Habitat Evaluation Above
High Priority Fish Passage Barriers

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This report was prepared by staff from the Skagit Fisheries Enhancement Group. Perry Welch provided project management and product production. Joel Breems was the primary author and one of the field surveyors. Other field surveyors included Reid Armstrong, Kevik Rensink, and Danny Cain. Ralph Riley and the Earthwatch Institute provided field survey as well.

Devin Smith of the Skagit River System Cooperative, and Tyson Waldo from Northwest Indian Fisheries Commission provided technical support. Kurt Buchanan (recently retired from Washington Department of Fish and Wildlife contributed anecdotal information on individual blockages. Alison Studley provided project oversight and product review.

Introduction

The Skagit River watershed is the largest river in the Puget Sound providing one third of its total freshwater input annually. Unlike many of the Puget Sound's other watersheds, the Skagit watershed remains largely intact and provides spawning and rearing opportunities to all species of salmonids and trout. Even with the Skagit watershed being largely intact and producing large numbers of smolts each year, it still falls far short of its historic capabilities. For example the winter coho smolt production capacity has been reduced by 34% from historic levels (Beechie et al 1994). With many salmon species currently threatened or endangered and facing increased development pressures in many regions, the Skagit watershed is becoming vitally important to all salmonid populations region wide. The current decrease in productivity in the Skagit River is in a large part a result of man-made barriers that block highly productive habitats upstream. Fish passage improvement projects remain one of the most cost effective restoration methods available, requiring a relatively small investment of resources and capital to a comparatively large increase in habitat access and productivity.

Even though fish passage improvement projects provide cost effective restoration projects, funding opportunities remain limited and competitive. In order to be the most effective with limited financial resources it is essential to have a working knowledge of the region allowing for prioritization of the various fish passage barriers. Having such a prioritization also improves the likelihood of receiving funding in a competitive statewide or national process.

For this project, the Skagit Fisheries Enhancement Group (SFEG) conducted on the ground habitat assessment for 56 streams within SFEG Focal Areas (Figure 1) and Skagit Watershed Council Target Areas (SWC) (Figure 2). This data was utilized to create a prioritized list of barriers, which is a valuable, flexible, and transferable tool to be used in the planning of fish passage improvement projects.

In addition to surveying the habitat above 56 identified barriers and ranking them in a prioritized list, this project provided a unique opportunity to gain extensive field knowledge of many watersheds throughout the Skagit basin. The gathering of this detailed field information also allowed SFEG to continue its goal of community outreach by providing an opportunity to begin a dialogue with many of the landowners, which in turn has led to many project opportunities.

