partial fish passage barrier (total barrier to chum), and is scheduled for replacement in 2001. A sewer pipe crossing of EF Steele, operated by Kitsap County Public Works, is a barrier to surface flow, enlarging a natural wetland complex in the upper drainage (this may be the same site as the barrier culvert at RM 0.8 identified in the WDFW SSHEAR culvert database, SITEID 15.0275 0.8). The creek sheet flows over the pipe creating a partial fish

passage barrier, but Paul Dorn indicates that persistent adult and juvenile coho are able to pass the pipe to reach spawning and rearing habitat above.

A fish trap has been operated since 1996 on SF Steele Creek downstream of Gluds Pond Road at RM 0.1 (Dorn)(this may be the same site as WDFW SSHEAR SITEID 15.0273 0.8). Adult coho and chum are being effectively passed upstream of the trap and above two impassable culverts to a location on the upstream side of the Gluds Ponds dams to spawn. The culvert at the Paulson Road crossing of EF Steele (WDFW SSHEAR SITEID 15.0275 0.4) is identified as a partial fish passage barrier (total barrier to chum), and is scheduled for replacement in 2001. A sewer pipe crossing of EF Steele, operated by Kitsap County Public Works, is a barrier to surface flow, enlarging a natural wetland complex in the upper drainage (this may be the same site as the barrier culvert at RM 0.8 identified in the WDFW SSHEAR culvert database, SITEID 15.0275 0.8). The creek sheet flows over the pipe creating a partial fish passage barrier, but Paul Dorn indicates that persistent adult and juvenile coho are able to pass the pipe to reach spawning and rearing habitat above. On SF Steele, there are three culverts (estimated cost to fix ~$0.5 million) and a failed fishway that are identified as fish passage barriers, all in the vicinity of the junction of Gluds Pond Road and Brownsville Highway (WDFW SSHEAR fish passage barrier database indicates barrier culverts at RM 0.18 and 0.23, and low-head barrier dams at RM 0.27 and 0.33). Recent landslides downstream of Gluds Pond have recruited significant sediment loads and some LWD to the creek, partially damming/restricting flow in certain areas; one site just upstream of RM 0.1 may be a fish passage barrier due to slides (Oleyar). Locals are known to move returning adult spawners upstream of fish passage barriers on SF Steele.

Floodplain Modifications

SF Steele is channelized for 0.2 mile south of Gluds Pond Road along the Brownsville Highway, where the creek is confined in a rock-lined fish passage channel between Gluds pond on one side and Brownsville Highway on the other. The creek lacks suitable habitat elements in this confined reach. EF Steele Creek 15.0275 is channelized and ditched from Madison Rd down to Paulson Rd, but not below RM 0.4 (Oleyar).

Channel Condition

The mainstem Steele Creek channel upstream of Paulson has been impacted by unrestricted animal access, creating a braided/dispersed channel. The landowner has not been willing to install fences to exclude livestock access.

Agriculture setbacks (fences) have been implemented in EF Steele, although there is little LWD. Channel conditions would benefit from placement of LWD. The TAG indicates there is no suitable salmonid habitat upstream of approximately RM 0.8 on EF Steele.

Recent slides in the lower 0.2 mile of SF Steele have recruited LWD (mixture of alder, fir, and cedar) to the creek, as well as significant amounts of sediment (Oleyar). There is little LWD present upstream of Gluds Pond, and the creek is heavily impacted by fine sedimentation and stormwater runoff.

Substrate

Adult coho and chum have been moved upstream of migration barriers on SF Steele Creek to utilize available spawning and rearing habitat. Substrate on Steele Creek (15.0273) is indicated as fair/good, with fine sediment impacts from agriculture lands adjacent to the stream. Substrate condition on EF Steele is good from the mouth to approximately 0.2 mile upstream of Madison Road. The substrate on SF Steele, from Gluds Pond to Walmart, was heavily impacted by erosion and fine sedimentation from the construction of Walmart, but substrate condition is recovering. However, substrate downstream of Gluds Pond on SF Steele has been severely impacted by sedimentation due to recent landslides, severely impacting spawning potential in this reach (Oleyar).

Riparian Condition

Steele Creek is located in a confined ravine, with deciduous riparian vegetation within the ravine. Riparian vegetation on SF Steele is comprised primarily of hardwoods upstream to Fairgrounds Road.

Water Quality

The TAG indicates presence of freshwater mussels, both upstream and downstream of Madison Road on EF Steele Creek (typically an indicator of excellent water quality).

The Bremerton-Kitsap Health District has been collecting water quality information at four locations in the Steele Creek watershed since 1996. Identified water quality concerns include consistent high fecal coliform counts (Mean=106 fc/100ml, upstream of culvert at Brownsville Highway), and low dissolved oxygen levels. The sample sites upstream of the culvert at Brownsville Highway, downstream of the culvert at 1110 Paulsen Road, and downstream of the culvert at Paulsen Lane (west of Corey Lane) all had observations of dissolved oxygen levels <10 mg/l, with >half or the samples at the latter two sites being <9.5 mg/l.

Water Quantity

The Department of Ecology has determined that Steele Creek and tributaries exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, no further water is available for consumptive appropriation from June 1 – October 15 (WAC 173-515-040). Applications for consumptive water appropriation at other times of the year are subject to minimum instream flows established in WAC 173-515-030.

SF Steele is heavily impacted by stormwater runoff from Waaga Way and extensive development, particularly upstream of Fairgrounds Road. This runoff has significantly altered the hydrology of SF Steele, resulting in significant erosion and fine sedimentation of the channel.

Estuarine

Steele Creek flows into a large estuarine area in Burke Bay. The Illahee Road Bridge constricts the opening at the mouth of the estuary, but there is still significant tidal exchange into the estuary. However, the undersized culvert at the Brownsville Highway crossing at the Steele

Creek inlet into Burke Bay restricts tidal influence upstream of the culvert, and has eliminated historic estuarine conditions upstream of the highway; this culvert should be replaced with a bridge or culvert of sufficient size to restore tidal influence upstream of the highway. The north shoreline of Burke Bay generally has little riparian vegetation and the shoreline is encroached upon in several places by businesses. There is a marina located right at the mouth of the stream; the marina was dredged at the time of construction, but has not required significant maintenance dredging.

Nearshore/Marine

The marine shoreline from the mouth south to Unnamed 15.0272 has recurrent slide activity. However, the recruitment of these bank materials to the nearshore environment is attenuated by the location of Illahee Road between the slides and the armored shoreline. The roadway fill extends into the historic intertidal area, and the roadfill prism is armored with large rock, eliminating natural shoreline configuration and processes.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Steele Creek and tributaries:

- **Replace culvert at the Brownsville Highway crossing with a bridge or larger culvert that restores natural tidal exchange and sediment transport, as well as unrestricted fish passage**
- **Prioritize and correct the three identified fish passage barrier culverts on SF Steele in the vicinity of Gluds Pond Road; evaluate and correct (if warranted) fish passage impacts of recent slides just upstream of RM 0.1**
- **Restore natural channel and floodplain configuration through area currently occupied by Gluds Pond; restore natural fish passage upstream of the pond**
- **Restore functional riparian habitat throughout watershed; restore riparian function by encouraging conifer regeneration in deciduous stands that historically had a conifer component**
- **Implement low impact development on NF Steele, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed, particularly on SF Steele**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore natural rates of recruitment of shoreline slide materials to the nearshore south of Steele Creek; identify options to reduce the intrusion of Illahee Road into the historic intertidal area and/or reduce the extent of armoring of the roadfill**
- **Correct fish passage barrier at Paulson Road crossing of EF Steele**

- **Restore natural channel configuration and floodplain integrity on Unnamed 15.0275 from Madison Road to Brownsville Highway**
- **Prevent unrestricted livestock access to Steele Creek upstream of Paulson Road**
- **Evaluate adult and juvenile fish passage status at sewer line crossing of upper EF Steele; implement corrective measures if determined to be a barrier**
- **Identify and correct sources of fecal coliform contamination**
- **Identify and correct causes of low dissolved oxygen levels**

Unnamed 15.0275A

General

This small independent tributary enters marine water on the northeast end of Burke Bay. The creek flows north-south between Ogle Road and Brownsville Highway. Fish presence and distribution is unknown. The culvert under Ogle Road is a complete fish passage barrier. There is approximately 0.7 mile of generally good quality habitat upstream. The housing density is low along the stream, and habitat restoration would provide good potential for chum production.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0275A:

- **Assess salmonid utilization and presence of suitable salmonid habitat in this creek**
- **Prioritize and correct the culvert fish passage barrier at Ogle Road**

Keyport Creek 15.0276

Figure 28: Styles Lagoon at the mouth of Keyport Creek (photo courtesy of Dept. of Ecology)

General

This small independent creek enters Styles Lagoon, on the southeastern portion of the Keyport Naval Station (Figure 28). Currently, the creek is thought to only support resident cutthroat. Historically, the creek probably had potential to support anadromous salmonids, but is currently impacted by fish passage barriers at the boundary of Keyport Base and west of where Keyport Road NE enters Brownsville Highway at the north end. Styles Lagoon is impounded by a tidegate at the mouth, placed to develop a fish

farm and freshwater lake on Keyport Base. Salmonid habitat could be improved by restoring Styles Lagoon as estuarine/nearshore habitat. There is an additional barrier at Old Military Road, but this barrier may be upstream of suitable habitat. Riparian condition is generally fair off Keyport Base, and is thought to be poor on Keyport Base. Substrate is fair off of Keyport Base, and unknown on-base. LWD condition is thought to be poor throughout. In addition, marine waters at the mouth of the creek are designated as a Superfund site.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Keyport Creek:

- **Restore natural tidal regime in Styles Lagoon**
- **Prioritize and correct identified fish passage barriers, as warranted**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity**
- **Restore riparian habitat, both on and off Keyport Base**
- **Restore marine sediment quality and water quality off the mouth of the creek**

Unnamed 15.0277

General

This creek is a very small independent creek entering saltwater on the southwestern shore of Dogfish Bay. The creek is known to support cutthroat, and has low potential for coho (Kalinowski). Anadromous fish passage is impaired by a blocking culvert (RM 0.1) at Lewato Road (SR 308).

Approximately 20-25 years ago, a landowner at the mouth of the creek diverted the creek into a farm pond. The land was subsequently sold to two purchasers on either side of the creek, who fought over who should have the creek on their property, with repeated diversions influencing the location of the creek. The dispute was moderated, with installation of a meandering channel with several step weirs, one of which is likely still impassable. Riparian condition is fair/good, and substrate condition is good south of Lewato Road.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0277:

- **Protect the integrity of existing estuarine nearshore habitat**
- **Correct potential fish passage barrier step weir upstream of mouth of creek**
- **Evaluate habitat conditions upstream of the blocking culvert at Lewato Road, prioritize and implement correction measures**

Daniels Creek 15.0278

General

This small independent creek enters saltwater at the west end of Dogfish Bay, west of Keyport. A local resident reports historic abundant returns of adult chum to this stream. The creek now supports chum near the mouth and cutthroat. The TAG had little information on habitat conditions on this stream, except for riparian condition observations that have been made while passing through the area. Land use is primarily agriculture from the mouth to SR 308, although much of this land is being converted to residential development. The TAG suspects that the culvert under Virginia Loop Road is likely a barrier to fish passage. Downstream of SR 308, the drainage is heavily impacted by agriculture, with little riparian vegetation. Riparian condition was indicated as good upstream of SR 308.

The Bremerton-Kitsap Health District has collected water quality information at two locations in Daniels Creek since 1996. Identified water quality concerns include high fecal coliform counts (Mean=182 fc/100ml, Max.=1600 fc/100ml (on several occasions), upstream of 14510 SR 308), and high turbidity (Mean=17.4 NTU, Max.=97 NTU). In addition, dissolved oxygen levels <10 mg/l have periodically been observed.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0278:

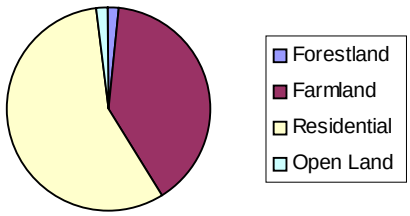
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff**
- **Restore functional riparian conditions downstream of SR 308**
- **Evaluate fish passage conditions at the Virginia Loop Road and SR 308 crossings; prioritize and implement corrective measures, as warranted**
- **Identify and correct sources of fecal coliform contamination and turbidity**

Little Scandia Creek 15.0279

General

This small independent creek enters saltwater midway down the west shore of Liberty Bay. It supports chum, coho, and cutthroat. PSCRBT (1994) indicates that Little Scandia Creek is one of the more impacted streams in the Liberty Bay/Miller Bay watershed area, especially in its lower reaches. Land uses adjacent to Little Scandia Creek, as identified by PSCRBT (1994) are identified in Figure 29.

Figure 29: Land Use Adjacent to Little Scandia Creek (from PSCRBT 1994)



Fish Access

There are several fish passage barriers on Little Scandia Creek. The culvert under SR 308 (RM 1.0) was evaluated by the Suquamish Tribe to not be a barrier to fish passage (Oleyar, 1998 survey). The culvert at the lowermost crossing of Scandia Road (RM 0.2) was previously a total fish passage barrier, but the culvert was replaced in 1999. The upstream Scandia Road crossing (RM 0.4) tends to fill with sediment that has to be removed on a periodic basis; it may be a barrier when filled with sediment. The culvert at Lundquist Road is plugged with sediment (PSCRBT 1994), and is indicated by the TAG to be a partial barrier.

Floodplain Modifications

The floodplain is generally constricted downstream of SR 308, with residential development in the lower 0.1 mile and agriculture to SR 308. Upstream of SR 308, the creek flows through an agricultural area, where the channel has been confined in a maintained ditch by local farmers, reducing channel complexity and wetlands, and significantly reducing associated spawning and rearing habitat (Dorn). Construction of a pond is proposed in a wetland adjacent to Little Scandia Creek downstream of the uppermost Scandia Road crossing, associated with creek reconstruction in the area (Kalinowski).

Channel Condition

LWD is lacking throughout the channel. There are few pools present downstream of the upper Scandia Road crossing (Kalinowski). Pool information upstream of Scandia Road was not available, but condition is likely poor given the lack of LWD.

Substrate

Substrate condition is fair/poor north of the lower Scandia Road crossing, consisting of fine sediment with pockets of gravel.

Riparian Condition

Riparian condition is generally fair, with narrow riparian buffers that are mostly deciduous with some conifer. There is heavy presence of reed canary grass. From the lower Scandia Road crossing to the mouth, the creek flows next to closely spaced residential homes, with the little remaining vegetation consisting of a few small trees and blackberries; between Lundquist Road and Scandia Road there is also very little riparian vegetative canopy, with clearing to the edge of the creek in several places (PSCRBT 1994).

Water Quality/Water Quantity

The Bremerton-Kitsap Health District has a water quality sampling station downstream of the fish weir, east of Scandia Court. No data were presented indicating water quality concerns.

Estuarine

Estuarine conditions in Little Scandia Creek are similar to those in Big Scandia Creek (15.0280). In addition, there is some concrete bulkhead presence as well as some concrete block debris in the stream channel in the lower 0.1 mile of the estuary (Oleyar).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Little Scandia Creek:

- **Prioritize and correct identified fish passage barriers at the uppermost crossing of Scandia Road and Lundquist Road**
- **Replace the culvert at the upper Scandia Road crossing to prevent filling with sediment**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore natural channel configuration and stream functions**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore riparian function throughout the watershed**
- **Identify and correct sources of fine sediment**

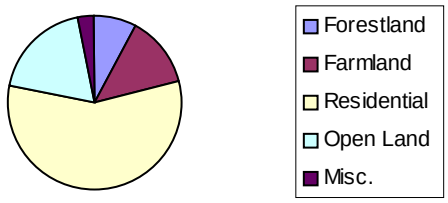
Big Scandia Creek 15.0280

General

Big Scandia Creek is an independent creek entering saltwater midway down the western shore of Liberty Bay. The creek supports chum, coho, steelhead, and cutthroat.

Land uses adjacent to Big Scandia Creek, as identified by PSCRBT (1994) are identified in Figure 30.

Figure 30: Land Use Adjacent to Big Scandia Creek (from PSCRBT 1994)



Fish Access

There are several identified fish passage barrier concerns on Big Scandia Creek, most of which are being addressed. The culvert under Scandia Road (RM 0.2, WDFW SSHEAR SITEID 15.0280 0.2) was a partial fish passage barrier, but was replaced with a bridge in 1999. The concrete box culvert under Viking Way is also a partial barrier. A major landslide of the Viking Way roadfill in 1997-98 affected fish passage potential. Stability of the site is being evaluated

prior to implementing fish passage correction measures, likely in 2000. The Salmon Enhancement Group has removed a concrete water diversion dam at RM 0.8-0.9 (Scandia Water Association fire supply), although there is still additional debris at the site that should be removed. The crossing of SR 3 is a barrier to fish passage, and there is no current intent to correct the barrier. The TAG indicates there is likely little habitat potential upstream of SR 3.

Floodplain Modifications

Big Scandia Creek is ditched/channelized upstream of the second crossing of SR 308 on the west side of Cox Road NW (RM 1.25).

Channel Condition/Substrate

The habitat quality is much better upstream of Viking Way than downstream. The substrate within Big Scandia Creek was heavily impacted by the Viking Way landslide (~200,000 yd^3 of material) in 1997-98. Large landslides upstream of Viking Way further compounded impacts in the same year, contributing LWD and massive amounts of sediment and fines to the system (Oleyar). Large amounts of sediment and fines downstream of the slide likely resulted in total loss of salmonid production downstream of Viking Way for the 1997-98 brood. Large fish returns and several storm events have significantly improved substrate conditions, however some areas of scoured streambed and thick sediment loads remain.

Riparian Condition

From the mouth of Big Scandia Creek upstream to Scandia Road, there is limited riparian cover through agricultural lands, and residents living near the creek have cleared most of the vegetation up to the edge of the stream. From Viking Way to Scandia Road, Big Scandia Creek flows through an alder bottom, much of which was affected by the Viking Way slide. Upstream of Viking Way, Big Scandia Creek is located within a steep deep ravine with wooded vegetation within the ravine. There is greenbelt protection upstream of Viking Way, but the riparian zone would benefit throughout with additional conifer. From RM 1.25-3.0, riparian condition is fair/poor, with limited riparian vegetation through agricultural and residential parcels (particularly adjacent to Cox Avenue).

Water Quality/Water Quantity

The total natural flow of Scandia Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further consumptive water appropriation (WAC 173-515-040).

Water quality and quantity may be affected by stormwater runoff from SR 3. The TAG recommends an evaluation of the extent of stormwater delivery from SR 3 to Big Scandia Creek. There is no current indication of channel incision downstream of SR 3.

The Bremerton-Kitsap Health District has been collecting water quality information at one location in Big Scandia Creek since 1996. Identified water quality concerns include high fecal coliform levels (Mean=83 fc/100 ml, Max.=1601 fc/100ml (several occurrences), at Scandia Court).

PSCRBT (1994) identified unrestricted animal access to the creek and riparian corridor downstream of Scandia Road, and in the upper headwaters near Hallman Road, with associated streambank erosion.

Estuarine/Nearshore/Marine

Big Scandia Creek has a small estuary, with heavy residential development on the shorelines. However, the shorelines are shallow and flat, and there is little bulkheading of the shorelines. The TAG indicated the natural character of the estuarine area is generally intact.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Big Scandia Creek:

- **Correct the fish passage barrier at Viking Way, once site stability evaluation is completed**
- **Protect integrity of natural estuary**
- **Restore natural channel configuration and floodplain integrity throughout the watershed, particularly upstream of Keyport Road**
- **Restore functional riparian zones throughout the watershed; encourage conifer regeneration in deciduous stands that historically had a conifer component**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to SR 3**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**
- **Prevent unrestricted livestock access to the creek**
- **Prioritize and correct the culvert fish passage barrier at SR 3**
- **Identify and correct sources of fecal coliform contamination**
- **Remove any debris at the old concrete water diversion dam site (RM 0.8-0.9) that may create a barrier to fish passage**

Unnamed 15.0281

General

This small independent creek enters Liberty Bay approximately 0.5 mile southwest of the north end of Liberty Bay, adjacent to the nursing home. The drainage currently supports chum only downstream of Viking Way. The TAG indicates that little is known regarding habitat conditions in this stream. A previous fish passage barrier at Viking Way has been corrected.

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0281:

- **Evaluate habitat conditions in this watershed; correct identified habitat limiting factors**

MF Johnson Creek 15.0283, Johnson Creek Tributary 15.0282, and NF Johnson Creek 15.0284

General

This small independent creek enters Liberty Bay approximately 0.45 mile southwest of the north end of Liberty Bay. The drainage supports chum, coho, and cutthroat. The TAG indicates that Unnamed 15.0282 (SF Johnson) identified in the WDF Stream Catalog (Williams et al. 1975) does not flow independently to Liberty Bay, and actually flows into Johnson Creek immediately downstream of Viking Way; it is identified and included in this section as Johnson Tributary (15.0282). In addition, Jon Oleyar indicates that the main channel in the watershed is actually NF Johnson (15.0284), but the following description utilizes the same channel numbering description identified in the WDF Stream Catalog.

Fish Access

There are numerous fish passage barriers in this watershed. The culvert on Johnson Tributary (15.0282) at Viking Way (WDFW SSHEAR SITEID 15.0282 0.01) is installed at a 20% grade with a 3-foot drop at the outlet (Tom Burns has evaluated the culvert as precluding all anadromous fish passage). In addition, there is a dam (WDFW SSHEAR SITEID 15.0282 0.08), just upstream of Viking Way that is a complete barrier. The TAG indicates the landowner is unwilling to consider removal of the dam. There is an additional culvert(s) just upstream of the dam that is a partial/complete barrier. The WDFW SSHEAR fish passage barrier database identifies the SR 3 culvert on Johnson Tributary as a fish passage barrier (SITEID 991241).

There is a collection of old piping, rocks, and debris on MF Johnson, approximately 0.1 mile upstream of the confluence with the NF, which is a partial fish passage barrier. In addition, there is an undermined concrete dam (WDFW SSHEAR SITEID 15.0284 0.3) on MF Johnson Creek, approximately 0.4 mile upstream of Viking Way and the confluence with NF Johnson, that may be a partial fish passage barrier (Oleyar indicates that this was not a barrier at the time he visited the site, but that it would be good to remove the structure). The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert at the SR 3 crossing of MF Johnson Creek (WDFW SSHEAR SITEID 991744).

There are also several barriers on NF Johnson. The creek goes around a trout pond just upstream of Viking Way (WDFW SSHEAR SITEID 15.0284 0.1). The trout pond does not interfere with the flow of the creek, however, the inlet to the pond is unscreened and draws from a small ditch which runs from the creek into the pond. There is potential to strand adult and juvenile salmonids in the pond. The pond should be removed from the floodplain, and/or the site should be evaluated by WDFW and screening of the inlet channel required to prevent stranding, if warranted. The previous fish passage barrier culvert at Cedar Lane (WDFW SSHEAR SITEID 15.0283 1.1) was replaced in 1999, but the streambed has regraded. The creek now cascades over

a rootwad in the channel, immediately upstream of the old culvert, which is likely a barrier to fish passage. In addition, there are two private culverts between Liberty Road and Cedar Lane that are partial barriers, and the culvert at Finn Hill Road (WDFW SSHEAR SITEID 15.0283 1.77) is a complete barrier. The WDFW SSHEAR fish passage barrier database also identifies fish passage barrier culverts at a private drive at RM 0.9 (WDFW SSHEAR SITEID 15.0283 0.9) and at SR 3 (WDFW SSHEAR SITEID 990218).

Floodplain Modifications

There are several floodplain modifications in the Johnson Creek watershed. There is a dam on Johnson tributary (15.0282), just upstream of Viking Way. There is an old concrete skeleton remnant of a dam on MF Johnson Creek at approximately RM 0.3 that alters the natural floodplain, but is not a fish passage barrier. There is a wetland complex on MF Johnson, upstream of SR 3, that should provide good coho and cutthroat habitat for fish that can access through downstream culverts (Doris Small has observed coho upstream of SR 3). The natural floodplain of NF Johnson Creek is confined where the creek is routed around a trout pond at RM 0.2. Otherwise the floodplain of NF Johnson is generally intact, as it is located within a confined ravine with no significant road impacts.

Channel Conditions

Channel conditions throughout this watershed are generally poor, with lack of LWD and few pools. In addition, the TAG identified concerns with an agricultural fence across NF Johnson (~250 feet downstream of Cedar Lane) that tends to collect debris and affects habitat quality.

Substrate

Substrate conditions were identified as good on NF Johnson Creek from Viking Way to Cedar Lane, and fair/good in the anadromous zones elsewhere in the watershed.

Riparian Condition

The ravine in which Johnson Creek is located is well vegetated with mixed alder and conifers from the headwaters downstream to Viking Way.

Riparian condition on Johnson tributary (15.0283A) is good upstream of Viking Way for 200-300 feet, unknown further upstream, and poor in the residential area downstream of Viking Way.

NF Johnson Creek has a series of extensive wetlands in the headwaters (upstream of Finn Hill Road) that have been heavily impacted by agricultural land use, with little effective riparian vegetation. This agricultural land is gradually being replaced by housing development. Riparian condition is also poor in the agricultural area from Cedar Lane to Finn Hill Road. Riparian condition elsewhere on NF Johnson is generally good, with mixed stands of alder, cedars, and other conifer (Oleyar).

Water Quality/Water Quantity

The total natural flow of Johnson Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further consumptive water appropriation (WAC 173-515-040). There is a water diversion channel just upstream of the mouth, apparently to maintain water flow to a pump (it is unclear whether this is a permitted water withdrawal, and appropriate hydraulic permits have not been obtained to do instream work)(Oleyar).

The TAG identified stormwater runoff from SR 3 as a concern, but specific impacts are unknown. There is no channel incision or scouring evident downstream of SR 3 at this time. Stormwater detention ponds for SR 3 are thought to be undersized to effectively address water quality and quantity concerns.

The Bremerton-Kitsap Health District has collected limited water quality information at one location in Johnson Creek since 1996. Identified water quality concerns include high fecal coliform levels (Mean=53 fc/100, downstream of Viking Way), although the mean sample value is heavily influenced by a very high count in July 1996.

Stream flow data for Johnson Creek (as measured downstream of Viking Way) are presented in Table 18. Stream flow during water years 1997-1999 ranged from <1 cfs to 150 cfs.

Table 18: Streamflow data for Johnson Creek (from Kitsap Public Utility District 2000)

Water Year	Mean Discharge (cfs)	Max. Discharge (cfs)	Min. Discharge (cfs)
1997	3.94	150	1.1
1998	3.35	40	0.97
1999	6.07	38	0.98

Estuarine/Nearshore/Marine

Estuarine habitat at the mouth of Johnson Creek is generally good. The shoreline is mostly low bank with little bulkheading, there is little storm or wave energy, and the shoreline has a vegetated buffer.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Johnson Creek and tributaries:

- **Remove concrete debris and scattered piping from the lower 0.2 miles of MF Johnson and restore natural channel configuration and function**
- **Replace undersized concrete box culvert under Viking Way on NF Johnson**
- **Prioritize and correct numerous identified fish passage barriers in this watershed**
- **Restore riparian function downstream of Viking Way on MF Johnson Creek and Johnson Tributary, and on NF Johnson upstream of Cedar Lane**
- **Protect good estuarine habitat at mouth of watershed**
- **Seek removal of the dams (located upstream of Viking Way) on MF Johnson Creek and Johnson Tributary**

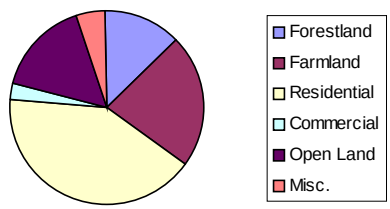
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance; retrofit state-of-the-art stormwater quality and quantity best management practices to SR 3**
- **Determine whether water diversion channel just upstream of the mouth has a water right; remove and restore site if warranted, ensuring that necessary permits are obtained**
- **Remove the agricultural fence across NF Johnson that collects debris during high flow events (located downstream of Cedar Lane)**
- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity**
- **Identify and correct sources of fecal coliform contamination**

Dogfish (WF Dogfish) Creek 15.0285, SF Dogfish (Wilderness, Harding) 15.0285A, NF (EF) Dogfish 15.0286, and Unnamed 15.0285B-0287

General

Dogfish Creek is the largest creek in the Liberty Bay/Miller Bay watershed (PSCRBT 1994), draining much of the developed area in Poulsbo. It enters the north end of Liberty Bay. The watershed supports chinook, chum, coho, steelhead, and cutthroat. Williams et al. (1975) indicates chinook historically utilized the watershed, although the TAG indicates that current chinook spawner escapement likely results from hatchery introductions into the watershed. The Suquamish Tribe has operated a chinook rearing pond on Dogfish Creek since 1984, in cooperation with Trout Unlimited (Dorn). Land uses adjacent to Dogfish Creek are identified in Figure 31.

Figure 31: Land Use Adjacent to Dogfish Creek (from PSCRBT 1994)



Fish Access

There are numerous fish passage concerns in the Dogfish Creek watershed. A rock weir, just upstream of the Lindvig Way culvert at the mouth of the stream, may be a fish passage barrier at lower tidal levels, and also precludes tidal interaction upstream of the rock weir. The culvert at the Bond Road crossing of Dogfish Creek at RM 0.4 (WDFW SSHEAR SITEID 990121) is failing (separating and collapsing). It is not currently a fish passage, but replacement of the failing culvert is still not scheduled and may create a future barrier (WDFW SSHEAR fish passage barrier database identifies this as a fish passage barrier). The partial fish passage barrier culvert under Bond RD just upstream of the junction of Big Valley and Little Valley roads was repaired in 1998 (likely the same site as WDFW SSHEAR SITEID 15.0285 1.35). The culvert at the church camp (1000 feet upstream from SR 307) is a partial barrier (coho and chinook salmon were both found above the church camp in 1999 (Oleyar), PSCRBT 1994 reports this to most

likely be a complete barrier), and the crossing of Big Valley Road (RM 3.4) may also be a partial barrier.

SF Dogfish has numerous fish passage problems. The culvert at the Bond Road crossing at the mouth is a partial barrier. There are 2-3 additional culverts that are partial barriers between Bond Road and SR 305. There are two private dams, approximately 0.2 mile upstream of Bond Road that are barriers to chum salmon; coho have been observed upstream as far as the (junction of Iverson Rd and 7th Ave NE) in both 1998 and 1999 (Oleyar). PSCRBT 1994 indicates landowner willingness to restore fish passage upstream of the rock dams. The last SR 305 culvert at Lincoln Drive is a barrier, and there is a private road with a dam just upstream that is a total barrier. [NOTE: These may be the same as the 15.0285A barrier records in the WDFW SSHEAR fish passage barrier database.]

The two crossings of Bond Road on NF Dogfish are passable, but need work to facilitate more effective fish passage. The WDFW SSHEAR fish passage barrier database identifies fish passage barrier culverts on NF Dogfish at RM 1.07 and 1.1. The prior complete barrier at Pugh Road (likely the same site as concrete dam identified in WDFW SSHEAR fish passage barrier database as SITEID 15.0287 0.15) on Unnamed 15.0287 was replaced in 1997. The fence on the Bledsoe property, just upstream of Pugh Road is also indicated as a partial barrier.

Floodplain Modifications

The TAG indicates that the floodplain of mainstem Dogfish Creek is heavily influenced by agriculture, with extensive channelization throughout much of the drainage. Channelization of Dogfish Creek was also identified by PSCRBT (1994).

Heavy commercial development and roads (SR 305 and Poulsbo Village) in Dogfish/SF Dogfish has severely confined the natural floodplain, eliminating virtually all floodplain function. The natural floodplain of SF Dogfish is extensively altered, despite presence of wide riparian buffers in the upper watershed. Stormwater runoff from extensive development in the upper watershed is routed to SF Dogfish at Caldart Avenue. For >1000 feet downstream, the creek channel has incised to hardpan, with the sediments transported and deposited in the low gradient reach downstream. This has narrowed the natural floodplain in the upstream reach, and artificially widened the floodplain downstream.

PSCRBT (1994) indicates the major land use impact on NF Dogfish is the constriction of the floodplain and creek channel by Bond Road. The road restricts the creek channel from meandering throughout the small narrow ravine.

Channel Condition

The TAG indicates that LWD and pool condition is extremely poor throughout the watershed. Severe bank and streambed erosion has occurred in the upper portion of SF Dogfish, but conditions have stabilized as most of the available sediment has been eroded from upper SF Dogfish. Bank erosion is also occurring along SR 307 on NF Dogfish, where the footprint of the highway forms the bank of the channel.

Substrate

Substrate condition throughout the watershed is poor. The TAG identified a high fine sediment load in mainstem Dogfish Creek. SF Dogfish is scoured to hardpan in the upper reach, and has very high fine sedimentation in the lower reach, despite being in a confined channel (roadside drainage ditch). An earthen dam in a tributary of NF Dogfish (at RM 0.6) failed in 1995, contributing a large sediment load and resulting in up to five feet of sediment accretion in the Dogfish Creek watershed. The failure resulted in a large loss of redds in the year of occurrence, but impacts have been moderated by subsequent flows.

Riparian Condition

Riparian condition throughout the watershed is poor. On mainstem Dogfish Creek, >75% of the riparian zone is in poor condition, due to combined impacts of roads, agriculture, commercial and residential development. SF Dogfish is heavily impacted by commercial development and roads, with the lower reaches confined to a roadside drainage ditch. Upstream of SR 305, SF Dogfish has wide riparian buffers (200-300 feet) of old second-growth conifer. Despite these buffers, there is no remaining gravel substrate in this reach and lack of streamflow during dry summer months. Regular trimming of riparian trees under the powerlines adjacent to Bond Road on NF Dogfish by the utility company impacts the ability to establish a functional riparian buffer (PSCRBT 1994).

Water Quality

PSCRBT (1994) indicates that runoff from Valley Nursery (except from the parking lot) flows directly into a roadside ditch next to Bernt Road, which then flows directly to into Dogfish Creek. They indicated potential for the runoff to contain high levels of nutrients (nitrogen, phosphorous), insecticides, and pesticides. More recent water quality monitoring by the county has not found any significant problems at the site. PSCRBT (1994) also indicated that runoff from a small duck/goose pen located next to the creek empties directly into Dogfish Creek; the TAG indicates there are no birds currently at the site. Upstream of the upper crossing of Bond Road, Dogfish Creek flows through two heavily used pastures that are in very poor condition, with unrestricted animal access to the entire section of stream. Substrate in this section consists of almost entirely fine sediments. Unrestricted animal access on at least four farms upstream of Big Valley Road was also noted. Some livestock fencing was identified, but the fences were placed next to the stream, leaving little to no buffer for vegetation except grass to grow. The public funds that were used to construct these fences may somewhat improve water quality, but do very little to provide useable habitat for fish or wildlife.

PSCRBT (1994) indicates that uncontrolled runoff to NF Dogfish from SR 307 is likely contributing pollutants to the creek, in addition to causing erosion of the stream banks.

Dogfish Creek is on the CWA 303(d) list for exceedance of turbidity and fecal coliform standards. The loading of fecal coliform to Liberty Bay was the primary reason for shellfish decertification in Liberty Bay. In addition, sampling in 1995 by the Suquamish Tribe indicated presence of high amounts of un-ionized ammonia. The Kitsap Conservation District and County Health Department are working on a partnership to address outstanding agricultural concerns in the Dogfish Creek watershed.

Upstream of Pugh Road on NF Dogfish, the major impact is animal access to the creek corridor (PSCRBT 1994). The creek banks are bare and eroding, and the creek has been flattened and widened by animal access.

The Bremerton-Kitsap Health District has been collecting water quality information at nine locations in the Dogfish Creek watershed since 1996. Identified water quality concerns include high fecal coliform levels (Means=80-517 fc/100, with particularly high counts in EF Dogfish and Dogfish Creek). Dissolved Oxygen levels <10 mg/l were also periodically observed in EF Dogfish (all three stations), SF Dogfish (downstream of Bond Road/Bondwood Drive), and WF Dogfish (upstream of 22431 Big Valley Road).

SF Dogfish has a significant population of freshwater clams (Oleyar). These are typically considered as an indicator of good water quality, although water quality in SF Dogfish is considered to be poor at best.

Water Quantity

Dogfish Creek and tributaries have been closed to further consumptive water appropriation since 1975 (WAC 173-515-040).

The TAG indicates that flows in mainstem Dogfish Creek are generally stable. Stream flow stability in the Dogfish Creek watershed is supported by significant wetland presence. PSCRBT (1994) indicates that wetlands comprise 12% of the total watershed acres (537 acres out of the total of 5,038 watershed acres). Several of the headwaters wetlands are currently being logged, and it is unknown what the extent of impact to stream flows may be. Stream flow data for Dogfish Creek (as measured at the intersection of Bond Road and SR 305) are presented in Table 19. Flows for water years 1991-1998 ranged from a minimum of 2.0 cfs to a peak flow of 300 cfs. Of particular note is the significant increase in peak stormwater flows beginning in 1996.

Table 19: Streamflow data for Dogfish Creek (from Kitsap Public Utility District 2000)

Water Year	**Mean Discharge (cfs)**	**Max. Discharge (cfs)**	**Min. Discharge (cfs)**
1991	8.98	83	4.2
1992	7.12	44	4.3
1993	8.02	40	3.1
1994	6.35	80	2.5
1995	8.83	75	2.5
1996	9.53	150	2.9
1997	11.4	300	2.0
1998	11.2	122	3.9

Flows in SF Dogfish are very flashy due to stormwater runoff from development in the watershed. Stormwater runoff from extensive development in the upper watershed, including runoff from a large-acreage area at Kitsap High School, is routed to SF Dogfish at Caldart Avenue. The effects of the stormwater runoff are evident in substrate condition, which is scoured to hardpan in the upper reach, with extensive deposition of fine sediment in the lower gradient reach downstream. Water withdrawal from a PUD well at Pugh and Lincoln has further reduced streamflow (50% reduction)(Dorn). The well has reduced chinook enhancement due to a loss of water availability.

Figure 32: Dogfish Creek estuary (photo courtesy of Dept. of Ecology)

Estuarine

Estuarine habitat at the mouth of Dogfish Creek (Figure 32) is highly altered. The culvert at Lindvig Way severely limits upstream saltwater exchange and sediment transport to the estuary. The rock weir upstream of the culvert has backed up a large amount of sediment that would otherwise have moved through to the estuary, and may even be a fish passage barrier at lower tidal levels. This has reduced the physical size and habitat quality of the estuary. Downstream of the Lindvig Way culvert, the bay is very long and shallow, with limited riparian vegetation along the shoreline.

Action Recommendations

Restoration potential for the Dogfish Creek watershed varies depending on location. Despite the myriad of habitat impacts in mainstem Dogfish Creek, the TAG indicates there is good potential for habitat restoration due to stable flows and current low development density in the watershed. However, SF Dogfish is identified by the TAG as the most severely impacted habitat in East Kitsap County, with restoration potential limited to only short sections. Even if the physical habitat in SF Dogfish can't be effectively restored, it is important to implement actions necessary to protect the integrity of habitat in lower Dogfish Creek and Liberty Bay.

The following ranked salmonid habitat restoration actions are recommended for Dogfish Creek and tributaries:

- **Replace culvert at Lindvig Avenue with bridge or culvert sufficient to pass sediments and restore tidal influence upstream of the culvert; remove rock weir upstream of Lindvig Way culvert**
- **Prioritize and correct numerous identified fish passage barriers in this watershed**
- **Protect integrity of headwater wetlands to maintain controlled instream flow**
- **Reduce habitat impacts on agricultural lands, including development and implementation of farm plans that restore stream functions**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed, particularly that contributing to the Caldart Avenue outflow to SF Dogfish; ensure that stormwater from future development throughout the watershed is fully addressed at the time of construction**
- **Reduce impacts of road crossings, including identified fish passage barriers, increased stormwater runoff to surface waters, water quality impacts from stormwater runoff, and increased fine sediment delivery from road surfaces and associated ditch maintenance**
- **Restore natural channel configuration and floodplain integrity through agricultural areas in the watershed**

- **Develop and implement a short-term LWD strategy to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore functional riparian zones throughout the watershed; encourage conifer regeneration in deciduous stands that historically had a conifer component**
- **Identify and correct sources of fecal coliform contamination (particularly in EF Dogfish) and un-ionized ammonia; prevent unrestricted livestock access to creek channels in the watershed**
- **Identify and correct causes of lower dissolved oxygen levels in EF Dogfish, SF Dogfish, and WF Dogfish**

Unnamed 15.0288

General

No salmonid distribution has been identified in this creek. The WDFW SSHEAR fish passage barrier database indicates presence of a fish passage barrier culvert at Lemolo Drive (RM 0.5, SITEID 15.0288 0.5).

Action Recommendations

The following salmonid habitat restoration actions are recommended for Unnamed 15.0288:
- **Assess salmonid utilization and salmonid habitat conditions**
- **Correct identified fish passage barrier at Lemolo Drive, as warranted**

Bjorgen Creek (identified as Deer Creek in headwaters) 15.0290

General

This small creek enters the western portion of Ne-Si-Ka Bay at the mouth of Liberty Bay. The creek currently supports adult spawning chum and coho up to SR 305 and cutthroat trout above and below SR 305. A detailed field assessment was completed in August of 1998 from salt water to approximately RM 1.0 (WDFW SSHEAR file 991742.wb1).

Fish Access

The culvert at Lemolo Shore Drive frequently gets blocked with debris and can restrict fish passage (Oleyar). The culvert under SR 305 (125 m long, RM 0.3, WDFW SSHEAR SITEID 991742) is a complete barrier to salmonids. In recent years creek residents have been moving adult salmon upstream of the SR 305 culvert (Dorn). A dam and associated pond at North Kitsap High School at RM 1.3 would be a total barrier, but is located upstream of the upper end of suitable salmonid habitat.

Channel Conditions

There is limited LWD present in the lower 0.3 mile (Oleyar), and LWD is generally absent upstream to RM 1.2. Otherwise, the creek has room to meander through a native buffer.

Substrate

Substrate in the lower 0.9 mile is good, with an estimated 2386 square meters of spawning habitat (SSHEAR 991742)

Riparian Condition

The creek channel from saltwater to RM 1.2 (lower end of Deer Run subdivision) is forested with second growth mixed timber. Reasonable buffers exist throughout much of this reach. Upstream of RM 1.2 much of the canopy has been removed leaving little to no riparian cover for 0.3 mile through the Deer Run subdivision and upstream.

Water Quality/Water Quantity

The relatively low gradient upper watershed is heavily developed. Specific impacts to altered hydrology to this creek have not been evaluated to date, but extent of impervious surface in the upper watershed poses significant risk to the ability to maintain the natural hydrologic regime in the watershed. The stormwater pond for the Deer Run subdivision is located immediately adjacent to the creek at RM 1.2. The stormwater treatment (water quantity and quality) provided by the pond is thought to not meet current stormwater standards. There is no significant channel incision noted in the upper watershed, but there is notable channel incision downstream of SR 305 (Dorn). The creek has stable base flows of approximately 200 gpm (Dorn).

Estuarine

The creek is bulkheaded on both sides of the mouth where the creek enters the bay, and the streambanks are armored for approximately 20 feet upstream through private property (Oleyar).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Bjorgen Creek:

- **Prioritize and correct fish passage barrier culvert at the SR 305 crossing**
- **Ensure that culvert at Lemolo Shore Drive is actively maintained to prevent obstruction by debris that may inhibit fish passage; replace with bridge or larger culvert that will effectively pass anticipated flows and debris**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed; ensure that stormwater releases from Deer Run subdivision meet current stormwater standards, relocate stormwater pond, if practicable, to outside the natural floodplain and in a manner that allows restoration of riparian function**
- **Develop and implement a short-term LWD strategy to restore instream habitat diversity and to arrest channel incision downstream of SR 305**
- **Restore riparian function upstream of the lower end of the Deer Run subdivision**
- **Reduce extent of streambank and shoreline armoring at mouth of creek**

Unnamed 15.0291 and Unnamed 15.0292

General

This small creek enters the central portion of Ne-Si-Ka Bay at the mouth of Liberty Bay. The creek currently supports chum and coho up to SR 305, presumed steelhead presence to the forks and cutthroat trout to RM 1.2 and to RM 0.45 in tributary 15.0292. Limited road access to much of this watershed may be an indication that habitat remains in good condition. The upper watershed is comprised of an extensive wetland west of Widme road.

Fish Access

The WDFW SSHEAR fish passage barrier database identifies the culvert under Lemolo Shore Drive (SITEID 15.0291 0.02) as a fish passage barrier. The culvert under SR 305 (~RM 0.2, WDFW SSHEAR SITEID 990709) is a barrier to anadromous salmonids, preventing access to approximately 1.9 mile of suitable habitat. Herron Pond is behind an earthfill dam with a standpipe overflow, on 15.0291 at RM 0.9. It is a complete barrier to fish passage, blocking access to 0.5 mile of wetland and creek habitat.

Floodplain Modifications

The channel of Unnamed tributary 15.0292 is incised, likely from stormwater runoff.

Channel Conditions

LWD condition is generally poor throughout this watershed.

Substrate

There appears to be an excess of gravel with some sand downstream of the mouth of Unnamed tributary 15.0292.

Riparian Condition

The creek channel from saltwater to SR 305 is forested with second growth mixed timber, except in the lower 0.2 mile, which is choked with blackberries. Reasonable buffers exist throughout much of this reach. Upstream to Herron Pond (RM 1.1), there are riparian buffers of mixed conifer/alder.

Water Quality/ Quantity

Land use in the upper watershed is rural development and horse farms, with an extensive wetland complex. Presumably this wetland complex provides broad benefits for both water quality and quantity. Minimal urban impacts exist, which should limit potential impacts to basin hydrology. Unnamed tributary 15.0292 is ephemeral and carries water only during the wet season.

Estuarine

A small estuarine area is slightly compromised by the Lemolo shore roadbed and adjacent nearshore marine residences. This is a relatively low energy marine shoreline.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0291 and tributaries:

- **Correct fish passage barriers at SR 305 and at Herron Pond**
- **Restore riparian function in the lower 0.2 mile of the creek, which is currently choked with blackberries**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Develop and implement a short-term LWD strategy to provide LWD presence until full riparian function is restored**

Sam Snyder (Firecracker) Creek 15.0293

General

This small creek enters the eastern portion of Ne-Si-Ka Bay at the mouth of Liberty Bay. The creek currently supports chum, coho to the impassable culvert at Lemolo Shore Drive and cutthroat trout above and below SR 305. The majority of the drainage (above SR 305) is high quality habitat, located in a deep ravine with minimal surrounding rural development. The lower 0.2 mile has a relatively steep gradient (2%-4%) and is compromised by private residences.

Fish Access

The culvert under Lemolo Shore Drive (RM 0.15) is a complete barrier to salmonids. The culvert under SR 305 (RM 0.25) is also a complete barrier to anadromous salmonids, preventing access to approximately 1.6 miles of suitable habitat.

Channel Conditions/Substrate/Riparian Condition

The creek channel above SR 305 (RM 0.25) is forested with second growth mixed timber providing good buffers throughout much of the upper watershed. LWD condition is unknown.

Water Quality/Water Quantity

The upper extremities of this watershed may be directly or indirectly connected to the extensive wetland complex west of Widme Rd. This complex should provide both water quality and quantity benefits for this system.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Sam Snyder Creek:

- **Correct fish passage barriers at Lemolo Drive and at SR 305**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Evaluate LWD condition, and if needed, develop and implement a short-term LWD strategy until full riparian function is restored**

Unnamed 15.0295

General

This small independent tributary enters Agate Passage approximately 0.25 mile southeast of Klaebel Creek. The creek is reported by the Suquamish Tribe to not have any potential anadromous salmon habitat. The creek is currently dammed at the mouth, with reservoir water used for the fire-protection system at the tribal center.

Action Recommendations

No salmonid habitat restoration actions are recommended at this time.

Klaebel (Thompson) Creek 15.0296 and Unnamed 15.0297

General

This small independent creek enters the west side of Agate Passage just south of the Agate Pass Bridge. It supports coho and cutthroat, with chum downstream of the fish passage barrier culvert at SR 305 (Oleyar). Unnamed tributary 15.0297 enters just upstream of the SR 305 culvert, near RM 0.4, and is spring fed with some year-round flow. Klaebel Creek is thought to have historically supported coho, although current salmonid use is limited to chum use near the mouth.

Fish Access

The culvert at the SR 305 crossing is reported to essentially be a total barrier. Several salmon carcasses were found on the upstream side of the SR 305 culvert years ago, but not recently (Oleyar). Fish passage at the mouth of Klaebel Creek may also be impaired by low stream flows and hindered by bank hardening by the landowner at the mouth of the creek.

Channel Condition

The streambanks on Klaebel Creek are generally stable; presence of pools, and particularly deep pools, is very limited; and LWD presence is fair/poor (Oleyar). The streambanks have been armored through the backyard of the residence right at the mouth of the creek.

Substrate

The substrate in Klaebel Creek is heavily impacted by fine sediment. Upstream of SR 305, the presence of heavy fines is thought to be due primarily to runoff from the tribal fireworks area and adjacent road runoff. Downstream of SR 305, the substrate is mostly fines, although there is some limited spawning.

Riparian Condition

Riparian condition at the SR 305 culvert on Klaebel Creek is poor due to heavy blackberry presence. Most of the land upstream of Totten Road has been in timber management with some rural private residences. The riparian zone is mixed second growth forest throughout much of this reach. On 15.0297, the riparian zone upstream of SR 305 has been cleared for agriculture, and there is even a barn that is built over the stream.

Water Quality

Water quality in Klaebel Creek is heavily impacted by fine-sediment laden runoff from the tribal fireworks area. Water quality in 15.0297 may be impaired by runoff from the agriculture area upstream of SR 305, particularly from the barn that is built over the creek.

The Bremerton-Kitsap Health District has collected limited water quality information at one location in Klaebel Creek since 1996. Identified water quality concerns include low dissolved oxygen levels (Mean=9.1 mg/l, Min.=4.3 mg/l), with a couple of observations of fecal coliform counts exceeding water quality standards, and one high turbidity sample.

Water Quantity

The total natural flow of Klaebel Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further consumptive water appropriation (WAC 173-515-040).

These streams drain areas that are rapidly developing. Although no existing water quantity concerns were identified, ongoing and pending development in the watershed poses significant risk to the ability to maintain the natural hydrologic regime in the watershed. Stormwater runoff is known to increase the frequency and magnitude of peak flows, also resulting in increased erosion, fine sedimentation, and bank instability.

Estuarine/Nearshore/Marine

A small estuarine area exists at the confluence with Agate Pass. There is a substantial intertidal area with good populations of native littleneck and butter clams. Shoreline private residences

have limited nearshore vegetation and bulkheaded shoreline throughout much of the estuarine reach.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Klaebel Creek and tributaries:

- **Correct fish passage barrier at SR 305**
- **Restore natural streambank function through residence at mouth of the creek**
- **Implement low impact development, including stormwater water quantity control and water quality treatment for stormwater runoff; retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed**
- **Eliminate fine-sediment laden runoff to creek from tribal fireworks area and adjacent roads**
- **Identify and correct causes of low dissolved oxygen levels**

Cowling Creek 15.0298 and Unnamed 15.0298A

General

This small independent creek enters Miller Bay on the west side at the mouth of the bay. Historically, the creek likely only supported trout, although there is limited chum spawning that occurs in the intertidal area. The Suquamish Tribe has operated a chum brood stock hatchery at the mouth of the creek since 1977. The hatchery was founded with native Chico Creek broodstock, provides the ongoing broodstock for East Kitsap chum programs, and contributes to the second largest run of chum to Kitsap County streams. The adult recapture facility is located in the intertidal area. Accumulated sediments are dredged periodically. The culverts on both forks under Miller Bay Road are total barriers to anadromous access, but correction would likely benefit only cutthroat passage. The hatchery also operates an instream short-term rearing pond and water intake diversion, both upstream of Miller Bay Road. These allow upstream fish passage when not in use.

The primary benefit of Cowling Creek (and other small tributaries to the west side of Miller Bay) to anadromous salmonids other than cutthroat is support of estuarine water quality in Miller Bay. The water quality support role of Cowling Creek has been substantially impaired. Although water quality of remaining instream flow is apparently good, installation of three PUD and local wells has occurred since 1977, resulting in a significant reduction of instream flows. The Bremerton-Kitsap Health District has been collecting water quality information at one location in Cowling Creek (downstream of weir at hatchery rearing pond) since 1996. Although there were no consistent water quality concerns identified, there were several occurrences of high fecal coliform counts (as high as 1600 fc/100ml), and a few occurrences of dissolved oxygen levels <10.0 mg/l.

Development in the basin has resulted in increased fine sedimentation and increased frequency and magnitude of peak flows due to stormwater runoff. Sediment impacts are particularly evident in SF Cowling Creek, which has high amounts of fine sediment in the substrate. Streambed scour is also evident on SF Cowling. Substrate condition in NF Cowling is indicated as fair.

Riparian condition on NF Cowling is indicated as good, at least in the lower 0.25 mile. Riparian condition on SF Cowling is indicated as good upstream to Columbia Street, and poor farther upstream.

Cowling Creek stream flow has dropped significantly, coinciding with installation of several large wells within the watershed. Consequently, the Suquamish Tribe was forced to relocate the adult recapture facility from an upstream location to the current intertidal location in 1994. Cowling Creek and tributaries are closed to further water appropriation year-round (WAC 173-515-040).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Cowling Creek and tributaries:

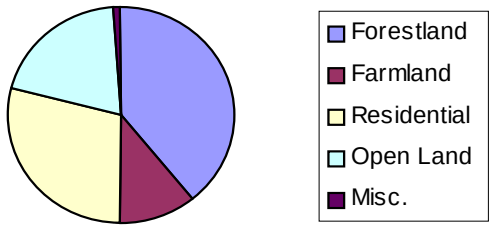
- **Correct fish passage barrier at Miller Bay Road**
- **Evaluate impacts of PUD wells on instream flow and identify options to restore instream flows and improve water quality**
- **Implement stormwater controls for existing and future development to maintain the natural hydrology of the watershed**
- **Identify and correct sources of fine-sediment stormwater runoff, particularly in SF Cowling**
- **Maintain and restore riparian function, particularly in SF Cowling Creek**
- **Identify and correct sources of fecal coliform contamination**

Grovers Creek 15.0299 and Unnamed 15.0300-0304

General

Grovers Creek flows into the north end of Miller Bay, is approximately 5 miles in length, and includes several tributaries. The drainage is by far the largest contributing to Miller Bay, and is characterized as very low gradient with large wetland plateaus. The watershed complex supports fall chinook (returns from hatchery plants), chum (to hatchery rack at RM 0.05), and coho, steelhead, and cutthroat to the headwaters. Land uses adjacent to Grovers Creek, as identified by PSCRBT (1994) are identified in Figure 33.

Figure 33: Land Use Adjacent to Grovers Creek (from PSCRBT 1994)



The Suquamish Tribe established the Grovers Creek Hatchery in 1978 as a chinook broodstock facility. Coho and steelhead were reared through the 1980s, but discontinued in the 1990s due to budget constraints and the success of the marine coho netpen program in Agate Pass (Dorn).

Fish Passage

Tribal elders indicate that Grovers Creek never had any significant chum run; it was primarily a coho creek (Paul Dorn). A tribal fall chinook hatchery is located just upstream of the mouth of Grovers Creek. The adult recapture weir is typically in place through early December. All adult chinook returns are removed at the hatchery weir for artificial hatchery production. All chum are presumed to be strays from the Cowling hatchery, although this has not been verified (no natural chum were observed during the evaluation period prior to initiation of the hatchery operation (Dorn)). Most adult chum spawn in the intertidal area downstream of the weir; those chum that return to the weir are removed and the eggs are sold by the Suquamish Tribe. Adult coho returns to the weir are presumed to be of net-pen origin (based on coded-wire tag ratio expansions), and are also not passed upstream. However, coho have been observed upstream, resulting from either passage around the weir or returns after the weir is removed in mid-December. Juvenile outmigration of coho, cutthroat, and numerous other species (stickleback, lamprey, etc.) is being monitored, and should provide an indication of natural salmonid production upstream of the hatchery weir. In addition, adult coho returning in 2000 will be 100% mass-marked, providing the opportunity to pass natural-origin coho upstream to spawn. Substrate quality and overall salmonid productivity in this watershed would likely benefit from increased numbers of adult spawners in the watershed.

Silver Springs Creek (right bank tributary to Grovers Creek near the mouth) has a barrier culvert under Miller Bay Road (just north of intersection with Gunderson Hill Road) that precludes anadromous access to a limited amount of upstream habitat. There is a barrier culvert at the Indianola Road crossing of Unnamed tributary 15.0302A (left bank tributary to Grovers Creek at the mouth) that blocks access to 0.3 mile of spawning habitat upstream.

Floodplain Modifications

The creek is channelized through the agricultural area upstream of Indianola Road. There are significant wetland complexes in lower Grovers Creek and at the intersection with Unnamed tributary 15.0302, which are being heavily impacted by encroachment from development and peat mining. There is no known stranding of adult or juvenile salmonids in the peat mining ponds, as they are isolated from the creek except at peak flows. Connecting the peat mining ponds to the creek may provide additional off-channel rearing habitat. There are extensive wetlands in the area from SR 104 to West Kingston Road. These wetland complexes provide excellent rearing habitat for juvenile coho. A&L Topsoil and one other business encroach onto the creek just downstream of Kingston Road.

A portion of Albertson's and the Park & Ride are built on wetland fill on Unnamed 15.0304, reducing the presence of wetlands and the altering the natural hydrology of the watershed. Land use north of SR 104 (RM 3.2-4.2) is primarily agriculture, with significant channelization and diking. In addition, there are several dikes constructed perpendicular to the floodplain that isolate the creek from the natural floodplain and confine flows to within the channel. These wetland fills are indicative of a much broader county-wide problem of exemptions for wetland fill associated with single-family residences, and general lack of protection of wetland habitats.

Channel Condition

The majority of the creek is low gradient, with deep tannin-stained channels predominating the lower 1.8 miles of stream. No information was identified on the status of pools. There are extensive wetlands and beaver ponds throughout the watershed, but pool condition in confined channel areas is likely poor due to the general lack of LWD. LWD is completely absent in the channelized agricultural reach upstream of SR 104, and is generally lacking elsewhere except in beaver dams.

Substrate

The TAG identified that substrate is heavily sedimented throughout the watershed, with limited amounts of suitable spawning habitat restricted to the higher gradients in the upper mainstem and tributaries. The substrate in the lower 2.0 miles is primarily peat through a series of beaver ponds. Heavy planting of coho (Minter Creek stock) has occurred throughout the watershed to take advantage of underutilized habitat.

Riparian Condition

The TAG identified that there is no riparian vegetation for one mile upstream of SR 104, due to agricultural modifications; this area is gradually being converted to urban uses. Between SR 104 and West Kingston Rd. agricultural practices have greatly reduced riparian function, with housing and horse farms encroaching right to the edge of the beaver ponds. Loss of riparian vegetation in the upper watershed likely exacerbates low flow problems in summer months. Downstream of West Kingston Road, there is fair to good riparian cover with mixed second growth in many reaches.

Water Quality

Grovers Creek is on the CWA 303(d) list for exceedance of fecal coliform levels.

Unnamed tributary 15.0302 drains two large developments (Whitehorse and Arborwood) that are currently in the development or early construction phase. Although there are currently no identified water quality problems, there is significant potential for groundwater and stormwater impacts. Unnamed tributary 15.0303 flows past the Kingston Junior High School, which the TAG reports has a drain that flows directly to the stream, with identified sedimentation and water quality concerns. The development that is occurring in the headwaters at George's Corner (on SR 104) is considered by the TAG to be the greatest current habitat concern for the watershed. The tribal hatchery has previously experienced problems with aquatic mold, likely the result of release of high nutrient levels associated with peat mining operations.

Unrestricted access of livestock to the creek in the agricultural area upstream of Kingston Road is thought to likely contribute increased levels of nutrients and fecal coliform. Water temperatures are likely also affected in this area by lack of riparian vegetation and land uses that result in decreased summer flows. Habitat conditions would benefit from exclusion of animal access to the creek and restoration of riparian function in this area.

The Bremerton-Kitsap Health District has been collecting water quality information at five locations in the Grovers Creek watershed since 1996. Identified water quality concerns include

high fecal coliform levels (Mean=73 fc/100, at Suquamish fish hatchery), and consistent observations of dissolved oxygen levels <10 mg/l, with levels as low as 6.5 mg/l.

Water Quantity

Flows in the Grovers Creek watershed are supported by significant wetland presence. PSCRBT (1994) indicates that wetlands comprise 17% of the total watershed acres (828 acres of the total of 4,936 acres).

Streamflow data for Grovers Creek collected by the Suquamish Tribe near their hatchery from March through December 1993 measured an average monthly flow of 7.19 cfs, a maximum monthly flow of 27.2 cfs, and a minimum monthly flow of 1.47 cfs (PSCRBT 1994). The measured maximum 1-day flow during this period was 32.06 cfs, the minimum 1-day flow was 1.47 cfs.

The Department of Ecology has determined that Grover's Creek and tributaries exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, no further water is available for consumptive appropriation from June 1 – October 15 (WAC 173-515-040). Applications for consumptive water appropriation at other times of the year are subject to minimum instream flows established in WAC 173-515-030.

Ongoing and pending development in the watershed, particularly in the headwaters, poses significant risk to the ability to maintain the natural hydrologic regime in the watershed. Stormwater runoff is known to increase the frequency and magnitude of peak flows, reduce base flows, as well as increasing erosion, fine sedimentation, and bank instability. The TAG identified concerns with reduced summer base flows, including the presence of only seasonal surface flows in the vicinity of SR 104. The water storage retention in the upper watershed is currently affected by the isolation of the creek from the historic floodplain upstream of SR 104, and development encroachment to the edge of the wetlands from SR 104 downstream to Kingston Road. The loss of water storage is likely to be further impacted as the upper watershed is converted to impervious surface.

Estuarine

The inner portion of Miller Bay provides excellent estuarine/marine nearshore habitat. The TAG indicates that wave energy and longshore transport of sediment are both low in Miller Bay, limiting the need for bank protection. However, the outer portion of Miller Bay is almost entirely bulkheaded, with presence of numerous docks and piers. Marine shoreline bulkheading has been shown in other areas to degrade the quality of nearshore habitat for juvenile salmonid use and baitfish production. In addition, the placement of bulkheads has resulted in loss of intertidal wetlands. There is potential for future requests for dredging to retain water depth adjacent to the docks/piers. Despite these problems, there is substantial good nearshore/estuarine habitat remaining in the inner portion of Miller Bay.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Grovers Creek and tributaries:

- **Correct fish passage barriers on tributaries near the mouth of Grovers Creek**

- **Pass spawning adult salmonids upstream of the tribal hatchery weir to fully utilize available spawning and rearing habitat**
- **Limit further construction of bulkheads and overwater structures in Miller Bay; remove existing structures where feasible**
- **Reestablish riparian function upstream of West Kingston Road**
- **Reconnect creek with natural floodplain in the one-mile agricultural reach upstream of SR 104**
- **Restore natural channel configuration and function in channelized reaches of the watershed**
- **Prevent unrestricted livestock access to the stream, from Kingston Road to SR 104**
- **Maintain wetland function throughout the watershed; prevent additional wetland filling associated with residential and commercial development**
- **Evaluate potential benefits of connecting peat mining ponds with creek to provide additional rearing area, implement is deemed appropriate**
- **Ensure state-of-the-art stormwater protection on pending development in the headwaters**
- **Develop and implement a short-term LWD strategy until full riparian function is restored**
- **Identify and correct source of fecal coliform contamination**
- **Identify and correct cause of lower dissolved oxygen levels**

The headwaters of Grovers Creek are in close proximity to the headwaters of Carpenter Creek (15.0309), and land use protections in the headwaters will likely benefit both watersheds.

Unnamed 15.0305, Independent Streams Immediately North and South of 15.0305

General

These small independent creeks enter the east side of Miller Bay. These streams would likely all support cutthroat in the absence of fish passage barriers on each of the streams; current presence and uppermost distribution of cutthroat are unknown. The streams are also important as they contribute to high quality estuarine/nearshore habitat in Miller Bay. Culverts at the Indianola Road crossing of each of these streams are barriers to fish passage. In addition, fish access to the creek north of Unnamed 15.0305 is blocked by a private trout hatchery near the mouth. Some landscaping has occurred on these streams to create instream waterfalls that may also be fish passage barriers.

No additional habitat information was available for these streams.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0305 and adjacent independent streams:

- **Evaluate habitat conditions upstream of fish passage barriers; prioritize and correct identified barriers as warranted**
- **Evaluate water quality conditions and maintain high water quality for continued support of estuarine conditions**

Kitsap Creek 15.0305X

General

Kitsap Creek is a small independent creek entering Port Madison approximately 0.75 mile east of the Indianola dock. The creek supports chum, coho, and cutthroat. A small community remote-site incubator (RSI) has released unfed chum salmon intermittently since 1995.

Fish Passage

The culvert under Indianola Road is a complete passage barrier. There is approximately 0.4mile of habitat upstream of the culvert with cutthroat use. The culvert at Shore Drive is a velocity barrier at certain flows, but does allow partial fish passage. There are natural higher creek gradient areas downstream of Indianola Road that naturally limit salmon access upstream.

Floodplain Modifications

The Shore Drive roadbed (RM 0.1) creates a dike which captures a significant quantity of gravel and fine sediment upstream that normally would have been transported into the lower creek section and out into Port Madison. At peak flow conditions the Shore Drive culvert is undersized and causes water to back up upstream and deposit material.

Channel Condition

From the mouth to Shore Drive, residential development encroaches to the edge of the stream. Upstream, channel condition is good. The creek is generally confined in an undeveloped ravine, which is naturally vegetated and provides adequate room for channel dynamics and recruitment of LWD.

Substrate

The TAG identified the substrate condition as good, with generally good gravel supply. Some periodic pulses of fine sedimentation have occurred associated with road bed failures (Indianola Road in 1998), likely contributing to the sediment accumulation upstream of Shore Drive. Gravel and fine sediment are deposited upstream of the undersized culvert at Shore Drive, resulting in excess sedimentation of the gravels and precluding normal sediment transport to the marine shoreline.

Riparian Condition

Downstream of Shore Drive, riparian condition is poor where residential lawns encroach to the edge of the stream. Upstream, riparian condition is good, as the creek is located in a wooded ravine below Indianola Road, with maturing second growth further upstream.

Water Quality/Water Quantity

Some limited discharge measurements have been recorded indicating flows ranging from a low of 0.15 cfs to 8.5 cfs at flood stage. The headwaters of this creek include a series of small

interconnected ponds forming an important wetland complex on the east fork. Proposed development in this area may pose a risk to the natural hydrology of the basin.

The Bremerton-Kitsap Health District has a water quality sampling station near the mouth. No data were presented indicating water quality concerns.

Estuarine/Nearshore/Marine

No estuarine habitat exists as this system discharges directly into Port Madison marine waters, along a high-energy shoreline. The nearshore has been residentially developed although no bulkheads exist in the immediate vicinity of the creek outlet.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Kitsap Creek:

- **Replace culvert at Shore Road crossing to provide natural transport of sediments to Port Madison**
- **Evaluate habitat conditions upstream of the fish passage barrier at Indianola Road; prioritize and correct as warranted**
- **Restore riparian function downstream of Shore Road**

The Indianola Greenway Plan (community adopted plan) identifies Kitsap Creek as an important resource targeted for protection by conserving adjacent lands. Continued implementation of this plan would help protect the long term health of this system.

Indianola Creek 15.0305X

General

Indianola Creek is a small independent creek entering Port Madison approximately 0.1 mile east of the Indianola dock. It supports chum, coho, and cutthroat. A small community RSI project has released unfed chum salmon intermittently since 1995 at RM 0.1.

Fish Access

The TAG reports four fish passage barriers in the lower half mile, but local residents are reported to be actively moving adult salmon past the lower three barriers. The uppermost barrier is under Indianola Road. There is approximately 1.5 mile of potential habitat upstream of Indianola Road that could potentially support coho production.

Floodplain Modifications

The creek is generally confined in a ravine, with no floodplain modifications noted.

Substrate

The TAG identified the substrate condition as good, with good gravel supply and no fine sedimentation concerns.

Riparian Condition

The TAG identified the riparian condition as good, as the creek is located in a wooded ravine. However, the whole watershed has been platted for development, and the cumulative impact of lot clearing is beginning to reduce riparian function. There is strong concern that continued development will further impair riparian condition. A 20-acre parcel, including both sides of the creek upstream of Indianola Road, has been placed in conservancy status, which will provide long-term riparian and habitat protection.

Water Quality/Water Quantity

Flows in the Indianola Creek watershed are supported by significant wetland presence. PSCRBT (1994) indicates that wetlands comprise 11% of the total watershed acres (368 acres of the total of 3,471acres). The TAG did not identify water quantity as a habitat limiting factor, but raised strong concerns of potential stormwater impacts associated with the pending development of platted areas throughout the watershed. Stormwater runoff is known to increase the frequency and magnitude of peak flows, reduce base flows, and increase erosion, fine sedimentation, and bank instability. Presently a number of roadbeds are within close proximity to the creek and discharge surface runoff directly into the stream.

The Bremerton-Kitsap Health District has a water quality sampling station near the mouth. No data were presented indicating water quality concerns.

Estuarine

Bulkheading of the natural shoreline exists to the west of the creek outlet. Residential yard maintenance has eliminated the natural beach berm vegetation.

Action Recommendations

The following salmonid habitat restoration action is recommended for Indianola Creek:

- **Evaluate habitat conditions upstream of the four fish passage barriers from Indianola Road downstream; prioritize and correct as warranted**

The Indianola Greenway Plan (community adopted plan) identifies Indianola Creek as an important resource targeted for protection by conserving adjacent lands. Continued implementation of this plan would help protect the long-term health of this system.

Unnamed 15.0305X

General

This small independent creek enters the northern shore of Port Madison approximately 1.0 mile west of Pt. Jefferson. The creek is known to support cutthroat. No information was available on habitat conditions in this watershed, other than the upper watershed currently identified as being in long-term forestry. However, this creek is important not only for its direct freshwater support of cutthroat, but also because it provides important estuarine habitat along the otherwise high-energy northern shoreline of Port Madison. The estuary generally remains in natural condition, and should be retained that way to provide habitat diversity along this shoreline.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0305X:

- **Evaluate freshwater habitat conditions**
- **Protect natural integrity of estuarine shoreline**

Unnamed 15.0306

General

This small independent creek (1.2 miles long) enters the southwest shore of Appletree Cove. The creek is known to support cutthroat in the lower reaches. The creek has extremely low flows during summer months. The culvert at the Jefferson Pt. Road crossing (WDFW SSHEAR SITEID 15.0306 0.44) is a fish passage barrier, with a steep gradient downstream of the road. There are two privately owned fish passage barriers upstream of Jefferson Point Road; the first is a private driveway culvert off of Strawberry Lane, which is a complete barrier, and the second is an unused road grade approximately 0.3 mile downstream of the beaver ponds in the upper watershed (Okeefe). [NOTE: The WDFW SSHEAR fish passage barrier database identifies two barrier culverts and a blown out road grade barrier upstream of Jefferson Pt. Road.] There are significant beaver ponds in the upper watershed, but no cutthroat were observed in the beaver ponds (Kalinowski). Availability and use of habitat is likely dependent on continued stability of the beaver dams in the upper watershed.

The Department of Ecology has determined that Unnamed 15.0306 and tributaries exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, they are closed to further water appropriation year-round (WAC 173-515-040).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0306:

- **Promote stability of beaver ponds in upper watershed**

- **Evaluate habitat conditions upstream of the Jefferson Pt. Road culvert; prioritize and correct as warranted**

Unnamed 15.0307

General

This small independent creek (1.2 miles long) enters the southern shore of Appletree Cove near the western end. The creek supports cutthroat. There are three culverts on the creek, but all are currently passable. Substrate condition is fair, consisting of fine sediments with patches of good clean gravel. The creek has riparian buffers, which are mainly deciduous. LWD is lacking throughout. This creek contributes to high quality estuarine habitat in inner Appletree Cove.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0307:

- **Develop and implement a short-term LWD strategy until full riparian function is restored**
- **Restore conifer presence in riparian buffer**

Unnamed 15.0308-0308A

General

This small creek enters the southwestern end of Appletree Cove. It supports coho and cutthroat. Substrate condition is fair, consisting of fine sediments with patches of good clean gravel. LWD is lacking throughout. Riparian condition is identified as poor in the upper watershed (RM 0.4-0.8), and the upper watershed is included within the boundaries of the pending Arborwood development. This creek contributes to high quality estuarine habitat in inner Appletree Cove.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0308 and tributaries:

- **Implement state-of-the-art stormwater control to address stormwater runoff from the Arborwood development, to ensure continuation of natural hydrology in this basin**
- **Restore riparian presence and function upstream of RM 0.4**

Carpenter Creek 15.0309

General

Carpenter Creek is the largest creek flowing to Appletree Cove, entering the northwest corner of the cove. The creek supports chum, coho, and cutthroat, and provides important water quality and quantity support to the high-quality estuarine habitat in inner Appletree Cove.

Fish Access

The culvert at West Kingston Road (at the mouth of the creek) is a fish passage barrier at low tide (Small), restricts saltwater exchange to the historic estuarine area upstream of the culvert, and also inhibits natural sediment transport to the outer estuary. Anadromous salmonids can access to the SR 104 culvert (RM 1.3), which is a partial fish passage barrier. From SR 104 upstream to Wyant Road (RM 2.5) there are approximately 12 additional culverts that are likely fish passage barriers.

Floodplain Modifications

From Carpenter Lake upstream to SR 104, the creek is channelized and diked.

Channel Conditions

There are few pools and little habitat diversity throughout, except for the very large beaver dam complex in the headwaters. LWD is generally absent.

Riparian Condition

From the mouth upstream to Carpenter Lake, the riparian buffer is narrow and all deciduous. From the lake to SR 104, riparian vegetation is absent. Upstream of SR 104, the riparian zone is again narrow and all deciduous.

Water Quality/Water Quantity

Carpenter Creek has relatively stable flows year-round. A very large beaver dam complex in the headwaters likely helps stabilize flows in Carpenter Creek. There are no significant stormwater impacts identified at this time. However, there are a number of recent development projects in the watershed (Arborwood, SR 104 widening, W. Kingston Road widening, other residential developments) that have potential to increase stormwater impacts to Carpenter Creek.

The Department of Ecology has determined that Carpenter Creek and tributaries exhibit low summer flows and have the potential for drying up or inhibiting anadromous fish passage during critical life stages; therefore, they are closed to further water appropriation year-round (WAC 173-515-040).

The Bremerton-Kitsap Health District has been collecting water quality information at two locations in Carpenter Creek since 1996. Identified water quality concerns include consistent observations of low dissolved oxygen levels (Mean=8.6 mg/l, Min.=6.7 mg/l), periodic

observations of water temperatures exceeding 15°C, and high fecal coliform levels downstream of Barber Cutoff.

Figure 34: Carpenter Creek estuary (photo courtesy of Dept. of Ecology)

Estuarine Condition

The natural estuary of Carpenter Creek extends upstream of West Kingston Road approximately 0.1 mile (Figure 34). However, the culvert at the West Kingston Road crossing restricts both saltwater exchange upstream of the culvert, and natural sediment transport to the outer estuary. This has resulted in a conversion of historic saltwater estuary habitat to low-gradient freshwater creek habitat. Kitsap County Roads is considering expansion of the road crossing, and the TAG recommends they replace the current culvert with a bridge of sufficient length to restore estuarine function upstream of the crossing.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Carpenter Creek:

- **Replace culvert at West Kingston Road crossing with a bridge of sufficient length to restore estuarine function upstream of the crossing**
- **Protect stable natural hydrology, including protecting the integrity of the very large beaver dam complex in the headwaters**
- **Restore floodplain function from Carpenter Lake upstream to SR 104**
- **Identify and correct causes of low dissolved oxygen, as identified in Bremerton-Kitsap Health District water quality sampling**
- **Evaluate habitat conditions upstream of the partial fish passage barrier at SR 104, and other upstream privately owned barrier culverts to Wyant Road; prioritize and correct as warranted**
- **Develop and implement a short-term LWD strategy until full riparian function is restored**
- **Restore riparian function throughout watershed**

There is an active watershed group in the Carpenter Creek drainage, named the Cutthroats of Carpenter. Carpenter Lake has been placed in County Trust status, and the upper part of the estuary is currently in the process of being put into public ownership. The headwaters of Carpenter Creek are in close proximity to the headwaters of Grovers Creek (15.0299), and land use protections in this area would benefit both watersheds.

Silver Creek 15.0310

General

This small (1.3 miles long) independent creek enters the Puget Sound shoreline approximately 0.5 mile north of Rolling Bay. The creek is known to support coho and cutthroat. Kitsap County replaced a prior fish passage barrier culvert at Hoffman Road (WDFW SSHEAR SITEID 15.0310 0.4) in approximately 1998. A channel regrade has occurred upstream, but the culvert is still considered passable. Riparian condition is indicated as fair; riparian buffers in the headwaters are generally <50 feet of second growth fir. There is a large beaver dam complex located on the north side of the stream.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Silver Creek:

- **Monitor fish passage status at Hoffman Road culvert; correct fish passage problems that develop**
- **Evaluate freshwater habitat conditions throughout watershed; correct identified salmonid habitat limiting factors**

Eglon Creek 15.0311 and Silver Creek 15.0312

General

This small independent watershed (~2.5 miles long) enters the western shore of Puget Sound just north of the Eglon Dock. The watershed supports coho and cutthroat. There is a public boat launch and associated parking that intrudes into the channel at the mouth of the creek. Eglon Creek is channelized through the agricultural area downstream of Eglon Road. In addition, the Eglon Road fill (RM 0.2) failed in ~1998, depositing approximately 500-600 yd^3 of roadfill intact into a downstream wetland. The deposition was left in the wetland because removal would have created greater habitat impact than leaving the material in place (Kalinowski). The creek flows through a series of beaver ponds and wetlands in the lower 0.75 mile, with gravel bed channels upstream. Riparian vegetation is indicated as good, consisting of mainly second growth fir.

The Bremerton-Kitsap Health District has been collecting water quality information at one location in Eglon Creek (their database lists the site as Silver Creek) since 1996. Identified water quality concerns include consistent observations of low dissolved oxygen levels (Mean=8.1 mg/l, Min.=3.2 mg/l), and periodic observations of water temperatures exceeding 15^oC and high fecal coliform levels (below pond north of boat ramp).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Eglon Creek and tributaries:

- **Restore natural channel configuration and function through the channelized agricultural area downstream of Eglon Road**

- **Assess potential of relocating/reconfiguring the boat launch and parking at the mouth of the creek, to restore channel function through this reach**
- **Identify and correct causes of low dissolved oxygen, as identified in Bremerton-Kitsap Health District water quality sampling**
- **Evaluate freshwater habitat conditions throughout watershed; correct identified salmonid habitat limiting factors**

Unnamed 15.0316

General

This small independent creek enters Puget Sound just south of Point No Point. Cutthroat were observed on the west fork approximately 0.25 miles upstream of Gusthalvor Rd., during a proposed culvert permit review (Kalinowski). Habitat conditions and fish distribution through the remainder of the watershed are unknown, although Kalinowski suspects there are likely several culvert fish passage barriers.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0316:

- **Evaluate freshwater habitat conditions throughout watershed; correct identified salmonid habitat limiting factors**

Unnamed 15.0318

General

This small independent creek enters Puget Sound approximately 1.5 miles west of Point No Point. Cutthroat have been observed north of Twin Spits Rd. and in Buck Lake (Kalinowski). It is unknown whether there are sufficient flows and suitable habitat for cutthroat or other salmonids between Twin Spits Rd. and Buck Lake. The culvert at the Twin Spits Rd. crossing is thought to be a fish passage barrier. Habitat conditions through the remainder of the watershed are unknown.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Unnamed 15.0318:

- **Evaluate fish passage status of culvert at Twin Spits Rd. crossing, and extent of suitable habitat upstream; correct problems as warranted**
- **Evaluate freshwater habitat conditions throughout watershed; correct identified salmonid habitat limiting factors**

Unnamed 15.0319A

General

This small independent creek (<1 mile long) enters Hidden Cove, which is approximately half way up the southern shore of Port Madison Bay near the north end of Bainbridge Island. Samples on one occasion found 27 juvenile coho and one sculpin upstream of Hidden Cove Road at the Hidden Cove Estates development site (PSCRBT 1995).

The mouth of the creek is located at the culvert under Hidden Cove Road. The culvert is undersized, has a 16-inch drop at the outlet, and a fairly steep gradient in the culvert. The culvert would be considered to be a barrier, if coho had not been detected upstream. The culvert is a partial passage barrier to coho and a complete barrier to other species, and should be evaluated further.

PSCRBT (1995) indicates the creek originates in wetlands, and flows through a wooded ravine with dense understory and mixed second-growth overstory. In addition, various small and intermittent drainages form side channels down the ravine slopes. Habitat conditions are identified as generally being good (Ash).

Figure 35: Altered estuarine/nearshore habitat in Hidden Cove, near the north end of Bainbridge Island (1992 photo courtesy of Dept. of Ecology)

Estuarine habitat condition in Hidden Cove is heavily impacted by bulkheads, fill of historic nearshore habitat, and presence of numerous overwater structures (Figure 35).

Action Recommendations

The following salmonid habitat restoration action is recommended for Unnamed 15.0319A:

- **Correct identified fish passage barrier at Hidden Cove Road**
- **Restore estuarine/nearshore habitat function, where feasible**

Dripping Water Creek 15.0320

General

This small (1.1 miles long) creek enters Puget Sound at the north end of Rolling Bay on the northeast shore of Bainbridge Island, draining part of the Sunrise watershed. The creek supports cutthroat in the lower reaches, and has potential salmonid habitat upstream. A natural appearing falls (fish passage barrier) exists 50-feet upstream from the marine shoreline (Ash); however, this falls may have been caused by channel and floodplain constrictions associated with road construction down the natural channel corridor. There is approximately 1.0-1.5 mile of potential anadromous salmonid habitat upstream of the falls.

Action Recommendations

The following salmonid habitat restoration actions are recommended for Dripping Water Creek:

- **Assess salmonid utilization upstream of the falls upstream of the mouth**
- **Assess habitat conditions upstream and downstream of the falls; correct identified salmonid habitat limiting factors**

Murden Cove Creek 15.0321, and Unnamed Tributaries 15.0322 and .0323

General

Murden Cove Creek and tributaries include approximately 3.7 miles of creek length, entering Murden Cove on the eastern shore of Bainbridge Island. The mainstem and tributaries contain some of the best fish habitat on Bainbridge Island, supporting chum, coho, and cutthroat (PSCRBT 1995).

From the mouth to SR 305, Murden Cove Creek flows through a deep, steep-walled ravine (PSCRBT 1995). The major impact to the ravine in this lower portion is runoff from the highway. From SR 305 to Wardell Avenue, the creek flows in a deep ravine parallel to Sportsmans Club Road. A large stormwater retention pond at the high school failed during construction in 1993, contributing large amounts of fine sediment to Murden Cove Creek. Sediment laden runoff from the play fields was also noted in 1994. Riparian condition is rated as poor downstream from the middle school site (Ash). The Castalia development has been constructed in the upper watershed since 1995; any effects on Murden Cove Creek are unknown.

Unnamed tributary 15.0322 joins Murden Cove Creek just upstream of SR 305. The tributary flows through wetlands, with much of the surrounding land in Park or Recreation District ownership, with a conservation easement held by the Bainbridge Island Land Trust (Ash). Unnamed tributary 15.0323 drains the western portion of the watershed, joining Murden Cove Creek south of Wardell Avenue. The headwaters of this tributary flow through wetlands, and the pastures of a horse stable operation.

The total natural flow of Murden Cove Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further consumptive water appropriation (WAC 173-515-040).

Estuarine habitat in Murden Cove is in very good shape with little development (Thiesfeld). Special care should be taken to protect this habitat to ensure continued habitat function over time.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Murden Cove Creek and tributaries:

- **Protect existing high-quality estuarine habitat**
- **Retrofit state-of-the-art stormwater quality and quantity best management practices to SR 305; ensure that stormwater from future development in the watershed is fully addressed at the time of construction**
- **Assess whether fine sediment delivery to the channel at the high school has been corrected since the last recorded observations in 1994; correct identified problems**
- **Assess potential water quality and sedimentation problems in the headwaters of Unnamed 15.0323, where the creek flows through pastures of a horse stable operation**
- **Restore functional riparian areas throughout watershed**

Ravine (Canyon, Winslow) Creek 15.0324

General

This independent creek is approximately 1.8 mile long, entering Eagle Harbor (west side of Bainbridge Island) near downtown Winslow. A citizens group has been active in pursuing restoration and enhancement of the stream. The creek originates near New Brooklyn Road, and flows south adjacent to SR 305, and supports chum, coho, and cutthroat. The lower 0.7 mile of Ravine Creek (from approximately 1200 feet downstream of High School Road to the mouth) are located in a steep, deep ravine. Although urban development encroaches to the edge of the ravine, the ravine is densely wooded and contains useable fish habitat (PSCRBT 1995). There has been some recent slide occurrence (Ash). There are two fish passage barriers in this reach; the first is a cascade at the outlet of an old dam site upstream of Winslow Way, the second is the culvert at the SR 305 crossing.

Habitat in the upstream portion of the creek has been altered. From the headwaters north of New Brooklyn Road, the creek flows into Sakai's pond, a wetland with excavated open water. Sakai's Pond overflows through a culvert into a channelized reach that is culverted under High School Road. Downstream of High School Road, the creek is culverted for approximately 1200 feet prior to entering the ravine. Stormwater runoff is identified as a problem in this creek (PSCRBT 1995).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Ravine Creek:

- **Prioritize and correct identified fish passage barriers at old dam site upstream of Winslow Way and at the SR 305 crossing**
- **Identify options to restore natural channel configuration and floodplain function upstream and downstream of High School Road; implement as practicable**
- **Retrofit state-of-the-art stormwater quality and quantity best management practices to existing development in the watershed; ensure that stormwater from future development is fully addressed at the time of construction**
- **Restore functional riparian areas throughout watershed**

Unnamed 15.0324A

General

This small (<1 mile long) independent creek enters Eagle Harbor (on the east side of Bainbridge Island) near the end of Winslow Way West. The creek supports coho, with presumed presence of cutthroat (Ash). No habitat information is available for this creek.

Action Recommendations

The following salmonid habitat restoration actions are recommended for Unnamed 15.0324A:

- **Assess salmonid habitat conditions; correct identified salmonid habitat limiting factors**

Sportsmen's Club Pond Creek 15.0325

General

This small independent creek (approximately 1 mile long) enters Eagle Harbor (on the east side of Bainbridge Island) on the north shore near Weaver Road NW. The stream originates near New Brooklyn Road, flowing through Sportsman Club pond. There is a dam located at the estuary that blocks anadromous fish access to the creek, with 1.0-1.5 mile of potential habitat upstream (Ash). The creek has the potential to support chum, coho, and cutthroat (Ash), but current salmonid utilization is unknown.

Action Recommendations

The following salmonid habitat restoration actions are recommended for Sportsmen's Club Pond Creek:

- **Correct identified fish passage barrier at the mouth of the creek**
- **Assess salmonid utilization and habitat conditions; correct identified salmonid habitat limiting factors**

Head of Bay Creek 15.0326

General

This small (1 mile long) creek enters the western end of Eagle Harbor, on the east side of Bainbridge Island. The creek is known to support chum, coho, and cutthroat (Ash). The creek originates north of High School Road, and flows west of Finch Road. A City of Bainbridge Island well is located next to the stream at RM 0.15, and the outfall from the well creates a fish passage barrier (PSCRBT 1995). The fish passage barrier at the City's well site prohibits access to most of the creek. The creek is also undercutting the upstream end of the culvert at the Eagle Harbor Drive crossing, next to auto repair shop (Ash).

There is some good riparian vegetation in the upper reaches of the creek. The lower reaches are in poor condition, due to riparian vegetation removal. LWD is generally lacking, and high presence of fine sediment is noted in the stream channel (Ash).

Action Recommendations

The following salmonid habitat restoration action is recommended for Head of Bay Creek:

- **Correct fish passage barrier at the outfall of the City of Bainbridge Island well**
- **Assess the condition and function of the culvert at the Eagle Harbor Drive crossing**
- **Restore functional riparian zones, particularly in the lower reaches of the watershed**

Blakely Falls Creek 15.0330X

General

This small (<1 mile long) steam enters approximately midway out the north shore of Blakely Harbor on the southeastern side of Bainbridge Island. The creek supports chum, coho, and cutthroat in the lower 350 feet of the creek. There is a natural waterfall just downstream of Halls Hill Road, which precludes upstream anadromous access (Ash).

Action Recommendations

The following salmonid habitat restoration action is recommended for Blakely Falls Creek:

- **Assess salmonid habitat conditions; correct identified salmonid habitat limiting factors**

Macs Dam Creek 15.0331

General

This small (0.8 mile long) creek flows from the north entering the western end of Blakely Harbor on the southeastern side of Bainbridge Island. PSCRBT (1995) indicates there is 1600 feet of usable cutthroat habitat upstream of Country Club Road; however, the TAG also indicates coho use in the lower portion of the creek. The culverts under Country Club Road and Blakely Avenue are both barriers to fish passage. In addition, a dam (Mac's Dam) in the headwaters is also a

barrier to fish passage. Habitat downstream of Country Club Road is generally poor, with shallow pools, silty gravel substrate, and partial canopy. Habitat upstream of Country Club Road is more diverse, comprised of deep pools with woody debris, clean gravel riffles, and dense riparian canopy.

Mac's Dam pond is approximately 3 acres with a maximum depth of 15 feet (PSCRBT 1995). Wetlands and a small unnamed creek supply water to the lake, while a small-diameter pipe outlet and leakage near the base of the dam maintain the water elevation. A dense second-growth forest and understory surround the lake, which contains largemouth bass.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Macs Dam Creek:

- **Prioritize and correct identified fish passage barriers at Country Club Road, Blakely Avenue (currently scheduled for replacement), and at Mac's Dam**
- **Restore riparian function downstream of Country Club Road**
- **Develop and implement a short-term LWD strategy downstream of Country Club Road, to provide LWD presence and habitat diversity until full riparian function is restored**
- **Restore functional riparian areas throughout watershed**

Unnamed 15.0332

General

This small (0.6 mile long) creek flows from the south entering the western end of Blakely Harbor on the southeastern end of Bainbridge Island. The creek supports coho in the very lower portion, with presumed cutthroat presence.

Action Recommendations

The following salmonid habitat restoration actions are recommended for Unnamed 15.0332:

- **Assess salmonid utilization and habitat conditions; correct identified salmonid habitat limiting factors**

Schel-chelb Creek 15.0028X and Unnamed Tributary

General

This small independent creek enters Rich Passage west of Lynnwood Center, on the south shore of Bainbridge Island. The creek has been re-routed to flow south from Bucklin Hill through a new, re-established wetlands, and enlarged saltmarsh and intertidal lagoon (the Schel-chelb Estuary Project), and Schel-chelb Creek supports coho and cutthroat and the tributary supports cutthroat.

Action Recommendations

The following salmonid habitat restoration actions are recommended for Schel-chelb Creek:

- **Assess salmonid utilization and habitat conditions; correct identified salmonid habitat limiting factors**

Fletcher (Springbrook) Creek 15.0340 and Unnamed 15.0341-0343

General

This creek is approximately 2.0 miles long, and is one of the larger streams on Bainbridge Island. It enters the eastern end of Fletcher Bay, flowing from the south along and under Fletcher Road. A 1982 study found juvenile coho, steelhead, and cutthroat downstream of Fletcher Bay Road, and coho and large numbers of cutthroat upstream of Fletcher Bay Road (Fiscus 1982, as cited in PSCRBT 1995). PSCRBT (1995) indicates the creek provides good fish habitat from the lower Fletcher Bay Road crossing to the mouth.

Fish Access

The culvert at the High School Road crossing, north of Fletcher Bay Road, may be a partial fish passage barrier due to being undersized and a drop at the outlet (Ash). The previous culvert fish passage barrier at the New Brooklyn Road crossing of Fletcher Creek (PSCRBT 1995) was repaired with installation of weirs and baffles in 1997 (Ash). The culvert under Battle Point Drive on Unnamed 15.0341 has a 1-2 foot drop at the outlet (PSCRBT 1995); this creek may be intermittent and it is unknown to what extent it would support salmonids. The culvert under Battle Point Drive on Unnamed 15.0343 (Issei Creek) has a 1-2 foot drop at the outlet (PSCRBT 1995); this creek is known to support coho and cutthroat (Ash). A temporary ladder/structure was installed as an Eagle Scout project, however the site is still a partial fish passage barrier. Double culverts at the Fletcher Bay Road crossing, upstream of the scout project, may also be partial barriers (Ash).

Channel Condition/Substrate

Gravel is present in the stream, although some sedimentation was observed (PSCRBT 1995). Several trails near the creek were noted as a probable source of sediment. A section of creek north of Fletcher Bay Road has been channelized into a wooden conveyance system, with associated fine sediment deposition (Ash).