Figure 1. Skagit Fisheries Enhancement Group Focal Areas Map

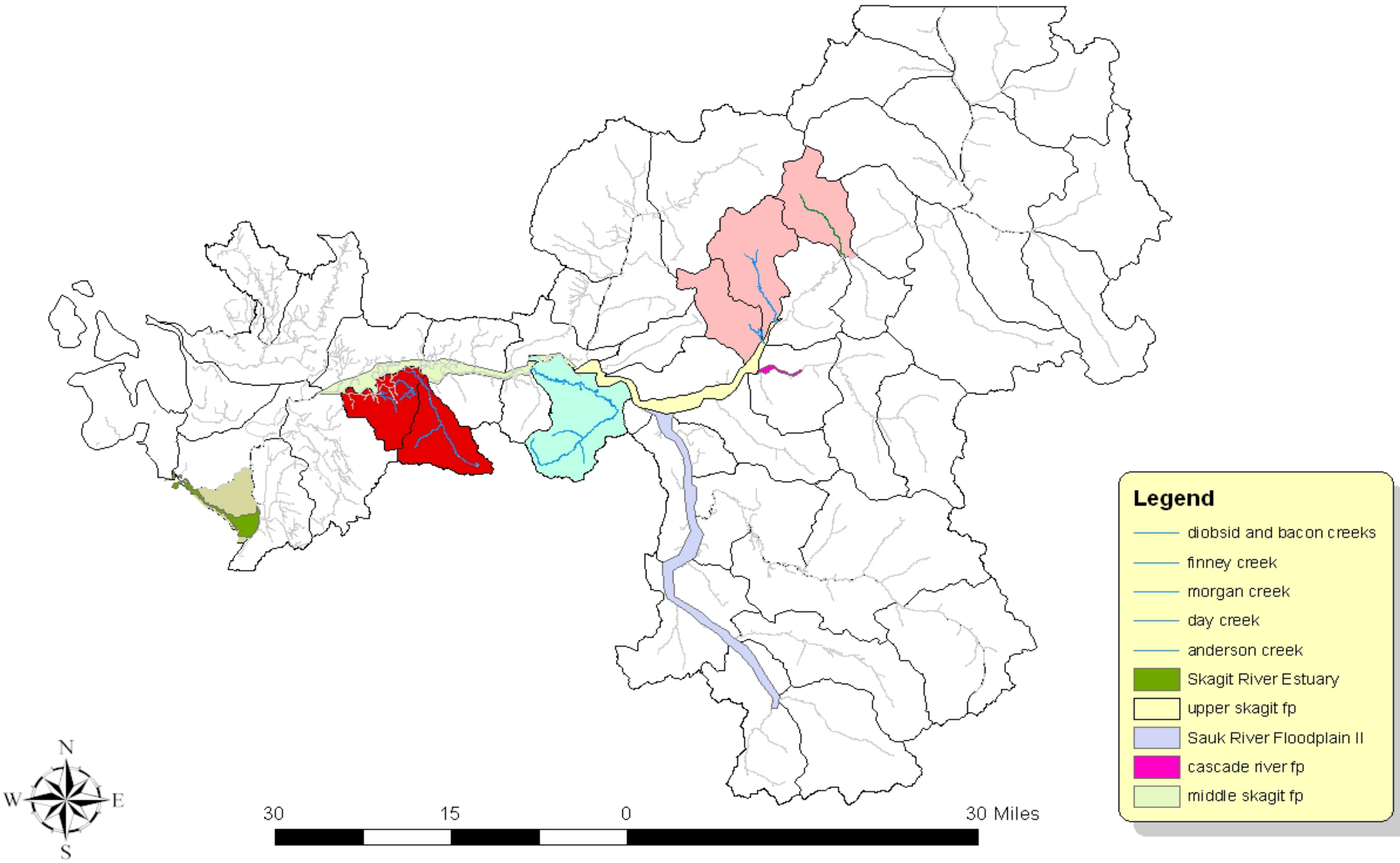
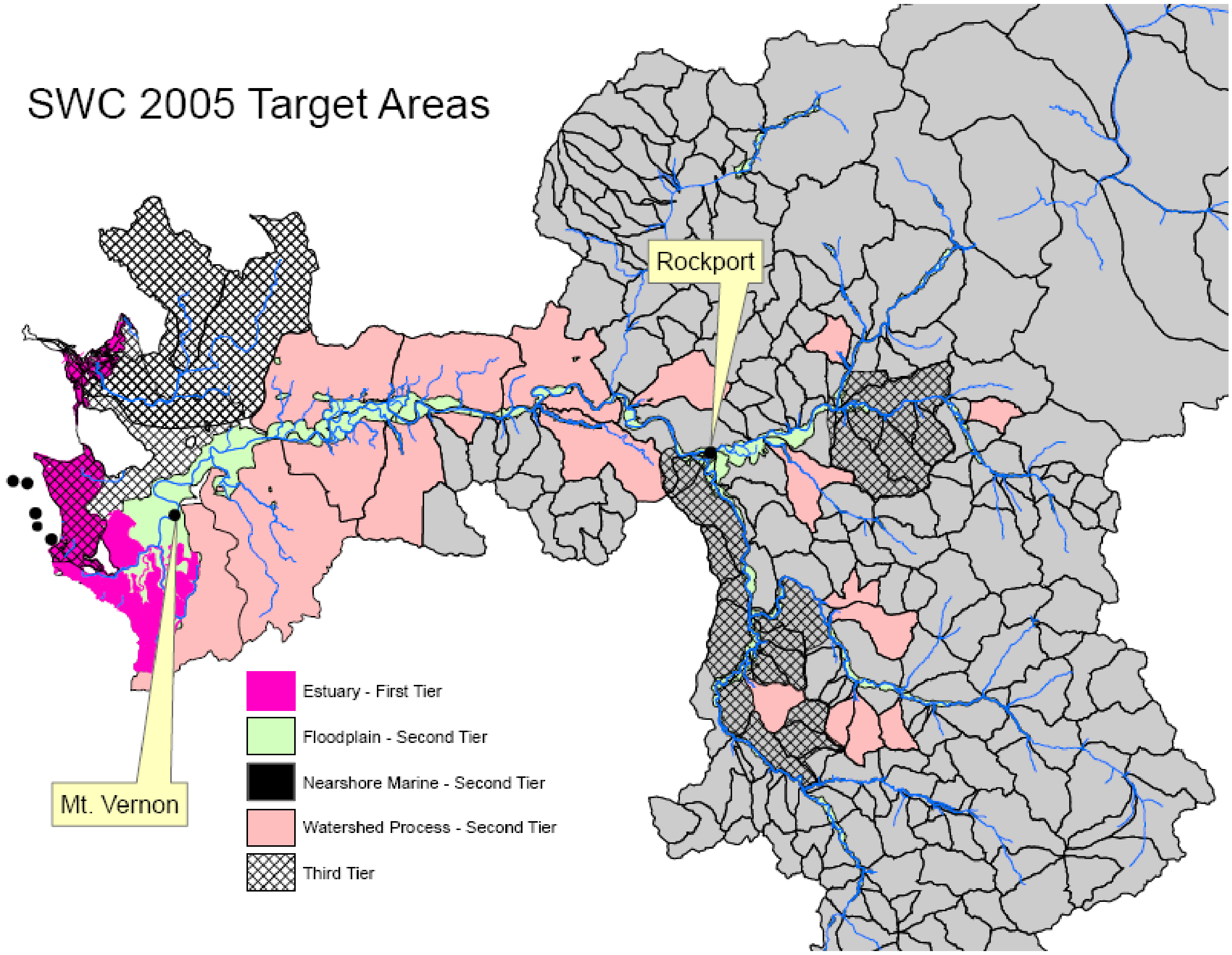


Figure 2. Skagit Watershed Council 2005 Target Areas



Objectives

This habitat assessment project narrows a list of 122 high priority fish passage problems by first identifying which problems are located within the SFEG Focal Areas and Skagit Watershed Council's 2005 Target Areas for salmon recovery and second by determining which stream crossings will provide direct benefit to Puget Sound Chinook and coho salmon. The emphasis of this project is to conduct assessments for isolated habitat at high priority barriers in the basin. This project will provide an opportunity to prioritize and identify restoration projects.

The proposed project targets restoration actions that fix fish passage barriers that prevent access to the greatest amount of high quality habitat. One of the goals of this project was to assess habitat conditions above known man-made barriers in order to develop a priority ranking based on habitat area.

In 2005, Skagit Fisheries Enhancement Group received a grant from the Pacific Salmon Commission Southern Endowment fund. Grant objectives were stated in the following four objectives.

Objective 1: Conduct habitat assessment on high priority blockages currently identified in Limiting Factors Analysis for the Skagit Watershed. Assess habitat conditions using a standardized method above 50 high priority fish passage barriers.

Objective 2: Develop a prioritized list of fish passage improvement projects based on habitat area, habitat conditions, accessibility, and land ownership.

Objective 3: Enhance ability of SFEG and project partners to target fish passage projects that will increase access to areas blocked by human caused impediments. Obtain landowner agreements to correct fish passage barriers at high priority locations.

Objective 4: Enhance ability of SFEG and partners to acquire funding for correction of fish passage barriers.

Background

A systematic inventory was conducted in 1999 by Skagit System Cooperative to assess fish passage problems in the Skagit Watershed. Over 1,800 stream crossings were included in this inventory. Approximately 900 fish passage problems were identified as a result. This information has been coupled with natural anadromous fish passage barrier information available for the Skagit Watershed in order to determine the length of habitat above barriers. However additional information is needed about the habitat that exists between the fish passage problems and the natural barriers in order to prioritize restoration actions.

The *Limiting Factors Analysis for the Skagit Watershed* (Washington Conservation Commission, 2003) contains the methods and results of a further GIS analysis that narrowed the list of 900 fish passage problems identified in the inventory to 122 high priority sites. Smith and Waldo (2003) determined the amount of habitat available upstream of each barrier by estimating the low flow wetted surface area for the generalized habitat types used by the Skagit Watershed Council. These habitat types are designated as either "key" or "secondary" depending on their importance to these species and "degraded" or "important" depending on their level of impairment.

Habitat is classified into these types in the GIS analysis based on gradient information taken from topographic maps and land use information taken from satellite imagery. Stream length was measured using GIS from each barrier to the next upstream barrier or to the upper extent of usable habitat if there were no upstream barriers. Upstream extent of usable habitat was determined using known natural barriers to fish migration and existing fish distribution maps. Surface area was calculated by multiplying the measured length for each habitat type by wetted width, which was estimated using two regression models.

This GIS analysis identified 122 barriers as a high priority for further analysis, 170 as medium priority, and 253 as low priority. (Other fish passage problems were eliminated from this list due to their estuary location, lack of information, or because multiple structures were present).

Methods

The high priority list was narrowed by identifying barriers that occur within SFEG's Focal Areas and Skagit Watershed Council 2004 Target Areas. Focal Areas are geographic areas associated with the Skagit and Sauk River systems that SFEG has identified in order to focus efforts where SFEG can have the greatest contribution to the health of native fish populations, while integrating the community in outreach and education programs with its restoration projects in order to optimize effectiveness. Focal Areas include tributaries, mainstem river reaches and estuarine systems that are most ecologically important to salmonid life histories based on current and potential biological productivity. The geographic area encompasses the Skagit River Basin. Primary Focal Areas include Upper Skagit River Tributaries (Diobsud, Bacon, Goodell Creeks); South Skagit River Tributaries (Day, Morgan, Anderson, Sorensen Creeks); Finney Creek; Upper Skagit River Floodplain; Middle Skagit River Floodplain; Cascade River Floodplain; Sauk River Floodplain; and Skagit River Estuary.

By overlaying high priority barriers on SFEG Focal Areas and SWC Target Areas, a list of 71 streams (Table 1) was identified for possible assessment using methods developed by the Skagit River System Cooperative (Smith 2003 and presented in appendix A). Habitat assessment began at the identified barriers and was measured in meters and identified by the habitat types defined in the protocol. Habitat types were based on gradient, substrate composition, flow, depth and stream behavior. The habitat types identified and measured were pool, pond, slough, riffle, and cascade by length and width. The survey was conducted to the natural anadromous fish barrier which was identified as a gradient of 20% or greater over 100 meters, 16% for streams smaller than 0.6 meters in width or a 3.7 meter or greater vertical falls, 2.0 meters if no plunge pool was present. GIS data on the natural anadromous barriers was also overlaid on the field maps. Detailed field notes were taken to identify features not highlighted by the data collected according to the protocol.

Field maps were prepared for field crews so that habitat barriers could be identified and access points and ownership could be established for each of the streams. Field maps consisted of color aerial 2001 photos overlain with a hydro-layer, LFA fish distribution layer, county road layer, barriers habitat layer, natural barrier layer, and tax parcel layer.

Field work was conducted from May through the end of June 2005, when stream flow decreased. Field work resumed in October 2005 and continued through April 2006. As part of the field work landowners were contacted and potential projects noted.

Data was compiled from previously surveyed streams and data collected in the field. All data was entered into an excel spreadsheet, and the individual habitat unit lengths and areas were calculated.

Additionally, field note summaries were written by SFEG and partners for streams where additional anecdotal information was gathered. These notes, included in appendix B, indicate all the landowner contacts, site conditions, and project ideas and will aid SFEG with future project planning and implementation, as well as further integrating SFEG into the community.

Findings

The list of high priority fish passage blockages that occur within Focal Areas is contained in Table 1. This list represents an initial cut. Not all of these sites were surveyed. During the field work, some additional sites were added and some were deleted due to a variety of reasons such as access constraints.