Riparian Condition

A section of the creek from Fletcher Bay Road to High School Road has been channelized, with limited riparian vegetation adjacent to the creek. Fencing to exclude animal access and riparian restoration are needed in this reach. The creek is located in a wooded ravine downstream of the lower Fletcher Bay Road crossing (RM 1.1), which has a wide riparian buffer between the creek and homes.

Water Quality/Quantity

The total natural flow of Fletcher Creek and tributaries is required for protection and preservation of instream resources. These waters are closed year-round to further consumptive water appropriation (WAC 173-515-040).

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Fletcher Creek and tributaries:

- **Prioritize and correct identified fish passage barriers at High School Road (Fletcher Creek), at Battle Point Drive, and at Fletcher Bay Road (Unnamed 15.0341 and 15.0343)**
- **Restore natural channel configuration and floodplain function from Fletcher Bay Road to High School Road, and northeast of High School Road**
- **Restore riparian function from Fletcher Bay Road to High School Road, and fence to exclude livestock access to the creek**
- **Identify and correct sources of fine sedimentation to the creek (trails near the creek have been identified as probable sediment source)**

Mosquito Bay (Big Manzanita) Creek 15.0344 and Tributaries

General

Mosquito Bay Creek is approximately 1.5 mile long, entering Mosquito Bay and Manzanita Bay on the west side of Bainbridge Island. The creek supports coho salmon, with potential use by chum, and cutthroat (Ash). This creek has as much salmonid production potential as any on Bainbridge Island. One tributary is approximately one mile long, originating in the wetlands near Manzanita Park, north of Day Road. It flows through a pond and pasture land, through a well vegetated ravine, and then crosses under Bergman Road, joining the mainstem at the Petersen Hill culvert. This tributary supports coho and cutthroat.

The culvert under Miller Road is a partial barrier to anadromous salmonids. The length and slope present a velocity barrier to salmonids. This culvert prevents access to approximately 1.5 mile of habitat. The culvert at the Bergman Road crossing is a partial fish passage barrier. The culvert is undersized, causing high velocity flows and flooding, limiting salmonid access.

Previous identified concerns of unrestricted livestock access to the channel occurs just upstream of Miller Road (PSCRBT 1995) have been addressed by fencing and riparian planting (Ash). The creek has been channelized upstream through an unused pasture north of Lovgren Road. Wetlands adjacent to the creek have been graded and filled in the lower reach of the stream. Riparian condition is generally good except for pasture areas located outside the ravine. The tributary is generally well vegetated, except for the area around the pond and pasture area.

Action Recommendations

The following ranked salmonid habitat restoration actions are recommended for Mosquito Bay Creek and tributaries:

- **Prioritize and correct identified fish passage barriers at Miller Road and Bergman Road**
- **Restore natural channel configuration and floodplain function through pasture area north of Lovgren Road**
- **Restore riparian function in pasture areas located outside the ravine**

MARINE/NEARSHORE HABITAT LIMITING FACTORS

Marine intertidal, nearshore, and sub-tidal areas provide critical habitat for salmonids, particularly for juvenile salmonid smolts as they migrate from freshwater to marine environments. Shallow nearshore areas are known to provide rearing habitat and shallow-water migration corridors that offer protection from predators. Subtidal areas also provide rearing support for salmonids, including production of benthic prey items. Marine intertidal, near-shore, and subtidal habitats have been significantly altered throughout East WRIA 15.

The marine nearshore area of East WRIA 15 includes the Puget Sound shorelines of Case (east shore) and Carr Inlets, several South Puget Sound Islands, Tacoma Narrows, Colvos Passage, Sinclair Inlet, Washington Narrows, Dyes Inlet, Liberty Bay, Port Madison, Bainbridge Island, and the east side of Foulweather Bluff. Combined, there are 320 miles of marine shoreline in East WRIA 15 (excluding Vashon Island), which support local salmonid stocks, as well as stocks originating from other Puget Sound WRIAs. East WRIA 15 is second of the Puget Sound WRIAs in total length of marine shoreline length, only slightly less than the shoreline length of WRIA 2 (San Juan Islands). The majority of the East WRIA 15 marine shoreline is relatively protected from severe weather conditions, although the east side of Bainbridge Island, Port Madison, and east shoreline of Foulweather Bluff are exposed to high wind and wave energy.

Key habitat impacts that limit nearshore/marine productivity in East WRIA 15 include: shoreline armoring/bulkheading and nearshore fill, effects of overwater structures, dredging and conversion of intertidal/shallow subtidal to deepwater habitat, alteration/loss of aquatic plant communities, loss/lack of functional shoreline riparian vegetation, water quality and nearshore/marine sediment contamination (particularly associated with current and previous Navy installations), and presence of numerous salmonid netpens which affect substrate quality (and potentially water quality). A short discussion of each of these impacts/concerns is provided below, followed by a shoreline reach description of identified impacts.

Documented Use of Near-Shore Marine Areas by Juvenile Salmonids and Baitfish

Juvenile salmonid and baitfish use of nearshore and subtidal marine habitats of East WRIA 15 is presumed to be ubiquitous, although there are few documented observations. Monthly beach seine sampling at three sites (Battle Pt. and Pt. Monroe on Bainbridge Island in central Puget Sound, and Anderson Island in southern Puget Sound) (Fresh et al. 1981) encountered seasonal presence of all five species of Pacific salmon, steelhead and cutthroat (Kurt Fresh, personal communication). In addition, large catches of herring were also encountered in the beach seine hauls. Stomach analysis indicated that calanoid copepods, euphausiids, brachyuran crab larvae, insects, larvacea, and gammerid and hyperiid amphipods were the primary food items of juvenile salmon and baitfish occupying shallow sublittoral and nearshore pelagic habitats <20m in depth (Fresh et al. 1981).

A study conducted by Department of Fisheries in 1979 (Haring 1980), to compare the effectiveness of avoiding capture of juvenile salmonids in a standard purse seine vs. one in which a 5-inch mesh panel was placed, was conducted at Apple Cove Pt. This site was selected due to consistent high encounter rates of juvenile chinook and coho in the purse seine commercial salmon fishery (September through November).

From 1979 to 1985, Washington Department of Fisheries conducted baitfish recruitment studies throughout Puget Sound, including a minimum of 40 sites throughout the nearshore area of East WRIA 15 (Dan Pentilla, personal communication). Nearshore fish samples were collected at night (generally during new moon conditions) from June through December using a tow net, towed as close to shore as practicable. Although the salmonid encounter data has not been analyzed, Dan Pentilla recalls that salmonid presence was generally as ubiquitous as herring presence, with presence in approximately two-thirds of the tows. Density varied between sites and between years, with greater density of young-of-the-year juveniles in June and gradually declining through September.

Numerous marine and nearshore locations throughout East WRIA 15 are known for salmon and cutthroat sport fishing, often with juvenile coho and chinook encountered while fishing (juveniles of other salmon species are not normally encountered by sport fisheries). Salmonid presence appears to be ubiquitous in the marine nearshore, with only the density of salmonid presence varying between specific locations. Baitfish are also known to be present even along the highly altered shorelines. Documented surf smelt, sand lance, and Pacific herring spawning areas in East WRIA 15 are identified on the Baitfish Maps located in the separate Maps file included with this report (maps provided by the Washington Department of Fish and Wildlife).

Shoreline Armoring

Nearshore areas provide support for salmonids in a number of ways:

- migration corridors for juvenile salmon and protection from predators,
- suitable substrate and detritus retention to produce the benthic food organisms on which many juvenile salmonids are dependent, and
- primary production areas for baitfish species (surf smelt, sand lance, and Pacific herring), which support salmonids at all life stages (Fresh et al. 1981). These areas are particularly important for chinook and chum, which have the greatest dependence of the salmon species on estuarine and near-shore habitats (Aitkin 1998).

The identified effects of shoreline armoring on finfish resources have not been specifically assessed, nevertheless, all indications are that shoreline armoring adversely effects ecosystem function and the fish resources that use these habitats. Schreffler et al. (1995) identified several case studies related to the physical effects for shoreline armoring, and identified the potential and observed effects of shoreline armoring. The following impacts have been identified as typically being associated with armoring of shorelines with bulkheads (Canning and Shipman 1995, Schreffler et al. 1995):

1. sediment supply to beaches is cut off, leading to starvation of the beaches of the sand and other fine-grained materials that typically make up a beach,
2. the hard face of the shoreline armoring, particularly concrete bulkheads, reflects energy back onto the beach, thus exacerbating beach erosion,
3. over time, sand and gravel beaches are transformed to large gravel and cobbles, possibly to bedrock or hard clay, exposing the footings of bulkheads and leading to undermining and failure,
4. embedded logs and vegetation which shades the upper beach are eliminated, thus degrading the value of the beach for baitfish spawning habitat,
5. transformation of the character of the beach affects the kinds of life the beach can support, and

6. the degradation of the beach results in loss of the shallow, nearshore migration corridors for salmonids that provide protection from predation.

Some of the observations in Schreffler et al. (1995) are the result of an interview with D. Pentilla (WDFW), who has extensive experience evaluating shorelines for baitfish spawning potential. He reported the following observed effects of shoreline armoring:

1. reduced sediment input from feeder bluffs to nearshore area,
2. permanent loss of habitat above +5 feet Mean Low-Low Water (MLLW) (Note: This represents the suitable habitat area for surf smelt and sand lance spawning),
3. loss of riparian vegetation that provides shade to the upper beach (Note: shade minimizes desiccation of baitfish eggs that are laid in high intertidal gravels and sands), and
4. change in substrate from finer to coarser-grained material

Juvenile salmonids are known to actively use the shallow nearshore for rearing habitat and predator avoidance. Shoreline armor/bulkhead encroachment into the natural intertidal area changes the natural shallow nearshore habitat to deeper water habitat, with the severity of impact dependent on the extent of encroachment. This not only affects the productivity of prey on which salmonids feed, but also increases susceptibility of juvenile salmonids to predation in the deeper water habitats.

Baitfish, upon which chinook and coho salmon prey, are particularly susceptible to impacts of shoreline armoring. Because surf smelt spawn high in the intertidal zone (from +7 ft mean low-low water (MLLW) to extreme high-high water (EHHW) in fine grained substrate, they are particularly susceptible to permanent habitat loss. Sand lance form localized schools that are usually associated with clean sandy bottoms. They are susceptible to deleterious effects of shoreline armoring because of preference for spawning high in intertidal (+5 feet MLLW to mean high-high water (MHHW)), in substrates varying from sand to sandy gravel (Canning and Shipman 1995). Surf smelt/sandlance spawning was documented on the Sinclair Inlet shoreline north of Gorst Creek in work done in 1936, but this spawning area has been totally lost due to the railroad fill, which has eliminated the natural intertidal shoreline (Dan Pentilla, personal communication). Similar spawning losses have occurred elsewhere where shoreline armoring has extended into the intertidal area enough to eliminate the mid- and upper-portions of the natural intertidal zone.

As noted above, shoreline armoring is known to affect littoral drift. The increased energy from wave reflection off the vertical face of bulkheads results in degradation of the beach materials, and loss of ability of the beach to retain detritus. One of the major biological effects that results from disrupting littoral drift is the loss or reduction of nutrients and food sources needed to sustain juvenile salmonids. Because juvenile salmonids are actively feeding during their outmigration, they need prey of appropriate quantities at the right time. Thus, growth rates of juvenile salmonids may be negatively impacted if their natural food supply is reduced or cut off due to shoreline armoring, adversely affecting their survival (Canning and Shipman 1995). Marine shorelines in East WRIA 15 are extensively armored/bulkheaded. The Kitsap County shoreline in East WRIA 15 is estimated to be approximately 80% developed: most developed parcels include a shoreline bulkhead (Folkerts). Most residential bulkheads extend a minimum of six feet into the natural intertidal area, with many extending far enough into the previous intertidal area to create building sites for homes or flat recreation pads at the base of steep bank

shorelines. In addition, the recruitment of sediment from the bluffs to feed natural shoreline processes has been eliminated.

Dredging and Conversion of Nearshore Habitat to Deepwater Habitat

Dredging has similar habitat effects as shoreline armoring, converting intertidal and shallow subtidal habitat to deepwater habitat. This alteration to deepwater habitat changes to contiguity of the shallow nearshore migration and rearing corridor. The effects of dredging can be further exacerbated by other structures associated with the dredging. Marine dredging in East WRIA 15 is associated mainly with navigation and boat moorage facilities. Three examples of different scales of marine dredging effects to habitat are dredging to maintain boat access to private docks in Miller Bay, commercial marina construction (various sites), and the Puget Sound Naval Shipyard (PSNS).

All of Miller Bay was a highly productive intertidal estuary. A sub-tidal channel was dredged in Miller Bay on the north side of Miller Spit to facilitate private boat moorage for single-family homes that were constructed on the spit. The historic intertidal area, that drained gradually as the tide receded, now acts as a collection basin for juvenile salmonids as well as predators during low tides. The normal nearshore rearing habitat and migration corridor functions for juvenile salmonids has been altered at this site, likely increasing their susceptibility to predation and mortality. In addition, impacts have been further exacerbated by the presence of a number of overwater docks and floats that may also impair normal nearshore migration for juvenile salmonids.

Marinas with boat moorage facilities are present throughout East WRIA 15; there are 17 marines in the Kitsap County portion of East WRIA 15, and 11 in the Pierce County portion (Goodwin and Farrell 1991). Most marinas involve at least some dredging of intertidal and shallow subtidal habitat to provide sufficient depth for navigation and boat moorage, without grounding of the boats at low tidal levels. This dredging creates a break in the naturally contiguous nearshore migration and rearing corridor utilized by juvenile salmonids, and is likely a direct loss of potential baitfish spawning habitat. In addition to the direct effects of dredging, there are several associated indirect effects to salmonid habitat associated with marinas. Many marinas have breakwater structures (treated-wood or rock) that extend from the upper intertidal well out into the subtidal area , that divert juvenile salmonids and baitfish out of the nearshore migration corridor into deeper waters where they are at increased risk of predation, and which interrupt littoral sediment transport. Marina dredging directly alters the natural substrate composition, likely reducing benthic productivity and the potential for growth of aquatic macroalgae. In addition, overwater shading of moored boats, boathouses, and docks and piers can also affect the benthic productivity, and may also affect nearshore migration behavior of juvenile salmonids. Marinas are also known to have increased incidence of water quality problems, including fuel spills, increased nutrients from lack of sewers, increased presence of toxics due to hull scraping and use of anti-fouling paint on boat hulls, and high concentrations of creosote-treated wood pilings and structures.

The habitat impacts at the PSNS (Figure 24, page 160) are not just the result of dredging, but rather the result of wholesale alteration of the natural shoreline configuration, of which dredging is just one of the associated impacts. The TAG indicates that extensive fill of the historic natural intertidal and shallow-subtidal occurred, on which the PSNS was built. In addition, numerous large piers were constructed and the subtidal area dredged to sufficient depth to provide access

and mooring for large Navy vessels. The combination of fill, dredging, and extensive overwater shading associated with piers and moored vessels has not only severely impacted salmonid use within the boundaries of the PSNS, but likely affects stocks from a broad geographic area that would normally use this shoreline as a migration/rearing pathway.

Alteration of Intertidal/Shallow Subtidal Vegetated Habitat

Intertidal and aquatic vegetated habitat is impacted by a variety of activities in East WRIA 15. Fill of upper intertidal (shoreline armoring/bulkheading or to facilitate development) often results in direct elimination of saltmarsh habitat. There are also several situations where alteration of natural sediment transport processes from estuaries (e.g., Carpenter Creek, Clear Creek) has resulted in sedimentation in the estuary, with associated loss of saltmarsh habitat.

A key nearshore habitat concern is the loss of eelgrass (*Zostera marina*) habitat in the intertidal/shallow subtidal area. Eelgrass provides valuable habitat for a variety of marine species, including very productive rearing habitat for rearing juvenile salmonids, and spawning habitat for herring. These habitats are directly impacted by physical alterations, such as nearshore fill or dredging. In addition they are adversely affected by overwater shading from piers, docks, floats, marinas, netpens, moored vessels and log rafts, boathouses, etc. The 28 commercial marinas in East WRIA 15 alone have >20,000 lineal feet of moorage dock (Goodwin and Farrell 1991), in addition to associated access ramps and moored boats, that result in overwater shading, potentially impairing growth of aquatic vegetation. The loss of natural shoreline sediment processes due to shoreline armoring, has likely resulted in a loss of potential eelgrass habitat. Remaining eelgrass meadows also appear to be at risk of eutrophication and elimination due to the increasing presence of ulvoid mats (*Ulva spp*.).

Ulva (spp) are an opportunistic green macroalgae that form dense mats which reduce light and oxygen, creating an anoxic environment (Hull 1987, Hernandez et al. 1997, as referenced in Shaffer and Burge 1999). Ulvoid blooms, promoted by nutrient loading, appear to have a negative impact on nearshore invertebrate and fish communities, as well a other vegetated habitats such as eelgrass beds (Blankenship 1993; Carpenter et al. 1998; Hagerman et al. 1996; Inkpen and Embry 1998; Isaksson et al. 1994; Macfarlane 1988; Short et al. 1995; Sogard and Able 1991; Vitousek et al. 1997; Wilson 1995; Wright 1989; as referenced in Shaffer and Burge 1999). Ulvoid mats may affect habitat conditions by changing the physical hydrography of the intertidal area. Physical changes may include a decrease in water flow, increased sedimentation, and a decrease in tidal flushing. Ulvoid mats may also prevent access to benthic prey organisms by creating a barrier over the substrate, and may result in mortality of benthic organisms and shellfish by smothering and creating low oxygen/anoxic conditions (Shaffer and Burge, in press).

TAG participants indicate there is increasing evidence of alteration/loss of eelgrass and aquatic macroalgae beds in the vicinity of stormwater outfalls. The mechanisms for these alterations are not well understood, but are likely related to both water quality impacts (increased nutrients, chlorination) as well as reduced salinity near the stormwater outfalls.

Loss/Lack of Shoreline Riparian Vegetation

There has been a significant loss of riparian function along the East WRIA 15 marine shoreline, associated with development (roads, railroads, residential and commercial construction). Marine shoreline riparian vegetation provides similar functions to those in the freshwater environment:

bank stability, shade, detrital/nutrient input, and contribution of large woody debris (LWD) to the marine shoreline. The importance of functional marine shoreline riparian zones has received less attention, and perhaps is less understood, than their freshwater counterpart. This is likely due, at least in part, to the limited exposure of shoreline riparian vegetation to marine waters only at higher tidal elevations. Shoreline riparian vegetation and LWD are important at all sites because of their role in providing shoreline stability and providing detrital/nutrient input that supports the nearshore food web. Shoreline riparian vegetation is particularly important on shorelines known to support surf smelt and sandlance spawning, where overhanging riparian vegetation shading the upper beach reduces desiccation of eggs that have been spawned at upper tidal elevations (Pentilla, 2000). It is important to note that in addition to retaining riparian buffers along the upper tidal elevation, it is also important to retain riparian buffers on feeder banks and at the top of feeder bluffs, as they provide the sources of LWD recruitment to the beaches below.

Marine Sediment/Water Quality

There are a number of marine water quality problems present in East WRIA 15. The soils on many of the upland areas in East WRIA 15 are not suitable for septics, yet much of the suburban/rural development utilize septic systems to treat wastewater. This, in conjunction with other fecal coliform sources, contributes to many of the streams in East WRIA 15 being listed on the Clean Water Act 303(d) list for fecal coliform contamination. Several marine areas near the mouths of these streams are also on the 303(d) list for fecal coliform contamination, including Carr Inlet, Case Inlet, Dyes Inlet and Port Washington Narrows, and Henderson Bay (north end of Carr Inlet). Sources of fecal coliform contamination should be identified prior to implementation of a comprehensive correction strategy.

There are salmonid netpen facilities at several locations in East WRIA 15. Commercial netpen installations are located at Manchester and at the southern end of Bainbridge Island, just west of Beans Pt. Large coho enhancement netpens are located in Agate Pass and in Hale Pass. Several additional small cooperative enhancement netpen facilities are located throughout the remainder of East WRIA 15. Netpen installations are known to affect sediment quality due to shading, and due to accumulation of excess food and fish feces that accumulate on the bottom in the vicinity of the netpen. Accumulation of excess food and feces on the substrate can result in large bacterial mats that cause surface sediments to go anoxic. There may also be effects to water quality in the vicinity of netpens.

There are also several water quality or sediment quality problems associated with current and previous Navy facilities. The TAG participants indicated that old munitions and debris disposal have resulted in sediment contamination at the Navy facilities at PSNS, Keyport, Manchester, and Jackson Park. In addition, Dyes Inlet/Port Washington Narrows, Port Orchard/Agate Passage/Rich Passage, and Sinclair Inlet are on the 303(d) list for exceedance of a broad variety of water quality parameters (Table 20), many of which are likely related to vessel maintenance and other activities at Navy facilities.

Water and sediment quality problems in Eagle Harbor are primarily related to past operations of the Wyckoff creosote wood-treating facility. The site is designated as a Superfund site and is currently undergoing cleanup activities.

Table 20: Clean Water Act Section 303(d) Water Quality Listings for Marine Waters in East WRIA 15 (from Dept. of Ecology 303(d) list)	
Marine Water	**CWA Section 303(d) Listing**
Dyes Inlet/Port Washington Narrows	3,3-Dichlorobenzidene, Antimony, Arsenic, Benz(a)anthracene, Benzo(b)fluoranthene, Bis(2-ethylhexyl) Phthalate, Cadmium, Chrysene, Mercury, Pentachlorophenol, Phenol, Silver, Sediment Bioassay, and Fecal Coliform
Port Orchard/Agate Passage/Rich Passage	Arsenic
Sinclair Inlet	1,4-Dichlorobenzene, 2,4-Dimethylphenol, 4-Methylphenol, Aldrin, Arsenic, Benz(a)anthracene, Benzo(ghi)perylene, Benzoic Acid, Bis(2-ethylhexyl) phthalate, Butylbenzyl phthalate, Cadmium, Chrysene, Copper, Dieldrin, Fecal Coliform, Fluoranthene, Indeno(1,2,3-cd)pyrene, Lead, Mercury, PCB-1254, PCB-1260, Phenanthrene, Phenol, Sediment Bioassay, and Zinc
Henderson Bay	Dissolved Oxygen and Fecal Coliform
Tacoma Narrows	Dieldrin
Carr Inlet	Dissolved Oxygen and Fecal Coliform
Case Inlet/Dana Passage	pH and fecal coliform
Eagle Harbor	Arsenic, Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene Chrysene, Dibenzo(a)anthracene, Indeno(1,2,3-cd)pyrene, Mercury, PAHs, and PCB-1254

Oil and Toxic Spills

The marine shorelines and resources of East WRIA 15 are at risk of significant adverse impacts from oil spills and other toxic spills in the marine environment. There are numerous marinas and docking facilities located in the various inlets and harbors of East WRIA 15. In addition, transport, storage, and transfer of large volumes of fuel occur at the PSNS and at the Navy Fuel Depot at Manchester. All of these pose a significant risk of chronic (small volume) or catastrophic toxic spills. Catastrophic spills have the potential to eradicate the productivity of the marine environment for extended periods of time. This risk factor does not lend itself well to restoration activities; the only viable mechanism to address this concern is diligent prevention.

General Marine Nearshore/Marine Action Recommendations

There are a number of habitat action recommendations that are generally applicable to all marine/nearshore areas. The relative ranking of these action recommendations is generally similar between shoreline reaches, but may vary dependent on current shoreline habitat conditions in each shoreline reach. To avoid duplication, these general marine/nearshore action recommendations are listed below; however, they should be considered in conjunction with reach specific action recommendations identified in following sections of this chapter.

General Action Recommendations for Marine Nearshore Areas

The following ranked salmonid habitat restoration actions are recommended for nearshore/marine habitats:

- **Protect existing functional nearshore habitat, and restore impaired nearshore function where possible**
- **Protect integrity of existing shoreline riparian vegetation, including forested vegetation at the top of steep feeder bluffs; restore shoreline riparian function where possible**
- **Minimize additional shoreline armoring, use soft-bank techniques where armoring is necessary; remove/pull back existing shoreline armoring where feasible**
- **Maintain/restore shoreline sediment contribution from feeder bluffs; prevent further development (homes, roads) on shorelines below feeder bluffs, and restore/supplement impaired feeder bluff contribution where possible**
- **Conduct comprehensive assessment of nearshore habitat conditions, including characterization of shoreline geology, substrate composition, riparian condition, and habitat utilization by salmonids, baitfish, shellfish, and other intertidal dependent species**
- **Remove creosote-treated pilings, where possible; use concrete or steel pilings for new construction and repair of existing structures**
- **Avoid/remediate stormwater impacts to nearshore habitat, including stormwater effects that increase the rate of shoreline bank erosion**

Habitat Factors Limiting Nearshore/Marine Salmonid Productivity

Following are reach specific descriptions of nearshore/marine habitat concerns for East WRIA 15, progressing from the south Puget Sound islands, then from the upper end of Case Inlet following the shoreline to the north to the tip of Foulweather Bluff, and then along the Bainbridge Island shoreline (similar pattern to the WRIA stream number sequencing in Williams et al. (1975). Reaches were designated on the basis of generally common nearshore/marine features and conditions, and are the result of collaborative discussions of the TAG. Reach specific habitat action recommendations are identified, where applicable. The general marine/nearshore habitat action recommendations are applicable to all identified shoreline reaches. Included with some of the shoreline descriptions are selected shoreline photos, most of which are from approximately 1992, and which are taken from the Dept. of Ecology Shorephoto website (photo sources identified). Early 1990s shoreline photos are available for the entire East WRIA 15 marine shoreline at the Department of Ecology Shorephoto website. The Dept. of Natural Resources has recently taken aerial oblique photographs of the entire Washington marine shoreline, and is currently analyzing the photos. Although the results of this effort are not yet available for reference, a report is anticipated in late 2000.

Marine shorelines are heavily armored in both Pierce and Kitsap counties. However, there are larger expanses of unarmored shoreline in the Pierce County portion of East WRIA 15, and greater opportunities to protect existing functional nearshore habitat than in many areas of Kitsap County. In addition, marine nearshore habitat in south Puget Sound does not currently have the densities of commercial land-use, marinas, or water/sediment quality problems that impair many of the nearshore areas in Kitsap County.

South Puget Sound Islands

Fox Island

- The southeast shore is high steep bank with frequent slide occurrence, likely exacerbated by development on the top of the feeder bluff; good sediment recruitment to the shore, but lack of associated LWD due to development on the top of the bluff
- North shore heavily developed; moderate bulkheading, even though the shore is not subject to major storm impacts
- Sandlance spawning is documented at a couple of locations on the northeast shoreline; herring spawning is documented in Hale Passage and off the southwest shore (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)
- Fox Island netpens located in Hale Passage on the northwest side of Fox Island (no information identified regarding potential habitat impacts)

McNeil Island

- Marine shorelines on the island range from low bank to high feeder bluffs
- Island is site of State Penitentiary; relatively little development other than the penitentiary facility
- Southeastern shoreline is heavily armored in the area of the penitentiary facility; absence of armoring or light armoring along remaining shorelines
- A security road is located around the entire island near the marine shoreline, but effects to nearshore habitat are unknown
- Herring spawning is documented north of McNeil Island (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Anderson Island

- Marine shorelines on the island range from low bank to high feeder bluffs
- Portions of the nearshore are relatively undeveloped; some of the bays and shoreline near the ferry terminal have light to moderate armoring
- Good estuarine habitat within Oro Bay
- Surf smelt and sandlance spawning is documented at several locations on the island; herring spawning is documented to the west of the island (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Heron Island

- Moderate shoreline development and armoring, except for southern end , which has a high feeder bluff that feeds a spit on the southwestern side of the island
- Riparian cover generally poor in areas with shoreline development and armoring
- Shorelines previously sampled for baitfish spawning, but not baitfish spawning habitat documented

Ketron Island

- Light shoreline development and armoring
- Shoreline mainly steep banks and feeder bluffs
- Shoreline riparian condition is good to excellent
- The eastern shoreline was sampled for baitfish spawning in the spring of 2000, but no baitfish spawning was documented

Action Recommendations for South Puget Sound Islands Nearshore/Marine Habitat

The following specific ranked salmonid habitat restoration actions are recommended for nearshore/marine habitats in south Puget Sound islands, these should be considered in conjunction with the general habitat action recommendations listed earlier in this chapter:

- **Conduct comprehensive assessment of nearshore habitat conditions on south Puget Sound islands, including characterization of shoreline geology, substrate composition, riparian condition, and habitat utilization by salmonids, baitfish, shellfish, and other intertidal dependent species**
- **Identify and correct sources of fecal coliform contamination**

Case Inlet

Mouth of Spring Creek to Rocky Pt.

- Intertidal area is sandy to the north and more gravelly to the south
- Roadway located right on the beach north of Rocky Pt.; there has been repeated replacement of the roadway as it continues to sink
- Lack of shoreline riparian vegetation due to numerous houses and the roadway
- Shoreline armoring is limited on the northern end, even with large number of houses on the shoreline
- Surf smelt spawning documented for much of this shoreline (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Rocky Pt. to Windy Pt. (at north end of Vaughn Bay)

- Shellfish harvest is prohibited in inner Rocky Bay due to fecal coliform contamination
- Shoreline armoring is light in inner Rocky Bay, and heavy in outer in the outer bay
- Shoreline riparian condition is good in inner Rocky Bay, poor in the outer bay
- There is significant contribution of stormwater from bluffs adjacent to Rocky Bay, as well as from Rocky Creek
- Surf smelt spawning documented at several locations (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Vaughn Bay

- There is a high quality natural sand spit at the mouth of Vaughn Bay
- The north and south shores of Vaughn Bay have a moderate amount of shoreline armoring
- Surf smelt spawning documented on Vaughn Spit (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Vaughn Bay to Herron Creek

- Mostly high, steep bank shoreline with numerous homes on the bluff
- Shoreline riparian condition at the top of the bluff is generally intact, except where homes encroach on the edge of the bluff
- Shellfish harvest is currently restricted in Dutcher Cove, but is threatened to move to prohibited based on recent coliform counts
- Shoreline armoring just south of Vaughn Bay extends substantially into the historic intertidal area
- Surf smelt spawning documented at several locations (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Herron Creek to Taylor Bay (including Herron Island)

- Shoreline typified by steep banks and feeder bluffs
- Shoreline is relatively undeveloped, with light armoring
- Shoreline riparian condition is good
- Surf smelt and sandlance spawning documented at several locations (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Taylor Bay to Small Spit Northeast of Devils Head

- Steep high-bank natural wooded shoreline
- Bluff slopes are generally stable; recent upland development may lead to increased stormwater runoff and increased demands for future shoreline armoring
- Surf smelt and sandlance spawning documented at several locations (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Action Recommendations for Case Inlet Nearshore/Marine Habitat

The following ranked salmonid habitat restoration actions are recommended for nearshore/marine habitats in Case Inlet, these should be considered in conjunction with the general habitat action recommendations listed earlier in this chapter:

- **Conduct comprehensive assessment of nearshore habitat conditions, including characterization of shoreline geology, substrate composition, riparian condition, and habitat utilization by salmonids, baitfish, shellfish, and other intertidal dependent species**
- **Identify and correct sources of fecal coliform contamination**

Carr Inlet/Hale Passage

Small Spit Northeast of Devils Head to South end of Filucy Bay

- Medium bank shoreline with significant development along the water
- Shoreline is heavily armored
- Shoreline riparian vegetation generally absent, but some limited areas of riparian vegetation remaining
- Surf smelt and sandlance spawning documented at several locations (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Filucy Bay to Hogan Pt.

- Shoreline is heavy developed, with heavy shoreline armoring, and light to moderate presence of overwater structures and creosote-treated wood
- Nearshore within Filucy Bay is generally a low-energy area
- Shoreline riparian vegetation generally absent through the heavily developed area, except northern end of Filucy Bay still has some naturally wooded shoreline
- Filucy Bay is threatened for closure of shellfish harvest, due to recent high coliform counts
- Surf smelt, sandlance, and rock sole spawning documented at several locations (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Hogan Pt. to South Head

- Medium bank to high bluff shoreline with moderate development
- Moderate shoreline armoring

- Shoreline riparian status is fair
- Limited surf smelt, sandlance, and rock sole spawning documented; herring spawning documented in Carr Inlet (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

South Head to Penrose Pt. State Park

- Habitat within Penrose Pt. State Park is generally natural and in good condition; there are trails in the park, but they don't significantly affect shoreline habitat integrity
- TAG participants were not familiar enough with shoreline south of Penrose Pt. to characterize habitat conditions
- Herring spawning documented in Carr Inlet (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Figure 36: Marine shoreline development and habitat modifications in Carr Inlet at the unincorporated settlement of Home (1992 photo courtesy of Dept. of Ecology)

Penrose Pt. State Park to Glen Cove

- Shoreline is heavily developed, both within Mayo and Van Geldern Coves, as well as the shoreline from Van Geldern Cove to Glen Cove; road located immediately adjacent to the marine shoreline through unincorporated settlement of Home (Figure 36)
- Sediment recruitment from the shoreline bluffs north of Van Geldern Cove has been interrupted by heavy shoreline armoring; many bulkheads at the base of steep bluffs extend well into the historic intertidal area
- There are transitory boat ramps in Van Geldern and Mayo Coves, with associated docks; also a number of moored vessels located in both coves
- Surf smelt and sandlance spawning documented at several locations; herring spawning documented in Carr Inlet (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Glen Cove to Minter Bay

- Very steep natural shoreline with little armoring
- Several old wooden Naval ships were brought from Bremerton, beached on Minter Spit, and burned (Huberd)
- Sandlance spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Minter Bay to Wauna

- Extremely steep bluff shoreline
- Little shoreline armoring except heavy armoring for approximately 1 mile near Wauna
- Good riparian condition at the top of the steep bluffs

Wauna Spit

- SR 302 constructed on fill placed on Wauna Spit, although fill appears to have been placed mostly above the high tide line, except near bridge
- Natural substrate appears to be generally intact on the spit
- No shoreline riparian vegetation present, although it is unknown whether there historically was any on the spit

Burley Lagoon

- Habitat condition in northern half of Burley Lagoon is excellent, with little shoreline armoring and natural shoreline characteristics
- Approximately 50% of the shoreline on the southern half of Burley Lagoon is armored, even though Burley Lagoon is generally low energy
- Shoreline riparian condition in the southern half of Burley Lagoon is poor-moderate
- Burley Lagoon is designated as Class AA marine waters. Harvest from Burley Lagoon shellfish beds was downgraded from approved to restricted in 1981, due to fecal contamination concerns (Dickes and Patterson 1994). The shellfish beds were subsequently upgraded to conditionally approved in 1993. In 1999, Burley Lagoon was again downgraded to prohibited because of elevated fecal coliform levels (KGI DRAFT 1999). Freshwater tributaries were considered to be the primary source of fecal coliform entering the estuaries, primarily from failing septics, livestock access from small farms, and stormwater runoff (Determan 1993, as cited in Dickes and Patterson 1994).

SR 302 to McCormick Creek

- This is steep bank feeder bluff shoreline with heavy development on the top of the bluff
- Old extension of McCormick Rd. is located right on the beach; the road is closed, is no longer useable, and is actively breaking up as a result of tide and wave action

McCormick Creek to Allen Pt.

- Medium bank shoreline with almost continuous shoreline armoring except in small inner bays
- General lack of shoreline riparian vegetation
- Surf smelt spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Allen Pt. to Kopachuck State Park

- The shoreline is heavily developed and armored
- General lack of shoreline riparian vegetation

Kopachuck State Park

- Generally good nearshore habitat, with intact intertidal habitat
- Some shoreline armoring at north end of park, but intertidal still in good condition

Horsehead Bay

- Shoreline is heavily developed and armored
- Presence of numerous piers and floats, and anchoring of numerous vessels
- Shoreline riparian vegetation is generally absent
- Heavy boat traffic in and out of the bay; gas sheens have been observed in the bay on several occasions (Iverson)

- Surf smelt and sandlance spawning documented; herring spawning documented in Carr Inlet (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Green Point

- Very steep bank natural shoreline with excellent habitat conditions
- Herring spawning documented in Carr Inlet (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Hale Passage

- Shoreline is heavily developed throughout Hale Passage
- The shoreline is almost entirely armored, except for a few short stretches; bulkheads extend well into historic intertidal is several locations
- Shoreline riparian vegetation is generally absent
- Large coho enhancement netpen facility located near Fox Island Bridge
- Sandlance spawning documented; herring spawning documented in Hale Passage (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Cromwell

- Shoreline heavily armored, with bulkheads extending well into historic intertidal area
- Cromwell Drive is located on fill in the historic intertidal area and runs right along the beach for 1.5 miles; the roadway is closed to through traffic due to recurrent slides, but provides continued driveway access from both ends
- Nearshore herring spawning was documented in spring 2000 (Molenaar, not included on East 15 Documented Baitfish files in the separate Maps file included with this report)

Wollochet Bay

Figure 37: Development impacts to nearshore habitat in Wollochet Bay (1992 photo courtesy of Dept. of Ecology)

- The bay is heavily developed with heavily armored shorelines (Figure 37), except for small estuarine areas at the mouths of the local creeks; shoreline at Indian Cove has little armoring, and shoreline habitat is good (except riparian)
- Shoreline riparian vegetation is generally absent
- Surf smelt and sandlance spawning documented; herring spawning documented in Hale Passage (see

East WRIA 15 Documented Baitfish files in the separate Maps file included with this report); several new herring spawning sites documented in the bay in spring 2000 (Molenaar)

Pt. Fosdick

- Steep natural shoreline with good sediment recruitment, except where bulkheaded to protect homes (includes numerous sites where bulkheads are located at the base of feeder bluffs)(Figure 38)
- Existing bulkheads extend well into historic intertidal area
- Riparian condition is poor on top of the bluff where there is development on the edge of the bluff
- Sandlance spawning documented; herring spawning documented in Hale Passage (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Figure 38: Marine shoreline at Pt. Fosdick showing development impacts to shoreline habitat west of Pt. Fosdick and natural steep bank shoreline to the northeast (1992 photo courtesy of Dept. of Ecology)

Action Recommendations for Carr Inlet/Hale Passage Nearshore/Marine Habitat

The following ranked salmonid habitat restoration actions are recommended for nearshore/marine habitats in Carr Inlet/Hale Passage, these should be considered in conjunction with the general habitat action recommendations listed earlier in this chapter:

- **Protect integrity of functional nearshore habitat, particularly at Penrose State Park, from the north end of Minter Bay to south of Wauna, the northern portion of Burley Lagoon, Kopachuck State Park, and Green Pt.**
- **Remove shoreline armoring and restore intertidal estuarine habitat at YMCA Camp Seymore**
- **Identify and correct sources of fecal coliform contamination**
- **Monitor marine water quality in Horsehead Bay**

Tacoma Narrows/Gig Harbor/Colvos Passage

Pt. Fosdick to Gig Harbor

- Steep high energy shoreline subject to recurrent slides
- Feeder bluff instability exacerbated by routing of stormwater from developments on the bluff directly over the side of the bluff or directly to the beach below

- Sandlance spawning documented; herring spawning documented in Tacoma Narrows (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Gig Harbor

- Shoreline is approximately 95% bulkheaded, affecting natural sediment contribution from adjacent uplands and nearshore sediment composition
- Numerous commercial and private docks and overwater structures throughout Gig Harbor
- Heavy boat traffic and boat moorage throughout harbor
- Shallow nearshore habitat converted to deepwater habitat as a result of dredging at Gig Harbor Yacht Club at the mouth of North Creek; interest has been expressed in further dredging, potential concerns of sediment contamination associated with marina
- Surf smelt spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Gig Harbor to Olalla

- Intermittent shoreline development and shoreline armoring
- Intermittent development of steep uplands adjacent to shoreline
- Shoreline riparian condition is good in reaches with no development, poor where development exists
- Surf smelt and sandlance spawning documented; herring spawning documented in Colvos Passage (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Olalla to Pt. Southworth

- Most of shoreline is steep wooded bluffs, with a few low bank developed areas, just north of Olalla, at Prospect Pt., and at the mouths of Fragaria and Wilson creeks
- Developed shorelines are heavily bulkheaded, but majority of shoreline reach not currently armored; demands for shoreline armoring are increasing as adjacent uplands are developed (Small)
- Approximately 20 houses at Prospect Pt. Constructed immediately below active feeder bluff; houses at high risk of damage/loss from slides (Figure 39)
- Heavy band of eelgrass presence along entirety of shoreline reach; natural feeder bluff sediment contribution should be retained to ensure continued presence of eelgrass
- Surf smelt and sandlance spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Figure 39: Prospect Pt. Development immediately below active feeder bluff (1992 photo courtesy of Dept. of Ecology)

Figure 40: Harper Estuary, site of planned estuarine restoration project (1992 photo courtesy of Dept. of Ecology)

Pt. Southworth to Pt. Glover

- Heavily developed and impacted marine shoreline; extensive shoreline armoring (residential bulkheads and riprap armoring of roadways immediately adjacent to the shore)
- Little functional shoreline riparian vegetation
- Restoration project planned for Harper Estuary (Figure 40) to remove fill from historic estuarine area, increase tidal intrusion upstream of Olympiad Drive, and restore historic intertidal wetlands on the east side of the estuary; increased presence of *Ulva* noted in the estuary, including areas that have gone anoxic (Jeff Davis)
- Presence of several derelict vessels in the Curley Creek estuary that should be moved/removed (Small)
- Much of the EPA/NMFS/Ecology facility at Manchester is located on previous Naval depot that was built on intertidal fill; site is currently designated as Superfund site, the nearshore in the vicinity of the dock has high presence of disposed metal and possibly old ordinance (Waknitz), and the dock is a large overwater structure with a high density of creosote-treated piles
- The natural outlet of Little Clam Bay, on the Naval Reserve, has been blocked with a causeway and tidegate, converting 23 acres of historic intertidal shoreline to ponded brackish water
- The Northwest Sea Farms net pens, and net pens for a co-op group, are located in Clam Bay, with likely impacts to benthic production, particularly near the footprint of the net pens
- Two marine boat ramps are located on EPA/NMFS property, and two on Navy property, that impair natural nearshore function (Small)
- Surf smelt and sandlance spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Action Recommendations for Tacoma Narrows/Gig Harbor/Colvos Passage Nearshore/Marine Habitat

The following ranked salmonid habitat restoration actions are recommended for nearshore/marine habitats in Tacoma Narrows/Gig Harbor/Colvos Passage, these should be considered in conjunction with the general habitat action recommendations listed earlier in this chapter:

- **Remove shoreline armoring (approximately 120 feet) and restore nearshore habitat at Doc Weathers Pierce County Park**
- **Implement planned habitat restoration in Harper Estuary**
- **Assess potential to restore Little Clam Bay to natural intertidal estuary**

- **Work with EPA/NMFS/Ecology/Navy to determine the feasibility of restoring natural shoreline and nearshore conditions in the extensively filled, bulkheaded, and docked shoreline in Clam Bay; assess opportunities to reduce/eliminate creosote presence and exposure at the EPA-operated dock**
- **Evaluate benthic and water quality impacts of Northwest Sea Farms net pens in Clam Bay, implement corrective management actions as warranted to address impacts**
- **Remove collapsed riprap and debris (from roadside armoring) from the intertidal area**
- **Assess options to consolidate and remove marine boat ramps on EPA/NMFS/Navy properties**
- **Assess the impacts of existing alterations to marine nearshore habitat in Gig Harbor; remediate impacts where possible**

Sinclair Inlet

Pt. Glover to Retsil Pt.

- Mostly low bank shoreline that is extensively developed
- Shoreline almost entirely armored; Beach Drive is armored and located directly on the shoreline through much of this reach, remainder of shoreline bulkheaded to protect residential property
- Lack of any functional shoreline riparian vegetation
- Surf smelt and sandlance spawning documented; herring spawning documented in Port Orchard (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Retsil Pt. to Ross Pt.