Table 1: List of Barriers Targeted for Habitat Assessment

Skagit Fisheries Enhancement Group

Barrier Habitat Assessment Evaluation

Selected High Priority Blockage for Assessment by SFEG Focal Areas

South Skagit Highway High Priority

Note	STTYPE	STREAM	TRIB_TO	LOCATION	SITE	PRIORITY
1	culvert	unnamed	3.0286	Farm access road off of Walberg Road. Located on Sundstrom dairy farm.	GN34.1.1	High
2	culvert	Gilligan Cr	Skagit R	South Skagit Highway crossing.	GN18.1.1	High
3	culvert	Morgan Cr	3.0286	Private driveway crossing off of South Skagit Highway.	GN13.1.1	High

Upper Skagit Floodplain High Priority

Note	STTYPE	STREAM	TRIB_TO	LOCATION	SITE	PRIORITY
4	culvert	unnamed	Lucas Slough	Martin Ranch Rd crossing at mile post 0.4.	IL11.1.1	High
5	culvert	unnamed	Harrison Slough	Martin Ranch Rd crossing at mile post 1.3.	IL12.1.2	High
6	culvert	unnamed	Skagit R	Martin Rd crossing.	IL26.1.1	High
7	Culvert	Olson Cr	Skagit R	SR 20 at mile post 105.4.	CD18.1.1	High

Upper Skagit Tributaries

8	Culvert	Babcock Cr	Skagit R	SR 20, milepost 118.3	DM1.1.2	High

Middle Skagit Floodplain

Note	STTYPE	STREAM	TRIB_TO	LOCATION	SITE	PRIORITY
9	culvert	unnamed	Skiyou Slough	Duffy Rd crossing adjacent to 26886 Duffy Rd.	HC109.1.1	High
10	culvert	unnamed	Skiyou Slough	Hoehn Rd crossing located 75 meters east of HC3.	HC110.1.1	High
11	culvert	unnamed	Mannser Cr	Field access road crossing 40 meters downstream of # AR3.1.2.	AR4.1.1	High
12	culvert	Mannser Cr	Skagit R	Hamilton Cemetery Rd crossing (south).	AR43.1.1	High
13	culvert	unnamed	Mannser Cr	Burrese Road crossing.	AR7.1.1	High
14	culvert	Careys Cr	Skagit R	Located on private drive. 35004 SR 20. (6 meters upstream of the Little Careys confluence	AR38.2.2	High

Table 1: List of Barriers Targeted for Habitat Assessment (continued)

Note	STTYPE	STREAM	TRIB_TO	LOCATION	SITE	PRIORITY
15	culvert	Careys Slough	Skagit R	Pettit Road crossing.	AR39.1.2	High
16	culvert	Davis Slough	Skagit R	South Skagit Highway crossing (east).	LA10.1.1	High
17	culvert	Red Cabin Cr	Etach Slough	Hamilton Cemetery Road crossing.	AR9.1.1	High
Hansen Creek Watershed						
Note	**STTYPE**	**STREAM**	**TRIB_TO**	**LOCATION**	**SITE**	**PRIORITY**
18	culvert	Red Cr	Hansen Cr	Tidegate through dike at the confluence of Hansen Cr and Red Creek	HC101.1.1	High
19	culvert	Red Cr	Hansen Cr	Field access road crossing at 25588 Helmick Rd.	HC123.1.1	High
20	culvert	unnamed	Red Cr	Approximately 0.9 miles east of HC14.	HC15.1.1	High
21	culvert	unnamed	Red Cr	Located approximately 300 meters upstream from HC15; adjacent to weigh station on Highway	HC16.1.2	High
22	culvert	unnamed	Red Cr	Gravel road crossing on Northern State Hospital land approximately 200 meters upstream	HC41.1.1	High
23	culvert	unnamed	3.0271	Old grade crossing located approximately 0.3 miles upstream of HC1.	HC44.1.1	High
24	culvert	unnamed	Coal Cr	Private drive crossing at 27491 Minkler Rd.	HC63.1.1	High
25	culvert	Red Cr	Hansen Cr	Nuwha ah Dr crossing.	HC82.1.1	High
26	culvert	Pipeline Cr	Jones Cr	Third Pipeline Rd crossing at mile post 0.6; adjacent to Cedar Flats Ln.	HC88.1.1	High
27	culvert	unnamed	Hansen Cr	Hwy 9 crossing located at mile post 59.4.	HC93.1.1	High
28	bridge	Hansen Cr	Skagit R	Old bridge crossing, approximately 0.2 miles upstream from HC38.	HC97.1.1	High
Sauk River Floodplain						
29	Culvert	unnamed	Sauk River	South Skagit Hwy crossing	RC2.1.1	High
30	Culvert	unnamed	Sauk River	South Skagit Hwy crossing	RC3.1.1	High
31	Culvert	Hobbit Cr	Sauk River	South Skagit Hwy crossing	RC4.1.1	High
32	Culvert	unnamed	Sauk River	South Skagit Hwy crossing	RC5.1.1	High
33	culvert	Lyle Cr	Sauk River	Hwy 530 crossing	RC10.1.1	High
34	culvert	unnamed	Sauk River	Hwy 530 crossing	RC12.1.1	High
35	culvert	Green Cr	Sauk River	Near mouth on logging rd	SP4.1.2	High
36	Culvert	Everett Cr	Sauk River	800m below Crawford Loop Rd	SP9.1.1	High
37	Culvert	Everett Cr	Sauk River	221m blw Crawford Loop RD	SP10.1.1	High
38	Culvert	Mouse Cr	Sauk River	Driveway crossing, 177m up from mouth	DC2.1.2	High
39	Culvert	unnamed	Sauk River	Milepost 1.9(from N), N Sauk River Rd	DC15.1.2	High
40	Culvert	unnamed	S Fork Sauk R	Mt Loop Hwy crossing, milepost 18.1	MO4.1.1	High
41	Culvert	unnamed	S Fork Sauk R	Mt Loop Hwy crossing, milepost 18	MO5.1.1	High
Sauk Prairie						
42	Culvert	Prairie Cr	Sauk River	Off of Sauk Prairie Rd, 1500m upstream of SP1, at field access	SP20.1.1	High
43	Culvert	Gravel Cr	Sauk River	Sauk Prairie Rd crossing	SP3.1.1	High
44	Culvert	unnamed	Everett Creek	Sauk Prairie Rd crossing	SP14.1.1	High
Cascade River Floodplain						
45	other	Jordan Cr	Cascade R	Approximately 0.75 meters downstream from JB27.	JB19.1.1	High
46	culvert	Shoemaker Cr	Cascade R	S Cascade R Rd crossing.	JB38.1.1	High
47	culvert	unnamed	Cascade R	Overgrown road crossing, 20 meters off the south side of the Cascade R Rd at mile post 1.	JB21.1.1	High
Middle Skagit Tributaries						
48	culvert	unnamed	Savage Cr	Logging road crossing. Located approximately 0.2 miles past PN4.1.1.	PN5.1.1	High
Concrete						
49	culvert	Lornezan Cr	Skagit R	Private road crossing at 44689 Dalles Rd.	GR8.1.1	High
50	culvert	unnamed	Lornezan Cr	Concrete Sauk Valley Rd crossing approximately 20 meters south of Hwy 20.	GR18.1.1	High
51	culvert	unnamed	Lornezan Cr	Superior Ave crossing.	GR22.1.1	High
52	dam	Lake Tyee	Grandy Cr	Dam/spillway structure located at the outlet to Lake Tyee.	GR30.1.1	High
53	dam	Grandy Cr	Skagit R	A private dam that is located approximately 125 meters upstream of GR2.	GR32.1.1	High
54	culvert	Grandy Cr	Skagit R	Burpee Hill Rd crossing.	GR2.1.1	High