- The shoreline is highly altered; filled, dredged, bulkheaded, with several marinas and remnant piling forests from previous overwater structures
- TAG participants expressed concern regarding the operation of marine fuel distributors along this shoreline
- Surf smelt and sandlance spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Ross Pt. to Gorst

- A large waterfront nursery is located on top of old landfill on historic intertidal zone; TAG indicated water and sediment quality concerns
- Abandoned barges, potential derelict vessels, and unpermitted vessel/barge/log raft moorage off Ross Pt.
- Rafting of creosote-treated piles off Ross Pt.
- Presence of old homesite foundations and piles on intertidal area south of Ross Pt. (shoreline restoration potential)
- Some good habitat potential on Ross Pt.; shoreline is bulkheaded in places, but riparian condition -on the point remains good
- A portable outhouse transfer facility is located on the waterfront just east of Gorst; TAG indicated water quality concerns
- Kitsap Marina commercial and recreational vessel moorage, with active vessel maintenance facility; TAG indicated water quality concerns
- Rafts of creosote piles and commercial vessels moored at private dock at Thompson Landing

Gorst to Puget Sound Naval Shipyard (PSNS)

- Upper intertidal eliminated and shoreline bulkheaded by fill for railway and SR 3
- No riparian vegetation along armored shoreline
- Old Port of Bremerton landfill in historic intertidal area north of Gorst; Kitsap County has ordered that the landfill encroachment into the intertidal area needs to be pulled back
- Water quality concerns associated with stormwater runoff from SR 3, located on the north shoreline of Sinclair Inlet

Figure 41: Aerial photo of portion of the PSNS shoreline (1992 photo courtesy of Dept. of Ecology)

Figure 42: Massive fish kill in Puget Sound Naval Shipyard drydock (white color on bottom of drydock is dead fish, Official U.S. Navy Photograph, circa 1949)

PSNS

- The historic natural shoreline has been entirely altered (Figure 41); most of the PSNS is on intertidal fill, extensive overwater structures, all open-water shorelines have been dredged to maintain ship berthing opportunities
- Extensive existing presence of creosote–treated wood, in pilings, mooring dolphins, and overwater structures; pilings and dolphins are being converted to concrete or steel over time
- Marine sediments in Sinclair Inlet are contaminated with a broad suite of contaminants, mostly associated with operations at the PSNS. Sinclair Inlet is on the CWA 303(d) list for 1,4-Dichlorobenzene, 2,4-Dimethyophenol, Aldrin, Arsenic, Benz(a)anthracene, Benzo(ghi)perylene, Benzoic acid, Bis(2-ethylhexyl)phthalate, Butylbenzyl phthalate, Cadmium, Chrysene, Copper, Dieldrin, Fluoranthene, Indeno(1,2,3-cd)pyrene, Lead, Mercury, PCB-1254, PCB-1260, Phenanthrene, Zinc, and exceedance of the fecal coliform standards
- There are documented extensive past fish kills associated with PSNS drydock operations (Figure 42); PSNS is working to prevent similar occurrences in the future by using a “bubble curtain” (Small)
- The Navy is currently conducting

an assessment of marine, surface and groundwater quantity and quality, marine sediment analysis, and surface water flows within Sinclair and Dyes Inlets (J. Davis)

Action Recommendations for Sinclair Inlet Nearshore/Marine Habitat

The following ranked salmonid habitat restoration actions are recommended for nearshore/marine habitats in Sinclair Inlet, these should be considered in conjunction with the general habitat action recommendations listed earlier in this chapter:

- **Preserve remaining fragmented parcels of undisturbed shoreline**
- **Protect and restore good shoreline habitat on Ross Pt.; remove old homesite foundations, pilings, and associated debris from intertidal area south of Ross Pt.**
- **Remove derelict vessels, unauthorized moorage, and creosote-treated pile rafting off of Ross Pt.**
- **Pull back intertidal fill at old Port of Bremerton landfill north of Gorst; restore natural shoreline configuration and function**
- **Restore nearshore ecological function on marine shoreline from the mouth of Gorst Creek to PSNS**
- **Remove boat ramp and riprap at the WDFW-owned facility at Annapolis; restore natural shoreline configuration**
- **Remove collapsed riprap and debris (from roadside armoring) from the intertidal area**
- **Remediate water quality and sediment contamination in Sinclair Inlet**
- **Monitor potential leachates from old landfill at nursery on southern shore of Sinclair Inlet; restore natural shoreline configuration and function, where possible**
- **Ensure that PSNS drydock operations conducted in manner that precludes entrainment of fish into drydock area**

Port Washington Narrows/Dyes Inlet

Figure 43: CSO outfall at Evergreen Park and nearby old fill of intertidal area (1992 photo courtesy of Dept. of Ecology)

Southern Shore of Port Washington Narrows (PSNS to Warren Ave. bridge)

- Several combined sewer overflows (CSO) entering this shoreline from the City of Bremerton
- The old landfill in Smith Cove is designated as a Superfund site; some fill of intertidal area has already occurred, and further fill and cover of tidelands is proposed
- Shoreline is heavily bulkheaded; high rate of bulkhead failure due to tidal energy

- Absence of shoreline riparian vegetation
- CSO discharge pipe from Evergreen Park (Figure 43, right center of photo) is exposed on surface of intertidal area with additional riprap cover; the pipe interrupts natural littoral drift and affects natural salinity, likely affecting ability of aquatic vegetation to persist
- Surf smelt spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

City of Bremerton Shoreline (Warren Ave. Bridge to Oyster Bay)

- Shoreline heavily bulkheaded
- High numbers of docks and other overwater structures
- Little shoreline riparian vegetation
- Surf smelt spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Oyster Bay

- Moderate shoreline bulkheading; no apparent need for bulkheading as Oyster Bay is a low energy shoreline
- City of Bremerton has prohibited further dock construction in the Oyster Bay channel
- Unevaluated concerns regarding high water temperatures, and stormwater impacts to salinity

Madrona Point

- Both sides of point heavily bulkheaded
- Potential historic nearshore connection with Oyster Bay at the base of the point
- Surf smelt spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Madrona Pt. to Erlands Pt.

- Erlands Pt. is heavily bulkheaded
- Historic nearshore of Jackson Park shoreline has been filled and bulkheaded; sediments are contaminated from past Navy ordinance disposal in the fill of the park; the Navy has just recently placed substantial additional nearshore fill to cap the contaminated sediments (some live ordinance remaining in the previous fill)(Small)
- Elwood Pt. in Jackson Park is designated Superfund site
- Some areas of good shoreline habitat remaining; shoreline heavily used by baitfish for spawning
- Two large overwater piers present in Jackson Park; one of the piers has been removed, the other is designated as a historic site, with high density of creosote pilings and mooring dolphins (some have been removed (Small))
- Surf smelt and sandlance spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Erlands Pt. to Silverdale

- Silverdale Park built on intertidal fill
- Shoreline is heavily bulkheaded for protection of single-family residences; variety of failed and collapsed bulkheads and other debris on beach in areas identified as baitfish spawning habitat
- Shoreline riparian condition is poor
- Some presence of overwater docks and floats

- Presence of aquatic vegetation other than eelgrass
- Tidelands at mouth of Chico Creek are leased; lessee is concerned that channel movement across natural estuarine prism may affect shellfish production, contrary to importance of retaining natural estuarine function
- Surf smelt, sandlance, and herring spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Silverdale to Tracyton
- Primarily single family residential land use of shoreline
- Shoreline heavily bulkheaded
- Natural sediment delivery processes out of Clear and Barker creeks have been interrupted by presence of road crossings at the mouths of the streams
- Shoreline riparian condition is poor
- Moderate presence of overwater structures
- CSO delivery to Washington Narrows affects water quality in Dyes Inlet, resulting in low dissolved oxygen and high fecal coliform contamination
- Surf smelt spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Tracyton to Herron Pt.
- Shoreline heavily armored and developed
- Shoreline riparian condition is poor
- There is a restaurant that is sited in a large overwater dock/pier, with significant overwater shading of nearshore habitat
- Nearshore conditions affected by CSOs entering Washington Narrows
- Aquatic vegetation is present throughout Washington Narrows

Action Recommendations for Port Washington Narrows/Dyes Inlet Nearshore/Marine Habitat

The following ranked salmonid habitat restoration actions are recommended for nearshore/marine habitats in Port Washington Narrows/Dyes Inlet, these should be considered in conjunction with the general habitat action recommendations listed earlier in this chapter:
- **Preserve remaining fragmented parcels of undisturbed shoreline**
- **Evaluate adverse effects of CSOs on salinity and eelgrass/macroalgae beds; remediate identified problems**
- **Remediate water quality and sediment contamination in Port Washington Narrows/Dyes Inlet**

Port Orchard (west shore; this is the water body of Port Orchard, not the City of Port Orchard)

Herron Pt. to Illahee
- Shoreline habitat at Illahee State Park is in poor condition; the shoreline is mostly bulkheaded, riparian condition is poor with a parking lot immediately adjacent to the beach, and a large ramp and pier structure
- Enetai shoreline is heavily bulkheaded and developed with poor riparian

- Surf smelt and sandlance spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Illahee to University Pt.
- Mostly high bank shoreline except at the town of Illahee
- Moderate bulkheading of shoreline
- Riparian condition is fair
- Little aquatic vegetation in this shoreline reach
- Surf smelt and sandlance spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

University Pt. to Brownsville
- Shoreline is developed, but on steep bluff
- Riparian condition is fair, except where removed for view corridors
- Shoreline is bulkheaded on north half, along the road
- History of landslides along the road, slide material does not enter the nearshore
- Surf smelt, sandlance, and herring spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Brownsville Bay
- Brownsville harbor is an early warning site for outbreaks of *Heterosigma spp.* (a dinoflagelate that causes fish mortality, and is a threat to commercial salmon farming and pen-rearing)

Brownsville to Keyport
- Marina on northern outside of Brownsville Bay; associated dredging and alteration of historic shoreline configuration
- Steep unstable shoreline bluff
- Excellent shoreline riparian condition
- Little shoreline armoring
- Nearshore heavily used for surf smelt spawning
- The Puget Sound Shoreline Atlas indicates presence of non-eel grass vegetation that supports herring spawning; Jon Oleyar has not found vegetation in surveys in this area
- Surf smelt, sandlance, and herring spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Action Recommendations for Port Orchard Nearshore/Marine Habitat

The following ranked salmonid habitat restoration actions are recommended for nearshore/marine habitats in Port Orchard, these should be considered in conjunction with the general habitat action recommendations listed earlier in this chapter:
- **Preserve remaining fragmented parcels of undisturbed shoreline**
- **Remediate water quality and sediment contamination in Port Orchard**

Liberty Bay – Miller Bay

Keyport Naval Base
- Presence of contaminated sediments; designated as a Superfund site

- Shoreline extensively bulkheaded, no riparian vegetation
- Two large piers with associated history of marine dredging; Keyport is planning to remove one of the piers
- Fence marking boundary of base extends out across the intertidal area, accumulating algae and possibly affecting littoral sediment transport
- Surf smelt spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Keyport to Lemolo Pt. (Liberty Bay)

- Roadway on southeast end of Dogfish Bay is located on fill and eliminates large area of historic intertidal habitat
- Entirety of Liberty Bay heavily developed; primarily residential on the west side, commercial on the north and east sides, commercial structures located on piers on southeast side
- Three marinas on east side (dredging, fuel spills, etc.)(Figure 44); conversion of shallow nearshore to deepwater habitat; creosote piling breakwater on the northern end
- Heavy baitfish use of nearshore throughout Liberty Bay
- Surf smelt, sandlance, and rock sole spawning documented (see East WRIA 15 Documented
- Baitfish files in the separate Maps file included with this report)

Figure 44: Marinas located on northeast shore of Liberty Bay (three adjoining photos); creosote piling breakwater on northern marina (1992 photos courtesy of Dept. of Ecology)

Lemolo Pt. to Pt. Bolin

- Shoreline moderately to heavily armored
- Shoreline riparian condition is fair (spotty and fragmented)
- Some eelgrass present in spotty patches
- There is a series of barges and other debris that was sunk to develop a gravel loading “dock” near the mouth of Unnamed 15.0291 (Williams et al. 1975); affects littoral sediment transport and baitfish spawning
- Surf smelt and herring spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Pt. Bolin to Miller Bay

- Shoreline is heavily bulkheaded
- Heavy eelgrass presence from Pt. Bolin to the Agate Pass bridge, including eelgrass presence off the Suquamish tribal center
- Shoreline riparian condition is poor

- Heavy surf smelt/sandlance spawning utilization
- Some presence of overwater structures and boat ramps on shoreline
- Suquamish sewer outfall contributes elevated nutrient levels
- Suquamish tribal netpens located south of Agate Pass bridge
- Surf smelt, sandlance, and herring spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Figure 45: Shoreline armoring and presence of docks on spit on southern shoreline of Miller Bay (1992 photo courtesy of Dept. of Ecology)

Miller Bay

- Miller bay is a highly productive estuarine area
- Shoreline is heavily bulkheaded (even undeveloped lots), even though Miller Bay is a low energy area; bulkheading appears mainly for aesthetics, recreational use, to facilitate development, and for septic placement
- Shoreline on north side of spit is dredged (Figure 45), with high density of overwater structures and presence of treated wood; likely impacts to flow and sediment transport within and from Miller Bay to Port Madison; birds have been observed herding and preying on juvenile salmonids in dredged channel
- Shoreline riparian condition is poor
- At least one past occurrence of residents pouring gas on salicornia and eelgrass beds to kill vegetation (Boettner)
- Surf smelt, sandlance, and herring spawning are documented at the mouth of Miller Bay (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Action Recommendations for Liberty Bay – Miller Bay Nearshore/Marine Habitat

The following ranked salmonid habitat restoration actions are recommended for nearshore/marine habitats in Liberty Bay/Miller Bay, these should be considered in conjunction with the general habitat action recommendations listed earlier in this chapter:

- **Preserve nearshore habitat integrity of remaining fragmented undisturbed shoreline parcels**
- **Remediate water quality and sediment contamination in Liberty Bay**

Figure 46: Functional natural shoreline and estuary east of Indianola at mouth of 15.0305X (1992 photo courtesy of Dept. of Ecology)

Figure 47: Lost historic intertidal wetland at Presidents Pt. (1992 photo courtesy of Dept. of Ecology)

Port Madison – Foulweather Bluff

Miller Bay Spit to Indianola

- Heavily developed shoreline; almost entirely bulkheaded with several significant beach groins
- Few overwater structures
- Documented baitfish spawning
- Riparian condition poor
- Small shoreline parcel holding by Indianola/Greater Peninsula Land Trust
- Sandlance, and herring spawning documented (see East WRIA 15 Documented Baitfish maps in the separate Maps file included with this report)

Indianola to Jefferson Head

- Functional natural shoreline (Figure 46) with good recruitment of sediment and LWD from shoreline bluff; Jefferson Head is at risk of substantial development
- Excellent natural estuary at mouth of Unnamed 15.0305X

Jefferson Head to Presidents Pt.

- Steep vertical feeder bluff shoreline
- Shoreline is fairly natural, although loss of riparian vegetation from top of bluff affects recruitment of LWD to beach below
- Jefferson Head community dock is a large overwater structure

Figure 48: U.S Coast Survey (1872) of Apple Cove Pt. wetland (photo courtesy of Ted Labbe, NWIFC)

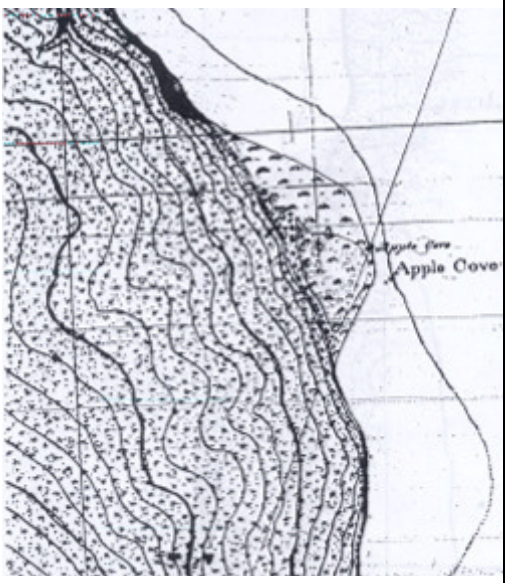


Figure 49: Remnant of historic intertidal wetland at Apple Cove Pt. (1992 photo courtesy of Dept. of Ecology)

President's Pt. to Point at South End of Appletree Cove

- Tidal connection with historic intertidal wetland at Presidents Pt. (Figure 47) has been eliminated
- Stormwater outfall from development at Presidents Pt. flows directly onto the upper part of the beach
- Presidents Pt. completely bulkheaded

Point at South End of Appletree Cove to Kingston Boat Ramp

- Shoreline is heavily armored
- Moderate presence of overwater structures
- Lack of any functional riparian vegetation
- Several grounded derelict vessels on shoreline
- Heavy eelgrass presence

Kingston Shoreline

- Natural shoreline completely altered
- Dredging at Kingston Marina has eliminated historic shallow nearshore habitat
- Jetty at Kingston Marina accumulating sand/mud in the Carpenter Creek estuary, preventing transport of sediment from the estuary to the shoreline to the north
- Shoreline is entirely armored
- Dept. of Transportation broke the Kingston sewer line during dredging operations nearly two years ago, increasing the amount of nutrients in Appletree Cove; correction is being held pending review of proposal to expand sewer line capacity, and likely to be two more years before corrective actions taken
- Sandlance spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Kingston Ferry Dock to Apple Cove Pt.

- The ferry dock is a very large overwater structure, with significant overwater shading
- Moderate shoreline armoring increasing bluff instability, likely due to increasing development and logging on the top of the bluff
- Stormwater drainage from development routed directly over the bluff and onto the beach
- Heavy eelgrass presence
- Stormwater impacts from development in Kingston area

Figure 50: U.S. Coast Survey (1872) depicting large intertidal wetland at Pt. No Pt. (photo courtesy of Ted Labbe, NWIFC)

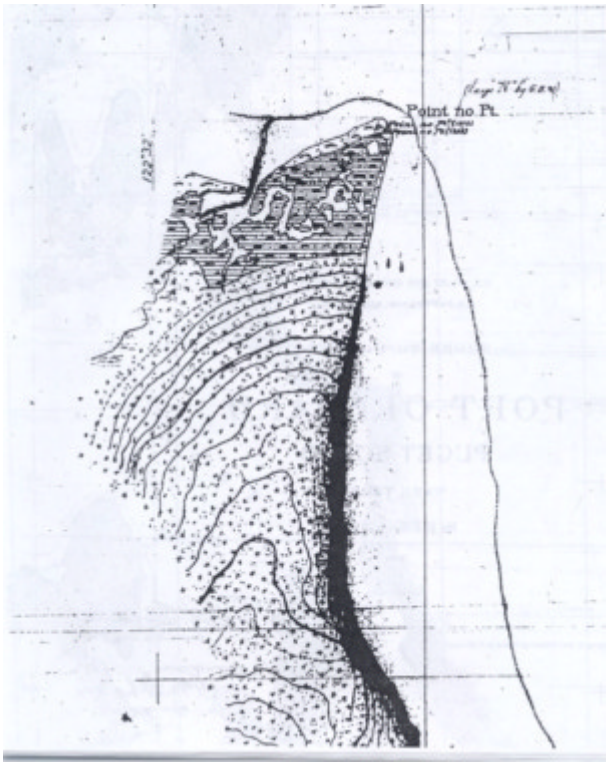


Figure 51: Current configuration of historic Pt. No Pt. intertidal wetland; note ditches to drain historic wetland area (1992 photo courtesy of Dept. of Ecology)

Apple Cove Pt. to Eglon

- Loss of large historic intertidal wetland at Apple Cove Pt. (Figure 48 and Figure 49)
- Development on historic intertidal wetland at Apple Cove Pt. is inundated at +7 ft. tidal elevation

Shoreline is moderately armored

- Steep unstable bluffs, except at Apple Cove Pt.
- Extensive eelgrass presence

Sandlance spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Eglon

- Port of Eglon filled historic estuary of Eglon Creek for boat ramp and associated parking lot

Eglon to Pt. No Pt.

- Geologically hazardous shoreline
- Limited shoreline armoring, but increasing demand for additional shoreline armoring
- Extensive eelgrass presence, likely supported by past geologic shoreline instability
- Very few overwater structures

Pt. No Pt. to Foulweather Bluff

- Heavy armoring of Skunk Bay shoreline
- Extensive eelgrass presence
- Few overwater structures
- Riparian condition is good from Foulweather Bluff to the middle of Skunk Bay
- There are two significant intertidal wetlands that have been impacted by placement of tidegates at the outlets; historic large wetland on the north side of Pt. No Pt. has been eliminated (Figure 50 and Figure 51)

- The shoreline at Hansville is very dynamic, with annual variations in beach elevation of 6-8 ft.
- Sandlance and surf smelt spawning has been documented west of Pt. No Pt., but beach surveys have been very limited
- The Norwegian Pt. stormwater outfall affects normal littoral drift cell processes
- Surf smelt and sandlance spawning documented (see East WRIA 15 Documented Baitfish files in the separate Maps file included with this report)

Action Recommendations for Port Madison/Foulweather Bluff Nearshore/Marine Habitat

The following ranked salmonid habitat restoration actions are recommended for nearshore/marine habitats in Port Madison/Foulweather Bluff, these should be considered in conjunction with the general habitat action recommendations listed earlier in this chapter:

- **Preserve nearshore habitat integrity of remaining fragmented undisturbed shoreline parcels**
- **Restore function of historic intertidal wetlands**

Bainbridge Island

Hidden Cove to Manzanita

- Shoreline heavily bulkheaded, except for some fragmented parcels south of the bridge
- Significant shoreline fill and loss of intertidal habitat northwest of Hidden Cove
- Riparian condition is fair, but poor on southern end
- High eelgrass presence throughout Agate Pass

Manzanita Bay

- Good nearshore habitat on north end of Little Manzanita Bay
- High concentration of piers, ramps, and floats, many are very long (250 ft.) and ground out at low tides
- All of Manzanita Bay heavily bulkheaded with poor riparian condition
- Little eelgrass, but presence of other herring spawning macroalgae

Arrow Pt. to Battle Pt.

- Moderately high bank shoreline, mostly developed for single-family residences
- Moderate to heavy shoreline armoring
- Fair to poor riparian condition
- Good undeveloped sand spit at Battle Pt. that warrants protection

Battle Pt. to Fletcher Bay

- Potentially isolated historic intertidal estuary south of Battle Pt.; need to evaluate potential to restore intertidal connection
- Shoreline is heavily armored
- Limited eelgrass presence

Fletcher Bay

- High density of Piers and floats; substantial nearshore dredging for private docks and boat moorage
- Shoreline almost entirely armored; few remaining parcels with natural shoreline conditions provide good habitat
- Moderate to poor riparian condition

Fletcher Bay to Crystal Springs

- Shoreline is geologically unstable high bank, and heavily bulkheaded
- Riparian condition is fair-poor
- Minor eelgrass presence along shoreline

Crystal Springs to Lynnwood Center

- Shoreline is nearly 100% bulkheaded; Crystal Springs Drive is constructed right on the beach through much of this shoreline
- Riparian vegetation is absent from this shoreline
- Kelp presence off Pt. White, eelgrass presence through Lynnwood Center area

Schel-chelb Estuary to Beans Pt.

- Excellent natural beach and dune area near Lytle Road
- Moderately cobbled beach at Fort Ward

Figure 52: Salmon netpen installation northwest of Beans Pt. (1992 photo courtesy of Dept. of Ecology)

- Stretches of the shoreline are armored between Schel-chelb and Fort Ward
- Old submarine anchor facilities (crib walls with rocks) off Fort Ward affect littoral sediment transport
- Three netpen facilities (with an associated large overwater pier) are located northwest of Beans Pt. (Figure 52)(two have been in the same location since 1974), in locations that would not likely meet existing guidelines for depth (current at the site exceeds standards); Ecology has relaxed monitoring requirements at this location due to low benthic impacts observed (Bill Waknitz)

Beans Pt. to Restoration Pt.

- New shoreline development at Beans Pt., shoreline entirely bulkheaded with removal of all riparian vegetation
- South shore of Bainbridge Island is all bulkheaded to Restoration Point, which is a natural rocky headland

Figure 53: Old log pond at the inner end of Blakely Harbor (1992 photo courtesy of Dept. of Ecology)

Restoration Pt. through Blakely Harbor

- Shoreline has low presence of shoreline armoring and overwater structures
- Riparian condition is currently good, but disappearing
- Land Trust and City of Bainbridge Island Parks has acquired inner Blakely Harbor; the area has a large salt marsh at the upper end, which would benefit from removal of jetties and debris blocking saltwater intrusion into an old log pond (Figure 53)

Rockaway Beach to Bill Pt. (south outer point on Eagle Harbor)

- Shoreline heavily armored
- Riparian vegetation absent
- Shoreline substrate is cobbles
- Houses are located on the beach directly below a steep bluff

Bill Pt. to Wing Pt. (Eagle Harbor)

- Harbor impacted by creosote debris accumulation; old Wyckoff creosote-treating facility is designated as Superfund site, Dept. of Transportation is storing (rafting) creosote wingwalls in upper estuary
- Extensive presence of bulkheads, overwater structures, anchored boats, and marinas; presence of two large ferry docks on north shore of Eagle Harbor
- History of a bulkhead contractor performing active boat and hull maintenance on the beach
- A conservancy area has been designated in the upper harbor; some patches of good shoreline habitat remaining on the north shore
- Potential to restore functional shoreline habitat west of the Wyckoff Superfund site
- Saltwater intrusion has been blocked from a historic intertidal wetland west of Wing Pt.; potential restoration opportunity to restore intertidal wetland function

Wing Pt. to Outer Murden Cove

- High bank shoreline is heavily armored
- Riparian condition is poor
- Large area of old landslide bench, with 11-13 homes at high risk

Inner Murden Cove

- Functional estuary with good habitat conditions; natural shoreline with good riparian condition

Murden Cove to Skiff Pt.
- Roadway is located right on the beach and bulkheaded; no riparian vegetation

Skiff Pt. through Rolling Bay
- Shoreline is heavily armored

North of Rolling Bay to Faye Bainbridge State Park
- High bluff shoreline; significant armoring, but some stretches of good natural shoreline
- Presence of large eelgrass beds

Faye Bainbridge State Park
- Excellent natural beach and dune habitat

Pt. Monroe to Hidden Cove (Port Madison Bay)
- Monroe Spit is heavily bulkheaded with intertidal fill
- Pt. Monroe lagoon is a natural depression that holds shallow tidal water; there is extensive presence of overwater docks and floats, and there is significant disturbance of the substrate within the lagoon by jetski activity

Hidden Cove (Port Madison Bay)
- Poor habitat conditions, with extensive presence of overwater docks and floats, extensive shoreline bulkheading, and lack of riparian vegetation
- Herring spawning has been documented in the Cove on macroalgae other than eelgrass

Action Recommendations for Bainbridge Island Nearshore/Marine Habitat

The following ranked salmonid habitat restoration actions are recommended for nearshore/marine habitats on Bainbridge Island, these should be considered in conjunction with the general habitat action recommendations listed earlier in this chapter:
- **Protect functional integrity of remaining high quality nearshore habitat areas, including Faye Bainbridge State Park, Schel-chelb estuary and beach/dune area at end of Lytle Road, Port Blakely estuary, inner Murden Cove, and the north end of Little Manzanita Bay**

ASSESSMENT OF HABITAT LIMITING FACTORS

The intent of HB 2496 and watershed restoration is to determine what stream restoration actions are appropriate to provide healthy, productive populations of salmon that will support sport, commercial, and tribal fisheries, and salmon for future generations. This goal requires a higher standard of habitat protection than what would be necessary to just ensure continued existence of the species. Although there remains some debate on specific habitat thresholds necessary for productive salmon habitat, there is broad consensus that salmon require:

- cool, clean, well-oxygenated water,
- instream flows that mimic the natural hydrology of the watershed, maintaining adequate flows during low flow periods and minimizing the frequency and magnitude of peak flows (stormwater),
- clean spawning gravels not clogged with fine sediment or toxic materials,
- presence of instream pools that will support juvenile rearing and resting areas for returning adults,
- abundance of instream large woody debris, particularly large key pieces, that provide cover, create pools, and provide habitat diversity,
- free, unobstructed migration for juveniles and adults to and from the stream of origin,
- broad, dense riparian stands of mature conifer that provides cover, shade, LWD recruitment, etc., and
- estuarine conditions that provide nearshore migration corridors and support production of prey organisms for juvenile outmigrants, as well as for juvenile salmonid rearing and for returning adults.

A more detailed discussion of the role of healthy habitat is included in a previous chapter of this report.

Salmonid Habitat Concerns

There are 125 separate streams entering saltwater in East WRIA 15 that are known to support salmonids, with an estimated 215 miles of known anadromous salmonid utilization. Watershed channel length ranges from single channels less than 1 mile in length to larger drainages with numerous tributaries (the Chico Creek watershed includes almost 68 miles of streams and tributaries, of which approximately 17 miles are accessible to anadromous salmonids (PSCRBT 1989)). Most of the streams in East WRIA 15 are low gradient and highly productive, particularly for chum, coho, and cutthroat. In addition, East WRIA 15 includes an estimated 320 miles of marine shoreline (excluding Vashon Island) that supports local anadromous salmonid stocks, as well as salmonid stocks from many of the other Puget Sound WRIAs.

The occurrence and severity of habitat limiting factors varies between watersheds within East WRIA 15 and between reaches within individual watersheds. Combined, these limiting factors significantly reduce the salmonid productivity potential of these streams. Initial significant impacts likely date back to early European settlement (mid- to late-1800s), as the gentle terrain and proximity to saltwater provided for easy logging access. Subsequent land use modifications (including agriculture, logging, and the increasing conversion to commercial/rural residential/urban development) have adversely impacted the quantity and quality of salmonid habitat, and accessibility to habitat in these streams. Current habitat condition has even been compromised by past well-intended actions to restore habitat, such as removal of log jams to

ensure fish passage, that are now known to have been very detrimental to habitat quality and diversity.

Many of the streams and estuarine areas in East WRIA 15 have been altered by logging, agriculture, and commercial/residential development. Land uses cause increased erosion and sedimentation, natural stream channels have been ditched and channelized, streambanks and shorelines have been armored, and some streams have even been completely confined within culverts to facilitate development. Many roadway crossings of streams have created complete/partial barriers to anadromous salmonid migration (see Map 7, in separate Maps file included with this report). Numerous small private dams have been built to create instream ponds, most of which are also barriers to fish migration. Roadways constructed along stream corridors and ditching/channelization constrict the natural floodplain and eliminate access to historic off-channel wetland habitats. Riparian condition is rated as fair/poor along many streams, or portions of streams. Riparian trees have been eliminated along many streams, and even where there is remaining woody riparian vegetation, historic conifer presence has been eliminated (or is sparse), limiting year-round canopy cover and LWD recruitment potential. LWD, particularly large key piece LWD that is stable and capable of influencing channel form, is noted as absent or severely lacking in many of the East WRIA 15 streams. Lack of LWD is also directly associated with the low instream pool frequency and lack of deep pools that are critical for juvenile and resident salmonid rearing and adult salmonid holding and resting prior to spawning. Presence of high levels of fines in the substrate is noted for numerous streams, although past quantitative substrate sampling is very limited for East WRIA 15 streams. Many of the streams in East WRIA 15 flow through deep steep-walled ravines for much of their length as they flow from the low elevation plateau of the Kitsap and Key peninsulas to saltwater. Although natural habitat characteristics are typically altered to some extent in these ravines, the ravines provide some buffer from adjacent development and opportunities for restoration.

Perhaps one of the largest impacts/threats to salmonid habitat in East WRIA 15 is alteration of natural stream hydrology. The Kitsap and Key peninsulas are very low elevation (<500m). Streamflows are dependent on rainfall, wetland storage, and groundwater infiltration to stream channels. Most of East WRIA 15 has shallow soils over deep compacted glacial till, resulting in limited groundwater storage potential. However, the limited infiltration potential has developed extensive wetlands in the headwaters of many of the streams. In addition, streambeds have evolved to handle a relatively narrow range of streamflow variation. Conversion from natural forested condition to agricultural/residential/commercial land uses has resulted in filling of floodplain wetlands, compaction of soils, and increased impervious surface, all of which increase the magnitude and frequency of peak streamflows and reduce groundwater and wetland storage, reducing base flows in these streams. When coupled with the current lack of LWD in most East WRIA 15 streams, this has significantly altered channel stability and substrate condition. In order to maintain the integrity of streams, it is imperative to provide state-of-the-art stormwater controls for new development, and retrofit stormwater controls to existing development. Future restoration potential in many streams is dependent on first addressing existing stormwater runoff problems, and this limitation will extend to the other streams unless stormwater is effectively addressed.

Productivity potential is further compromised by the severe decline in numbers of adult salmonids that have returned to these streams to spawn in recent years, whose carcasses provide the marine nutrient base that serves as the foundation of the food web for juvenile salmonids and other stream associated invertebrates, fish, and wildlife. Loss of adult salmonid spawning also

has an effect on the nature of channel substrate and shape. Large numbers of spawning salmonids modify riverine habitat in ways beneficial to future generations of salmonids; loss of these geomorphic functions, which salmon perform, results in further habitat degradation. Changes in salmonid abundance, and relative abundance between different species can change the fundamental predator/prey relationships, which developed between salmonid populations over thousands of years. This loss of ecosystem function also causes reduced productivity of the ecosystems which salmonids inhabit.

Estuaries provide critical rearing and transition habitat for salmonids as they move as juveniles from fresh to saltwater, and as adults from the marine environment back to freshwater. Marine nearshore areas support juvenile salmonid rearing and migration and production of food fish on which salmonids prey. The estuarine and nearshore habitats of East WRIA 15 are critically important for salmonids originating from local streams, and in addition provide support for juvenile salmonids originating from other WRIAs in central and southern Puget Sound. This includes providing support for juvenile chinook, which are listed as Threatened under the Endangered Species Act. The habitat quality and natural physical processes of estuarine and nearshore environments have been severely impacted throughout much of East WRIA 15. Estuaries have been impacted by encroachment on, and fill of, historic intertidal areas at the mouths of streams for roadways and other development. Nearshore habitat has been significantly altered due to extensive armoring and alteration of the marine shoreline, and associated alteration of the longshore littoral drift process, with probable associated loss of productive eelgrass habitats. Roadways across or along the mouths of streams and marine shorelines have significantly altered or eliminated estuarine and nearshore function.

Habitat Condition Rating

As noted above, there is often significant variability in the status of specific habitat elements between different reaches of the stream. In the Habitat Limiting Factors by Sub-Basin chapter, stream or reach-specific information is provided, where available. Composite habitat observations and data are summarized for independent drainages to saltwater and major tributaries in Table 21 as representative habitat condition ratings (Good, Fair, and Poor) by stream, for each of the identified habitat elements in the previous chapter of this report. The Salmonid Habitat Condition Rating Standards used to develop these habitat condition ratings are included for reference in Appendix B. The ratings generally represent the composite habitat condition for a stream; some reaches of the stream may be better or worse. The range of habitat condition ratings is presented where habitat quality differs between reaches within a watershed. Many of the habitat condition ratings for these streams are based on qualitative observations and experience of the TAG participants, due to the lack of quantitative habitat assessments for most of the streams in East WRIA 15.

Action recommendations to address identified habitat limiting factors for each stream are included in the Habitat Limiting Factors by Subbasin chapter. However, the common thread between the action recommendations is restoration of stream and floodplain ecological function (represented by “good” habitat ratings for each of the specific habitat elements). These functions are not only critical to restoring salmonid populations in these watersheds, but are also critical to the overall stream function and quality of life in East WRIA 15 (including factors such as prevention of flooding impacts, maintaining water quality for instream and domestic use, maintaining shellfish production and harvest potential in estuarine and nearshore areas, etc.).

Table 21 also identifies those streams/habitat elements for which insufficient information was available to make a habitat condition assessment. These are noted in the table as Data Gaps (DG). The absence of a stream in the list does not necessarily imply that the stream is in good health. Some streams may not be listed because they have not been visited, or no information is available. Others may show more impacts because they are easily accessible and have been the focus of more extensive scientific observations and study. Although the streams in East WRIA 15 are typically short, low gradient, and relatively accessible, it is interesting that that there is little known regarding habitat conditions in a large number of the drainages. In addition, there are certain habitat elements, such as presence of toxics or the condition and role of marine nutrients, were there is generally no information available, even for the streams with the greatest amount of available habitat information. It is very difficult to assess the historic role of marine nutrients without information on the number of historic spawners.

The purpose of Table 21 is to provide a quick visual reference to indicate the relative health and relative knowledge base of individual streams, in relation to salmonid habitat, and to provide a relative comparison of habitat condition within and between streams. The summary information in the table is useful as a general guide to habitat problem "hot spots" that warrant restoration consideration, or additional assessment data collection to guide habitat restoration. However, the Habitat Limiting Factors by Subbasin chapter should be consulted for specific stream information and action recommendations on which to base specific salmonid habitat restoration proposals. The potential benefit of proposed habitat restoration actions may be limited due to number of habitat problems in a stream, higher priority limiting factors that should be addressed first, sequencing of projects to ensure effectiveness, etc.

Habitat Restoration Potential

Despite the extensive impacts that have occurred to fresh and marine water habitats in East WRIA 15, and the number of "fair" or "poor" habitat ratings that exist throughout the area, there are a number of reasons to be optimistic regarding the future of salmonid habitat and productivity in East WRIA 15. The greatest habitat restoration potential in East WRIA 15 is likely in the larger systems that were historically the largest producers of salmonids: Coulter, Rocky, Minter, Burley, Olalla, Crescent, Curley, Blackjack, Gorst, Chico, Clear, Steele, Dogfish, Grovers, and Carpenter creeks. However, habitat restoration in other streams should also be actively considered, as these streams contribute to the overall productivity of East WRIA 15, and cumulatively these streams contribute significant overall salmonid production. Restoration of estuarine and nearshore habitat is also critical, as these habitats support local salmonid stocks as well as stocks originating from other central and southern Puget Sound WRIAs. Habitat protection and restoration action recommendations for individual streams and estuarine/nearshore habitats are identified in the Habitat Limiting Factors by Subbasin chapter of this report.

Restoration projects in East WRIA 15 should be considered in relation to the production potential of the stream and the anticipated benefits of the restoration project. Several of the streams have areas where habitat is currently in relatively good condition, and these areas should be protected (see Habitat In Need Of Protection chapter of this report). Other degraded habitats have potential to provide excellent habitat and warrant special consideration. Unfortunately, the habitat in some streams (particularly those in densely developed watersheds) has been severely impacted, limiting the potential benefits of restoration.

Table 21: Assessment of Habitat Limiting Factor Severity for Salmonid-Bearing Watersheds within East WRIA 15

				Channel Conditions				Water Quality			Hydrology			
Stream	**WRIA Index**	**Fish Access**	**Floodplain Connectivity**	**LWD**	**Pools**	**Substrate**	**Riparian Condition**	**Temp/ DO**	**Fecal**	**Toxics**	**Peak Flow**	**Low Flow**	**Estuarine**	**Lack of Nutrients**
Spring Creek	**15.0001**	F	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Coulter Creek	**15.0002**	F	G	G	G	F-G	P-F[i]	F-G	DG	DG	NA	SC	DG	DG
Unnamed	**15.0012**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0014**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Rocky Creek	**15.0015**	F	G	P	DG	DG	F	F-G	G	DG	G	SC	DG	DG
Fork Muck Cr.	**15.0016**	G	P	DG	G	G	P	P	DG	DG	G	SC	NA	DG
Winter Creek	**15.0017**	P	DG	DG	DG	DG	G	DG	DG	DG	G	SC	NA	NA
Unnamed	**15.002X**	P	P	P	P	P	P-G	DG	DG	DG	DG	SC	DG	DG
Unnamed	**15.0023**	P	P	P	P	P	G	DG	DG	DG	P	DG	DG	DG
Vaughn Creek	**15.0023A**	DG	F	DG	DG	P-F	G	G	DG	DG	DG	SC	G	DG
Dutcher Creek	**15.0026**	P	G	G	G	G	DG	DG	DG	DG	G	SC	DG	DG
Unnamed	**15.0028**	G	DG	G	G	G	G	DG	DG	DG	DG	DG	DG	DG
Herron Creek	**15.0029**	G	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0030**	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0031**	DG	DG	P	DG	P	P	DG	DG	DG	DG	DG	DG	DG
Whiteman Creek	**15.0032**	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	P	DG
Taylor Bay Cr.	**15.0034**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0035**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0036**	P	DG	DG	DG	DG	P	DG	P	DG	DG	DG	DG	DG
Schoolhouse Creek	**15.0039**	P	P	DG	DG	DG	P	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0039X**	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0040**	F	DG	P	DG	P	F	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0041**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0041A**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Mayo Creek	**15.0042**	P	DG	DG	DG	DG	DG	P	P	DG	DG	DG	P	DG

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Stream	**WRIA Index**	**Fish Access**	**Floodplain Connectivity**	**LWD**	**Pools**	**Substrate**	**Riparian Condition**	**Temp/ DO**	**Fecal**	**Toxics**	**Peak Flow**	**Low Flow**	**Estuarine**	**Lack of Nutrients**
Unnamed	**15.0042A**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0043**	G	DG	P	DG	DG	P	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0044**	P	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Lackey Creek	**15.0046**	G	G	G		G	G	DG	DG	DG	DG	DG	P	DG
Minter Creek	**15.0048**	P	P	DG	P-G	G	P-G	G	P	DG	DG	DG	DG	DG
L. Minter Cr.	**15.0051**	F	G	P	DG	G	P-G	G	P	DG	DG	DG	NA	DG
Huge Creek	**15.0052**	F	G	F	DG	DG	DG	G	P	DG	DG	DG	NA	DG
Unnamed	**15.0053**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0054**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Burley Creek	**15.0056**	F	G	P	P	P	P-F	F	P	DG	P	G	DG	DG
Little Bear Cr.	**15.0057**	F	G	G	G	G	F	G	P	DG	DG	G	NA	DG
Purdy Creek	**15.0060**	F	DG	G-DG	G-DG	DG	P-F	G	P	DG	DG	SC	DG	DG
Goodnough Creek	**15.0063**	P	P	F	P	P-F	F-G	G	G	DG	DG	DG	DG	DG
McCormick Creek	**15.0065**	P	F	P-G	P-G	P	P-G	G-P	G	DG	P	DG	DG	DG
Lay Creek	**15.0068**	P	DG	P	P	F	F	DG	DG	DG	DG	P	G	DG
Rosedale Creek	**15.0069A**	P	G	P	P	G	P	DG	DG	DG	DG	DG	DG	DG
Mark Dickson Cr.	**15.0070**	DG	P	P	F	F-G	P-F	DG	DG	DG	DG	DG	G	DG
Lake Sylvia Cr.	**15.0070A**	P	P	P	P	P-G	P	DG	DG	DG	DG	DG	NA	DG
Unnamed	**15.0071**	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Warren Creek	**15.0072**	P	DG	F	P-F	F	G	DG	DG	DG	DG	DG	DG	DG

Table 21: Assessment of Habitat Limiting Factor Severity for Salmonid-Bearing Watersheds within East WRIA 15

				Channel Conditions				Water Quality			Hydrology			
Stream	**WRIA Index**	**Fish Access**	**Floodplain Connectivity**	**LWD**	**Pools**	**Substrate**	**Riparian Condition**	**Temp/ DO**	**Fecal**	**Toxics**	**Peak Flow**	**Low Flow**	**Estuarine**	**Lack of Nutrients**
Muri Creek	**15.0074**	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Artondale Creek	**15.0075**	DG	P	F	F	F	F	DG	DG	DG	DG	DG	DG	DG
Wollochet Creek	**15.0076**	P	G	P-F	P-F	G	G	DG	DG	DG	DG	DG	G-F	DG
Garr Creek	**15.0080X**	DG	P	DG	DG	DG	DG	DG	DG	DG	F	DG	DG	DG
Sullivan Gulch Cr.	**15.0087**	DG	G	F	P	F	F-G	DG	DG	DG	P	DG	DG	DG
Schoolhouse Creek	**15.0090**	F	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.009X**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Doc Weathers Cr.	**15.0096**	P	P	P	P	F	G	DG	DG	DG	DG	DG	DG	DG
North Creek	**15.0097**	F	G	P	F	G	P-F	DG	DG	DG	P	SC	P	DG
Crescent Creek	**15.0099**	G	P	P	P	F	P	DG	DG	DG	G	SC	F	DG
Sunrise Creek	**15.0105**	P	P	DG	DG	P	F	DG	DG	DG	DG	DG	DG	DG
Olalla Creek	**15.0107**	P	P	P	P	F-P	P	G	F	DG	DG	SC	F	DG
Fragaria Creek	**15.0115**	G	G	F-P	DG	G	G	DG	DG	DG	DG	DG	DG	DG
Wilson Creek	**15.0178**	G	G	F-P	DG	DG	F	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0181**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	P	DG
Unnamed	**15.0183**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Curley Creek	**15.0185**	F	G	P-G	DG	F	P-G	P	F	DG	P	SC	F-G	DG
Salmonberry Cr.	**15.0188**	G	P	P	P	F	P-F	P	F	DG	P	SC	NA	DG
Duncan Creek	**15.0191**	P	P	DG	DG	DG	G	DG	DG	DG	P	DG	DG	DG
Beaver Creek	**15.0192**	G	DG	G	G	DG	P-DG	G	P	DG	DG	SC	P	DG

Table 21: Assessment of Habitat Limiting Factor Severity for Salmonid-Bearing Watersheds within East WRIA 15

				Channel Conditions				Water Quality			Hydrology			
Stream	**WRIA Index**	**Fish Access**	**Floodplain Connectivity**	**LWD**	**Pools**	**Substrate**	**Riparian Condition**	**Temp/ DO**	**Fecal**	**Toxics**	**Peak Flow**	**Low Flow**	**Estuarine**	**Lack of Nutrients**
Unnamed	**15.0193**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0194**	F	DG	F	DG	DG	F	DG	DG	DG	DG	DG	G	DG
Unnamed	**15.0195**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	G	DG
Duncan Creek	**15.0196**	DG	DG	DG	DG	DG	DG	G	P	DG	DG	DG	DG	DG
Sullivan Creek	**15.0200**	P	DG	DG	DG	DG	DG	DG	DG	DG	P	SC	P	DG
Wilson Creek	**15.0201**	F	P	DG	DG	DG	P-F	DG	P	DG	P	G	F	DG
Annapolis Creek	**15.0202**	F	P	P	DG	P-F	P	F	P	DG	P	G	P	DG
Blackjack/Square Cr.	**15.0203**	G	G	F-P	DG	G	P-F	F	P	DG	P	P	P	DG
Ruby Creek	**15.0205**	G	F	F	P	G	P	F	G	DG	DG	DG	NA	DG
Unnamed	**15.0208**	P	P	P	P	DG	P	DG	DG	DG	P	DG	P	DG
Ross Creek	**15.0209**	F	G	F	P	F	F	F	F	DG	P	SC	P	DG
Unnamed	**15.0210**	P	G	P	P	DG	F	DG	DG	DG	DG	SC	NA	DG
Anderson Creek	**15.0211**	F	P	F	P	G	G	G	G	DG	G	G	P	DG
Gorst Creek	**15.0216**	F	P	P-G	P-G	F	P-G	F	P	DG	P	P	F	DG
Unnamed	**15.0217**	P	G	G	G	G	P-G	G	G	DG	P	G	NA	DG
Jarstad Cr.	**15.0218**	P	G	P	P	G	G	F	G	DG	G	G	NA	DG
Parish Cr.	**15.0220**	G	G	G	DG	P	DG	G	G	DG	P	G	NA	DG
Heins Cr.	**15.0221**	P	G	P	P	G	G	G	G	DG	G	G	NA	DG
Wright Creek	**15.0225**	G	G	DG	DG	DG	DG	DG	DG	DG	DG	DG	G	DG

Table 21: Assessment of Habitat Limiting Factor Severity for Salmonid-Bearing Watersheds within East WRIA 15

				Channel Conditions				Water Quality			Hydrology			
Stream	**WRIA Index**	**Fish Access**	**Floodplain Connectivity**	**LWD**	**Pools**	**Substrate**	**Riparian Condition**	**Temp/ DO**	**Fecal**	**Toxics**	**Peak Flow**	**Low Flow**	**Estuarine**	**Lack of Nutrients**
Unnamed	**15.0226**	P	DG	DG	DG	DG	P-F	G	F	DG	P	DG	DG	DG
Chico/Wildcat Cr.	**15.0229**	F	P-G	P-G	P-G	P-G	P-G	F	F	DG	DG	SC	F	DG
Kitsap Cr.	**15.0230**	P	F	P	P	G	F	P	P	DG	DG	SC	NA	DG
Dickerson Cr.	**15.0231**	F	F	P-G	DG	G	P-G	F	F	DG	DG	SC	NA	DG
Lost Cr.	**15.0234**	G	G	G	G	F	G	DG	DG	DG	DG	SC	NA	DG
Strawberry Creek	**15.0246**	P	P	P	P	P	P-F	DG	F	DG	P	SC	NA	DG
WF Strawberry	**15.0247**	P	G	DG	DG	DG	F	DG	DG	DG	P	SC	NA	DG
Unnamed	**15.0248**	P	P	P	P	P	P	DG	DG	DG	P	NA	P	DG
Clear Creek	**15.0249**	G	P	P	P	P	F	P	P	DG	P	DG	P	DG
WF Clear Cr.	**15.0250**	F	P	F	P	G	P-G	G	G	DG	F	DG	NA	DG
Barker Creek	**15.0255**	P	P	G-P	P	F	P-G	P	P	DG	P	SC	P	DG
Hoot Creek	**15.0255A**	P	P	P	P	P	P	DG	DG	DG	DG	SC	NA	DG
Unnamed	**15.0257**	P	DG	P	DG	F	P	DG	DG	DG	DG	DG	DG	DG
Pharmann Creek	**15.0258**	P	P	P	DG	P	P	P	P	DG	P	DG	DG	DG
Mosher Creek	**15.0259**	F	F	DG	DG	P-G	P-G	G	F	DG	F	G	G	DG
Unnamed	**15.0260**	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Dee Creek	**15.0264**	P	DG	G-P	DG	P	G-P	F	P	DG	P	DG	P	DG
Illahee Springs Cr.	**15.0265**	DG	DG	DG	DG	DG	DG	DG	P	DG	DG	DG	DG	DG
Illahee Creek	**15.0266**	G	P	P	P	P	P	F	F	DG	P	P	F	DG
Unnamed	**15.0269**	P	DG	DG	DG	DG	G	DG	DG	DG	DG	DG	DG	DG