Table 1: List of Barriers Targeted for Habitat Assessment (continued)

Nookachamps

Note	STTYPE	STREAM	TRIB_TO	LOCATION	SITE	PRIORITY
55	culvert	Cold Springs Cr	EF Nookachamps		NC60.1.2	High
56	culvert	Turner Cr	EF Nookachamps		NC97.1.1	High
57	fishway	unnamed	W F Nookachamps	Private railroad grade crossing that is 10 meters east of Hwy 9 at mile post 48.	NC135.1.2	High
58	culvert	unnamed	WF Nookachamps		NC72.1.1	High
59	culvert	unnamed	WF Nookachamps		NC136.1.1	High
60	culvert	Murrays Creek	03.0256	On otter pond road, Maxwell property	NC147.1.1	High
61	culvert	unnamed	Lake Cr	Lake Cavanaugh Rd crossing; adjacent to 25315 Lake Cavanaugh Rd.	NC184.1.1	High
62	culvert	unnamed	Lake Cr	Hwy 9 crossing at mile post 43.1.	NC163.1.1	High
63	culvert	Lake Cr	Big Lake	Hwy 9 crossing at mile post 42.39.	NC190.1.1	High
64	culvert	unnamed	Lake McMurray	Private drive crossing at 23253 Hwy 534.	NC174.1.1	High
65	culvert	Klahowya Cr	EF Nookachamps		NC10.1.1	High
66	Culvert	unnamed	Walker Cr		NC28.1.1	High
67	Culvert	unnamed	Walker Cr		NC55.1.1	High
68	Culvert	unnamed	Walker Cr		NC56.1.1	High
69	Culvert/d	unnamed	Walker Cr		NC57.1.1	High
70	Culvert	Klahowya Cr	EF Nookachamps		NC6.1.1	High
71	Dam	unnamed	3.0248	At outlet to Lake Challenge in Fire Mountain Boy Scout Camp.	NC9.1.1	High

Beginning in May 2005 through April 2006 SFEG and its partner- Earthwatch Institute- surveyed barriers from this list. This resulted in habitat assessment above 56 barriers for a total of 128 km of stream surveyed.

Five of the barrier sites had already had habitat assessments performed as test cases for the protocols and some of the barrier sites were assessed by other entities with different funding sources. Habitat assessment efforts were not duplicated at these sites, but their results were incorporated in the prioritizing.

Habitat type areas were totaled by summing the areas for each unit for all of the streams except for NC10.1.1, NC 60, JB38, JB21.1.1, JB19.1.1, BL1.1, NC190.1.1, and Morovitz. The pool measurements for these streams were totaled and averaged for each reach during the initial data collection. The average pool area for each reach was multiplied by the number of pools per reach to calculate total pool area for these streams. IL1.1.1 was included in the ranking at a later date because of previous knowledge of the system and the potential for funding. The IL1.1.1 data included area (m^2) for slough and channel. The pool and riffle measurements were extrapolated from the channel measurement based on an average percent pool by area from randomly selected streams of similar gradients. Twelve percent of the area of the 2-4% gradient and three percent of the 4-8% gradient reaches were counted as pools based on the average percent pool composition of comparable streams. The remainders of the channel areas were counted as the riffle area for the purposes of ranking.