Table 21: Assessment of Habitat Limiting Factor Severity for Salmonid-Bearing Watersheds within East WRIA 15

				Channel Conditions				Water Quality			Hydrology			
Stream	**WRIA Index**	**Fish Access**	**Floodplain Connectivity**	**LWD**	**Pools**	**Substrate**	**Riparian Condition**	**Temp/ DO**	**Fecal**	**Toxics**	**Peak Flow**	**Low Flow**	**Estuarine**	**Lack of Nutrients**
Unnamed	**15.0272**	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Steele Creek	**15.0273**	P	F	P	DG	P-G	F	P	P	DG	P	SC	F	DG
Unnamed	**15.0275A**	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Keyport Creek	**15.0276**	P	DG	P	DG	F-DG	P-F	DG	DG	DG	DG	DG	P	DG
Unnamed	**15.0277**	P	DG	DG	DG	G	F-G	DG	DG	DG	DG	DG	DG	DG
Daniels Creek	**15.0278**	P	DG	DG	DG	DG	P-G	G	P	DG	DG	DG	DG	DG
Little Scandia Cr.	**15.0279**	F	P	P	P	F-P	F-P	DG	DG	DG	DG	DG	F	DG
Big Scandia Creek	**15.0280**	F-G	F	DG	DG	P	P-F	G	P	DG	DG	DG	G	DG
Unnamed	**15.0281**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Johnson Creek	**15.0283**	P	F	P	P	F-G	P-G	G	P	DG	DG	CL	G	DG
Dogfish Creek	**15.0285**	F	P	P	P	P	P	G	P	DG	P	CL	P	DG
SF Dogfish Cr.	**15.0285A**	P	P	P	P	P	P	F	F	DG	P	CL	NA	DG
NF Dogfish Cr.	**15.0286**	F	P	P	P	P	P	F	P	DG	F	CL	NA	DG
Bjorgen Creek	**15.0290**	P	G	P	DG	G	G-P	DG	DG	DG	P	G	P	DG
Unnamed	**15.0291**	P	P	P	DG	F	G	DG	DG	DG	P	G	F	DG
Sam Snyder Creek	**15.0293**	P	DG	DG	DG	DG	G	DG	DG	DG	DG	DG	DG	DG
Klaebel Creek	**15.0296**	P	G	F-P	P	P	F	P	F	DG	DG	CL	F	DG
Cowling Creek	**15.0298**	P	DG	DG	DG	P-F	P-G	F	F	DG	P	P-CL	DG	DG
Grovers Creek	**15.0299**	P	P	P	P	P	P-G	P	P	DG	DG	P-SC	P	DG
Unnamed	**15.0305**	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG

Table 21: Assessment of Habitat Limiting Factor Severity for Salmonid-Bearing Watersheds within East WRIA 15

				Channel Conditions				Water Quality			Hydrology			
Stream	**WRIA Index**	**Fish Access**	**Floodplain Connectivity**	**LWD**	**Pools**	**Substrate**	**Riparian Condition**	**Temp/ DO**	**Fecal**	**Toxics**	**Peak Flow**	**Low Flow**	**Estuarine**	**Lack of Nutrients**
Kitsap Creek	**15.0305X**	P	P-G	P-G	DG	G	P-G	DG	DG	DG	DG	DG	G	DG
Indianola Creek	**15.0305X**	P	G	DG	DG	G	G	DG	DG	DG	DG	DG	P	DG
Unnamed	**15.0305X**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	G	DG
Unnamed	**15.0306**	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	CL	DG	DG
Unnamed	**15.0307**	G	DG	P	DG	F	F	DG	DG	DG	DG	DG	G	DG
Unnamed	**15.0308**	DG	DG	P	DG	F	P	DG	DG	DG	DG	DG	G	DG
Carpenter Creek	**15.0309**	P	P	P	DG	DG	P	P	P	DG	G	G-CL	P	DG
Silver Creek	**15.0310**	G	DG	DG	DG	DG	F	DG	DG	DG	DG	DG	DG	DG
Eglon Creek	**15.0311**	DG	F	DG	DG	DG	G	P	F	DG	DG	DG	F	DG
Unnamed	**15.0316**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0318**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0319A**	P	G	G	G	G	G	DG	DG	DG	DG	DG	P	DG
Dripping Water Cr.	**15.0320**	G	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Murden Cove Cr.	**15.0321**	DG	G	DG	DG	P	P	DG	DG	DG	P	CL	DG	DG
Ravine Creek	**15.0324**	P	P	DG	DG	DG	DG	DG	DG	DG	P	DG	DG	DG
Unnamed	**15.0324A**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Sportsmens Club Pond Creek	**15.0325**	P	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Head of Bay Cr.	**15.0326**	P	DG	P	DG	P	P-G	DG	DG	DG	DG	DG	DG	DG
Blakely Falls Creek	**15.0330X**	G	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG

Table 21: Assessment of Habitat Limiting Factor Severity for Salmonid-Bearing Watersheds within East WRIA 15

				Channel Conditions				Water Quality			Hydrology			
Stream	**WRIA Index**	**Fish Access**	**Floodplain Connectivity**	**LWD**	**Pools**	**Substrate**	**Riparian Condition**	**Temp/ DO**	**Fecal**	**Toxics**	**Peak Flow**	**Low Flow**	**Estuarine**	**Lack of Nutrients**
Macs Dam Creek	**15.0331**	P	DG	DG	P-G	P-G	P-G	DG	DG	DG	DG	DG	DG	DG
Unnamed	**15.0332**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG
Schel-chelb Creek	**15.0028X**	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	DG	G	DG
Fletcher Creek	**15.0340**	F	P	DG	DG	P	P-G	DG	DG	DG	DG	CL	DG	DG
Mosquito Bay Cr.	**15.0344**	P	P	DG	DG	DG	G-P	DG	DG	DG	DG	DG	DG	DG

Habitat Condition Ratings

G = Average habitat condition considered to be good for the listed watershed
F = Average habitat condition considered to be fair for the listed watershed
P = Average habitat condition considered to be poor for the listed watershed
DG = Data Gap
SC= Seasonal closure to further surface water withdrawals
CL= Year-round closure to further surface water withdrawals

HABITAT IN NEED OF PROTECTION

Christopher May Ph.D. (principal investigator), in conjunction with Concurrent Technologies Corporation (CTC) conducted a study to identify salmonid refugia on the Kitsap Peninsula. Although the study focused on watersheds in Kitsap County, the study does include those streams with headwaters in Kitsap County and mouths in Pierce or Mason counties. Specific methodologies employed were directed at key indicator characteristics and criteria identified as critical factors in beneficial salmon habitat (Frissell 1998, Frissell et al. 1999, as cited in CTC 2000). In addition, the study prioritized identified refugia for conservation, enhancement, and restoration efforts. Although some watersheds or subwatersheds were not proposed as refugia, the report (CTC 2000) indicates they are still considered significant in respect to regional salmon recovery efforts. Every watershed, stream, and nearshore area warrants protection and stewardship. The study does not imply that protection of designated refugia alone is ecologically sufficient to support salmon recovery or even to maintain current conditions: it is a necessary, but not completely sufficient first step in a comprehensive, long-term ecosystem conservation program (CTC 2000).

A major objective of the study was to support the early actions necessary to preserve the last remaining areas of high quality salmonid spawning and rearing habitat on the Kitsap Peninsula (CTC 2000). Protection of these "last best places" is an important part of the salmon recovery process, but alone will not be sufficient to ensure the restoration of natural runs of wild salmonids. The refugia concept is built on the premise that remaining natural, wild populations of salmonids can benefit most if protection and restoration efforts are concentrated in those areas which still retain a functioning level of ecological integrity, and which provide critical life history support. This theory considers both salmonid life-history requirements and critical watershed processes in this analytical approach (Williams et al. 1997, as cited in CTC 2000).

Following, in *italics*, is an excerpted overview of the salmonid refugia selection and classification process from the Kitsap Peninsula Salmonid Refugia Study report (CTC 2000):

Following identification of possible refugia using both fish-centered and landscape-centered approaches, a qualitative evaluation of watershed, riparian, and instream conditions was made. The number of wild salmonid species each proposed refugia supported was determined, as well as the presence of any ESA-listed species.

Refugia were also placed in one of three qualitative categories based on their present conditions. Those areas that: (1) support natural salmonid productivity and diversity; (2) have an undisturbed, forested watershed and an intact, natural riparian corridor; and (3) have a high level of ecological integrity, were rated the highest (refugia Category "A"). Unfortunately, due to the level of development on the Kitsap Peninsula, very few refugia of this category were identified within the study area. However, Category "A" refugia do exist in Hood Canal and other areas of Puget Sound (Frissell et al. 1999).

Those areas with somewhat disturbed watershed conditions and those areas that had less than natural riparian, instream, or nearshore habitat, but still supported natural assemblages of native salmonids, were rated as category "B" refugia. Although the salmonid populations and habitat quality (riparian, instream, and nearshore) in these areas ("B") were well below historic levels, they have shown some resistance to degradation. They also tend to be in an early stage of recovery due to some natural resilience. These refugia (Table 22) are not pristine, but frequently constitute the best remaining salmonids habitat and generally support the largest remaining fish

Table 22: East Kitsap Refugia (from CTC 2000)					
Watershed Stream	**Refugia Code**	**Refugia Type**	**Salmonid Diversity**	**ESA Listing**	**Refugia Category**
Agate Passage	AGT	NS	5	PSC	B
Anderson Creek	ANG	NC	4	PSC	B
Bainbridge Island (E)	BIE	NS	5	PSC	B
Bainbridge Island (W)	BIW	NS	5	PSC	B
Barker Creek	BRK	NC	5	PSC	B
Big Scandia Creek	BSC	NC	4	N/A	B
Blackjack Creek	BLJ	NC/FW	5	PSC	B
Burley Creek	BUR	NC	5	PSC	C
Burley Lagoon	PUR	NS	5	PSC	C
Case Inlet	CAS	NS	5	PSC	B
Chico Creek	CCO	NC/FW	5	PSC	B
Clear Creek	CLR	NC	5	PSC	C
Colvos Passage	COL	NS	5	PSC	B
Coulter Creek	CLT	FW	5	PSC	B
Curley/Salmonberry Creek	CSB	NC/FW	5	PSC	B
Dogfish Creek	DOG	NC/FW	5	PSC	B
Dyes Inlet (E)	DYE	NS	5	PSC	C
Dyes Inlet (W)	DYW	NS	5	PSC	C
Eglon/Silver Creek	EGS	FW	4	N/A	B
Gorst Creek	GOR	NC/FW	5	PSC	B
Grovers Creek	GRV	NC/FW	4	N/A	C
Indianola	IND	NS	5	PSC	B
Keyport/Brownsville/Illahee	BKP	NS	5	PSC	B
Liberty Bay	LIB	NS	5	PSC	B
Miller Bay	MLB	NS	5	PSC	B
Olalla Creek	OLL	FW	5	PSC	B
Point-No-Point	PNP	NS	5	PSC	B
Rocky Creek	RKY	FW	5	PSC	B
Sinclair Inlet	SIN	NS	5	PSC	C
Steele Creek	STL	NC/FW	5	PSC	B

Notes:

Refugia Types
NS = Nearshore or estuary
FW = Focal watershed
NC = Nodal or riparian corridor

Salmonid Diversity
# of salmonid species in watershed

ESA Listing
PSC = Puget Sound chinook

Refugia Category
A = Natural undisturbed conditions; high ecological integrity
B = High quality, but altered conditions; good ecological integrity
C = Potential future refugia; significantly modified conditions

runs in their geographic sub-region. It should be noted that, in addition to land conservation and aquatic resource protection, rehabilitation/restoration measures will be required to maintain or enhance the ecological integrity of these areas. On a positive note, this category of refugia ("B") comprised the bulk of all Kitsap areas identified.

The third category of refugia quality ("C") includes those areas that can best be described as "potential" refugia. These areas are historically important salmonid resource areas, but typically have degraded watershed and. or habitat conditions that do not currently support natural levels of ecological integrity or salmonid populations. Also included in this category ("C") were those streams with good habitat conditions, but due to downstream fish-passage barriers or hatchery operations, do not fully support native runs of wild salmonids. The ability of these areas to fully support native anadromous salmonids is speculative, but they warrant

recognition because of their historic productivity and/or their potential for high ecological integrity. These areas also may be geographically positioned such that they are the only possible refugia within a critical sub-region of Puget Sound. If migration barriers were removed, hatchery operations modified to support wild salmonids, and/or watershed and habitat conditions improved, these areas could become high-quality refugia.

It should be understood that there is a degree of uncertainty in the evaluation and selection process. It was decided not to distinguish between each of the proposed refugia at this point, but to wait until GIS-based analysis was complete before prioritizing. The underlying goal of this project in conservation and not restoration, so in-depth habitat assessment was not deemed appropriate at this time. It is important to recognize that the evaluation and selection criteria are not all-inclusive. Although some areas are not presently proposed as "refugia", they may still be considered significant in respect to regional salmon recovery efforts. Every watershed, stream, and nearshore area deserves protection and stewardship. It should also be reiterated that this study does not imply that protection of designated refugia alone is ecologically sufficient to support salmon recovery or even to maintain current conditions. Salmonid refugia designation is a necessary, but not sufficient, first step in a comprehensive, long-term ecosystem conservation program.

The location of refugia boundaries was a relatively difficult task. Where [possible, natural geographic feature or topographic breaks were used to delineate refugia boundaries. Watershed boundaries based on a digital elevation model (DEM) were used where appropriate, based on hydrologic and ecological considerations. Ecologically based boundaries were also used to delineate refugia boundaries for nearshore and stream-riparian ecosystems (Noss and Cooperrider 1994, Spence et al. 1996, Knutson and Naef 1997). In delineating refugia, attention was given to their size. Every effort was made to include sufficient area to encompass the migratory, spawning and rearing needs of all salmonid species indigenous to the watershed under consideration for refugia status.

Each refugia was also evaluated for salmonid diversity based oh current, historical, and potential salmonid utilization. The numbers of species that have been, are, or could be supported by the stream are indicated for each refugia (Table 22). In addition those currently "ESA-listed" species supported by each refugia were also noted.

The following categories were utilized for designating salmonid refugia in this study (modified based on Frissell 1997, 1998, 1999):

- *Focal Watersheds (FW)*
- *Nodal Corridors or Riparian Reserves (NC)*
- *Critical Contributing Areas (CCA)*
- *Nearshore Refugia and Migration Corridors (NS)*

Focal Watersheds

The term "focal watershed" (FW) was developed by Frissell (1998) to describe "key" catchment areas (refugia) that contain relatively unimpaired ecological structure and function in support of a significant number of salmonid species and life stages. In this study, the term is used to designate stream ecosystem watershed refugia. The scale of these refugia is typically on the order of 10-100 square kilometers. These areas are analogous to the "key watersheds" designated under the FEMAT (1993) process. FW refugia include anadromous migration corridors, as well as spawning and rearing habitat for a number of species. It will be important

to maintain, enhance, or restore natural watershed processes within designated FW refugia to create a complex, diverse landscape pattern of habitats favorable to the native salmonid community. Maintaining connectivity between high-quality habitat patches within each FW will also be critical to the success of the refugia.

This classification of refugia was used to designate those areas that still have a low level of watershed development and retain a significant amount of intact, natural riparian corridor. The FW refugia have maintained a relatively natural hydrologic regime and have very few water quality problems. To be designated as a FW, a watershed must also retain a significant degree of natural salmonid productivity, species diversity, and resilience.

In short, a FW should be able to function as a recolonization source for regional salmonid population recovery. Those refugia designated as focal watersheds are by no means pristine, but they have a significant proportion of natural landscape (forest and wetlands) and segments of high quality instream habitat. The FW selections concentrated on those watersheds that have the greatest potential for recovery to a natural condition. Clearly, the preponderance of research indicates that an ecosystem or watershed approach is the optimum method of aquatic resource protection (Noss and Cooperrider 1994, Spence et al. 1996, Stouder et al. 1997, Naiman and Bilby 1998). Designation of FW refugia recognizes this and will rely heavily on innovative, "fish-friendly" land-use management to conserve our remaining aquatic resources. Clearly, protection and restoration efforts will also be required as part of the overall watershed-based refugia strategy.

Nodal Corridors or Riparian Reserves

Nodal corridors (NC) are those stream segments where refugia occur in the form of complex mosaics of instream habitat, off-channel wetlands, floodplain complexes, and natural riparian forests (Sedell et al. 1990, Stanford et al. 1996, Frissell 1998). These areas have also been called "riparian reserves" (Noss and Cooperrider 1994). As with focal watersheds, these refugia also tend to sustain a disproportionately heavy use by numerous salmonid species and support several life stages. In this study, the NC refugia designation was used for those watersheds where development exists and cumulative impacts have already occurred. It was assumed that protection on a watershed scale was not feasible in these areas. The basic hypothesis is that a riparian reserve strategy will be most effective in the long-term. This approach assumes that protecting a nearly continuous forested corridor around the stream-riparian ecosystem can mitigate for land-use and human activities. Based on current research (May et al. 1997), it is likely that human activities in the watershed will also need to be moderated so as to reduce the cumulative impacts on hydrology, water quality, and other environmental factors. NC refugia have a degree of local resistance to external disturbances and a level of natural resilience. The inclusion of the entire floodplain area, channel migration zone (CMZ), and any associated likely that human activities in the watershed will also need to be moderated so as to reduce the cumulative impacts on hydrology, water quality, and other environmental factors. NC refugia have a degree of local resistance to external disturbances and a level of natural resilience. The inclusion of the entire floodplain area, channel migration zone (CMZ), and any associated wetlands is critical to the structure and function of these riparian reserves (Sedell et al. 1990, Stanford et al. 1996, Frissell 1998). Many nodal corridors have high groundwater levels ,unconfined near-surface aquifers, or extensive hyporheic zones that interact with surface waters in complex paths that help control stream temperatures, hydrologic flows, and nutrient flux (Sedell et al. 1990, Stanford et al. 1996, Knutson and Naef 1997, Frissell 1998). The availability of groundwater and frequent inundation of floodplain areas also encourages natural riparian succession and recovery of native vegetation (Gregory et al. 1991).

Associated with each NC are important tributary and upland areas designated as critical contributing areas (CCA). CCA are not by themselves refugia, and typically do not directly provide habitat for anadromous salmonids, but do contribute indirectly to downstream habitat. These areas, including seasonal and intermittent streams or wetlands, are hydrologically connected to associated nodal corridors. Also included in the CCA category ere areas of steep slopes (>30%), which are prone to mass-wasting events and can be significant sources of sediment to downstream NC refugia. In addition to protecting downstream refugia from hydrologic and erosional impacts, there are also water quality concerns that justify the designation of an area as a CCA. The purpose of this designation is to call attention to upland and tributary areas that may be of critical importance in maintaining ecological integrity of downstream NC refugia habitat. Restoration efforts, such as improved stormwater treatment or rehabilitation of roads within the CCA may be especially important to protecting or enhancing downstream NC refugia habitat (Frissell 1998). It is important to note that all lands within the watershed of a NC/CCA likely influence conditions within the refugium to some degree; therefore, proper land-use management or the entire watershed landscape is vital to the conservation of salmonid resources.

Nearshore and Estuarine Areas

A new type of refugia was developed for this project to address the ecologically important marine environment that is critical to the survival of several salmonid species, including the ESA-listed Puget Sound chinook (PSC). These areas were designated as nearshore refugia (NS). Although most salmonids spend a significant portion of their life history spawning and rearing freshwater, all the anadromous species utilize saltwater areas for the majority of their existence. An important period in the typical salmonid life cycle is spent in the transitional area of the nearshore environment (Groot and Margolis 1991). This is a critical rearing area for juvenile salmonids of all species, but it is especially important to sea-run cutthroat trout, as well as chinook, chum, and pink salmon (Stouder et al. 1997). Juvenile salmonids remain in nearshore habitats for varying residence periods depending on the species, their size at smolt migration from freshwater, the time of year of transition to the marine environment, and the habitat conditions in the nearshore/estuary areas. It should be noted that these designated nearshore refugia, like their freshwater counterparts, also have "critical contributing areas." These areas consist of the shorelines and small streams that drain directly into the nearshore areas. Management of these shoreline areas will be one of the keys to restoring and preserving our nearshore salmonid refuge areas.

One of the most interesting features of salmonid utilization of the nearshore environment is the extraordinary variability that exists with respect to its use. The nearshore habitats used by juvenile and adult salmonids have four primary functions. First, these areas function as foraging habitat. The food selected by salmonids tends to vary with species, age, and size. Detritus-based food webs are important for young salmonids, whereas larger prey are more important to older, larger juveniles. Even with the potentially large selection of prey, only a limited suite of prey is utilized by salmonids (Simenstad 1977). Diet can also vary from species to species. Second, nearshore areas are also critical refuge habitat for adult and juvenile salmonids. Shallow, turbid nearshore areas provide excellent cover for juvenile salmonids to avoid predation. Historically, nearshore areas of Puget Sound were dominated by eelgrass beds and complex intertidal habitat (Simenstad 1994). A third function of nearshore areas is as a physiological transition zone for smolts moving from the freshwater to the marine environment (Simenstad et al. 1982). Finally, adult and juvenile salmonids utilize the nearshore as a migration corridor as they move to and from the ocean environment (Simenstad et al. 1982). The use of nearshore and estuary areas by

salmonid populations is an important part of how they have been able to persist over the long-term in the changing Pacific Northwest environment.

As a result of the variable patterns of nearshore and estuarine use that exist within the salmonid community, the significance of these refugia varies within and among species. Among salmonid researchers and fisheries biologists, it is generally agreed that chinook and chum are the most dependent on nearshore areas (Simenstad et al. 1982, Groot and Margolis 1991, Stouder et al. 1997). It would appear to be no mere coincidence between this ecological fact and the current listing of both species based on the extensive changes that have occurred in the nearshore environment of Puget Sound. The construction of docks, sea-walls, and other human modifications of the nearshore area, as well as degraded water quality due to sewage, stormwater, and industrial runoff appear to have adversely impacted this critical salmonid habitat. The cumulative impacts of these changes have affected the structure of prey communities, reduced the refuge habitat area available, and dramatically modified the ecological functions of the nearshore environment (NRC 1996).

Based on understanding of the importance of nearshore ecotones to almost all salmonid species and our less than complete knowledge of these critical marine habitat areas, protection efforts should be very conservative. An interim protective strategy, similar to that established for riparian areas on streams that support ESA-listed species, should also be established for nearshore refugia. No removal of native vegetation should be allowed in critical nearshore areas, estuaries, and sensitive (steep banks and landslide-prone shorelines). The impacts of development within the nearshore "riparian zone", including structures, septic systems, docks, bulkheads, and roads should be reduced to negligible levels in all refugia. A conservative resource protection strategy should be established for nearshore and "marine riparian" refuge areas until such time as our understanding of these critical habitat areas improves or is refined so as to allow some low impact development. Where development already exists or is planned, "fish friendly" principles should be utilized. In summary our modification of the "nearshore landscape" has diminished the ability of salmonid species to effectively utilize one of their critical rearing and migration habitats (Broadhurst 1998). Recovery of sustainable salmonid populations will require extensive protection, enhancement, and restoration efforts in our designated nearshore refugia (Lynn 1998). The shoreline, low-order streams, seasonal/intermittent channels, and areas directly up-slope from nearshore habitat should be considered as critical contributing areas (CCA) for these refugia.

Although the larger watersheds (Coulter Creek, Rocky Creek, Burley Creek) that originate in Kitsap County, and flow through Pierce County to marine waters, were considered in the Kitsap Peninsula Salmonid Refugia report, the study did not look comprehensively at other watersheds on the Gig Harbor and Key peninsulas in Pierce County. Additional larger watersheds in Pierce County that warrant special consideration for protection are:

- Minter Creek watershed
- Crescent Creek watershed

Although both of these watersheds have somewhat disturbed habitat conditions, both watersheds support natural assemblages of salmonid species and have excellent salmonid production potential. There are also several smaller watersheds with generally good habitat conditions that also warrant protection consideration, including:

- Vaughn Creek
- Dutcher Creek
- Unnamed 15.0028
- Lackey Creek

- Rosedale Creek,

Additional estuarine/nearshore areas in the southern Puget Sound of East WRIA 15 that warrant special consideration for protection include:

- Burley Lagoon (identified in Kitsap Refugia report (CTC 2000))
- Lay Creek estuary
- Wollochet Bay
- Rocky Bay
- Vaughn Bay
- Inner Minter Bay
- Devils Head, Green Pt., and Pt. Fosdick feeder bluffs
- Remaining fragmented shorelines that have not been armored/bulkheaded

Action Recommendations

The following salmonid habitat protection actions are recommended:

- **Review local land-use ordinances; revise as appropriate to ensure protection of existing functional freshwater and nearshore salmonid habitats, including identified refugia**
- **Incorporate habitats that warrant special consideration for protection in the Pierce County portion of East WRIA 15 into a comprehensive salmonid refugia strategy**

DATA GAPS

Although there are a number of watershed reports that have been published related to the drainages and marine waters in East WRIA 15, most have focused primarily on water quality elements. The reports have included limited assessment of habitat factors limiting salmonid production. Much of the information presented in this report reflects the collective personal experience of watershed experts (governmental, tribal, and private) who have been working in these watersheds. In most cases, their personal knowledge is based on site-specific habitat evaluations, rather than comprehensive watershed assessments.

There are several habitat elements for which available information is very limited and for which evaluations cannot be made based on past visual observations (e.g. - water quality, water quantity, status of marine-derived nutrients, etc.). These habitat elements represent general data gaps, except for limited cases where quantitative assessments have been made. Although condition of other habitat elements can typically be assessed based on visual observations, there are a significant number of streams, stream reaches, or shoreline reaches, where no recent personal observations by TAG participants have been made. Generally, knowledge of habitat conditions in freshwater areas was more limited in southern East WRIA 15 streams (Pierce County) than in northern East WRIA 15 streams (see Assessment chapter of this report). This is due, in part, to fewer applications for Hydraulic Project Approvals (issued by WDFW) in southern East WRIA 15 watershed, and treaty-Indian (this area is within the usual and accustomed area of the Puyallup, Nisqually, and Squaxin tribes) habitat efforts concentrating primarily on streams and marine areas closer to their reservations. Efforts should be made to fill identified data gaps, to provide a more complete knowledge base on which to base a prioritized habitat restoration strategy for East WRIA 15.

Data Gaps by Habitat Element

Fish Access

An inventory of fish passage barriers on state highways has been completed for East WRIA 15, including development of Priority Index (PI) values that assist in restoration prioritization. PIs require an assessment of habitat quality and quantity upstream of the identified barrier, and an assessment of whether other barriers exist upstream or downstream of the site. In addition, the South Puget Sound Salmon Enhancement Group (SPSSEG) is currently conducting a comprehensive inventory of fish passage barriers within the Pierce County portion of East WRIA 15; a report should be available by the end of 2000. Although the SPSSEG study should identify all barriers in Pierce County, this initial round does not include development of PIs for the barrier sites. The Kitsap Conservation District (KCD) is working on an inventory of privately owned fish passage barriers in Kitsap County; this is not a comprehensive systematic inventory at this time, but does provide a complete barrier inventory of those drainages in which inventory work has been done (Okeefe). The KCD inventory also does not provide PIs for identified barriers. Completion of a comprehensive inventory of fish passage barriers is needed for Kitsap County. Development of PIs for all identified barriers is also needed to assist in restoration prioritization of the numerous barriers in East WRIA 15.

Floodplain Modifications

Although channelization, dredging, and damming of streams has been common in many of the East WRIA 15 streams, information is quite limited on the extent to which these constrictions

have impaired floodplain function. Most of this past work has been done without an evaluation of the effects to side-channel connectivity, sediment transport, flow velocity, substrate stability, riparian integrity, etc. Studies identifying the cause-effect linkage of floodplain modifications to salmonid habitat would improve the knowledge base used to address current problems and avoid similar problems in the future.

Channel Conditions

The vast majority of streams in East WRIA 15 are identified as being deficient in LWD or pool frequency, particularly in relation to presumed historic condition. There is limited quantitative data to determine the extent of deficiency in relation to target conditions. Knowledge or information regarding bank stability conditions is also generally lacking. Quantitative stream habitat assessments would be beneficial in determining location and appropriate extent of restoration actions, and in providing a baseline for future comparison.

Substrate

No quantitative substrate composition of stream bed stability information was available for East WRIA 15 streams. Qualitative substrate condition evaluations were made for approximately half of the streams; no information or assessment was made for the remaining streams (see Assessment of Habitat Limiting Factors chapter). Of particular concern are the lack of any quantitative information on the relative percentage of fines (particles <0.85 mm) that are present in the gravels (fines exceeding 11% are known to adversely affect salmonid egg incubation in the gravels), and the extent to which streambed elevations have been affected by alterations of natural hydrology. Without substrate quantitative baseline data, it is possible that we may not be recognizing cases where substrate condition is a salmonid habitat limiting factor. A structured substrate sampling program over time would provide improved baseline data on which to make decisions and a reference base for evaluation of habitat restoration benefits.

Riparian

Riparian condition was identified as a habitat limiting factor for the vast majority of streams in East WRIA 15. However, no quantitative sampling data were available to identify specific locations needing riparian restoration. As a result, riparian recommendations are quite general. A comprehensive evaluation of riparian condition, using remote sensing and aerial photography, would provide an excellent information base to use in development of a comprehensive riparian restoration strategy. It would also provide improved baseline data on which to make decisions and a reference base for evaluation of habitat restoration benefits.

Water Quality

The Bremerton-Kitsap Health District has developed a good water quality database for a number of streams in Kitsap County. Although the primary focus of the data collection is on presence of fecal coliform, what makes the data useable for habitat evaluation is that data collected also includes a number of water quality parameters that are necessary to evaluate potential impacts to salmonids (temperature, dissolved oxygen, pH, turbidity). A similar program should be expanded to include other representative streams in East WRIA 15, particularly in Pierce County.

Marine nutrients, provided by salmon carcasses, have been documented as providing the nutrient base for the aquatic food web, as well as contributing significantly to the nutrient base for the

riparian zone and resources that use the riparian area. The returning salmon and steelhead run sizes are much lower than historic levels for most of the streams in East WRIA 15. Little is known regarding current marine nutrient levels in comparison to historic levels and the implications to stream productivity resulting from the loss of marine nutrients.

Water Quantity

East WRIA 15 streams are particularly sensitive to alterations in natural watershed hydrology, as instream flows are strictly supported by precipitation and groundwater. The importance of maintaining instream flows in these streams has long been recognized, with closure to additional water appropriations occurring in some drainages as long ago as the late 1940s. Although there are seasonal or total closures for several streams in East WRIA 15, there appears to be no reason to conclude that similar protection measures are not appropriate for the other drainages in East WRIA 15. Data is currently unavailable to determine the impacts of additional water appropriations to instream salmonid habitat. Instream flow requirements should be developed and implemented for all streams in East WRIA 15.

The salmonid habitat in many of the streams in East WRIA 15 is noted as being adversely affected by the increased frequency and magnitude of peak flows due to stormwater runoff. This runoff results from increased rate and volume of runoff from impervious surfaces, and the channeling of runoff that alters natural infiltration and runoff patterns. This impact is not likely to benefit substantially from further data collection; rather, local governments should complete actions necessary to implement effective stormwater protection ordinances, and implement measures to address existing stormwater impacts.

Estuarine

The natural tidal exchange and sediment transport has been altered in many of the estuaries in East WRIA 15. Although we know the character of the estuaries has been altered, and we presume that there are adverse effects to salmonids, there is insufficient information available on the specific effects of these changes to salmonid access and utilization.

Nearshore/Marine

Marine nearshore habitat has been extensively altered throughout East WRIA 15. Although it is known that there are areas of heavy shoreline armoring, quantitative estimates of armored vs. natural shoreline are not currently available. The Dept. of Natural Resources has recently completed an inventory of overhead and oblique photographs of the entire Washington marine shoreline. An analysis of these photos is anticipated in late 2000. Although this will give a better estimation of the extent of shoreline armoring, the localized effects to shoreline energy, bank erosion on adjacent shoreline parcels, substrate composition, detrital accumulation, benthic production, shoreline sediment recruitment, littoral drift, and baitfish spawning will likely remain as outstanding questions.

Similarly, it is clear that shoreline riparian status is severely compromised throughout much of East WRIA 15. There is information indicating that the loss of riparian shade on the marine shoreline impairs baitfish spawning success (Pentilla 2000). However, with the extent of shoreline armoring and riparian loss that has occurred, we are currently unable to estimate what the nearshore productivity could be in the absence of existing habitat impairments.

Eelgrass and aquatic macroalgae habitats have been documented as very important to salmonids. The presence and occurrence of *Ulva* (spp) appears to be increasing. *Ulva* (spp) appears to provide little salmonid habitat benefit, and it is unknown to what extent *Ulva* may be replacing eelgrass or other aquatic macroalgae beds. A comprehensive regular assessment of eelgrass and other aquatic macroalgae distribution and composition would provide an initial baseline and improved understanding of changes over time. In addition, TAG participants indicated a concern that eelgrass beds may be lost in the vicinity of combined sewer overflow (CSO) outlets, due to lowered salinity or other unknown impacts. An assessment of localized water quality, sediment, and salinity in the vicinity of CSOs would improve understanding of potential adverse impacts to eelgrass beds, provide a foundation for development of marine habitat restoration projects, and provide for better future CSO siting guidelines.

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APPENDICES

APPENDIX A

East WRIA 15 Salmonid Distribution

The following streams in East WRIA 15 are identified as having anadromous salmonid presence. Distribution is based primarily on input of Technical Advisory Group (TAG) participants, with additional consideration of other sources, including A Catalog of Washington Streams and Salmon Utilization (Williams et al. 1975), Salmon and Steelhead Stock Identification (WDF, WDW, and WWTIT 1993), Streamnet (WDFW), Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP), and the Puget Sound Stream Survey Database (WDFW).

Known distribution (code=1 in species column) in these streams represents current knowledge, which is limited to those only streams/locations where observations have been made at the appropriate time of year, and may be significantly different than historic distribution, with current distribution likely being more limited. Reasons for more restricted current distribution include habitat conditions that no longer support salmonids; presence of barriers that preclude salmonid access to productive habitats; and reduced spawner populations that tend to narrow the distribution extent, limit the ability of the fish to maintain suitable substrate conditions, and limit the return of marine nutrients from carcass decomposition that support the instream food web for subsequent juvenile salmonid production.

Presumed species distribution (code=2 in species column) is also identified for a number of streams and species, particularly cutthroat. Little assessment work has been done to verify the extent of cutthroat distribution in WRIA 15. The cutthroat distribution noted in this table reflects only those few streams where direct observations have been made, or where cutthroat distribution is presumed to the uppermost distribution of other salmonids. TAG participants indicate that cutthroat distribution is likely in perennial streams wherever stream gradient is suitable, and in seasonal/intermittent streams where ponds or open-water wetlands exist to sustain cutthroat through dry periods. Potential distribution (code=3 in species column) is only noted for a few streams thought to likely support salmonids, but on which no observations have been made. Potential salmonid distribution is much greater than represented, particularly for cutthroat.

Sustained stream gradient breaks of 8% or 12% (identified by SSHIAP), natural fish passage barriers (cascades, falls), and man-made fish passage barriers are identified on the barriers map in the Maps appendix to this report, but are not included in this reference table or on the species distribution maps. Stream gradient breaks may represent upstream passage barriers to anadromous salmonids; gradient breaks of 8% typically limit upstream passage of chum, while gradient breaks of 12% typically limit upstream passage of other anadromous salmonid species (applicable to chinook only in larger perennial streams). Cutthroat distribution may occur upstream of gradient breaks, provided stream gradient upstream of the gradient break is suitable.

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
14	Spring Creek	15.0001		1				0.25	Smith	To water diversion structure approximately 400 feet upstream of the County Road
217					1			0.25	PCTAG	
							2	0.25		Presumed cutthroat distribution to at least extent of other known salmonids
12	Coulter Creek	15.0002	1					3.80	Phinney	
13				1				4.10	Phinney	
216					1			5.30	Phinney	
12						2			Iverson, Kalinowski	Steelhead distribution presumed to be similar to chinook
510							1	7.75	PCTAG	
124	Unnamed	15.0003	1					0.10	PCTAG	
10				1				1.00	Phinney	
124						2			Iverson, Kalinowski	Steelhead distribution presumed to be similar to chinook
10							2	1.00		Presumed cutthroat distribution to at least extent of other known salmonids
920	Unnamed	15.0004	1					0.25	Phinney	
11				1				0.50	PCTAG	
213					1		1	1.50	Phinney	
920						2			Iverson, Kalinowski	Steelhead distribution presumed to be similar to chinook
971	Unnamed	15.0005					1	0.10	Phinney	
504	Unnamed	15.0006					1	0.55	PCTAG	
214	Unnamed	15.0007			1		1	0.50	Phinney	
215	Unnamed	15.0007A			1			0.30	PCTAG	Tributary to 15.0002 entering at ~RM 3.10. Coho distribution to forks.
505							1	1.65	PCTAG	
506	Unnamed	15.0007B					1	0.45	PCTAG	

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
507	Unnamed	15.0007C					1	1.00	PCTAG	Distribution to head waters at Lake Kriegler. Tributary to 15.0002 entering at ~RM 3.5.
972	Unnamed	15.0008			1			0.20	Phinney	
972							2	0.20		Presumed cutthroat distribution to at least extent of other known salmonids
973	Unnamed	15.0009			1			0.30	Phinney	
508							1	0.80	PCTAG	
509	Unnamed	15.0010					1	0.40	PCTAG	
NA	Unnamed	15.0012							PCTAG	Anadromous salmonid utilization status unknown
NA	Unnamed	15.0014							PCTAG	Anadromous salmonid utilization status unknown
8	Rocky Creek	15.0015	1					1.75	PCTAG	
9				1				3.00	PCTAG	
211					1			3.30	PCTAG	
700						1		3.30	PCTAG	
503							1	4.50	PCTAG	
934	Fork Muck Creek	15.0016	1					0.05	Baranski, Smith	Distribution limited to very lower portion due to lack of flows when adult chinook return
6				1				0.90	Smith, Iverson	
943				2				2.40	Smith, Iverson	Presumed presence to 144th, potential to extend higher into watershed
212					1			9.00	PCTAG	Distribution to headwaters
6						1		0.90	PCTAG	Distribution known to Wright-Bliss Rd., likely to move farther upstream since bridge replaced
502							1	9.00	PCTAG	Distribution to headwaters
NA	Winter Creek	15.0017								Anadromous salmonid utilization status unknown
7	Unnamed	15.0017A		1				1.10	PCTAG	Distribution to forks. Right bank tributary to 15.0016 entering at ~RM 0.5.
209					1			1.10	PCTAG	Distribution to forks.
501							1	1.10	PCTAG	Distribution to forks.

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
210	Unnamed	15.0021			1		2	0.25	PCTAG	Presumed cutthroat distribution to at least extent of other known salmonids
5	Unnamed	15.002X		1				0.01	PCTAG	Small independent tributary entering midway up the southern/eastern shore of Rocky Bay
208					1			0.01	PCTAG	
208							2	0.01		Presumed cutthroat distribution to at least extent of other known salmonids
NA	Unnamed	15.0022							PCTAG	Anadromous salmonid utilization status unknown
1040	Unnamed	15.0023			1		1	0.1	Small	Fish observed to culvert at Hall Road
4	Vaughn Creek	15.0023A		1				0.80	Smith, Iverson	Distribution to forks. Independent stream entering saltwater ~ 0.10 miles south of 15.0023.
207					1			0.80	Smith, Iverson	Distribution to forks.
4							2	0.80		Presumed cutthroat distribution to at least extent of other known salmonids
944	Dutcher Creek	15.0026		3				0.70	Smith, Iverson	Chum potential to road, but unknown presence
205					1			1.20	Smith, Iverson	
205							2	1.20	PCTAG	Presumed cutthroat distribution to at least extent of other known salmonids
206	Unnamed	15.0027			1			0.50	PCTAG	Distribution to headwaters.
206							2	0.50		Presumed cutthroat distribution to at least extent of other known salmonids
204	Unnamed	15.0028			1			0.70	PCTAG	
204							2	0.70		Presumed cutthroat distribution to at least extent of other known salmonids
3	Herron Creek	15.0029		1				0.40	Kalinowski	Distribution to culvert , but steep gradient upstream
203					1			1.30	Smith	Distribution to wetland in headwaters
203							2	1.30		Presumed cutthroat distribution to at least extent of other known salmonids

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
1035	Unnamed	15.0029A		1	1		2	0.01	PCTAG	RB trib. Entering Herron Cr. Just upstream of the mouth. Flows through Herron Beach Comm. Club. Distribution not noted on species maps. Presumed cutthroat distribution to at least extent of other known salmonids.
NA	Unnamed	15.0030							PCTAG	Anadromous salmonid utilization status unknown
2	Kingmans Creek	15.0031		1				0.05	Smith	
202					1			0.05	Smith	
NA	Unnamed	15.0031X							PCTAG	Anadromous salmonid utilization status unknown
NA	Whiteman Creek	15.0032							PCTAG	Anadromous fish passage barrier at mouth
201	Taylor Bay Creek	15.0034			1			0.25	White (landowner)	
201							2	0.25	PCTAG	Presumed cutthroat distribution to at least extent of other known salmonids
NA	Unnamed	15.0035							PCTAG	Anadromous salmonid utilization status unknown
NA	Unnamed	15.0036							PCTAG	Anadromous fish passage barrier at mouth
1	Schoolhouse Creek	15.0039		1				0.15	PCTAG	Distribution to Reeves Road
200					1			0.30	PCTAG	Distribution to ostrich farm
500							1	0.75	PCTAG	Distribution to headwaters.
945	Unnamed	15.0039X		1				0.20	Smith	Independent stream entering the north end of Filucy Bay immediately east of 15.0039. Known presence in lower 1000 ft.
945					1			0.20	Smith	Known presence in lower 1000 ft.
945							2	0.20		Presumed cutthroat distribution to at least extent of other known salmonids
NA	Unnamed	15.0040							PCTAG	Anadromous salmonid utilization status unknown
NA	Unnamed	15.0041							PCTAG	Anadromous salmonid utilization status unknown

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
990	Unnamed	15.0041A			1			0.25		Small independent tributary entering the small bay on the eastern end of the southern shore on Mayo Cove
990							2	0.25		Presumed cutthroat distribution to at least extent of other known salmonids
NA	Mayo Creek	15.0042							PCTAG	Anadromous salmonid utilization status unknown
989	Unnamed	15.0042A			1			0.40	PCTAG	Independent tributary entering the southern shore of Van Geldern Cove at the eastern end of the cove
989							2	0.40		Presumed cutthroat distribution to at least extent of other known salmonids
118	Unnamed	15.0043		1	1			0.50	PCTAG	Distribution to Hoff Road
642							1	0.65	PCTAG	Distribution to headwaters.
	Unnamed	15.0044		3					Kalinowski	Potential chum presence, but unknown
451					1			0.50	Kalinowski	Distribution to headwaters.
451							2	0.50		Presumed cutthroat distribution to at least extent of other known salmonids
117	Lackey Creek	15.0046		1				0.75	PCTAG	
450					1			1.20	Small	Distribution to Highway 302
450							2	1.20		Presumed cutthroat distribution to at least extent of other known salmonids
116	Minter Creek	15.0048	1	1				2.10	PCTAG	
448					1			4.25	PCTAG	Distribution to Pine Rd.
725						1		4.25	Kalinowski	Distribution to Pine Rd.
640							1	4.25	PCTAG	Distribution to Pine Rd.
115	Little Minter Cr.	15.0051	1					1.05	PCTAG	
447					1			3.00	Kalinowski	Distribution to headwaters.
639						1		3.00	PCTAG	Distribution to headwaters.
639							2	3.00		Presumed cutthroat distribution to at least extent of other known salmonids

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
449	Huge Creek	15.0052			1			3.75	PCTAG	Distribution to headwaters.
726						1		2.50	Kalinowski	Distribution to Pine Rd.
641							1	3.75	PCTAG	Distribution to headwaters.
NA	Unnamed	15.0053							PCTAG	Anadromous salmonid utilization status unknown
NA	Unnamed	15.0054							PCTAG	Anadromous salmonid utilization status unknown
114	Burley Creek	15.0056	1					1.90	Iverson	Observed to ~0.5 miles upstream of Oak St. bridge; Small has observed to RM 1.5, but indicated distribution extends upstream
114				1				1.90	Iverson	
441					1			5.20	PCTAG	Distribution to headwaters.
724						1		5.20	PCTAG	Distribution to headwaters.
637							1	5.20	Kalinowski	Distribution to headwaters.
113	Unnamed	15.0056A		1				0.15	PCTAG	Right bank tributary entering Burley Creek at ~RM 1.5.
113							2	0.15		Presumed cutthroat distribution to at least extent of other known salmonids
935	Little Bear Creek	15.0057	1					0.10	Baranski, Kalinowski, Iverson	Chinook observed to only RM 0.1 prior to passage barrier correction(Baranski)
130			2					1.15	Kalinowski, Iverson	Distribution based on correction of culvert and presumed passage upstream.
935				1				0.10	PCTAG	
112				2				1.00	PCTAG	Distribution based on correction of culvert and presumed passage upstream.
935					1			0.10	PCTAG	
446					2			1.90	PCTAG	Distribution to headwaters based on correction of culvert and presumed passage upstream
638							1	1.90	PCTAG	Distribution to headwaters.
439	Unnamed	15.0059			1			0.30	PCTAG	Distribution to instream pond just downstream of SR 16

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
658							1	1.75	PCTAG	Distribution to headwaters.
440	Unnamed	15.0059A			1			0.25	PCTAG	Left bank tributary entering 15.0056 at ~RM 3.0.
440							2	0.25	PCTAG	Presumed cutthroat distribution to at least extent of other known salmonids
936	Purdy Creek	15.0060	2					0.10	Kalinowski, Iverson	Presumed distribution to Highway 3.
111				1				1.00	Kalinowski	
438					1			2.50	Kalinowski	
723						1		2.60	Kalinowski	
636							1	2.75	Kalinowski	
437	Unnamed	15.0061			1			0.30	Kalinowski	
635							1	0.60	Kalinowski	
436	Goodnough Creek	15.0063		1	1			0.01	PCTAG	Distribution limited to lower 100 yds. downstream of old highway
992							1	0.80	Kalinowski	Distribution to beaver dams near golf course on 15.0064
991	Unnamed	15.0064					1	0.40	Kalinowski	Distribution to beaver dams near golf course
110	McCormick Creek	15.0065	1					0.90	Baranski	Distribution to mouth of 15.0066; SSD indicates chinook observed in tributary 15.0066 to RM 1.0, but thought to be a data error
109				1				0.75	PCTAG	Distribution to 15.0066
425					1			0.75	PCTAG	Distribution to 15.0066
722						1		0.75	Kalinowski	Distribution to 15.0066
110							1	0.80		Distribution to mouth of 15.0066
946	Unnamed	15.0066					1	0.20	PCTAG	
108	Lay (Nelyali) Creek	15.0068		1				0.50	PCTAG	To confluence of tributary 15.0069
432					1			0.50	PCTAG	To confluence of tributary 15.0069
947							1	0.25	Iverson	

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
975	Rosedale Creek	15.0069A		1	1		1	0.25	PCTAG	Independent tributary entering the north end of inner bay directly west of Raft Island
107	"Mark Dickson" Cr.	15.0070		1	1		1	0.75	PCTAG, Small	Fish distribution to culvert at outlet of pond; no habitat upstream.
948	Lake Sylvia Cr.	15.0070A		1				0.20	Kalinowski, Small, Burns	Chum distribution not extending quite to Lake Sylvia
431					1			0.30	PCTAG	Right bank tributary entering 15.0070 at ~RM 0.30. Fish distribution to dam at outlet to Lake Sylvia.
431							2	0.30		Presumed cutthroat distribution to at least extent of other known salmonids
NA	Unnamed	15.0071							PCTAG	Anadromous salmonid utilization status unknown, stream gradient possibly too steep for anadromous use
429	Warren Creek	15.0072			1			0.25	Iverson	Juvenile coho observed to road
429							1	0.25	Iverson	Distribution at least to culvert
976	Muri Creek	15.0074					1	0.40	Vernon Young (landowner), Iverson	Stream was shocked by Travis Nelson (Iverson) with only cutthroat found
106	Artondale Creek	15.0075		1				0.60	PCTAG	
427					1			0.90	PCTAG	
NA						3			PCTAG	Potential for steelhead based on stream size, but presence unknown
427							1	0.90	Iverson	
949	Wollochet Creek	15.0080		1				0.20	Burns	
977					1			0.10	PCTAG	
978							1	2.00	Iverson	Distribution at least to Hunt Rd.
1038	Unnamed	15.0080A			1			0.25	PCTAG	Left bank tributary entering 15.0080 at RM 0.3, just downstream of the intersection of Fillmore and Wollochet
979							1	0.50	PCTAG	

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
NA	Garr Creek	15.0080X							Kalinowski	All anadromous fish use precluded by 600-ft. impassable culvert at mouth. Extent of cutthroat distribution unknown.
105	Sullivan Gulch Cr.	15.0087		1				0.15	Kalinowski	Distribution to 25th St. NW (mouth of 15.0087A as noted below)
426					1			0.15	Smith	
634							1	0.75	Iverson	Distribution to mouth of 15.0088
950	Unnamed	15.0087A			1			0.25	PCTAG	Left bank tributary entering 15.0087 just upstream of road
950							2	0.25		Presumed cutthroat distribution to at least extent of other known salmonids
951	Schoolhouse Creek	15.0090		1	1			0.50	Alsbury	Distribution to Powerline Rd.
952							1	0.75	Alsbury	Distribution extending ~300 m upstream of the uppermost Eckenstem/Johnson Rd. crossing
994	Unnamed	15.009X					1	0.10	Iverson	Small independent stream on Fox Island entering the northwestern end of the second inlet from the east on the northern shore of the island
NA	Doc Weathers Cr.	15.0096								Fish passage barrier at mouth, cutthroat potential if habitat restored
104	North Creek	15.0097		1				0.75	Kalinowski	Also known as Donkey Creek.
424					1			0.75	PCTAG	
721						1		0.75	PCTAG	
721							2	0.75		Presumed cutthroat distribution to at least extent of other known salmonids
103	Unnamed	15.0098		1				0.01	PCTAG	
103							2	0.01		Presumed cutthroat distribution to at least extent of other known salmonids
131	Crescent Creek	15.0099	1					2.00	Kalinowski	Historic distribution to RM 2.0 (SSD); contemporary distribution downstream of RM 0.9 (Baranski)

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
102				1				2.00	PCTAG	
423				2				3.10	PCTAG	Presumed chum distribution to lake based on no barriers and low gradient
423					1			3.10	PCTAG	Distribution to headwaters at Crescent Lake.
720						1		3.10	Kalinowski, Iverson	Distribution to headwaters at Crescent Lake.
980							1	3.80	PCTAG	Distribution through upper end of Crescent Lake
101	Sunrise (Ed's) Cr	15.0105		1				0.10	PCTAG	
422					1			0.40	Smith	Natural coho to forks
633							1	0.40	PCTAG	
100	Olalla Creek	15.0107	1					1.75	Kalinowski	Juveniles observed to RM 1.75; Baranski indicates adult distribution thought to only extend to Forsman Rd. culverts at RM 1.0
132				1				1.75	Kalinowski	Chum to mouth of 15.0111
421					1			4.20	Kalinowski	Distribution to headwaters.
719						1		3.30	Kalinowski	
632							1	4.20	Kalinowski	Distribution to headwaters.
99	Unnamed	15.0108		1				0.20	Kalinowski	
418					1			0.20	Kalinowski	
631							1	1.60	Kalinowski	Distribution to headwaters.
419	Unnamed	15.0110			1			0.10	Kalinowski	
419							2	0.10		Presumed cutthroat distribution to at least extent of other known salmonids
420	Unnamed	15.0113			1			0.30	Kalinowski	
420							2	0.30		Presumed cutthroat distribution to at least extent of other known salmonids
417	Fragaria Creek	15.0115			1			0.25	Kalinowski	
630							1	0.15	Kalinowski	
417							2	0.25		Presumed cutthroat distribution to at least extent of other known salmonids

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
416	Unnamed	15.0116			1			0.30	Kalinowski	
657							1	0.30	Kalinowski	
98	Wilson Creek	15.0178		1				0.10	KCTAG	
415					1			0.20	Kalinowski	
629							1	0.55	KCTAG	
628	Unnamed	15.0180					1	0.20	Kalinowski	Distribution to Kara Lane
627	Unnamed	15.0181					1	0.30	KCTAG	
414	Unnamed	15.0183			1			0.50	KCTAG	
626							1	0.75	KCTAG	
937	Curley Creek	15.0185	1					1.80	Oleyar	
NA				1				3.70	KCTAG	Distribution throughout and into Salmonberry Creek
NA					1			3.70	KCTAG	Distribution throughout and into Salmonberry Creek
NA						1		3.70	KCTAG	Distribution throughout and into Salmonberry Creek
NA							1	3.70	KCTAG	Distribution throughout and into Salmonberry Creek
953	Unnamed	15.0186		1				0.30	Oleyar	Distribution to Locker road
445					1			0.40	Small	
624							1	0.70	KCTAG	
954	Unnamed	15.0187		1				0.10	Oleyar	
444					1			0.65	Small	Chris Byrnes has observed coho upstream of Locker Rd.
622							1	0.65		
123	Salmonberry Cr.	15.0188		1				1.60	Oleyar, Davis	
NA					1			3.80	Kalinowski	Presence based on distribution in 15.0190, nothing precluding access downstream of Mile Hill Rd.; Doris Small has observed in vicinity of Bullman Rd.
921						1		3.00	Oleyar	Known distribution; nothing preventing distribution to headwaters
NA							1	3.80		Known distribution based on known presence upstream in 15.0190

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
	Unnamed	15.0189		1			1	1.10	KCTAG	Distribution to headwaters.
442					1			0.75	Small	
NA	Unnamed	15.0189A							KCTAG	Right bank tributary entering Salmonberry at RM 3.0; creek probably provides rearing, spawning use unknown
443	Unnamed	15.0190			1			0.30	Small	
623							1	0.60	KCTAG	Distribution to headwaters.
97	Duncan Creek	15.0191		1				0.01	Dave Kimbal	Chum distribution to impassable culvert at road
621					1			0.20	KCTAG	
621							1	0.20	Kalinowski	
96	Beaver Creek	15.0192		1				0.60	Burns	
413					1			1.30	KCTAG	
620							1	1.50	KCTAG	
411	Unnamed	15.0193			1			0.40	Kalinowski	
411							2	0.40		Presumed cutthroat distribution to at least extent of other known salmonids
95	Unnamed	15.0194		1				0.10	Kalinowski	
412					1			0.30	Kalinowski	
955							1	0.90	KCTAG	
94	Unnamed	15.0195		1				0.01	Kalinowski	
94							2	0.01		Presumed cutthroat distribution to at least extent of other known salmonids
410	Duncan Creek	15.0196			1			0.50	Kalinowski	
410							2	0.50		Presumed cutthroat distribution to at least extent of other known salmonids
956	Sullivan Creek	15.0200		1				0.05	Kalinowski	A few chum observed spawning at the mouth of the stream
956							2	0.05		Presumed cutthroat distribution to at least extent of other known salmonids

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
957	Wilson Creek	15.0201		1				0.05	Kalinowski	Distribution to wall at upper end of sewage treatment plant
409					1			0.55	Kalinowski	Distribution to Mile Hill Drive
959							2	1.80	KCTAG	Distribution of cutthroat unknown, but presumed to headwaters
958	Annapolis Creek	15.0202		1				0.80	KCTAG	
408					1			0.60	KCTAG	
619							1	1.50	Kalinowski	
90	Blackjack/Square Cr.	15.0203	1					1.70	Oleyar	
92				1				5.30	KCTAG	
406					1			7.50	Bob Wiltermood	Distribution to Square Lake
727						1		4.90	Kalinowski	Distribution to mouth of 15.0206
654							1	8.20	KCTAG	Continued as extension of main stem of Blackjack Creek.
91	Ruby Creek	15.0205		1				0.40	Dorn/Zischke	Chum historically, but not in recent years
405					1			1.60	Kalinowski	As many as 20 coho adults to headwaters
653							1	1.20	KCTAG	Distribution to headwaters.
405							2	1.60		Presumed cutthroat distribution to at least extent of other known salmonids
93	Unnamed	15.0206		1				0.30	KCTAG	
656					1		1	0.60	KCTAG	
656						1		0.60	Kalinowski	
922	Unnamed	15.0206X				1		0.60	KCTAG	Right trib. entering 15.0206 at ~RM 0.5
922							2	0.60	KCTAG	Right trib. entering 15.0206 at ~RM 0.5; presumed cutthroat distribution to at least the extent of other known salmonids
655	Unnamed	15.0206X			1			0.50	Baranski	Right bank tributary entering 15.0206 at ~RM 0.7
655							1	0.50	KCTAG	Right bank tributary entering 15.0206 at ~RM 0.7
407	Unnamed	15.0207			1			0.10	Baranski	

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
407							2	0.10		Presumed cutthroat distribution to at least extent of other known salmonids
618	Unnamed	15.0208					3	0.75	Kalinowski	Historic presence only, habitat eliminated by road
89	Ross Creek	15.0209		1				0.75	KCTAG	
404					1			1.20	KCTAG	Possible presence to wetlands at headwaters, but unknown
404							2	1.20	KCTAG	Presumed cutthroat distribution to at least extent of other known salmonids
88	Unnamed	15.0210		1				0.40	KCTAG	
403					1			0.60	KCTAG	
728						1		1.60	KCTAG	
617							1	1.70	KCTAG	
919	Anderson Creek	15.0211		1				0.60	Oleyar	
401					1			1.00	KCTAG	
923						1		1.60	Kalinowski	Distribution to Old Clifton Rd.
615							1	1.00	KCTAG	
960	EF Anderson	15.0212		1				0.25	Oleyar	
402					1			0.80	KCTAG	
616							1	1.00	KCTAG	
87	Unnamed	15.0215		1				0.70	KCTAG	
399					1			1.00	Small	
613							1	1.00	KCTAG	
83	Gorst Creek	15.0216	1					1.10	Oleyar/Zischke	
84				1				1.90	KCTAG	
397					1			3.40	KCTAG	Distribution to base of landfill.
718						1		1.80	KCTAG	
611							1	3.40	KCTAG	Distribution to base of landfill.
86	Unnamed	15.0217		1				0.10	KCTAG	
400					1			1.15	Kalinowski	
614							1	1.25	KCTAG	

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
961	Jarstad Creek	15.0218		1	1			0.10	Oleyar	Distribution to railroad
609							1	0.50	KCTAG	
85	Parish Creek	15.0220	1					0.10	Baranski	
85				1				0.10	KCTAG	
398					1			0.60	Baranski	
612							1	1.25	KCTAG	
396	Heins Creek	15.0221		1	1	1		0.20	Oleyar	Distribution to railroad
610							1	1.50	Oleyar	Distribution at least through Heins Lake
82	Wright Creek	15.0225		1				0.01	KCTAG	
608							1	0.80	Kalinowski	Distribution to dam.
81	Unnamed	15.0226		1				0.28	Kalinowski	Distribution to Highway 3
395					1			0.28	Kalinowski	Distribution to Highway 3
981							1	0.60	Kalinowski	Distribution to forks based on identified presence in 15.0227
607	Unnamed	15.0227					1	0.25	Kalinowski	
938	Chico/Wildcat Cr.	15.0229	1					0.50	Oleyar	Distribution to golf course
77				1				4.30	KCTAG	Distribution to Wildcat Lake.
393					1			4.30	KCTAG	Distribution to Wildcat Lake; there is potential in tribs. To lake, but unknown
393						1		4.30	KCTAG	Distribution to Wildcat Lake
605							1	5.75	KCTAG	
962	Unnamed	15.0229x		1	1			0.10	Oleyar	Left bank tributary to Chico entering just upstream of Highway 3
962							2	0.10		Presumed cutthroat distribution to at least extent of other known salmonids
963	Unnamed	15.0229X			1			0.05	Oleyar	Left bank trib. entering Chico at RM 0.3; distribution to Chico Way
963							2	0.05		Presumed cutthroat distribution to at least extent of other known salmonids

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
80	Kitsap Lake Creek	15.0230		1				0.50	KCTAG	Distribution to Kitsap Lake.
606					1			2.30	Baranski	Distribution through lake into tributary stream
80						1		0.50	KCTAG	Distribution to Kitsap Lake.
606							2	2.30		Presumed cutthroat distribution to at least extent of other known salmonids
79	Dickerson Creek	15.0231		1				0.75	KCTAG	Distribution to natural falls
392					1			0.75	KCTAG	Distribution to natural falls
715						1		0.75	KCTAG	Distribution to natural falls
392							1	0.75	Oleyar	Distribution to natural falls
1029	Unnamed	15.0232		1			2	0.10	Oleyar	
76	Unnamed	15.0233		1				0.30	KCTAG	
76							2	0.30		Presumed cutthroat distribution to at least extent of other known salmonids
78	Lost Creek	15.0234		1				1.90	Oleyar	Distribution to natural impassable cascade
394					1			1.90	Oleyar	Distribution to natural impassable cascade
717						1		1.90	Oleyar	Distribution to natural impassable cascade
604							1	1.90	Oleyar	Distribution to natural impassable cascade
1028	Unnamed	15.0235		1	1		1	0.10	Oleyar	
1027	Unnamed	15.0236		1	1		1	0.10	Oleyar	
964	Unnamed	15.0229x		1				0.05	Oleyar	Left bank tributary entering Wildcat at RM 4.2
964							2	0.05		Presumed cutthroat distribution to at least extent of other known salmonids
75	Unnamed	15.0241		1				0.05	KCTAG	
603							1	0.35	KCTAG	Distribution to forks.
74	Unnamed	15.0242A		1				0.50	KCTAG	Independent stream entering Dyes Inlet ~.20 miles north of 15.0241.
602							1	0.10	KCTAG	

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
73	Unnamed	15.0242B		1				0.05	KCTAG	Independent stream entering Dyes Inlet ~.40 miles north of 15.0241.
601							1	0.10	KCTAG	
600	Unnamed	15.0243					1	0.10	KCTAG	
599	Unnamed	15.0244					1	0.10	KCTAG	
72	Koch Creek	15.0245		1				0.10	KCTAG	
598							1	0.10	KCTAG	
71	Strawberry Creek	15.0246		1		1		1.00	KCTAG	Distribution to Highway 3
389					1			2.05	Kalinowski	
596							1	2.05	KCTAG	
924	WF Strawberry	15.0247		1				0.10	Burns, Dorn	Distribution to Highway 3
390					1			0.60	Kalinowski	
924						1		0.15	Kalinowski	Distribution to Highway 3
597							1	0.75	KCTAG	
NA	Unnamed	15.0248							KCTAG	No salmonid utilization due to habitat elimination, important to water quality in Dyes Inlet
68	Clear Creek	15.0249	1					0.80	KCTAG	
69				1				1.40	Oleyar	
982					1			2.60	KCTAG	Distribution based on presence in 15.0254
925						1		2.30	Dorn	Distribution to Mountain View Rd.
556							1	2.80	KCTAG	
70	WF Clear Creek	15.0250	1	1				1.10	KCTAG	Distribution to forks.
386					1			1.50	KCTAG	
926						1		0.30	Dorn	Distribution to Highway 3
594							1	1.50	KCTAG	
965	Unnamed	15.0251		1				0.80	Kalinowski	Distribution to Bangor Base
387					1			0.30	KCTAG	
595							1	0.40	KCTAG	
385	Unnamed	15.0254			1			0.50	KCTAG	Distribution to headwaters.

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
385							2	0.50	KCTAG	Presumed cutthroat distribution to at least extent of other known salmonids
64	Barker Creek	15.0255	1					0.30	KCTAG	Distribution to Nels Nelson Road, extend to forks when culvert replaced
65				1				1.50	Kalinowski, Small	
379					1			2.50	KCTAG	Distribution to 2nd instream pond
714						1		1.20	KCTAG	Distribution to mouth of Hoot Creek
588							1	2.75	KCTAG	
379	Hoot Creek	15.0255A			1			0.50	KCTAG	Left bank tributary entering Barker at ~RM 1.2.
983							1	1.20	Kalinowski	
1032	Unnamed	15.0257		1			1	0.25	Dorn	Chum use to blocking culvert at Tracyton Blvd.
1031	Pharmann Creek	15.0258					1	0.20	Dorn	Chum use to blocking culvert at Tracyton Blvd.
1030	Mosher Creek	15.0259		1				0.25	Kalinowski	Distribution to Tracyton Blvd.
384					1			1.25	Kalinowski	Distribution to headwaters reported by residents
553							1	1.25	Kalinowski	Distribution to Saturn Lane
1033	Unnamed	15.0260					2	1.00	Kalinowski	Cutthroat presence reported by residents, upper extent of distribution unknown, represented to SSHIAP gradient barrier
NA	Unnamed	15.0262							KCTAG	Steep gradient, flashy flows, no anadromous potential
67	Dee (Enetai) Creek	15.0264		1				0.10	Small	Independent stream entering on West side of Port Richard ~1 mile North of Point Herron.
383					1			0.20	Small	
592							1	0.30	Small	
NA	Illahee Springs	15.0265							KCTAG	Anadromous salmonid utilization status unknown
66	Illahee Creek	15.0266		1				0.40	Small	Independent stream entering on West side of Port Richard ~3 miles north of Point Herron.
382					1			0.70	Dorn	Current distribution to just below Rollin Hills Golf Course
1037					3			1.00		TAG reports historic coho presence to headwater

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
										wetlands
589							1	0.70	Small	
591	Unnamed	15.0267					1	0.10	Small	Right bank tributary entering 15.0266 at ~RM 0.45.
381	Unnamed	15.0267A			1			0.25	Small	Left bank tributary entering 15.0266 at ~RM 0.20.
500							1	0.25	Small	
NA	Unnamed	15.0269							KCTAG	Fish passage barrier just upstream of mouth
NA	Unnamed	15.0272							KCTAG	Fish passage barrier just upstream of mouth, thought to have cutthroat potential
939	Steele Creek	15.0273	1					0.20	Baranski	Distribution to mouth of 15.0275
63				1				0.50	KCTAG	
378					1			1.00	KCTAG	
927						1		0.40	KCTAG	
586							1	2.00	Dorn	
940	SF Steele Cr.	15.0274	1					0.10	Oleyar	
61				1				0.20	KCTAG	
376					1			1.60	Kalinowski	Distribution based on dead carcass in headwaters
928						1		0.30	KCTAG	
587							1	1.50	Kalinowski	
941	EF Steele Creek	15.0275	1					0.30	Baranski	Distribution to road
62				1				0.50	KCTAG	
377					1			0.60	KCTAG	
929						1		0.20	KCTAG	
585							1	1.60	Dorn	
584	Keyport Creek	15.0276					1	0.20	KCTAG	Independent stream entering Styles Lagoon on Keyport Naval Station
583	Unnamed	15.0277					1	0.35	KCTAG	Independent stream entering saltwater ~0.20 miles east of 15.0278.
NA					3				KCTAG	Coho potential, but unknown
60	Daniels Creek	15.0278		1				0.05	KCTAG	

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
NA					3				KCTAG	Coho potential, but unknown
582							1	0.45	KCTAG	
59	Little Scandia Creek	15.0279		1				0.10	Oleyar, Kalinowski	
375					1			0.20	Kalinowski	
581							1	1.15	KCTAG	
58	Big Scandia Creek	15.0280		1				1.00	KCTAG	
374					1			3.10	Dorn	Distribution to Highway 3
713						1		2.50	KCTAG	
580							1	2.90	KCTAG	
57	Unnamed	15.0281		1				0.05	KCTAG	
57							2	0.05		Presumed cutthroat distribution to at least extent of other known salmonids
966	MF Johnson Cr.	15.0283		1				0.10	Oleyar	
372					1			0.20	KCTAG	
579							1	0.50	KCTAG	
967	Johnson Cr. Trib.	15.0282		1				0.10	Dorn, Oleyar	Distribution limited to downstream of mass of concrete and piping debris
967							2	0.10		Presumed cutthroat distribution to at least extent of other known salmonids
56	NF Johnson Creek	15.0284		1				1.00	Oleyar	
373					1			1.50	Oleyar	Distribution to Highway 3
578							1	1.10	KCTAG	
120	Dogfish Creek	15.0285	1					1.50	KCTAG	
55				1				1.75	KCTAG	
454					1			2.80	KCTAG	
712						1		1.60	KCTAG	
577							1	2.90	Kalinowski	

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
54	SF Dogfish	15.0285A		1				0.90	Patrick Allen/Dorn	Left bank tributary entering 15.0285 at ~RM 0.40. Distribution to below forks.
368					1			1.00	Kalinowski	Distribution to forks.
573							1	1.00	Zischke	Distribution to forks.
369	Unnamed	15.0285B			1			0.15	KCTAG	Right bank tributary entering 15.0285A at ~RM 0.40.
574							1	0.25	KCTAG	
942	NF/EF Dogfish	15.0286	1					0.70	Suquamish	
121				1		1		1.00	KCTAG	Distribution to forks.
370					1			1.75	KCTAG	
575							1	1.80	KCTAG	
371	Unnamed	15.0287			1			0.45	KCTAG	
576							1	0.45	KCTAG	
53	Bjorgen Creek	15.0290		1				0.30	KCTAG	
367					1			1.40	KCTAG	
993							1	1.40	KCTAG	
52	Unnamed	15.0291		1				0.20	KCTAG	
366					1			0.20	KCTAG	
930						2		0.30	KCTAG	Presumed distribution to fork
572							1	1.20	KCTAG	
931	Unnamed	15.0292				2		0.10	KCTAG	
571							1	0.45	KCTAG	
51	Sam Snyder Creek	15.0293		1				0.25	KCTAG	
365					1			0.25	KCTAG	
569							1	0.25	KCTAG	
570							3	1.80	KCTAG	Potential cutthroat distribution to headwaters.
364	Unnamed	15.0294			1			0.15	KCTAG	
364							2	0.15		Presumed cutthroat distribution to at least extent of other known salmonids
119	Klaebel	15.0296		1				0.25	KCTAG	

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
363					1			0.85	KCTAG	
568							1	1.10	KCTAG	
50	Unnamed	15.0297		1				0.10	KCTAG	
50							2	0.10		Presumed cutthroat distribution to at least extent of other known salmonids
362	Cowling Creek	15.0298		1				0.05	KCTAG	
362					1			0.05	Dorn	Distribution downstream of highway
567							1	0.60	KCTAG	
566	Unnamed	15.0298A					1	0.40	KCTAG	Left bank tributary entering 15.0298 at ~RM 0.10.
49	Grovers Creek	15.0299	1	1				0.05	Dorn	Distribution to hatchery rack
565					1			5.10	Kalinowski	Distribution to headwaters
711						1		3.30	Dorn	Distribution to Highway 104
565							1	5.10	Dorn	Distribution to headwaters.
358	Unnamed	15.0300			1			0.15	Dorn	Right bank tributary entering 15.0299 at ~RM 0.10.
561							1	0.60	Dorn	
357	Unnamed	15.0301			1			0.20	Dorn	Left bank tributary entering 15.0299 at ~RM 0.10.
357							2	0.20		Presumed cutthroat distribution to at least extent of other known salmonids
360	Unnamed	15.0302			1			0.80	Dorn	
562							1	1.00	Dorn	
	Unnamed	15.0302A					1	0.90	KCTAG	Right bank tributary entering 15.0302 at ~RM 0.4
359	Unnamed	15.0303			1			0.40	Dorn	
563							1	0.50	Dorn	Distribution to headwaters.
361	Unnamed	15.0304			1			0.40	Dorn	
932						1		0.25	Dorn	Distribution to Highway 104
564							1	0.60	Dorn	
NA	Unnamed	15.0305							KCTAG	This and other adjacent independent streams have fish passage barriers at the mouth, most have potential to support at least cutthroat

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
48	Kitsap Creek	15.0305X		1				0.25	KCTAG	Independent stream entering saltwater ~1.15 miles southeast of 15.0305.
356					1			0.30	KCTAG	
559							1	0.90	Zischke	
47	Indianola Cr.	15.0305X		1				0.10	KCTAG	Independent stream entering saltwater ~ 1.50 miles southeast of 15.0305
355					1			0.30	KCTAG	
558							1	0.60	KCTAG	
557	Unnamed	15.0305X					1	0.50	KCTAG	Independent stream entering Port Madison 1.0 mile southwest of Pt. Jefferson
555	Unnamed	15.0306					1	0.30	Kalinowski	
554	Unnamed	15.0307					1	0.75	Kalinowski	
354	Unnamed	15.0308			1		2	0.70	Kalinowski	Presumed cutthroat distribution to at least extent of other known salmonids
968	Carpenter Creek	15.0309		1				0.80	KCTAG	
353					1			1.30	KCTAG	Distribution to Highway 104
552							1	1.25	KCTAG	
352	Silver Creek	15.0310			1			1.10	KCTAG	
551							1	1.20	KCTAG	
351	Eglon Creek	15.0311			1			0.40	Kalinowski	
549							1	0.70	Kalinowski	
550	Unnamed	15.0312					1	0.90	KCTAG	
1041	Unnamed	15.0316					1	1.25	Kalinowski	Cutthroat observed approx. 0.25 mile upstream of Gusthalvor Rd.
660	Unnamed	15.0318					1	0.1	Kalinowski	Cutthroat observed downstream of Twin Spits Rd. Cutthroat also observed in Buck Lake, but questionable whether sufficient flow and habitat exist between Buck Lake and lower creek to support cutthroat

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
463	Unnamed	15.0319A			1		1	0.15	Ash	Independent stream entering Port Madison Bay at the north end of Bainbridge Island.
1039	Dripping Water Cr.	15.0320			1			0.15	Ash	Independent stream entering Puget Sound at the north end of Rolling Bay on the northeast shore of Bainbridge Island
984							1	1.1	Ash	Cutthroat observed upstream of falls at RM 0.15; suitable cutthroat habitat to headwaters
128	Murden Cove Creek	15.0321		1				0.40	Ash	
464					1		1	0.60	Ash	
129	Ravine Creek	15.0324		1				0.20	Ash	
985					1			0.30	KCTAG	
652							1	0.60	KCTAG	
986	Unnamed	15.0324A			1			0.01	Ash	Independent stream entering Eagle Harbor near end of Winslow Way W.
986							2	0.01		Presumed cutthroat distribution to at least extent of other known salmonids
NA	Sportsmens Club Pd.	15.0325								Fish passage barrier at mouth, potential to support anadromous salmonids
969	Head of Bay Cr.	15.0326		1	1			0.20	Ash	Tributary enters end of Eagle Harbor; anadromous distribution to dam at RM 0.2
988							1	0.50	Ash	
970	Blakely Falls Cr.	15.0330X		1	1		1	0.05	Ash	Independent tributary midway out north shore of Blakely Harbor on Bainbridge Island; distribution to Halls Hill Rd.
456	Macs Dam Creek	15.0331			1			0.15	KCTAG	Independent stream entering northwest end of Blakely Harbor on Bainbridge Island
643							1	0.30	Ash	
455	Unnamed	15.0332			1			0.05	KCTAG	Independent stream entering southwest end of Blakely Harbor on Bainbridge Island

GIS #	Stream Name	Stream#	Species					Extent (RM)	Source	Comments
			Chin	Chum	Coho	Sthd	Cutt			
455							2	0.05		Presumed cutthroat distribution to at least extent of other known salmonids
457	Schel-chelb Creek	15.0328X		1	1		1	0.40	Ash	Independent stream in Rich Passage entering harbor northwest of Pleasant Beach.
645	Unnamed	15.0328X					1	0.50	KCTAG	Right bank tributary entering Schel-chelb Cr. at ~RM 0.35.
126	Fletcher Creek	15.0340		1				1.00	Ash	
NA					1			1.20	KCTAG	Uppermost distribution based on presence in 15.0342
933						1		0.50	KCTAG	
646							1	1.60	Kalinowski	
459	Unnamed	15.0341			1			0.40	KCTAG	
647							1	0.40	KCTAG	
1036	Unnamed	15.0342			1		2	0.30	Daly via Ash	
648	Issei Creek	15.0343			1		1	0.6	Ash	
127	Manzanita Creek	15.0344		1				0.25	Ash	
462					1			1.15	Ash	
650							1	1.15	Ash	
461	NF Manzanita	15.0344A			1			0.50	Ash	Right bank tributary entering 15.0344 at ~RM 0.25
651							2	0.50		Presumed cutthroat distribution to at least extent of other known salmonids
460	Unnamed	15.0345			1			0.10	KCTAG	
649							1	0.20	KCTAG	

Appendix A fish distribution information sources

Sources:	PCTAG	Pierce County Technical Advisory Group (primarily WDFW, Puyallup Tribe, Pierce County)
	KCTAG	Kitsap County Technical Advisory Group (primarily WDFW, Suquamish Tribe, Kitsap County, City of Bainbridge Island)
	Ash	Terry Ash, City of Bainbridge Island
	Baranski	Chuck Baranski, WDFW
	Dorn	Paul Dorn, Suquamish Tribe
	Kalinowski	Steve Kalinowski, WDFW
	Iverson	John Iverson, Puyallup Tribe
	Smith	Blake Smith, Puyallup Tribe
	Zischke	Jay Zischke, Suquamish Tribe
	Small	Doris Small, WDFW
	Burns	Tom Burns, WDFW
	PSCRBT	Puget Sound Cooperative River Basin Team (published reports)
	Oleyar	Jon Oleyar, Suquamish Tribe
	Phinney	Lloyd Phinney, Consultant
	Alsbury	Todd Alsbury, SPSSEG
	Suquamish	Paul Dorn, Jay Zischke, Jon Oleyar
	Puyallup	Blake Smith, John Iverson

APPENDIX B

SALMONID HABITAT CONDITION RATING STANDARDS FOR IDENTIFYING LIMITING FACTORS

Under the Salmon Recovery Act (passed by the legislature as House Bill 2496, and later revised by Senate Bill 5595), the Washington Conservation Commission (WCC) is charged with identifying the habitat factors limiting the production of salmonids throughout most of the state. This information should guide lead entity groups and the Salmon Recovery Funding Board in prioritizing salmonid habitat restoration and protection projects seeking state and federal funds. Identifying habitat limiting factors requires a set of standards that can be used to compare the significance of different factors and consistently evaluate habitat conditions in each WRIA throughout the state.

In order to develop a set of standards to rate salmonid habitat conditions, several tribal, state, and federal documents that use some type of habitat rating system (Table 1) were reviewed. The goal was to identify appropriate rating standards for as many types of habitat limiting factors as possible, with an emphasis on those that could be applied to readily available data. Based on the review, it was decided to rate habitat conditions into three categories: Good, Fair, and Poor. For habitat factors that had wide agreement on how to rate habitat condition, the accepted standard was adopted by the WCC. For factors that had a range of standards, one or more of them were adopted. Where no standard could be found, a default rating standard was developed, with the expectation that it will be modified or replaced as better data become available.

Table 1 - Source documents

Code	**Document**	**Organization**
Hood Canal	Hood Canal/Eastern Strait of Juan de Fuca Summer Chum Habitat Recovery Plan, Final Draft (1999)	Point No Point Treaty Council, Skokomish Tribe, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Washington Department of Fish and Wildlife
ManTech	An Ecosystem Approach to Salmonid Conservation, vol. 1 (1995)	ManTech Environmental Research Services for the National Marine Fisheries Service, the US Environmental Protection Agency, and the US Fish and Wildlife Service
NMFS	Coastal Salmon Conservation: Working Guidance for Comprehensive Salmon Restoration Initiatives on the Pacific Coast (1996)	National Marine Fisheries Service
PHS	Priority Habitat Management Recommendations: Riparian (1995)	Washington Department of Fish and Wildlife
Skagit	Skagit Watershed Council Habitat Protection and Restoration Strategy (1998)	Skagit Watershed Council
WSA	Watershed Analysis Manual, v4.0 (1997)	Washington Forest Practices Board
WSP	Wild Salmonid Policy (1997)	Washington Department of Fish and Wildlife

The ratings adopted by the WCC are presented in Table 2. These ratings are not intended to be used as thresholds for regulatory purposes, but as a coarse screen to identify the most significant habitat limiting factors in a WRIA. They also will hopefully provide a level of consistency between WRIAs that allows habitat conditions to be compared across the state. However, for many habitat factors, there may not be sufficient data available to use a rating standard or there may be data on habitat parameters where no rating standard is provided. For these factors, the professional judgment of the TAG should be used to assign the appropriate ratings. A set of narrative standards will be developed in the near future to provide guidance in this situation.

In some cases there may be local conditions that warrant deviation from the rating standards presented here. This is acceptable as long as the justification and a description of the procedures that were followed are clearly documented in the limiting factors report. Habitat condition ratings specific to streams draining east of the Cascade crest were included where they could be found, but for many parameters they were not. Additional rating standards will be included as they become available. In the meantime, TAGs in these areas will need to work with the standards presented here or develop alternatives based on local conditions. Again, if deviating from these standards, the procedures followed should be clearly documented in the limiting factors report.

Table 2 - WCC salmonid habitat condition ratings

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
Access and Passage						
Artificial Barriers	% known/potential habitat blocked by artificial barriers	All	>20%	10-20%	<10%	WCC
Floodplains						
Floodplain Connectivity	Stream and off-channel habitat length with lost floodplain connectivity due to incision, roads, dikes, flood protection, or other	<1% gradient	>50%	10-50%	<10%	WCC
Loss of Floodplain Habitat	Lost wetted area	<1% gradient	>66%	33-66%	<33%	WCC
Channel Conditions						
Fine Sediment	Fines < 0.85 mm in spawning gravel	All – Westside	>17%	11-17%	≤11%	WSP/WSA/ NMFS/Hood Canal
	Fines < 0.85 mm in spawning gravel	All – Eastside	>20%	11-20%	≤11%	NMFS

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
Large Woody Debris	pieces/m channel length	≤4% gradient, <15 m wide (Westside only)	<0.2	0.2-0.4	>0.4	Hood Canal/Skagit
	or use Watershed Analysis piece and key piece standards listed below when data are available					
	pieces/channel width	<20 m wide	<1	1-2	2-4	WSP/WSA
	key pieces/channel width*	<10 m wide (Westside only)	<0.15	0.15-0.30	>0.30	WSP/WSA
	key pieces/channel width*	10-20 m wide (Westside only)	<0.20	0.20-0.50	>0.50	WSP/WSA
	* Minimum size to qualify as a key piece:	BFW (m) / Diameter (m) / Length (m) 0-5 / 0.4 / 8 6-10 / 0.55 / 10 11-15 / 0.65 / 18 16-20 / 0.7 / 24				
Percent Pool	% pool, by surface area	<2% gradient, <15 m wide	<40%	40-55%	>55%	WSP/WSA
	% pool, by surface area	2-5% gradient, <15 m wide	<30%	30-40%	>40%	WSP/WSA
	% pool, by surface area	>5% gradient, <15 m wide	<20%	20-30%	>30%	WSP/WSA
	% pool, by surface area	>15 m	<35%	35-50%	>50%	Hood Canal

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
Pool Frequency	Channel widths per pool	<15 m	>4	2-4	<2	WSP/WSA
	Channel widths per pool	>15 m	-	-	chann width / pools/ mile / cw/ pool 50' / 26 / 4.1 75' / 23 / 3.1 100' / 18 / 2.9	NMFS
Pool Quality	pools >1 m deep with good cover and cool water	All	No deep pools and inadequate cover or temperature, major reduction of pool volume by sediment	Few deep pools or inadequate cover or temperature, moderate reduction of pool volume by sediment	Sufficient deep pools	NMFS/WSP /WSA
Streambank Stability	% of banks not actively eroding	All	<80% stable	80-90% stable	>90% stable	NMFS/WSP
Sediment Input						
Sediment Supply	$m^3/km^2/yr$	All	> 100 or exceeds natural rate*	-	< 100 or does not exceed natural rate*	Skagit
	* Note: this rate is highly variable in natural conditions					
Mass Wasting		All	Significant increase over natural levels for mass wasting events that deliver to stream	-	No increase over natural levels for mass wasting events that deliver to stream	WSA
Road Density	mi/mi^2	All	>3 with many valley bottom roads	2-3 with some valley bottom roads	<2 with no valley bottom roads	NMFS
	or use results from Watershed Analysis where available					

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
Riparian Zones						
Riparian Condition	• riparian buffer width (measured out horizontally from the channel migration zone on each side of the stream) • riparian composition	Type 1-3 and untyped salmonid streams >5' wide	<75' or <50% of site potential tree height (whichever is greater) OR • Dominated by hardwoods, shrubs, or non-native species (<30% conifer) unless these species were dominant historically.	• 75'-150' or 50-100% of site potential tree height (whichever is greater) AND • Dominated by conifers or a mix of conifers and hardwoods (≥30% conifer) of any age unless hardwoods were dominant historically.	• >150' or site potential tree height (whichever is greater) AND • Dominated by mature conifers (≥70% conifer) unless hardwoods were dominant historically	WCC/WSP
	• buffer width • riparian composition	Type 4 and untyped perennial streams <5' wide	<50' with same composition as above	50'-100' with same composition as above	>100' with same composition as above	WCC/WSP
	• buffer width • riparian composition	Type 5 and all other untyped streams	<25' with same composition as above	25'-50' with same composition as above	>50' with same composition as above	WCC/WSP

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
Water Quality						
Temperature	degrees Celsius	All	>15.6° C (spawning) >17.8° C (migration and rearing)	14-15.6° C (spawning) 14-17.8° C (migration and rearing)	10-14° C	NMFS
Dissolved Oxygen	mg/L	All	<6	6-8	>8	ManTech
Hydrology						
Flow	hydrologic maturity	All	<60% of watershed with forest stands aged 25 years or more	-	>60% of watershed with forest stands aged 25 years or more	WSP/Hood Canal
		or use results from Watershed Analysis where available				
	% impervious surface	Lowland basins	>10%	3-10%	≤3%	Skagit
Biological Processes						
Nutrients (Carcasses)	Number of stocks meeting escapement goals	All Anadromous	Most stocks do not reach escapement goals each year	Approximately half the stocks reach escapement goals each year	Most stocks reach escapement goals each year	WCC
Lakes (further work needed)						
Estuaries (further work needed)						

APPENDIX C

WDF Stream Catalog (Williams et al. 1975)

Appendix C includes a copy of that portion of the WDF Stream Catalog (Williams et al. 1975) pertinent to East WRIA 15 streams. The East WRIA 15 Salmonid Habitat Limiting Factors Report is organized using the stream index sequencing in the WDF Stream Catalog, generally progressing from Case Inlet (southern end of East WRIA 15) to Foulweather Bluff (northern end of WRIA 15), and then to Bainbridge Island streams. Not all salmonid streams were identified and included in the WDF Stream Catalog; additional streams are identified in the Limiting Factors Report with an alpha character or extension in the stream index number. Location of these streams is discussed in the text of the report. Permission to reproduce and include this information in this report was obtained from the Department of Fish and Wildlife.

Images for the WDF Stream Catalog may not display clearly when viewed on screen. The reader may obtain a clearer image by printing the image.

KITSAP BASIN

Water Resource Inventory Area 15

The many rivers and streams located within the boundary of the Kitsap Peninsula can best be defined and discussed by locality if the Peninsula is divided down the middle from north to south. This division then separates the streams flowing generally eastward draining into Puget Sound and southern Puget Sound from those flowing westward and southerly into Hood Canal. By this method it is also easier to geographically define the commercial and sport fisheries which harvest the salmon production from these streams. Within this basin there are 521 identified streams providing over 665 linear miles of drainage.

The streams draining into Puget Sound from the east half of the Kitsap Peninsula are rather small in comparison to those of the west half and represent typical lowland type streams with generally moderate gradients. Considerable deciduous growth, interspersed by stands of conifers, farm land, and suburban developments is common on all streams. Many of these streams originate from lakes, ground water run-off, or swamp-like basins. Stream profile characteristics are, for the most part, pool riffle in nature with water quality and aquatic insect production highly conducive to anadromous fish habitation.

PHOTO 15-1. Most streams of this basin originate from spring fed swamps (Headwaters Tahuya River).

Moving from south to north the major streams of the East Kitsap segment include Coulter, Rocky, Lackey, Minter, Burley, Purdy, Crescent, Ollala, Gurley, Blackjack, and Gorst creeks. Virtually every one of these streams is inhabited by anadromous fish including at least two species of salmon. Several smaller independent streams are also located in the east Kitsap drainage and support impressive numbers of salmon spawners for their size.

The marine waters along the shorelines and borders of the east Kitsap basin and southern Puget Sound through the Tacoma Narrows into Carr Inlet contain a highly diversified salt water environment. These waters are vital to the marine fish and shellfish resources by providing mixing and transition zones from the cool, dense saline ocean waters to the warmer, less saline water layers of the shallow shelfs, bays, and channels of the peninsula.

Within these prominent protected waters, including Dye and Sinclair inlets, Liberty Bay, Port Madison, Port Orchard, Gig Harbor, Quartermaster Harbor, and Carr Inlet, are rich feeding areas for anadromous fish. The strongly mixed currents within Colvos Passage and the Tacoma Narrows also create prime feeding areas by collecting a great diversity of marine organisms within the tide rips.

The streams and rivers draining the west side of the Kitsap Peninsula are larger than those of the east side, but originate in adjacent and similar headwater terrain. Moving from north to south the major streams of the West Kitsap segment flowing into Hood Canal include Big Beef Creek, Dewatto River, Anderson Creek, Tahuya River, Stimson, Little Mission, and Big Mission creeks, and the Union River. These systems support impressive populations of anadromous fish with at least two salmon species utilizing each stream.

The marine waters of Hood Canal are unique due to the slow exchange and mixing of waters in the extensive length of the canal. Depths generally exceed 50 fathoms with large areas in the 70-fathom and deeper range. There are also shallow shelfs and bays that provide warmer waters rich in nutrients.

The relatively large volume of fresh water draining into the canal forms a layer over the salt water or sometimes stratifies at different depths depending upon the temperature differences between the drainage run-off and the salt water. Thus the environmental changes here play an important role in triggering algae and zooplanktonic blooms which produce heavy seasonal food supplies.

The many independent rivers and streams provide a total of over 665 linear miles of stream length to the Kitsap basin, most of which is accessible.

PHOTO 15-2. Limited estuaries are typical of streams in this basin (mouth of Coulter Creek).

Fish Inventory and Distribution

Four species of Pacific salmon, chinook, coho, chum, and pink, currently utilize Kitsap basin drainages. No established populations of sockeye have been observed in any of the Kitsap streams. These salmon species migrate, spawn, and rear in approximately 600 linear miles of independent streams and their tributaries.

Chinook Salmon — In this basin chinook salmon utilize the larger drainages in addition to some of the smaller creeks. Coulter, Rocky, Minter, Burley, Gorst, Chico, and Dogfish creeks in the east Kitsap drainages and the Dewatto, Tahuya, and Union rivers in the west Kitsap drainages all contain established fall chinook populations. Chinook utilize the lower stream sections where larger quantities of gravel and greater flows are found. Use of the smaller independent basin drainages by this species is minimal since these streams exhibit very low flows during the normal chinook migration and spawning periods.

Upstream migrations of fall chinook in these lowland streams extend over two months (mid-September to mid-November), depending on the stream flows and temperatures (Table 15-1). Early runs of chum salmon also overlap the chinook spawning in many of these streams during the same period. These two species also utilize the same spawning reaches in most cases. The essential difference between them is the preference of chinook for the larger gravel and heavier flows than the chum. The peak spawning occurs between mid-October and mid-November and is usually completed in all small streams by the end of November. Following incubation and subsequent fry emergence, the majority of chinook fry rear in these lowland systems for 3 or 4 months and enter the estuaries around May or early June depending on the spring run-off flows. Juvenile migrants tend to remain longer in the lower Tahuya and Union rivers where deep holes and tidal influences provide ideal conditions for the conversion from fresh to salt water rearing.