With the habitat area measured for all habitat types, prioritizing the barriers can be done for any fish species present within the Skagit watershed basin by weighting the habitat areas based on individual species use. Fish passage problems are one of the primary factors limiting coho smolt production in the Skagit watershed. Coho smolt production has decreased 34% from historic levels (Beechie et al, 1994). Many of the barriers surveyed are primarily a barrier to juvenile fish, preventing coho fry from accessing historically productive rearing areas. For this reason winter coho production estimates were used as the benchmark for prioritization (Table 2). For all of the streams, the areas for pools, riffles, sloughs, and cascades were summed and multiplied by its corresponding potential winter coho smolt production numbers. The production numbers are outlined in *Estimating Coho Salmon Rearing Habitat and Smolt Production losses in a Large River Basin, and Implications for Habitat Restoration* (Beechie et al 1994). The corresponding production number was used to prioritize the culverts for replacement (Table 3).

Table 2: Coho Production Estimates by Habitat Type

Habitat type	Potential Coho smolt production (smolts per area)
Tributary Pool(winter)	1.085/m^2
Tributary Riffle (winter)	0.00/m^2
Pond (winter)	1.163/m^2

Using the potential coho smolt production numbers the barriers were ranked according to total winter smolt production (Table 3). A map of the barriers is provided in figure 3.

Table 3: Barriers Prioritized by Coho Smolt Production For Improvement

Priority	SiteID	Pool	Riffle	Pond/Slough	Cascade	Glide	Potential winter production
1	HC15.1.1	583.15	10244.43	128117.2	931.8		149633.0
2	IL1.1.1	30.222	514.278	110915	388.1		129026.9
3	Mannser	937.3	9428.48	95033.6	1510.6		111541.0
4	Lake Tyee	87.16	9428.48	95033.6	1510.6		110618.6
5	Otter Creek	175.8	1730.7	83686	55.5		97517.6
6	AR4.1.1	1177.21	2740.82	72705	825.38		85833.2
7	HC16.1.2	496.65	7968.15	57990	931.8		67981.2
8	IL26.1.1	347.5	2788.8	27872.5	0		32792.8
9	IL12.1.2	1363.34	6686.58	10492.42	0		13681.9
10	Pipeline	366.1414	2575.488	10393.98	2055.75		12485.5
11	NC147.1.1	415.75	3248.045	9137.5	0		11078.0
12	GN13.1.1	799.1	6285	8502.2	658.2		10755.1
13	SP10.1.1	802.88	3771	6320	1440.6		8221.3
14	BL1.1.1	33.94	9177.35	6604.6	0		7718.0
15	SP14.1.1	116.9	889	5140	1068.8		6104.7
16	JB19.1.1	5396.17	20582.47	0	26056.13		5854.8
17	RC10.1.1	804.8	3546.95	2500	1774.6		3780.7
18	DC15.1.2	487.3	2701.2	2258	0		3154.8
19	CD18.1.1	2538.91	5826.7	0	1018.5		2754.7
20	NC190.1.1	2509.22	4780.177	0	0		2722.5
21	GR2.1.1	758.3	6255.9	876	1495.5		1841.5
22	GR32.1.1	752.1	5982.5	876	1438.5		1834.8
23	Morgan	1650	0	0	0		1790.3
24	NC184.1.1	190.2	3160.1	1185	104.5		1584.5

Table 3: Barriers Prioritized by Coho Smolt Production for Improvement (continued)

Priority	SiteID	Pool	Riffle	Pond/Slough	Cascade	Glide	Potential winter production
25	HC93.1.1	22	599.1	1332	0		1573.0
26	LA10.1.1	105	200.05	1234.1	0		1549.2
27	NC6.1.1	1328.56	2632.896	0	0		1441.5
28	SR35.1.1	451.64	3126.76	750	0		1362.3
29	HC63.1.1	75.3	5621.2	876.9	262.5		1101.5
30	RC12.1.1	906.82	2119.4	0	293.5		983.9
31	HC41.1.1	97.94	2753.8	750	0		978.5
32	Morovitz	871.86	14466.49	0	0		946.0
33	GN18.1.1	838.278	2097.072	0	1687.316		909.5
34	RC5.1.1	731.54	3655.7	0	825.2		793.7
35	AR9.1.1	563.2	606.35	0	0		611.1
36	DY4.2.3	395.6	129.55	0	0	363.9	429.2
37	NC60.1.2	325.44	218.13	0	0		353.1
38	SP3.1.1	325.42	1615	0	3752.8		353.1
39	JB21.1.1	316.2	216.32	0	0		343.1
40	PN5.1.1	311.49	2094.15	0	30.2		338.0
41	DY3.1.1	290.23	520.8	0	0		314.9
42	GR33.1.1	285.4	1780.5	0	655.8		309.7
43	NC163.1.1	18.54	358	200	82.2		252.7
44	RC3.1.1	190.5	1335	0	72		206.7
45	RC2.1.1	174.3	1142.1	0	45.8		189.1
46	Parsons	159.25	415.75	0	514.9		172.8
47	DB4.1.1	157.1	421.9	0	573.1		170.5
48	RC6.1.1	118.4	962.7	0	0		128.5
49	NC9.1.1	66.4	208	0	0		72.0
50	GR18.1.1	55.5	3066.7	0	721		60.2
51	GR22.1.1	54.8	2154.7	0	721.7		59.5
52	DB3.1.1	50.8	322.8	0	206.3		55.1
53	JB38.1.1	31.47	1585.273	0	1126.187		34.1
54	DM1.1.2	4.68	31.32	0	0		5.1

In conjunction with the field notes (listed in appendix B) this prioritized list will serve to maximize the effectiveness of SFEG fish passage improvement projects. Using this data and other anecdotal evidence collected, a short list of preliminary potential projects was produced (Table 4).

Figure 3. Blockages Where Habitat Survey Occurred

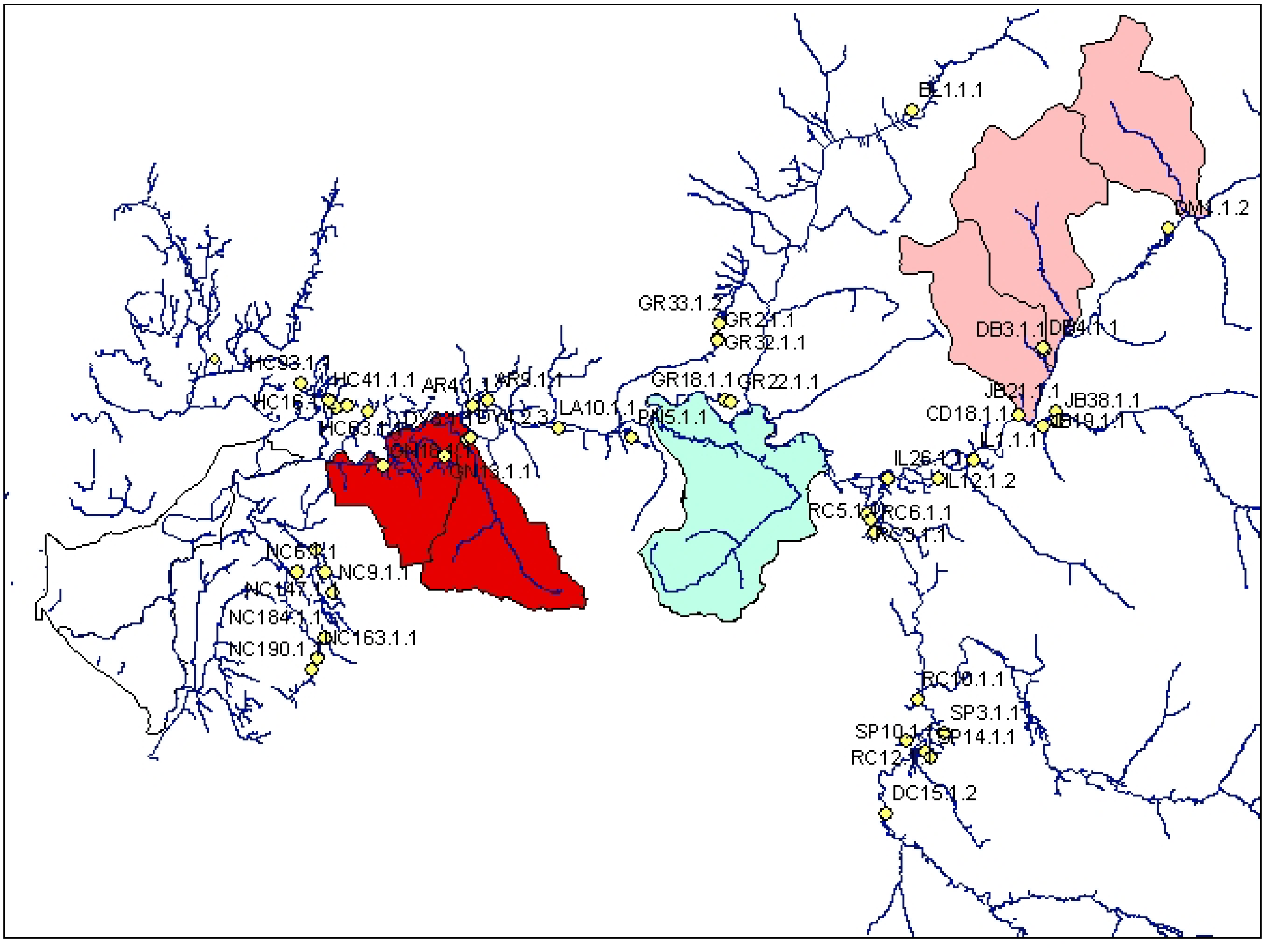


Table 4: Potential Projects

Stream Name	Site ID	Priority	Project
Tributary to Red Creek	HC16.1.2	7	Remove relic culvert to improve sediment transport and fish migration. Landowner contacted
Winters Creek	GN13.1.1	12	2 potential projects wetland revegetation and sediment control issues. Landowners have been contacted
Everett Creek	SP10.1.1	13	Landowner contacted. Interest in culvert removal, livestock exclusion, and riparian planting
Tributary to Coal Creek	HC63.1.1	29	Enhance ditched stream, exclude cattle, and riparian planting
Tributary to Diobsud Creek	DB4.1.1	47	Replace partial barrier culvert for juvenile migration. Landowner willingness established.
Tributary to Diobsud Creek	DB3.1.1	52	Replace perched culvert to improve passage and sediment transport. Landowner willingness has been established

Discussion

For the purpose of this project SFEG chose to use potential coho smolt production numbers as our benchmark in the ranking process. However the habitat assessment data is versatile. Using the habitat data the ranking can be adapted to virtually any salmonid species which is known to utilize these habitat types, making this list a valuable, flexible, and transferable tool for SFEG and our partners. The current ranking provides a general ranking across watersheds within the Skagit basin, but is designed to be quickly adapted to a narrower scale as well as account for additional factors. These factors could include different salmonid species utilization, land use, landowner willingness, cost, and additional barriers upstream. The current prioritization does not currently account for these factors.