The annual escapement of fall chinook adults in the East Kitsap streams from 1966 to 1971 has ranged from 530 to 2,350, averaging 1,470 per year. The three larger rivers comprising the West Kitsap drainage into Hood Canal have had annual escapements ranging from 160 to 800 chinook from 1966 to 1971 and averaging 550 fish (Table 15-2).

Coho Salmon — All of the accessible independent lowland streams of the Kitsap Peninsula are utilized by coho salmon. Spawning occurs in every independent stream and tributary where suitable conditions exist, particularly in the upper headwaters. Since coho are well adapted to the typical lowland-type streams found in this basin, they inhabit the most remote and extreme rivulets, as well as the springs, swamps, and marshes forming the upper headwaters and high water overflow areas on many of these drainages. Coho juveniles rear throughout the accessible lengths of these streams and in the associated estuaries and marine habitats.

Adult coho begin entering the larger rivers and streams of this basin in early to mid-September and the smaller streams about the end of October. These runs continue well into late December. Spawning commences in mid to late October and is generally completed by late December. Following incubation and emergence from the gravel, the juveniles normally remain in the stream for more than a year, migrating seaward early in their second year of fresh-water life. In many of the smaller streams that generally suffer reduced summer flows in this basin, the coho juveniles are forced to migrate out as fry within the first six months of residency. Resident fry reluctant to move downstream during receding summer low flows suffer heavy mortalities due to stranding, desiccation, extreme water temperatures, or predation. The out-migration extends through the period of late February to mid-July with the peak usually occurring in mid -April.

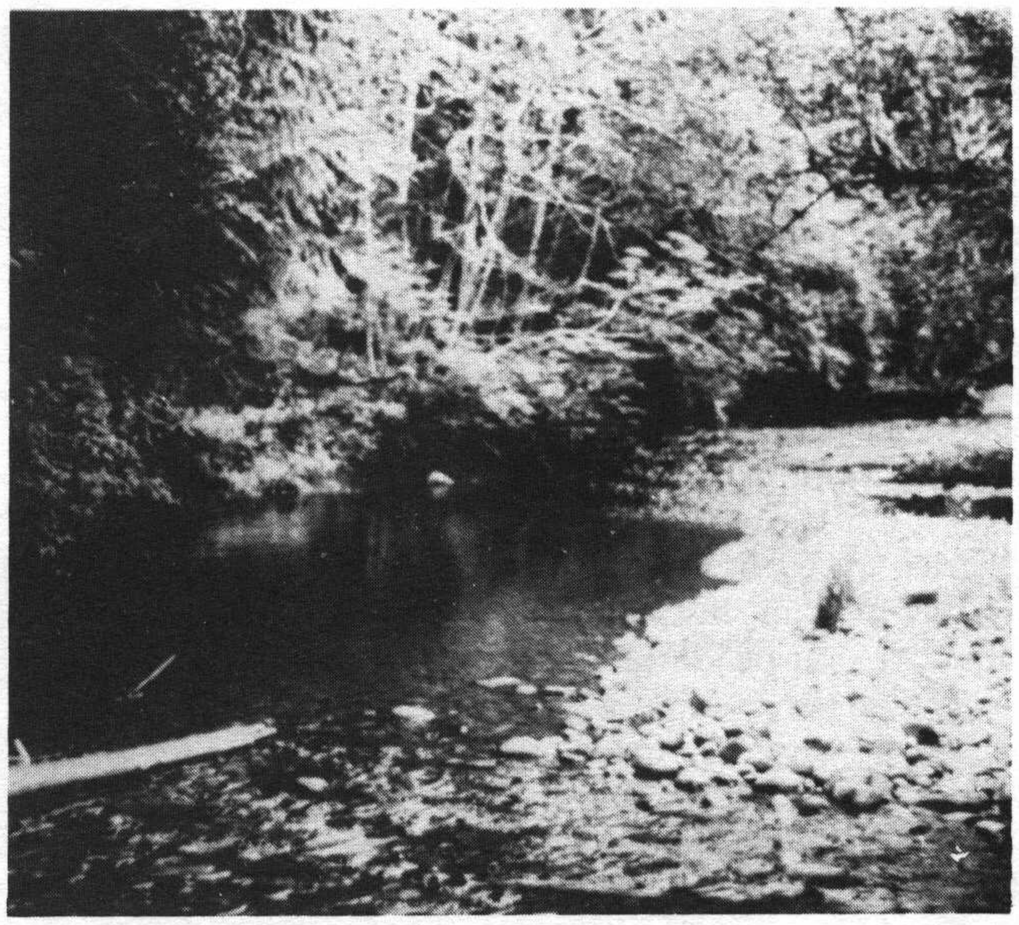


PHOTO 15-3. Upper Dewatto Creek offers superior coho habitat.

Estimates of adult coho spawning escapements to the West Kitsap streams for the period 1960 to 1970 have ranged from 9,100 to 30,100, averaging 19,000 annually. Those to the East Kitsap rivers and streams ranged from 6,650 to 27,800, averaging 16,650 annually.

Chum Salmon — Impressive runs of chum salmon occur in most of the Kitsap streams and a few are found in nearly every accessible stream. Principal chum streams include Coulter, Rocky, Lackey, Burley, Purdy, Crescent, Gurley, Blackjack, Dogfish, Chico, Gorst, Big Beef, Anderson, Big Mission, Little Mission and Rendsland creeks, as well as the Dewatto, Tahuya, and Union rivers. Many of these streams maintain only a single race or run of chum salmon while several others have two distinct runs (early and late). Those containing early and late runs are Coulter, Rocky, Big Beef, and Anderson creeks and the Union River. The three chum runs entering both the Dewatto and Tahuya rivers overlap to such an extent that they can hardly be separated. These adults start arriving in mid-September with spawning waves continuing on into January.

The early chum runs enter the basin's independent streams beginning September 15th with spawning concluded by October 20th. The intermediate runs occur within the period October 15th to November 25th, while late runs are comprised of spawners utilizing the late fall-early winter period between November 20th and January 5th.

PHOTO 15-4. Chum salmon utilize the lower sections of most Kitsap streams (Union River).

The distribution of chum spawners varies widely between streams due to the size and nature of the watersheds. Spawning normally starts immediately above the tidal influence and extends upstream as far as good spawning gravels are accessible. Following incubation and subsequent fry emergence, the juveniles migrate seaward. This migration starts in mid to late February and is completed by mid-May.

Based on spawning ground information, it is estimated that the East Kitsap streams had annual chum escapements ranging from 27,200 to 85,700 for the period 1966 to 1971, averaging about 46,850 annually. In the West Kitsap rivers and streams chum salmon escapements were estimated to range from 20,250 to 47,950, during this same period, averaging 29,550 annually.

Pink Salmon — The typical lowland type streams of the Kitsap Peninsula are not normally inhabited by pink salmon as they seem to prefer drainages that are of glacial origin. The Nisqually River in Southern Puget Sound and Skokomish River in Hood Canal are the southern extremities of the range of pink salmon. Minter Creek is the only Kitsap Peninsula stream to record a meager return of pink salmon each odd year. The largest run to return to the rack occurred in 1963 when 1,794 were counted. A few stray adult pinks wander into the Dewatto, Tahuya, and Union rivers each cycle from the heavy runs that inhabit the larger west side Hood Canal rivers.

Salmon Production

Minter Creek Salmon Hatchery is the only artificial production facility within the Kitsap Peninsula basin. This station originated in 1937 as the Minter Creek Biological Station to assess the natural escapements in this system through rack counts and controlled releases. Since 1955 this facility has operated as a production hatchery with expansion of the egg incubation and rearing facilities to accommodate 12,-500,000 coho and chinook out-migrants. These fingerlings are essentially planted within the basin drainages, but many are on occasion also released outside the basin to bolster depleted runs in Puget Sound waters. In addition, chum and pink salmon are also propagated from this hatchery. For the period 1966 to 1971, chinook returns to the Minter Creek Hatchery rack ranged from 1,589 to 10,913 adults, averaging 4,904 annually. Coho rack counts ranged from 5,580 to 47,582, averaging 17,704 spawners annually. Chum salmon returns ranged from 61 to 920, averaging 432 with none spawned artificially.

Between 1966 and 1971 a total 20,006,000 chinook and 10,171,000 coho were released in the Kitsap basin with an average annual plant of 3,343,000 chinook and 1,695,000 coho. Plants in 1971 included 2,269,300 juvenile chinook (114,000 lbs.) into the Kitsap watersheds and 3,543,100

Timing of salmon fresh-water life phases in the Kitsap Basin WRIA 15

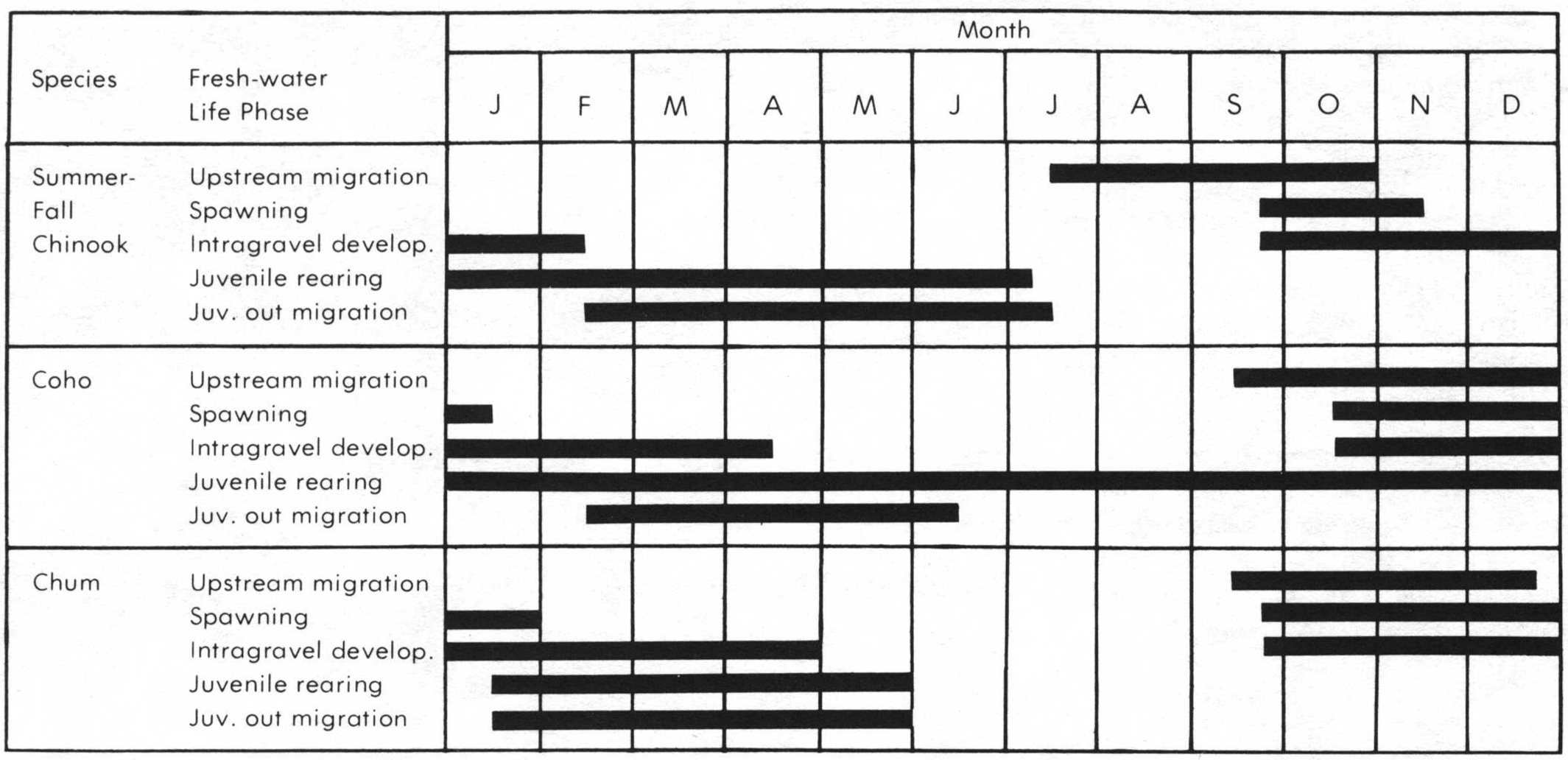


TABLE 15-2. Salmon Escapement Level for the Kitsap Basin WRIA 15.

	1966-1971 Escapements [1]	
Species	*Range*	*Average*
Chinook	5,600— 8,000	6,900
Coho	33,500— 75,600	53,300
Chum	47,400—133,700	76,400
	Natural Escapement Potential	
Chinook	8,000	
Coho	70,000	
Chum	90,000	
Pink	< 71,000	

[1] *Includes natural plus artificial combined escapements.*

juvenile coho (23,400 lbs.) released into the Shelton, Deschutes, and Kitsap watersheds. [1]

Preliminary information from marking programs and commercial and sport catch statistics indicates that the present salmon planting program from this basin contributes approximately 36,350 chinook and 95,900 coho to these fisheries annually. The tremendous sea survivals in 1970-71 plus the heavy increases in artificial plants indicate that production from these lowland streams should double the contribution to these fisheries in the next cycle.

Harvest

Salmon produced and reared in the Kitsap basin contribute to the U.S. and Canadian, Pacific Ocean sport and commercial fisheries and to all the fisheries existing through the Strait of Juan de Fuca and throughout Puget Sound and Hood Canal. The estimated total contributions (all species) to these various fisheries has for the years 1966-1971 ranged from 200,200 to 462,100 salmon.

A commercial fishery was authorized in Carr Inlet off the mouth of Minter Creek north of a line true west from Green Point on October 23, 1970. One night of gill net fishing by 100 vessels followed by some 40 purse seiners the next day harvested 14,578 coho and 140 chinook in a 24-hour period. The exceptional sea survival of all stocks from this year class had resulted in a tremendous coho escapement to all Washington streams. Minter Creek, below the hatchery rack, was clogged with spawners to the extent that the oxygen in the creek was depleted below tolerance levels and fish were dying. The total harvest plus escapement accounted for 11,055 chinook and 62,600 coho. A commercial fishery was again allowed in this area in 1971 to harvest the surplus fish returning to Minter Creek.

[1] *The average weight of juvenile salmon from hatchery releases is 20 coho/lb. and 125 chinook/lb.*

In past years Indian fishing in this areahas been nearly non-existent, but adjudication of Indian fishing rights now in progress may cause significant alterations in both fishing patterns and catch.

Sport angling for salmon is growing in popularity in the marine waters of the Kitsap Peninsula with fishermen concentrating their efforts along the drop-off shelf around Glen Cove, Minter Creek, Wauna, the mouth of Burley Lagoon at Purdy, and Raft Island and Cutts Island waters. Winter blackmouth fishing is particularly attractive in these waters as large numbers of immature feeder salmon utilize the marine waters of the Kitsap Peninsula the year around. Since many of the bays and inlets are semi-protected from prevailing winds and rough water and have good access at boat launching ramps and resort areas, sport fishermen are attracted to these waters. The most concentrated sport fisheries are found in the areas of heavy currents, tide rips, and back eddys where food organisms are abundant and salmon congregate, such as Point No Point, Point Jefferson, Agate Pass, Orchard Point-Manchester, West Passage, the Tacoma Narrows, and Fox Island Channel.

The marine salmon sport catch for the waters surrounding the Kitsap Peninsula cannot be accurately depicted because there are three salmon punch card areas involved. These are Area 9, Admiralty Inlet-Possession Sound; Area 10, Seattle-Bremerton; and Area 11, South Puget Sound. The fisheries in these three areas catch the salmon originating from many other watersheds both within Puget Sound and Canada.

Limiting Factors

Limiting factors refer to conditions that lead to a complete loss or reduction of the environment's fish production potential, excluding harvest or exploitation. They include only those conditions presently considered alterable. Within the Kitsap basin major limiting factors include seasonal flooding, low summer flows, intermittent debris or beaver dams, and water quality problems in the areas of concentrated land developments and major marine activities of the metropolitan centers.

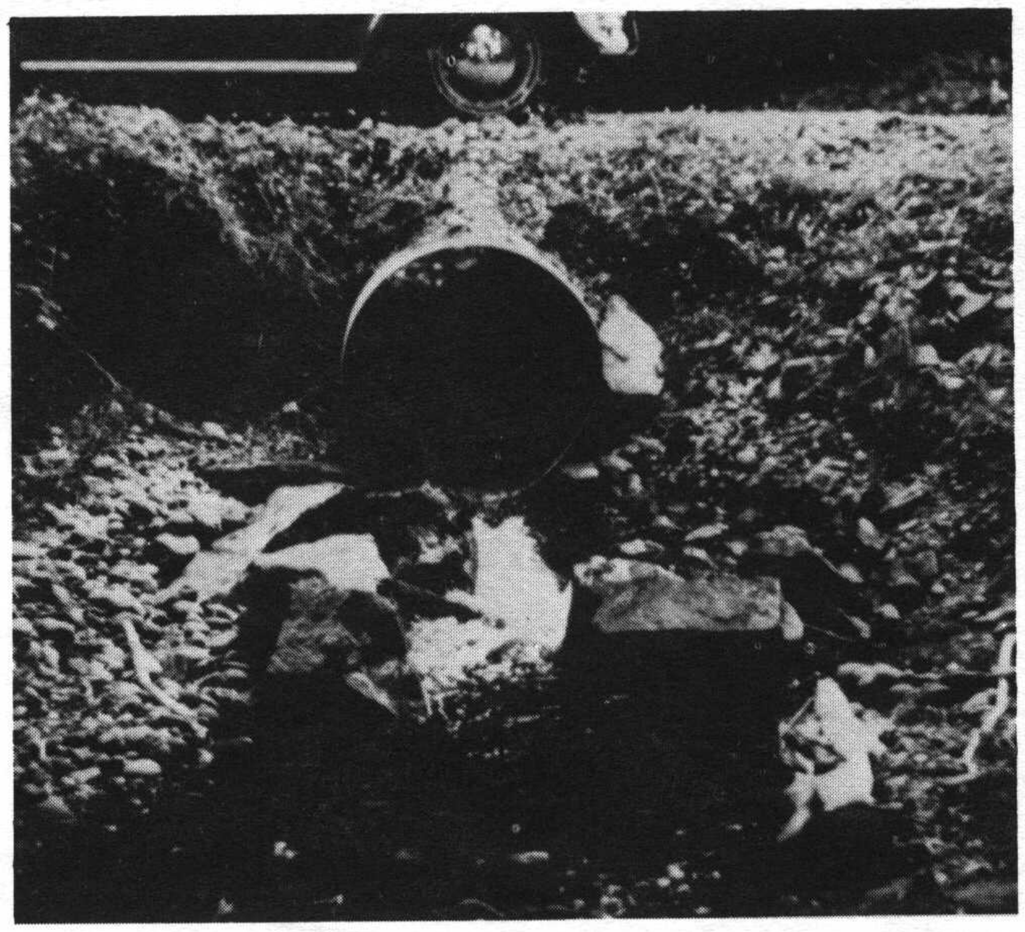


PHOTO 15-5. Improperly placed culverts block migrations to many miles of upstream area (Dewatto Creek tributary).

Stream flow — The seventeen major independent rivers and streams of the Kitsap Peninsula all originate in lower elevation foothills with no supporting glaciers or snow packs to provide continuous melt in warm summer months. Since the streams draining this area are entirely dependent on rainfall, seasonal flooding occurs infrequently in each of the basin's drainages and the effects of flooding in the smaller streams is usually minimal. In the rivers, however, the flow intensity has the capacity to destroy the salmon spawn and alter the quality of the spawning and rearing habitat. Extensive logging and land developments around the many lakes within the upper watersheds intensifies the intermittent run-off, increasing the magnitude of short duration floods.

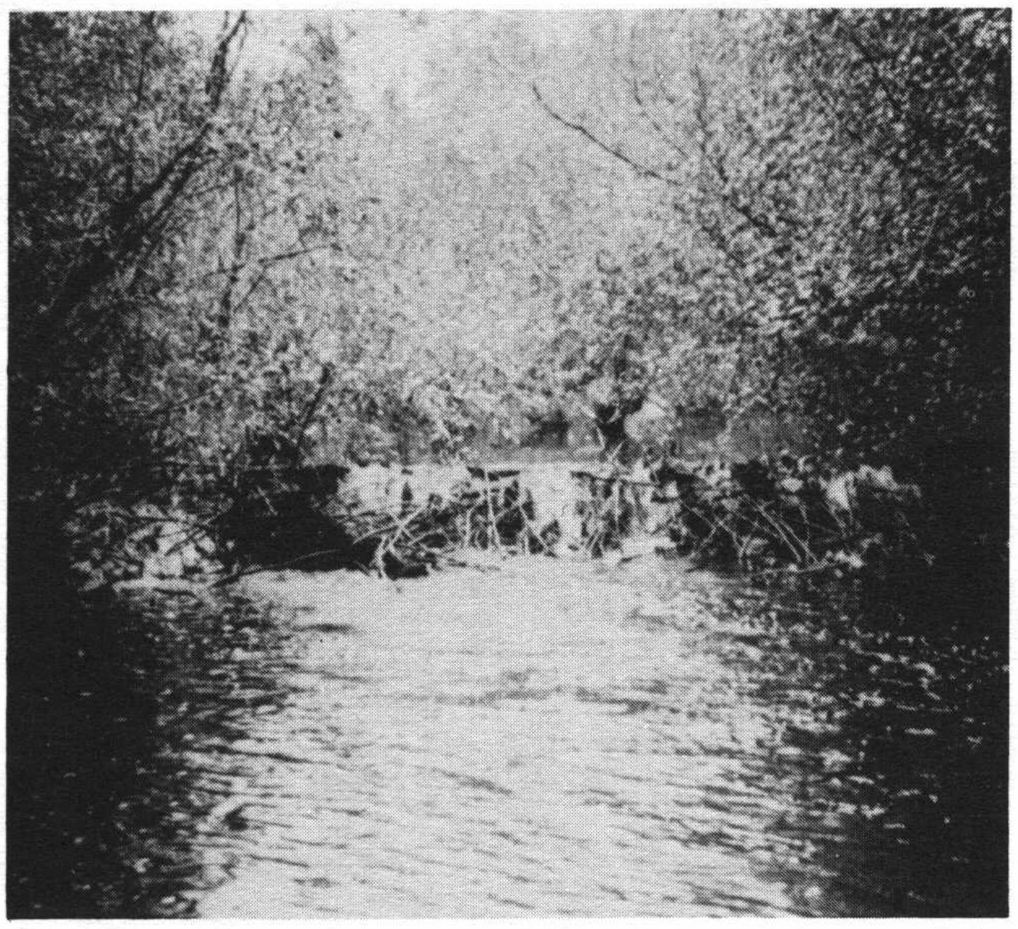


PHOTO 15-6. Beaver dams are a common and recurring problem in the Kitsap basin (Goldsborough Creek).

The seasonal low flows are a serious limiting factor in virtually every basin stream, but are extremely critical where extensive land clearing has occurred. Except for the natural lakes and swamps there is little opportunity for flow augmentation. The accelerated population expansion within this basin is resulting in the deterioration of stream environments and salmon production in many areas. Increased demands for municipal and industrial water supplies are already being expressed.

Physical barriers — Most of the streams in the basin contain moderate gradients throughout their lengths which salmon are able to utilize. Only four drainages in this basin contain blocks of which three are man-made and only one is natural. Two of the man-made barriers have fishways. These are the dam on Lake Symington on Big Beef Creek at RM 5.2 and the dam on Tahuya Lake at the headwaters of the Tahuya River. The pumping station and fish rack on Gorst Creek is a total block to the upper watershed which is the City of Bremerton's water supply. McKenna Falls is the only natural barrier to fish migration and is located at RM 6.5 on the Union River. Above the falls the City of Bremerton maintains a storage dam and reservoir.

Intermittent barriers created by debris accumulation or by beaver activity occur periodically on all of the basin's streams.

Water quality — Since much of the peninsula is cutover land that has grown back to second growth fir and deciduous trees and brush, poor water quality is not a particular problem at this time. High water temperatures above those tolerable by salmonids occur in the summer and fall months in Big Beef Creek from the impounded waters of Lake Symington. In the Union River severe low flows and high temperatures occur annually due to reservoir impoundment. Localized effluent problems are noticeable in the marine waters of the Bremerton-Port Orchard area largely due to industrial wastes and the lack of secondary sewage treatment plants. Recreational developments are rapidly expanding in the upper watersheds of this basin and pose a potential pollution problem in the near future.

Limited spawning and rearing area — Low flows in the fall and early winter preclude adult spawners from entering many of the small lowland-type streams that are prevalent here. Likewise, reduced rearing habitat during these periods is a serious threat to the coho stocks in these streams. On naturally dry years these smaller streams cannot sustain fish life due to extremely low flows. Anderson Creek and Big Beef Creek have undergone serious gravel bed scouring and have become silted in their upper sections due to land development activities.

Watershed development — Much of the upper watersheds are used for growing Christmas trees. This continual cutting of the land cover creates intensified run-offs. The creation of recreational developments and construction of summer homes around lakes and ponds is accelerating. Heavy pressures to dam streams in the basin in order to create home and recreational land developments are increasing. Future expansion of U.S. Naval facilities and programs within this basin can also be anticipated. Since no further sources of municipal and industrial water supplies are available from the small streams on the peninsula, all future demands and requirements will have to be satisfied from rivers outside of this basin, logically from the Olympic Peninsula rivers.

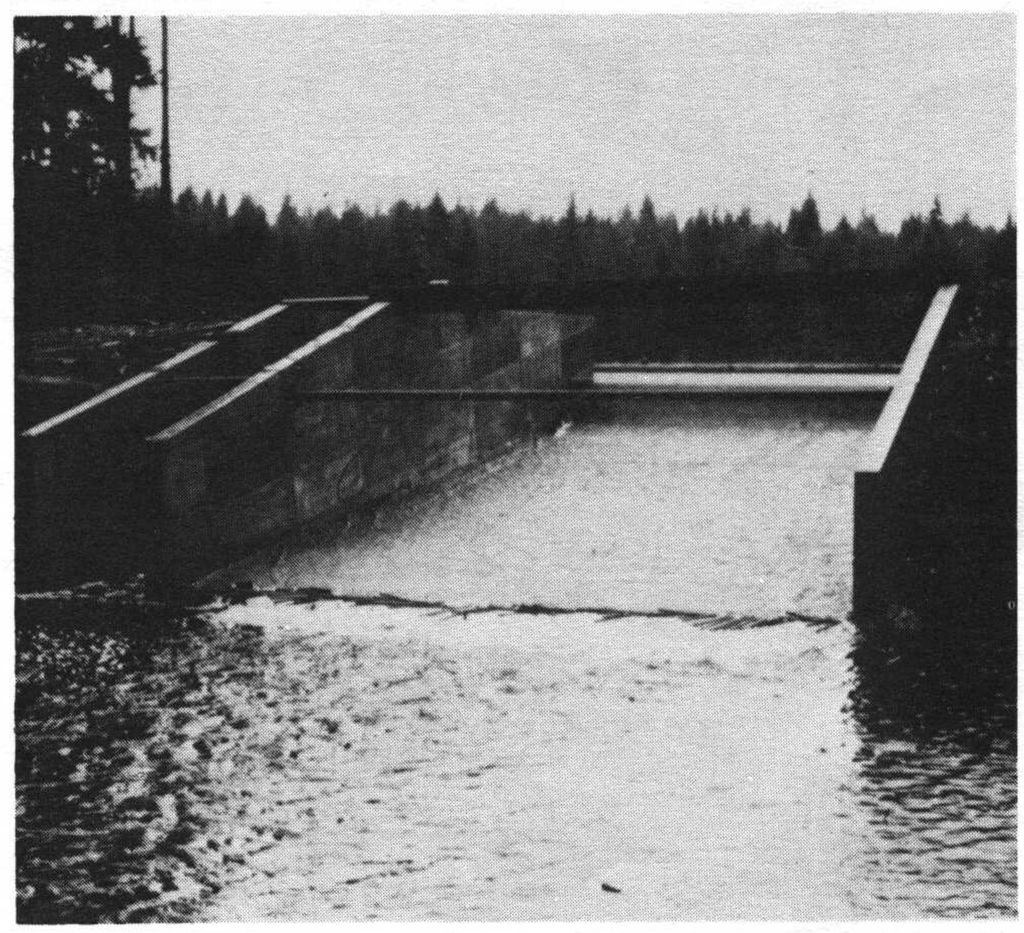


PHOTO 15-7. Damming of streams to enhance property values causes significant habitat losses (unnamed tributary to Tahuya River).

COULTER-ROCKY CREEKS

Coulter Creek, Rocky Creek, and five unnamed drainages flow into three bays that form the northernmost portion of Case Inlet. Interestingly, the relatively small watershed area lies within the boundaries of three counties; Kitsap, Pierce, and Mason. Total stream length is 43.2 miles, with the two major creeks sharing most of this total.

Stream Description

One description of physical watershed characteristics applies to all the streams within this sub-basin. The headwaters of the several streams lie in sparsely developed lowland hills of the southern Kitsap Peninsula. Streams flow in a southerly direction through moderately sloped valleys covered with second growth timber. Land development is very limited except for a rural development belt along the marine shorelines.

Existing land use is predominantly for second growth timber, with a few Christmas tree farming areas. Second growth logging is now under way and has been relatively intensive in portions of Coulter Creek. Coulter and Rocky creeks are similar in drainage area and size, although Coulter Creek has significantly greater flows (there are no known published stream flow data available on these streams). Both streams, however, afford excellent salmon habitat and rank high in productivity.

Coulter Creek enters southern Puget Sound at the tip of North Bay, the northernmost extension of Case Inlet. Stream gradient is moderate to shallow throughout much of its accessible length. It is very stable, has dense stream bank cover, and has many areas of excellent quality spawning gravel. Several very old log jams are present in the channel; however, these have seemingly served to stabilize the existing stream habitat over a period of many years, and they do not presently limit production. There are occasional areas with shallow gradient and semi-swampy habitat that provide superb rearing conditions throughout the year.

Rocky Creek enters Rocky Bay to the south. Stream gradient may be slightly steeper than Coulter Creek, with fewer quiet water areas, but spawning and rearing habitat is still exceptional. Stream bank cover in both these important drainages remains dense, even though there has been recent logging of adjacent lands.

A major left bank tributary enters Rocky Creek at mile 0.4. While this stream has an apparent larger drainage area, and half again the mainstem length of Rocky Creek, its value for salmon production is apparently minimal. Coho spawn and rear in its lower reaches, but much of the upper watershed is unproductive and has only seasonal flows.

Salmon Utilization

Virtually all areas of Coulter and Rocky creeks with year round flow are utilized by salmon for spawning and rearing. Coho ascend Coulter for more than five miles, and Rocky Creek is accessible to Fern Lake at mile 3.4. The major Rocky Creek tributary is also utilized by coho, but the upper limit of production is unknown. Large runs of chum salmon enter both streams, and the lower three miles of Coulter Creek and 1.5 miles of Rocky Creek are heavily utilized for spawning. Both early (October) and late (December-January) stocks return to the streams.

The unnamed independent drainages have unknown production, but it is believed to be minor. Tributary No. 0023, entering the head of Vaughn Bay, appears to have excellent coho production habitat.

Limiting Factors

Existing productivity of the stream remains favorable, in spite of past and present logging activity. Severe poaching during recent years, particularly on Rocky Creek's chinook and early chum salmon stocks, has been severe. Intense patrol of problem areas during recent years has reduced this problem; however, stocks have not yet responded to this protection.

Beneficial Developments

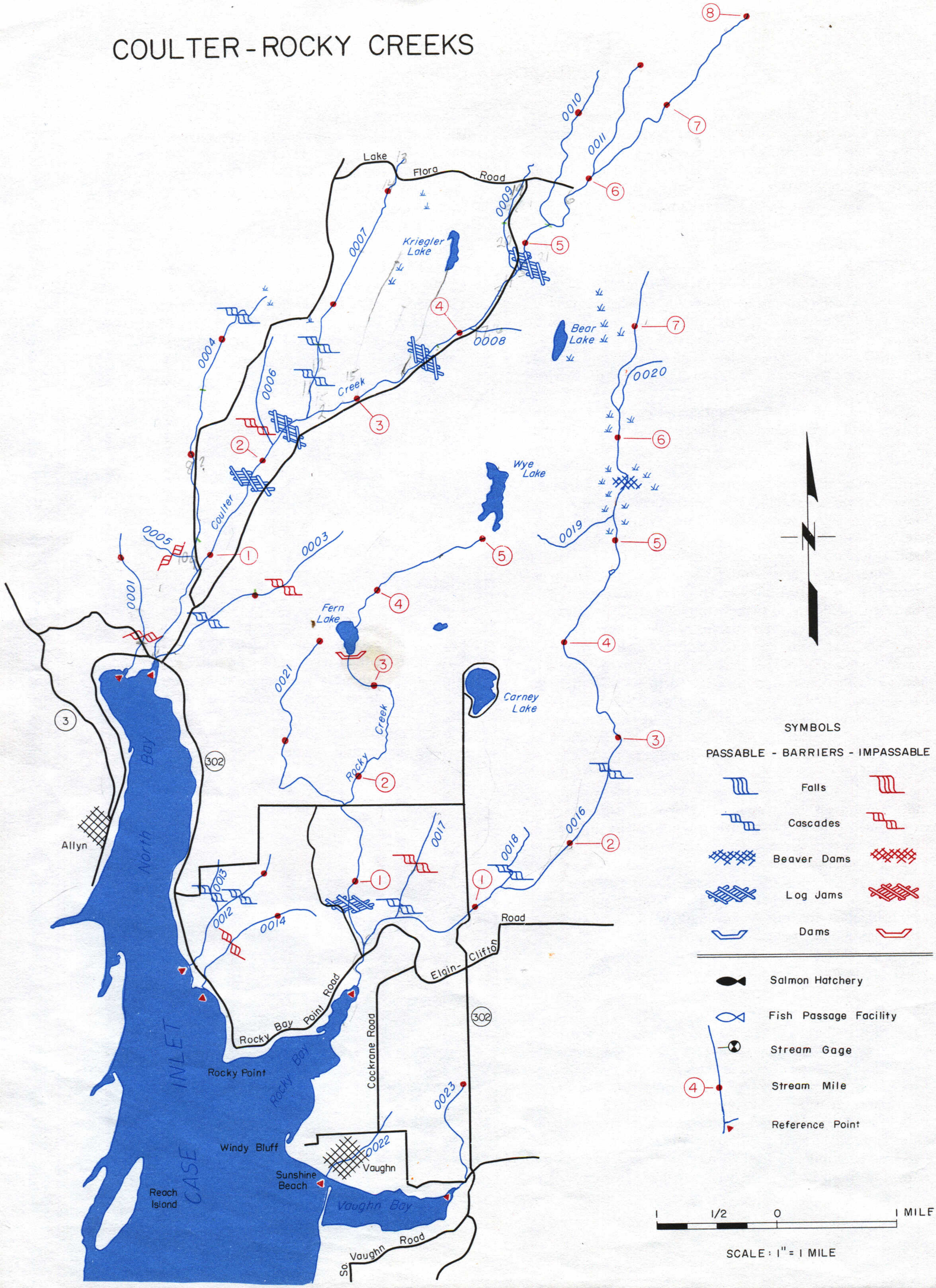
Occasional hatchery plantings have been made to supplement production in Coulter and Rocky creeks. Stream channel clearance and maintenance has been conducted when necessary. A research facility on Fern Lake, in upper Rocky Creek, has been operated for several years by the Washington Department of Game and the University of Washington. Research has been primarily devoted to steelhead and resident trout.

Habitat Needs

Stream areas within this sub-basin are quite undeveloped and are producing close to their maximum natural potential, with exception of sections depleted through poaching. The maintenance of this productive level only requires that the habitat be maintained in its present condition. With the ultimate development that can occur, this may be impossible, but it is of extreme importance that every possible precaution be taken to protect the stream areas through enforcement of the fisheries code.

PHOTO 15-6. Log jam on Coulter Creek.

COULTER - ROCKY CREEKS



COULTER-ROCKY CREEKS
Kitsap Basin — WRIA 15

Stream Number	Stream Name	Location Of Mouth	Length	Drainage Area	Salmon Use
0001	Unnamed	Sec8,T22N,R1W	1.2	—	Coho, (Chum)
0002	Coulter Creek	Sec9,T22N,R1W	8.0	—	Chin., Coho, Chum
0003	Unnamed	LB-0.05	1.9	—	Coho, Chum
0004	Unnamed	RB-0.85	2.6	—	Coho, Chum
0007	Unnamed	RB-2.5	2.3	—	Coho, (Chum)
0010	Unnamed	RB-5.3	1.5	—	Unknown
0011	Unnamed	RB-6.05	1.0	—	Unknown
0012	Unnamed	Sec28,T22N,R1W	1.15	—	Unknown
0014	Unnamed	Sec28,T22N,R1W	1.3	—	Unknown
0015	Rocky Creek	Sec27,T22N,R1W	5.0	—	Chin., Coho, Chum
0016	Unnamed	LB-0.4	7.5	—	Coho, (Chum)
0021	Unnamed	RB-1.7	2.0	—	Unknown
	Fern Lake	Outlet-3.4	—	—	
0023	Unnamed	Sec2,T21N,R1W	1.0	—	Unknown

CARR INLET
Independent Drainages

Numerous small streams drain the small watersheds of the Longbranch Peninsula, McNeil Island, Anderson Island, and the southeasternmost portion of the Kitsap Peninsula. Of the 33 independent streams in this group, the largest is Artondale Creek, tributary of Wollochet Bay. Its mainstem length is 2.2 miles; however, most of the independent streams are one mile or less in length. Combined stream mileage of all streams, including tributaries, is only 38.0 miles.

Stream Description

Terrain throughout this portion of southern Puget Sound is predominantly low hills that frequently extend to the shoreline area. Valleys are small, like the streams they sustain, and typically have moderate or steep slopes. Vegetation is mixed deciduous and coniferous second growth timber, and is rather dense in undeveloped valleys and along streams.

Watershed use, other than second growth timber, is almost totally rural home development and a few small farms. Settlement is most dense along the low or moderate bank waterfront shoreline areas. Streams are mostly stable and have excellent cover, but due to their size and occasionally steepness of terrain their accessibility and value for anadromous fish is limited. Several of the streams have intermittent flow, which also limits productivity. Type of bottom material varies, of course, from stream to stream according to its size and gradient. In most of the creeks, however, gravel is the predominant substrate.

Salmon Utilization

Artondale Creek, the largest stream, has moderate runs of coho and chum, but totally the salmon production in this group of streams is minor when compared to most other areas of southern Puget Sound. Six of the other 32 streams are known to contain coho, and one small chum population has been observed in a stream near Longbranch. Coho and chum are believed to be reproduced in a few other streams, but this has not been verified.

Limiting Factors

The natural limiting factor of streams in this area is their small size and restricted accessibility. Some habitat damage has occurred in areas where home development has been intense.

Beneficial Developments

There have been no facilities, projects, or programs designed to benefit or increase salmon production in any of these streams.

Habitat Needs

Better identification of existing or potential areas of salmon production are needed. This should be followed by efforts to maintain the habitat of those streams that are of productive value for salmon, through implementation of the fisheries code and close scrutiny of any proposed water diversion. Small scale enhancement projects also deserve future consideration.

CARR INLET
Independent Drainages

CARR INLET — INDEPENDENT DRAINAGES
Kitsap Basin — WRIA 15

Stream Number	Stream Name	Location Of Mouth	Length	Drainage Area	Salmon Use
	SOUTHERN LONG BRANCH PENINSULA				
0026	Dutcher Creek	Sec15,T21N,R1W	1.8	—	Coho, (Chum)
0028	Unnamed	Sec22,T21N,R1W	1.2	—	None
0029	Unnamed	Sec28,T21N,R1W	1.7	—	Unknown
0036	Unnamed	Sec24,T20N,R1W	1.3	—	Coho, (Chum)
	RAFT ISLAND TO POINT FOSDICK				
0072	Warren Creek	Sec25,T21N,R1E	1.1	—	Unknown
0075	Artondale Creek	Sec24,T21N,R1E	2.2	—	Coho, (Chum)
0076	East Branch	LB-0.65	1.1	—	Coho, (Chum)
0078	Unnamed	RB-1.2	1.4	—	Unknown
0080	Unnamed	Sec24,T21N,R1E	1.4	—	Coho, (Chum)
0081	Unnamed	RB-0.25	1.7	—	Coho, (Chum)
0083	Unnamed	RB-0.5	1.3	—	(Coho)
0086	Unnamed	RB-1.0	1.35	—	(Coho)
	Unnamed Lake	Outlet-1.4	—	—	
0087	Sullivan Gulch Creek	Sec29,T21N,R2E	1.2	—	Unknown

HENDERSON BAY DRAINAGES

Henderson Bay lies at the uppermost portion of Carr Inlet. Several important salmon streams enter the area including, by decreasing size, Minter, Burley, Purdy, Lackey, and McCormick creeks. There are also unnamed minor drainages. Total mileage of the ten independent streams and their tributaries is 40.6.

Stream Description

Quality of the stream habitat is dependent upon the intensity of development. Rural homes and farms are the predominant settlement, with the highest population density around the communities of Purdy, Burley, and Key Center. The Burley Creek valley contains several farms and is the most heavily developed watershed of this stream group.

The terrain surrounding these streams is characterized by low hills of moderate slope, with heavy mixed second growth vegetation in all uncleared areas. In spite of moderately heavy settlement, stream bank cover is mostly dense and brushy, except in a few areas where home sites border the stream. Portions of Burley Creek have farm and pastureland extending to the stream margin.

Stream conditions include mostly moderate gradients and favorable production habitat. Stream channels are stable, and flows are infrequently extreme. As a result of the predominantly moderate gradient, the substrate is mostly gravel of sizes suitable for salmon spawning. Enough stream bank cover remains to provide favorable rearing conditions in all streams.

Salmon Utilization

Coho production in this sub-basin has been dominated by artificial propagation at the Minter Creek Hatchery for many years. In addition to contributions to ocean and Puget Sound sport and commercial fisheries, intensive terminal commercial fisheries in Carr Inlet have been employed in recent years to harvest available surpluses of coho salmon. Minter Creek Hatchery is also an important chinook salmon station, with fishery contribution of statewide importance for many years. Natural production in Minter Creek totals approximately 600 spawners annually, plus a small population of wild chum salmon.

Natural production of coho, chum, and chinook salmon is also important in this group of streams. Burley Creek has returns of coho and chum salmon, and the only wild stock of chinook salmon in the sub-basin. Both early (October) and late (December) chum salmon runs return to this stream. Purdy Creek, also located near the head of Henderson Bay, supports coho and chum salmon, with returns in recent years appearing to be below their potential.

Lackey Creek is one of the smaller streams; however, its present chum salmon production is the most important. Several hundred fish return to the limited available spawning area each year, after contribution to Puget Sound's commercial chum fishery.

McCormick Creek supports a minor run of coho, and is believed to have some chum salmon spawning. Of the unnamed streams, only the creek entering near Raft Island is believed to contain salmon.

Limiting Factors

There are few natural causes that limit productivity for salmon in these streams. Lackey Creek is an exception, where greater production could be realized with more available spawning area. There are apparent limitations in production related to development of the watersheds, however. Gravel quality and egg survival in Burley Creek is poor. From the times of earliest logging through present farm use, sediment in the form of silt and fine sandy materials has contaminated the streambed.

Coho and chinook artificial propagation at the Minter Creek Hatchery has enjoyed extreme success over many years, but this has been accomplished at the apparent expense of an important chum run that once returned to the stream. Yearling coho predation on emerging chum fry has been charged as the cause of this depletion. Present programs, however, are designed to restore this production through later timing of hatchery coho releases as well as artificial propagation of chum salmon.

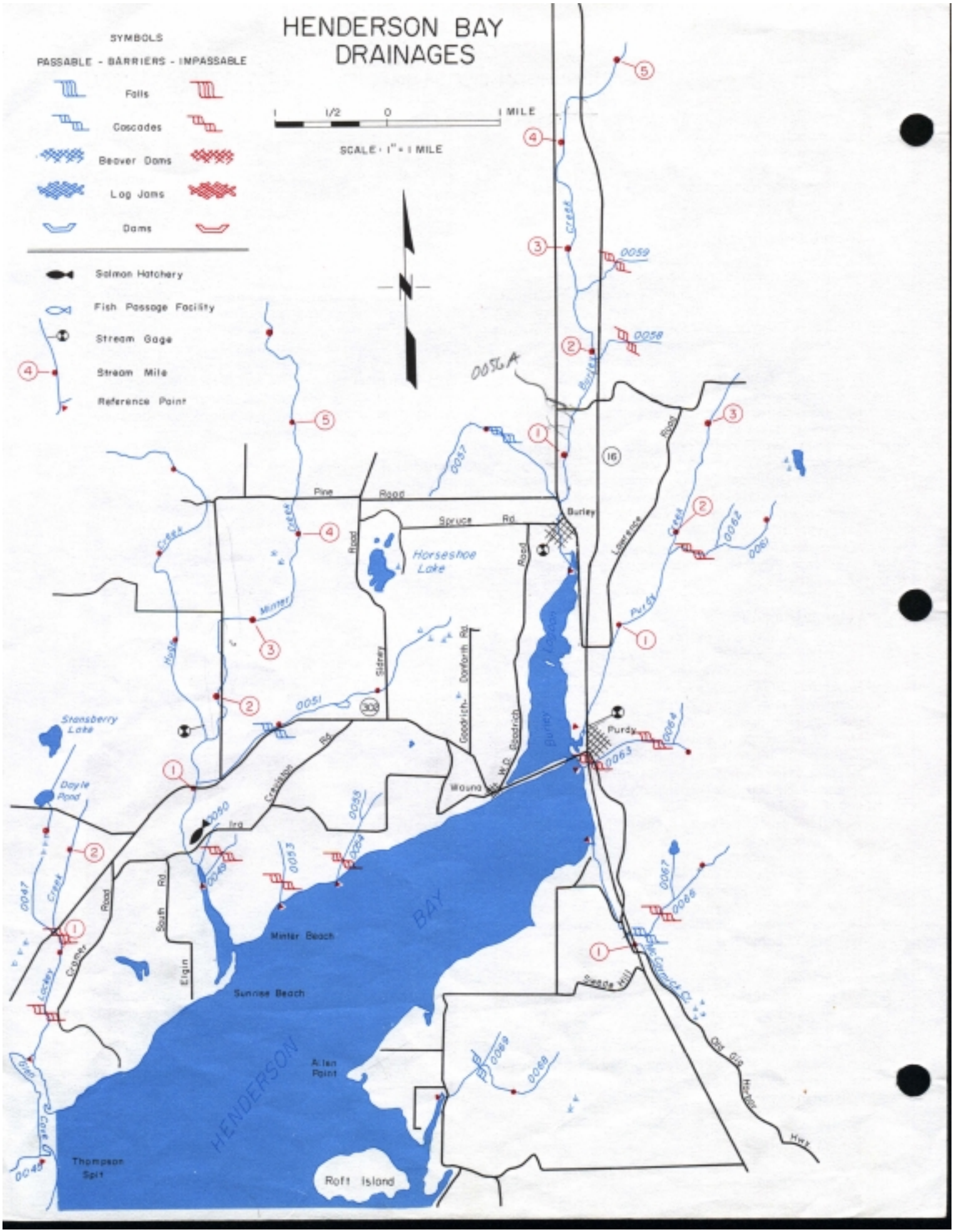
Beneficial Developments

The Minter Creek Salmon Hatchery is the dominant production facility in this district, and provides annual releases of chinook and coho fingerlings to many of the streams of the Kitsap Peninsula and other Puget Sound river systems. Programs to benefit salmon production include stream habitat maintenance, and a spawning gravel improvement project to increase the usable area of Lackey Creek.

Habitat Needs

Restoration of spawning habitat in Burley Creek would be most beneficial, and plans have been formulated for implementation in the future. Hydraulic projects and water diversion proposals for these streams must be carefully reviewed for potential impact on stream productivity.

PHOTO 15-7. Head of tidal influence below Minter Creek hatchery.


HENDERSON BAY DRAINAGES
SYMBOLS
PASSABLE - BARRIERS - IMPASSABLE
Falls
Cascades
Beaver Dams
Log Jams
Dams
Salmon Hatchery
Fish Passage Facility
Stream Gage
Stream Mile
Reference Point
1 1/2 0 1 MILE
SCALE: 1" = 1 MILE
Pine Road
Spruce Rd.
Horseshoe Lake
Burley
Purdy
Shansberry Lake
Doyle Pond
Minter Beach
Sunrise Beach
Allen Point
Thompson Spit
Raft Island
HENDERSON BAY
Minter Creek
Purdy Creek
Burley Creek
Lawrence Creek
Lackey Creek
Gibson Creek
Sidney Rd
Goodrich Rd
Donforth Rd
Crescent Rd
Wound Rd
Iro Rd
South Rd
Elgin Road
Lawrence Road
Sunset Hill
Old Gib Highway
0047
0048
0049
0050
0051
0053
0054
0055
0056
0057
0058
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0060
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0055A
16
303

HENDERSON BAY DRAINAGES
Kitsap Basin — WRIA 15

Stream Number	Stream Name	Location Of Mouth	Length	Drainage Area	Salmon Use
0046	Lackey Creek	Sec6,T21N,R1E	2.5	—	(Coho), Chum
0047	Unnamed	RB-1.25	1.9	—	None
	Doyle Pond	Outlet-1.3	—	—	
0048	Minter Creek	Sec29,T22N,R1E	6.3	—	Chin., Coho, Chum
0051	Unnamed	LB-1.05	2.95	—	Coho, Chum
0052	Huge Creek	RB-1.5	3.7	—	Coho, Chum
0056	Burley Creek	Sec12,T22N,R1E	5.2	—	Chin., Coho, Chum
0057	Unnamed	RB-0.55	1.9	—	Coho, (Chum)
0060	Purdy Creek	Sec24,T22N,R1E	3.55	—	Coho, Chum
0061	Unnamed	LB-1.75	1.2	—	(Coho)
0063	Unnamed	Sec24,T22N,R1E	1.0	—	Unknown
0065	McCormick Creek	Sec25,T22N,R1E	1.6	—	Coho, (Chum)
0066	Unnamed	RB-0.85	1.3	—	Unknown
0068	Unnamed	Sec2,T21N,R1E	1.5	—	(Coho),(Chum)

COLVOS PASSAGE
Independent Drainages

Streams within this region may be grouped into three areas: those draining the Kitsap Peninsula to Colvos Pass from northern Pierce and southern Kitsap counties, all tributaries of Vashon Island, and all drainages on Maury Island. There are only three streams of moderate size, plus numerous small drainages of which few are named. The 49 independent streams and their tributaries contain a total of 59.35 stream miles. Ten are located on the Kitsap Peninsula, 28 on Vashon Island, and 11 drain Maury Island.

Stream Description

Topography, extent of land development, watershed cover, and stream characteristics are similar throughout this sub-basin. The short streams cut narrow valleys through hilly land, most of which lies below 400-foot elevation. Only the three larger drainages of Crescent, Olalla, and Judd creeks contain broad valleys and level terrain. Watershed cover and habitat is dependent upon the extent of development, and is varied. Dense valley and stream cover of second growth vegetation occurs in virtually all areas that remain unsettled. Proximity to Seattle and Tacoma has led to increasingly heavy rural development. Gig Harbor is the largest population center and is the home port for an important segment of the Puget Sound commercial salmon fleet. Other communities include Olalla, Vashon Heights, Vashon, and Burton. Vashon Island is accessible only by ferry and this has limited the rate of development. Numerous small farms are located throughout the drainages.

Crescent Creek flows south from its headwaters at Crescent Lake and enters the bay at Gig Harbor. It has moderate or shallow gradient throughout its length, and substrate is predominantly gravel with sandy sections. Stream conditions in the lower 2.0 miles are particularly favorable for salmon production.

Olalla Creek is the largest stream. Gradient is shallow in the upper and middle sections, with slow moving water and sandy substrate interspersed with riffle sections. Gradient increases in the lower mile, and here the stream channel contains much suitable spawning gravel. Portions of the upper watershed bordering farmland has limited cover; however, downstream areas offer vegetation and brush to provide favorable rearing areas.

Judd Creek on Vashon Island contains 2.9 miles of mainstem and has numerous tributaries. Gradient is moderate to shallow, and the stream contains suitable spawning and rearing habitatnfor salmon.

Salmon Utilization

Olalla, Crescent, and Judd creeks support returns of coho salmon in most of their accessible stream area. Olalla Creek, due to its larger size, is the most productive. Coho are known to return to a few of the small independent streams, and possible productivity in others has not been verified.

Important chum salmon runs return to Crescent and Olalla creeks. These stocks arrive later than the bulk of Puget Sound production, spawning in late December and early January. The lower mile of both streams offer excellent spawning area, and are heavily utilized each year. Judd Creek is also believed to support chum salmon; however, the run size has not been assessed. A few of the minor tributaries have potential for chum salmon; however, production is unknown.

Limiting Factors

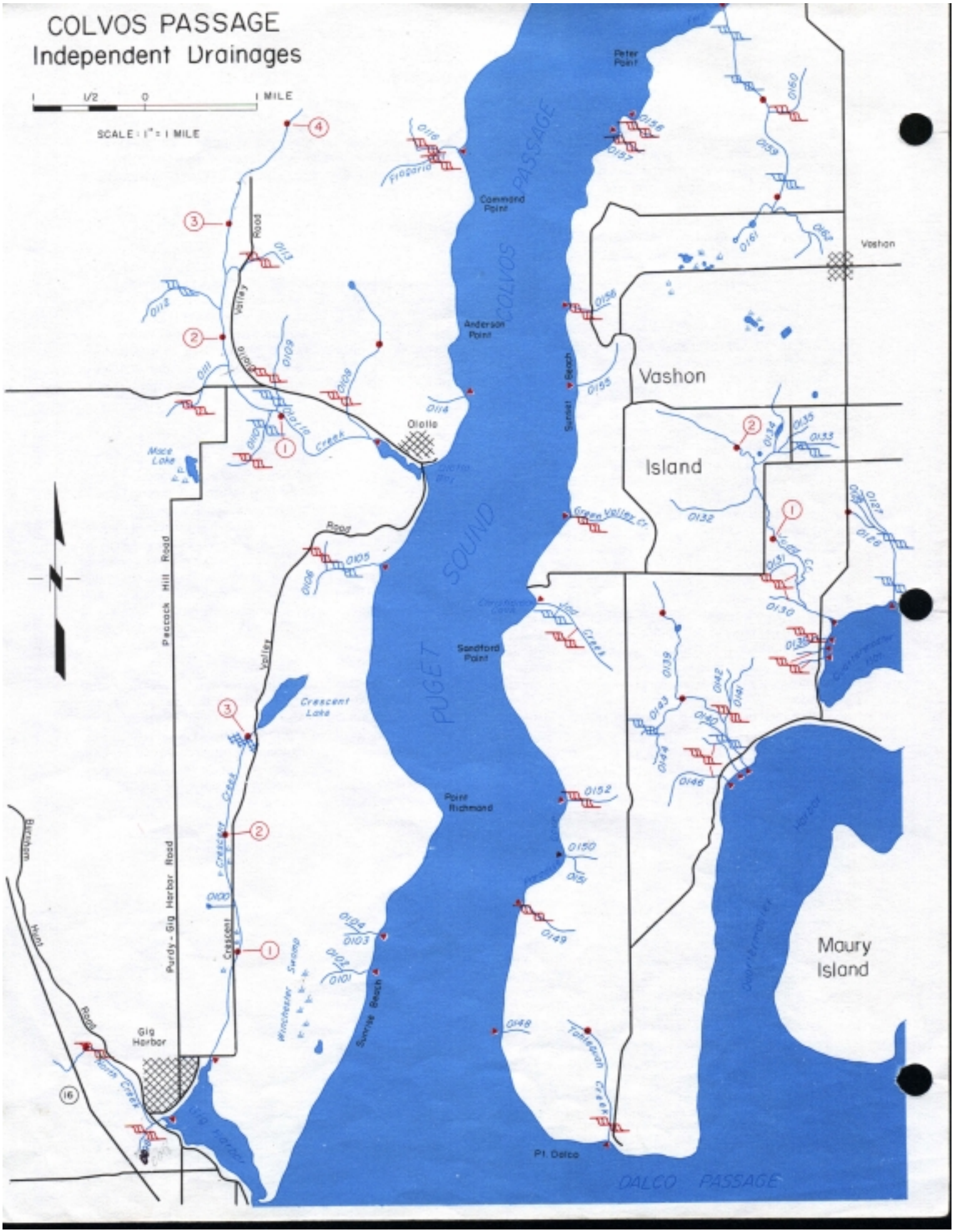
The major observed deterrent to maximum production in the two most important streams, Crescent and Olalla creeks, is habitat deterioration that has occurred during early years of logging and from subsequent farming practices. Stream substrate in portions of both creeks is unsuitable for salmon spawning due to the accumulation of sandy sediment. Other limiting factors include lack of stream bank cover in localized areas, low or intermittent summer flows in many of the smaller tributaries, and local problems of poaching.

Beneficial Developments

Crescent and Olalla creeks have received coho plants from Minter Creek Hatchery; however, production in all streams has been predominantly natural. A recent Department of Fisheries cooperative project with the Gig Harbor Commercial Fishermen's Civic Club has incubated and released chum salmon from North Creek (known locally as Donkey Creek). Chum salmon eggs have been placed in stream-side gravel incubation boxes that receive controlled water flow. This project has been continuing since 1971, with encouraging fry production. Adult returns have yet to be evaluated.

Habitat Needs

Due to the small size of the streams in the area, all future water diversions should be carefully examined prior to approval. Stream habitats also deserve careful protection since portions are already in a degraded state. Future stream habitat restoration and enhancement projects should be considered by this Department. Determination of habitat quality and salmon production is badly needed in those small streams were information is lacking.


COLVOS PASSAGE
Independent Drainages
1/2
0
1 MILE
SCALE: 1" = 1 MILE
Peter Point
Command Point
Anderson Point
Sunset Beach
Vashon
Vashon Island
Olalla
Olalla Creek
Mace Lake
Valley Road
Peacock Hill Road
Purdy - Gig Harbor Road
Crescent Lake
Crescent Creek
Crescent
Sandford Point
Point Richmond
Sunrise Beach
Winchester Swamp
Gig Harbor
North Creek
Burnham
Hunt Road
Tacoma Creek
Green Valley Cr.
Maury Island
Pt. Dalco
DALCO PASSAGE
PUGET SOUND
COLVOS PASSAGE

COLVOS PASSAGE — INDEPENDENT DRAINAGE
Kitsap Basin — WRIA 15

Stream Number	Stream Name	Location Of Mouth	Length	Drainage Area	Salmon Use
0097	North Creek	Sec6,T21N,R2E	1.4	—	Coho, Chum
0099	Crescent Creek	Sec5,T21N,R2E	3.1	—	Coho, Chum
	Crescent Lake	Outlet-3.1	—	—	
0107	Olalla Creek	Sec4,T22N,R2E	4.2	—	Coho, Chum
0108	Unnamed	LB-0.01	1.6	—	Coho, (Chum)
	VASHON ISLAND [1]				
0121	Unnamed	Sec29,T23N,R3E	1.2	—	Unknown
0123	Unnamed	Sec5,T22N,R3E	1.7	—	Unknown
0126	Unnamed	Sec17,T22N,R3E	1.0	—	Unknown
0129	Judd Creek	Sec18,T22N,R3E	2.9	—	(Coho), (Chum)
0139	Unnamed	Sec19,T22N,R3E	2.3	—	Unknown
0147	Tahlequah Creek	Sec2,T21N,R2E	1.2	—	(Chum)
0159	Unnamed	Sec13,T22N,R2E	2.8	—	Unknown
	MAURY ISLAND [1]				
0173	Unnamed	Sec21,T22N,R3E	1.1	—	Unknown
0174	Unnamed	LB-0.05	1.0	—	Unknown

[1] *Tributaries listed from northernmost point in clockwise order around islands.*

SINCLAIR INLET
Independent Drainages

Streams within this area include the tributaries of Sinclair Inlet, the southern portion of Port Orchard, Yukon Harbor, and one tributary in northern Colvos Passage. There are 22 streams, mostly small, and all lie in east-central Kitsap County. Total miles of stream, including mainstem and tributaries, is 66.2.

Stream Description

Of the 22 small streams, only three could be classified as being of moderate size: Curley Creek, Blackjack Creek, and Gorst Creek. These drainages comprise 39.05 miles, or 59% of the sub-basin total. Watersheds are moderately settled, with rural residences and occasional small farms, although areas near Bremerton and Port Orchard are heavily developed. There are numerous small communities including Gorst, Annapolis, Manchester, South Colby, Southworth, Long Lake, and Bethel.

Curley Creek has 5.3 miles of mainstem and 8.2 of tributaries. It drains Long Lake (314 acres) and enters Yukon Harbor at the community of South Colby. Salmonberry Creek, the inlet to Long Lake, flows in a southerly direction to Long Lake while Curley Creek flows northerly to salt water, with the streams roughly paralleling each other but flowing in opposite directions. Gradient is moderate or shallow in nearly the entire watershed, while substrate is either sand or gravel with only occasional coarse material in the lower few miles of stream. The heaviest settlement is a rural community and several farms near the north end of Long Lake.

Blackjack Creek is 6.9 miles long, with 6.05 miles of tributary. It flows in a northerly direction with its mouth at the City of Port Orchard. Much of the upper portion of Blackjack Creek lies in a broad valley where gradient is shallow. Below this the lower 2.5 miles of stream has moderate gradient as it flows through a deep valley dividing the City of Port Orchard. Gradient is moderate and substrate is predominantly gravel. The stream bank cover and immediate terrain is dense, even though the section lies within the city limits. Stream gaging records are available for the years 1947 through 1950, at river mile 0.4. The range of flows indicate Blackjack Creek is a very stable stream, with minimum of 6.7 and maximum of 285 cfs during this period. Annual mean flows were 20 to 26 cfs.

Gorst Creek has a beautiful watershed that is virtually undisturbed above its lower mile. It is part of the City of Bremerton's water supply and has restricted entry and development. The stream habitat is also excellent, but unfortunately it is totally inaccessible to salmon, at a barrier at mile 0.6. Below this there is moderate gradient and excellent gravel substrate. It flows through a densely populated area, however, and cover is intermittent.

Other streams are quite small; however, some are salmon producers. Most have moderate gradient and contain some spawnable material. Development within the watersheds is varied.

Salmon Utilization

Streams within this area are extremely important for chum and coho salmon. Early stocks of chum salmon, that enter and spawn during October, utilize the lower two miles of Blackjack Creek and the lower 1.25 mile of Curley Creek. Late-run chum salmon use all of the accessible areas of Gorst Creek. Total chum spawners within the sub-basin are 3,400 annually. Curley Creek and Salmonberry Creek, above and below Lost Lake, are important coho areas. Much favorable rearing habitat is available, and it is probable that the lake provides additional rearing capacity. Blackjack Creek also has a good run of coho, while production in Gorst Creek is limited by the accessible area available. Coho escapements total about 1,100 spawners to all these streams.

Limiting Factors

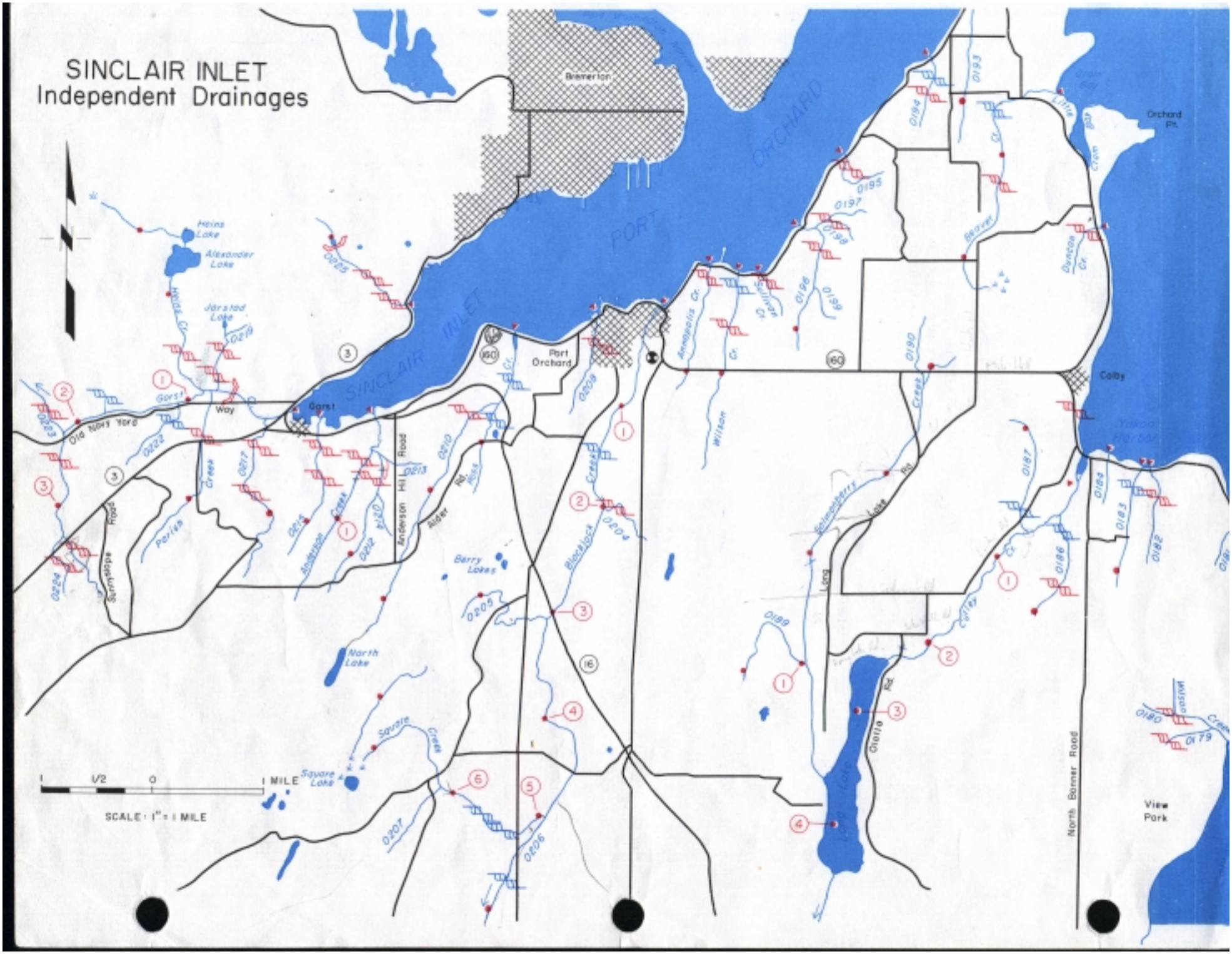
Limiting factors include the blockage of Gorst Creek to upstream access, minor natural factors of stream gradient and gravel availability, and impact of watershed developments in certain areas.

Beneficial Developments

Occasional plants of coho have been made into Curley and Blackjack creeks. Chinook were also released into Gorst Creek. During the early 1960's, Heins and Alexander lakes, on a tributary of Gorst Creek, were utilized as fish farms. Success was limited and they were discontinued after short operation. Coho have been reared in Clam Bay, an enclosed salt water lagoon near Manchester, and chum salmon in a pond on nearby Beaver Creek. A private marine aquaculture facility is operated near Beaver Creek. A private marine aquaculture facility is operated near Manchester, and has contributed some accidental "plants" when fish have escaped or been inadvertently released.

Habitat Needs

Close regulation of hydraulic projects, within the streams, is needed to maintain the present habitat and production level. It would be desirable to open the upper watershed of Gorst Creek; however, the City of Bremerton is not receptive to this. A watershed management plan should be developed by the City of Port Orchard and associated communities through the Shorelines Management Act to curtail development on these streams.


SINCLAIR INLET
Independent Drainages
Bremerton
PORT ORCHARD
SINCLAIR INLET
Port Orchard
Gorst
Old Navy Yard
Way
Heins Lake
Alexander Lake
Jarstad Lake
Hidden Cr.
Parish Creek
Sunnyslope Road
Anderson Hill Road
Alder Rd.
Berry Lakes
North Lake
Square Creek
Square Lake
Blackjack Creek
Annapolis Cr.
Sullivan Cr.
Wilson Creek
Salmonberry Lake
Long Rd.
Olalla Rd.
Colby
Orchard Pt.
Beaver Cr.
Davidson Cr.
Yukon Harbor
North Banner Road
View Park
1/2 0 1 MILE
SCALE: 1" = 1 MILE

SINCLAIR INLET — INDEPENDENT DRAINAGE
Kitsap Basin — WRIA 15

Stream Number	Stream Name	Location Of Mouth	Length	Drainage Area	Salmon Use
0183	Unnamed	Sec34,T23N,R2E	1.1	—	Unknown
0185	Curley Creek	Sec4,T23N,R2E	5.3	—	(Chin.), Coho Chum
0186	Unnamed	RB-0.35	1.1	—	(Coho)
0187	Unnamed	LB-0.65	1.2	—	(Coho)
	Long Lake	Outlet-2.45	—	—	
0188	Salmonberry Creek	LB-3.6	4.2	—	Coho
0189	Unnamed	RB-1.0	1.1	—	(Coho)
0192	Beaver Creek	Sec16,T24N,R2E	2.4	—	(Coho), (Chum)
0193	Unnamed	Sec8,T24N,R2E	1.4	—	Unknown
0196	Unnamed	Sec19,T24N,R2E	1.2	—	Unknown
0201	Wilson Creek	Sec25,T24N,R1E	1.8	—	Unknown
0202	Annapolis Creek	Sec25,T24N,R1E	1.2	—	Unknown
0203	Blackjack Creek	Sec25,T24N,R1E	6.9	—	Coho, Chum
0205	Unnamed	LB-3.05	1.3	—	Unknown
0206	Unnamed	RB-4.95	1.75	—	(Coho)
0207	Square Creek	LB-6.15	2.5	—	Unknown
0209	Ross Creek	Sec27,T24N,R1E	1.4	—	Unknown
0210	Unnamed	LB-0.65	2.3	—	Unknown
0211	Anderson Creek	Sec33,T24N,R1E	1.8	—	(Coho),(Chum)
0212	Unnamed	RB-0.35	1.4	—	Unknown
0215	Unnamed	Sec33,T24N,R1E	1.3	—	Unknown
0216	Gorst Creek	Sec32,T24N,R1E	3.9	—	Chin., Coho, Chum
0217	Unnamed	RB-0.3	1.6	—	Coho, (Chum)
0220	Parish Creek	RB-0.8	1.7	—	None
0221	Heins Creek	LB-0.85	2.4	—	None
	Alexander Lake	Outlet-1.2	—	—	
	Heins Lake	Outlet-1.55	—	—	
0225	Unnamed	Sec28,T24N,R1E	1.2	—	None

DYES INLET DRAINAGES

Dyes Inlet and its tributaries lie in Kitsap County north of Bremerton. There are 17 individual streams entering this inlet containing 49.25 creek miles. Chico Creek is the largest and most important of the streams in this drainage area.

Stream Descriptions

Dyes Inlet is an extremely confined arm of central Puget Sound that is joined to Port Orchard via Port Washington Narrows. Streams drain the low land and foothills surrounding the inlet, entering from all sides. Chico Creek, the largest drainage, has 6.0 mainstem miles and contains 14.55 miles of tributaries. Other important independent streams are Clear and Barker creeks, while the remaining 14 tributaries are all small.

Chico Creek drains the timbered regions west of Bremerton and enters Dyes Inlet at Chico Bay at the community of Chico. Four major branches comprise the watershed; Kitsap, Dickerson, Lost, and Wildcat creeks. There are 2 major lakes in this stream system; Kitsap Lake has 250 surface acres, and Wildcat Lake has 113.

The upper watershed, within Lost, Wildcat, and Dickerson creeks, has moderately rugged and heavily timbered slopes. These tributaries, and a portion of the mainstem, flow through sections of deep valley of restricted development. The lower 1.7 miles mainstem has a much broader valley, with moderately heavy residential and small business development. The shores of Kitsap and Wildcat lakes are also heavily settled. Stream gradient through all but the uppermost reaches is moderate, and substrate is predominantly medium sized gravel. Mean discharge of Chico Creek near its mouth has been 34.4 cfs over 15 years of record; however, late summer and early fall flows are very low.

Clear Creek flows south through a broad shallow valley and enters Dyes Inlet at its northernmost tip, near the town of Silverdale. Portions of this watershed are heavily developed, mainly residences and small farms. Watershed and stream bank is mixed conifer and deciduous timber. Upper portions of the stream along with the lower 0.25 mile have moderate gradients, while the other portions have shallow gradients and sandy substrate. Stream discharge records were kept on only one year, from July to October, 1947, and show a range in flow from 1.5 to 9.0 cfs.

Barker Creek originates in Island Lake, 43 acres in size, and flows south to enter the east shore of Dyes Inlet. This watershed is also moderately developed with rural homes. Vegetative cover along the stream banks is varied. The stream gradient is moderate throughout and has predominantly gravel substrate.

The remaining drainages entering Dyes Inlet are all short and small. Some are accessible near their mouths, but most are steeper than the larger creeks in this drainage area. Development within these smaller watersheds is moderately heavy near the shores of Dyes Inlet.

Salmon Utilization

In spite of the small total stream length available within this drainage sub-basin, salmon production is outstanding. Chico, Clear, and Barker creeks all have important runs of chum and coho. There is also believed to be coho production in some of the minor streams. The chum salmon run in Chico Creek is by far the largest population. They spawn throughout the entire mainstem and lower portions of all tributaries. Chum salmon also utilize the lower reaches of Clear and Barker creeks. Coho are found throughout all accessible areas of Chico, Clear and Barker creeks, including tributaries. Chum salmon returns to the area total approximately 10,000 annually while coho average 1,500 adults.

Limiting Factors

Low summer and fall stream flows have affected production of coho and chum salmon in this drainage. Portions of some of the streams or their tributaries have intermittent flow, while discharge from all streams is minimal. During certain years the low flow conditions have extended into late October and November, and have interfered with the upstream migration of the early portion of the major chum run to Chico Creek. The area is relatively heavily developed and populated, and the usual problems associated with water quality, construction adjacent to the stream, numerous road and highway crossings, and poaching are common.

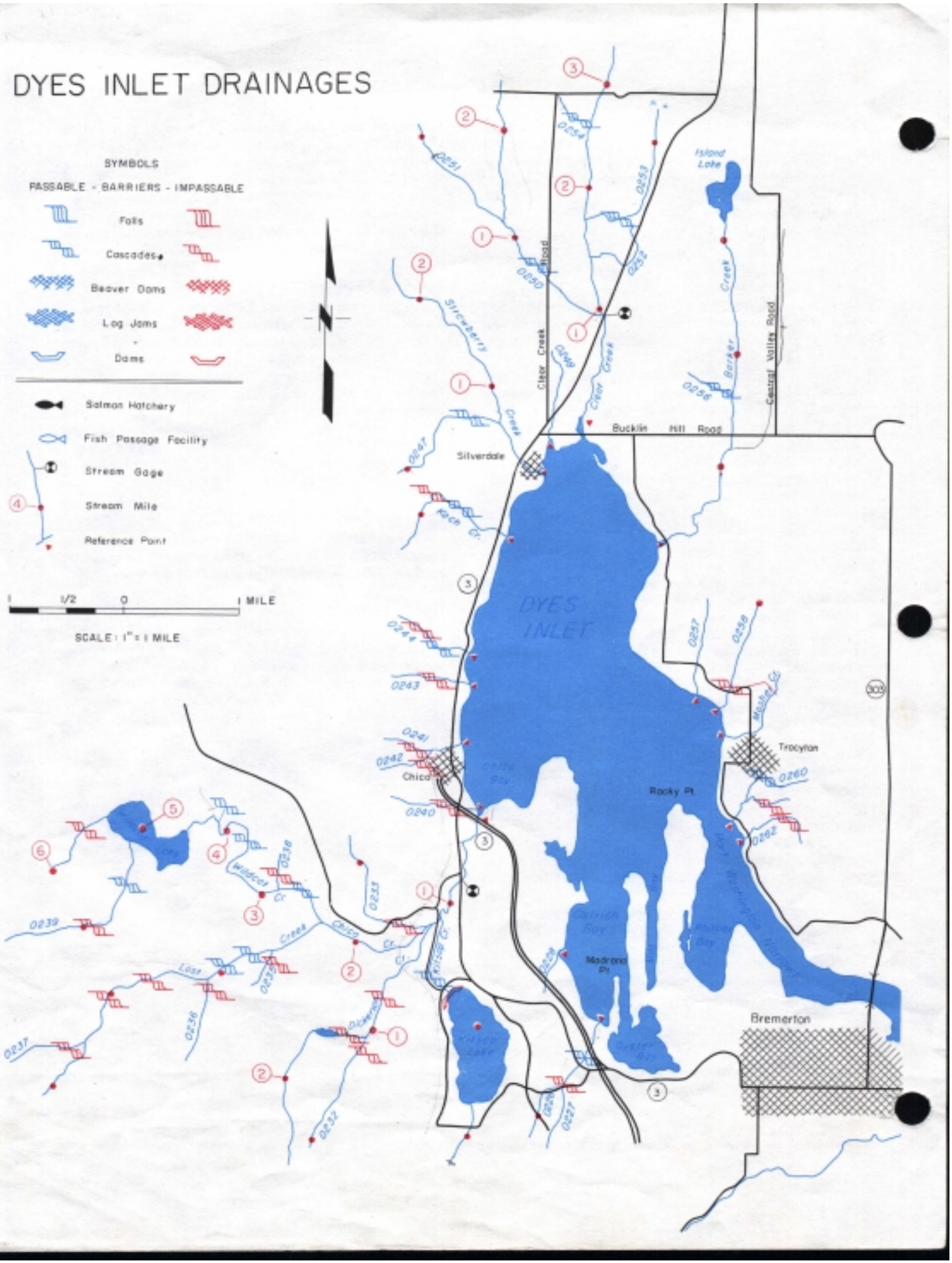
Beneficial Developments

There have been no facilities developed for enhancement or production of salmon stocks in this area. Occasional hatchery plants of coho have been made in past years.

Habitat Needs

To maintain existing stream habitats, future developments must be controlled through the state hydraulics code, within the watershed. Diversion of additional water from the streams during low flow periods would be particularly detrimental. There may be a potential for creating additional spawning area artificially, particularly in Clear Creek.

DYES INLET DRAINAGES



DYES INLET DRAINAGES
Kitsap Basin — WRIA 15

Stream Number	Stream Name	Location Of Mouth	Length	Drainage Area	Salmon Use
0226	Unnamed	Sec16,T24N,R1E	1.2	—	Unknown
0229	Chico Creek	Sec5,T24N,R1E	6.0	—	Coho, Chum
0230	Kitsap Creek	RB-1.2	2.3	—	Coho, (Chum)
	Kitsap Lake	Outlet-0.6	—	—	
0231	Dickerson Creek	RB-1.3	2.8	—	(Coho), (Chum)
0232	Unnamed	RB-1.15	1.1	—	Unknown
	Unnamed Lake	Outlet-1.4	—	—	
0233	Unnamed	LB-1.35	1.2	—	(Coho), (Chum)
0234	Lost Creek	RB-2.3	3.1	—	Coho, (Chum)
	Chico Creek cont. as Wildcat Creek	@ mi. 2.31	—	—	
	Wildcat Lake	Outlet-4.45	—	—	
0239	Unnamed	RB-4.95	1.8	—	None
0245	Koch Creek	Sec20,T24N,R1E	1.35	—	Unknown
0246	Strawberry Creek	Sec20,T25N,R1E	2.5	—	(Coho), (Chum)
0247	Unnamed	RB-0.65	1.1	—	Unknown
0249	Clear Creek	Sec16,T25N,R1E	3.2	—	Coho, Chum
0250	Unnamed	RB-0.91	2.35	—	Coho, Chum
0251	Unnamed	RB-1.2	1.1	—	None
0253	Unnamed	LB-1.75	1.4	—	Unknown
0255	Barker Creek	Sec21,T25N,R1E	3.15	—	Coho, Chum
	Island Lake	Outlet-3.15	—	—	
0258	Unnamed	Sec34,T25N,R1E	1.0	—	Unknown

NORTH KITSAP PENINSULA
Independent Drainages

The North Kitsap Peninsula drainage area includes many independent streams, all small, that enter the northern portion of Port Orchard, Liberty Bay, Port Madison, and Admiralty Inlet. Included also are all tributaries draining Bainbridge Island. There are a total of 58 streams, including 20 on Bainbridge Island, when combined total only 88.0 stream miles. Streams draining the North Kitsap Peninsula to Hood Canal are described under Kitsap 802.

Stream Description

Terrain of this peninsula is predominantly low rolling hills separated by numerous small valleys. The region has been moderately heavily settled, particularly near Poulsbo on Liberty Bay, and Winslow on Bainbridge Island. There are numerous smaller communities including Hansville, Kingston, Suquamish, Keyport, Brownsville, and Illahee, plus rural home and farm development throughout the region.

Watershed cover is intermittent, due to the extent of development. Vegetated areas, where they exist along the streams, are mostly dense underbrush. Stream gradients, as well as type of substrate, vary among the many tributaries. Most of the smallest streams tend to have steeper gradient. Predominant stream substrate throughout the region is gravel and sand. Stream flow records are available from only one watershed, Dogfish Creek, where the mean flow for 24 years was 8.94 cfs. This small stream is also very stable, with annual low flows seldom below 1 cfs and often 2 cfs or more. This stable condition has been noted in other streams within the area, particularly those with shallower gradients that lie in the lower elevation valleys.

Four streams are worthy of individual mention, including Illahee, Steele, Dogfish, and Grovers creeks. Illahee Creek has moderate gradient,nstable stream flow, and excellent stream bank cover. Gravel quality, however, contains much sand and fine material. This is at least in part due to the construction of a large golf course within the upper watershed where the denuded area was open to winter rains. Sediment from earth slides and heavy erosion was deposited throughout the stream.

Steele Creek, entering Port Orchard at Brownsville, has moderate gradient and excellent gravel throughout much of its length. The south branch is inaccessible in all but its lower 0.1 mile due to a highway fill and culvert blockage. The north branch and its tributary have excellent cover and provide high quality habitat. Dogfish Creek has a moderately shallow gradient, with some substrate sections of sand and fine material and others containing favorable spawning gravel.

Grovers Creek is the longest stream in this basin subarea with 5.1 miles of mainstem. The stream has much suitable cover; however, gradient is shallow in many areas and quality of the substrate is limited.

Salmon Utilization

Due to their stable nature, many of the small drainages have year-round flow and produce salmon. Coho and chum salmon are the predominant species, yet surprisingly chinook also return to Dogfish Creek. The heaviest coho production is in Steele, Dogfish and Grovers creeks, while the best chum salmon streams are Steele and Dogfish creeks. Chum and/or coho production has been reported in several of the smaller independent drainages. Total coho production for this area is approximately 800 spawners, while chum production is near 1,000. Chinook returns in Dogfish Creek have ranged from 20 to 100 fish per year.

Limiting Factors

Natural limiting factors within the area are the small size of the streams and restricted accessibility. Shallow gradient sections also affect gravel quality. In addition to the man-caused sediment deposition in Illahee Creek, the removal of stream bank cover and acceleration of erosion has caused gravel contamination in some areas.

Beneficial Developments

A gravel improvement project has been completed on Dogfish Creek, replacing sediment contaminated gravel with high quality material. During the late 1950's and early 1960's two brackish water impoundments were utilized as natural rearing facilities, located in lagoons near Keyport and Kingston; however, benefit/cost ratios were not favorable. Hatchery plants have been made occasionally in streams within this area.

Habitat Needs

Some streams may have potential for spawning gravel improvement, where gradient is suitable. The serious problem of gravel quality in Illahee Creek needs repair; however, this would undoubtedly require a costly project that would bring back only moderate return.

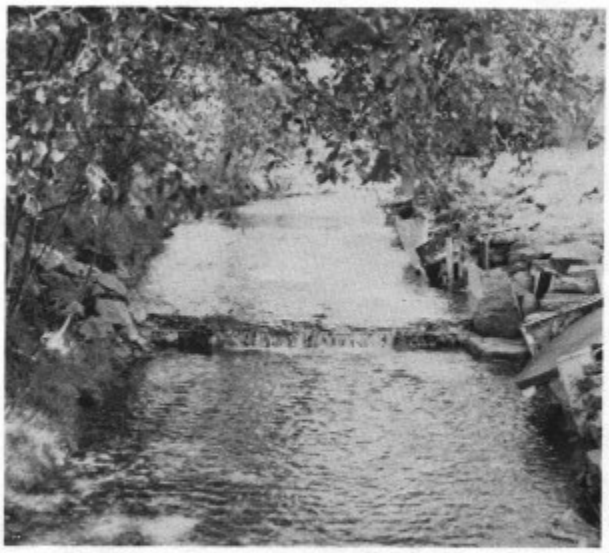
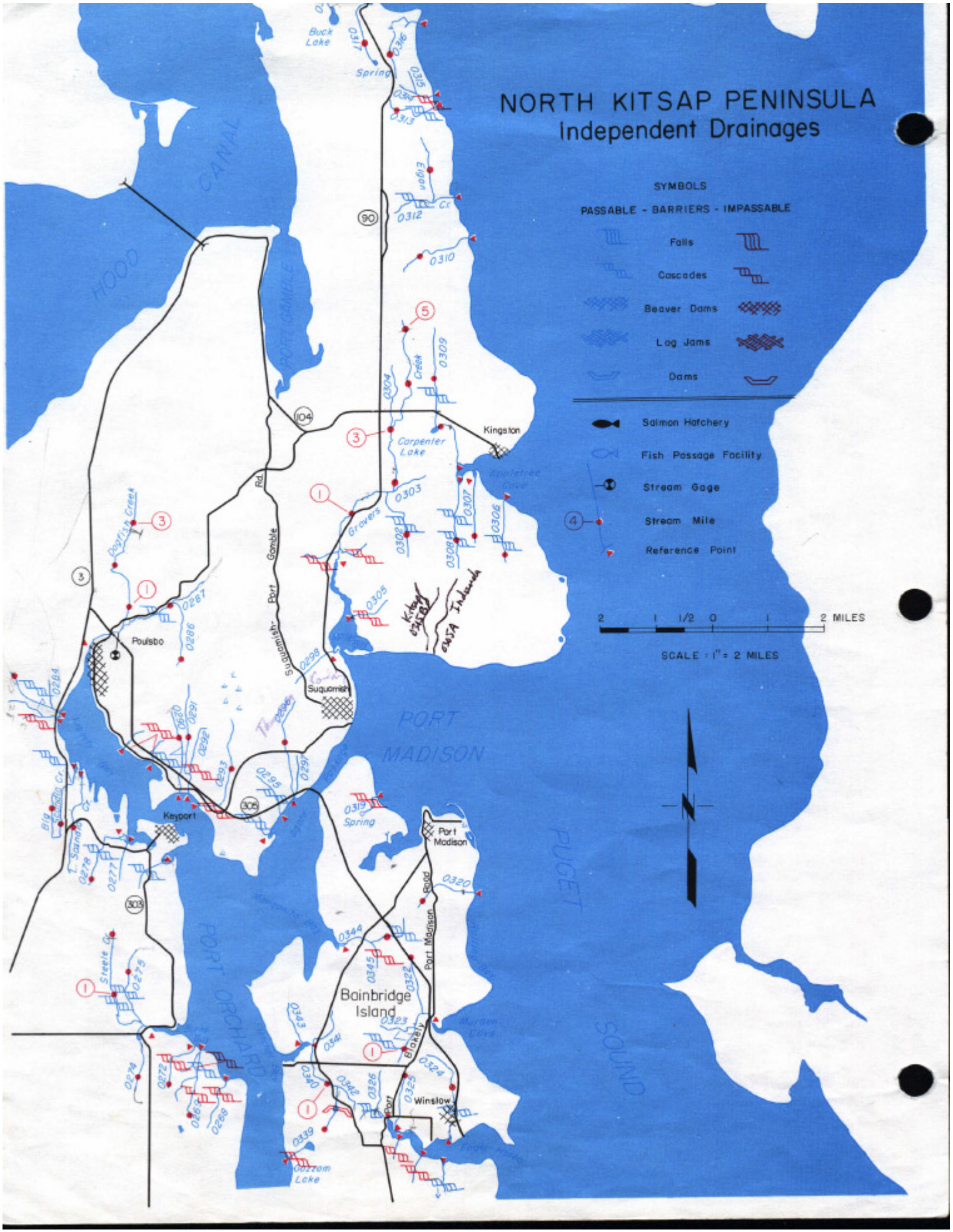


PHOTO 15-8. Streambed cleaning and stabilization on Dogfish Creek.


NORTH KITSAP PENINSULA
Independent Drainages
SYMBOLS
PASSABLE - BARRIERS - IMPASSABLE
Falls
Cascades
Beaver Dams
Log Jams
Dams
Salmon Hatchery
Fish Passage Facility
Stream Gage
Stream Mile
Reference Point
2 1 1/2 0 1 2 MILES
SCALE : 1" = 2 MILES
HOOD CANAL
PORT GAMBLE
PORT MADISON
PUGET SOUND
PORT ORCHARD
Bainbridge Island
Kingston
Poulsbo
Suquamish
Keyport
Port Madison
Winslow
Port Gamble Rd
Port Madison Road
Carpenter Lake
Grovers Creek
Buck Lake
Spring
Blakely
Steele Cr
Big Valley Cr
T. Sandy Cr
Appletree Cove
Murden Cove
Eagle Harbor
Ozzom Lake
Kitsap Indians
0316
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0320

NORTH KITSAP PENINSULA — INDEPENDENT DRAINAGES
Kitsap Basin — WRIA 15

Stream Number	Stream Name	Location Of Mouth	Length	Drainage Area	Salmon Use
0266	Illahee Creek	Sec31,T25N,R2E	1.4	—	Coho, (Chum)
0269	Unnamed	Sec24,T25N,R1E	1.1	—	Unknown
0272	Unnamed	Sec24,T25N,R1E	1.1	—	Unknown
0273	Steele Creek	Sec14,T25N,R1E	2.1	—	Coho, (Chum)
0274	Unnamed	RB-0.1	1.3	—	(Coho), (Chum)
0275	Unnamed	LB-0.2	1.5	—	(Coho), (Chum)
0278	Unnamed	Sec35,T26N,R1E	1.05	—	Unknown
0279	Little Scandia Creek	Sec27,T26N,R1E	1.8	—	(Coho), (Chum)
0280	Big Scandia Creek	Sec27,T26N,R1E	2.2	—	(Coho), Chum
0283	Unnamed	Sec22,T26N,R1E	1.05	—	Unknown
0285	Dogfish Creek	Sec15,T26N,R1E	3.5	—	Chin., Coho, Chum
0286	Unnamed	LB-0.75	2.1	—	Coho, (Chum)
0290	Unnamed	Sec25,T26N,R1E	1.5	—	Unknown
0291	Unnamed	Sec25,T26N,R1E	1.9	—	Unknown
0293	Unnamed	Sec36,T26N,R1E	1.8	—	Coho, (Chum)
0296	Unnamed	Sec29,T26N,R2E	1.7	—	Unknown
0299	Grovers Creek	Sec4,T26N,R2E	5.1	—	Coho, Chum
0302	Unnamed	LB-1.85	1.5	—	Unknown
0306	Unnamed	Sec36,T27N,R2E	1.1	—	Unknown
0307	Unnamed	Sec35,T27N,R2E	1.2	—	Unknown
0308	Unnamed	Sec35,T27N,R2E	1.45	—	Unknown
0309	Unnamed	Sec26&Sec35, T27N,R2E	2.9	—	(Coho), (Chum)
0310	Unnamed	Sec2,T27N,R2E	1.45	—	Unknown
0311	Eglon Creek	Sec2,T27N,R2E	1.6	—	(Coho), Chum)
0313	Unnamed	Sec26,T28N,R2E	1.3	—	Unknown
0316	Unnamed	Sec22,T28N,R2E	1.5	—	Unknown
0317	Unnamed	Sec16,T28N,R2E	1.4	—	Unknown
	Unnamed Lake	Outlet-0.05	—	—	
	BAINBRIDGE ISLAND [1]				
0320	Unnamed	Sec2,T25N,R2E	1.1	—	Unknown
0321	Unnamed	Sec15,T25N,R2E	1.3	—	Unknown
0322	Unnamed	LB-0.4	1.0	—	Unknown
0324	Unnamed	Sec26,T25N,R2E	1.7	—	Unknown
0325	Unnamed	Sec27,T25N,R2E	1.0	—	Unknown
0340	Unnamed	Sec20,T25N,R2E	2.0	—	Unknown

[1] *Tributaries listed from northernmost point in clockwise order around islands.*

NORTH KITSAP PENINSULA — INDEPENDENT DRAINAGES
Kitsap Basin — WRIA 15

Stream Number	Stream Name	Location Of Mouth	Length	Drainage Area	Salmon Use
	Unnamed Reservoir	Outlet-1.4	—	—	
0344	Unnamed	Sec9,T25N,R2E	1.6	—	Unknown