As a result of using potential winter coho smolt production numbers as the benchmark for ranking all of the top ranked barriers have a higher ratio of sloughs, ponds, and pools to riffles reflecting the rearing habitat needs of coho. We chose to use this method for several reasons. First, the majority of these barriers are located on smaller streams above the regions utilized by species other than coho. Steelhead are known to utilize areas above those of coho however habitat usage data is not currently available for use in this ranking. As steelhead habitat usage data becomes available it could be used as a ranking criteria. Second, the majority of these barriers are only partial barriers, not creating a barrier for adult fish, but rather juvenile migrants to rearing habitats. Coho fry migrants would be the main species affected by these barriers which greatly limit the amount of quality rearing habitats by blocking passage. (Smith, personal communication). Finally, measurements were taken over the entire length of the streams upstream of the barrier. Other ranking method (i.e. Priority Index Washington Department of Fish and Wildlife) only call for surveying 20% of a stream above the barriers, it would be a disservice to the project to not fully utilize the data collected. Due to the detail of the data collected it is possible to enter the streams into alternate ranking procedures such as the priority index or the SWC cost effectiveness model at a later date as needed.

Conclusions

While the SFEG ranking currently focuses on a single species rather than taking a multispecies approach, it better serves our current purposes by narrowing the scale of the prioritization the species most effected by the barriers, which is coho. As priorities and focuses change and adapt in the future, such as the proposed listing of Puget Sound steelhead under the Endangered Species Act, the data and prioritization can be adapted to meet these yet undetermined needs.

Through the course of this project SFEG was able to meet the objectives stated in the Pacific Salmon Commission grant application.

Objective 1. Conduct Habitat Assessment on high priority blockages currently identified in Limiting Factors Analysis for the Skagit Watershed. Assess habitat conditions using a standardized method above 50 high priority fish passage barriers.

> SFEG was able to identify 71 passage barriers from the initial list of 122 high priority barriers. SFEG with the help of its partner organizations were able to survey 56 barriers using a standardized method as well as a few additional barriers which were identified as priorities during the course of the project

Objective 2. Develop a prioritized list of fish passage improvement projects based on habitat area, habitat conditions, accessibility, and land ownership.

> Using the data collected by SFEG and its partners a prioritized list of barriers was produced which most effectively addresses the current habitat needs of the Skagit basin. As these needs and focuses change and adapt the ranking can be adapted to produce a prioritization focusing on other factors. This includes adaptation into the priority index and the SWC cost effectiveness model.

Objective 3. Enhance ability of SFEG and project partners to target fish passage projects that will increase access to areas blocked by human caused impediments. Obtain landowner agreements to correct fish passage barriers at high priority locations.

> On the ground data collection and the prioritized list provide the direction needed to ensure the most cost effective use of funding when engaging in fish passage improvement projects. Through the process of data collection in the field and meeting with partner organizations SFEG has made many landowner contacts which have and will continue to produce landowner agreements and enthusiasm for salmon enhancement in focal areas.

Objective 4. Enhance ability of SFEG and partners to acquire funding for correction of fish passage barriers.

> Funding sources are limited and competitive for salmon habitat restoration in the Skagit watershed. This barrier prioritization will not only guide our project planning to have the greatest effect, but will also strengthen our applications to potential funding sources. The prioritization allows us to demonstrate to potential funding entities that each project has

the highest possible habitat gain as well as a greater potential for success because we are aware of how the quality and quantity of habitat to be opened compares watershed wide.

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Appendix A: Methods to survey habitat upstream of artificial fish passage barriers

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Skagit System Cooperative
August 26, 2003

The purpose of this habitat survey method is to evaluate habitat conditions upstream of artificial fish passage barriers (poorly designed culverts or other crossing structures) to determine how much and what type of habitat would be made available to anadromous salmonids if the barrier were corrected to provide passage. This method is intended to be quick and efficient, but collect enough information to estimate fish production for steelhead and coho using available models and to generate a priority index rating using WDFW methods. The results will be used to prioritize culverts for restoration.

Equipment
stadia rod or other measuring stick
laser rangefinder, laser level, or hand level
hip chain
measuring tape
diameter tape or log calipers
waders, rain gear, field forms, and pencils

Beginning the Survey
Begin by locating the barrier of interest. The barriers have already been surveyed and evaluated with the WDFW fish passage methodology, so the survey should start with a map or aerial photograph locating each barrier, a site identifier number for the barrier, a written description of the location, and physical information about the barrier. It will be important to spend time making sure the survey starts at the right barrier. Confirm the following characteristics for the barrier: structure type, length, span, rise, presence of bed material, slope, and outfall drop. Record any physical characteristics that have changed or are different from the original survey information. Document any other information that may be relevant for restoration planning.

Once the barrier has been located and adequately described, habitat conditions should be surveyed from the passage barrier upstream to the natural barrier to fish migration including all tributaries that provide habitat. Survey upstream from the barrier using a hip chain to measure stream length and identify the location of measured features.

Channel Reaches
The stream should be divided into reaches based on gradient and channel characteristics (Table 5) and should generally be a minimum of 100 m long. It will not be necessary to finalize reaches in the field, but it is useful to note the hip chain reading where reach breaks are likely. Reach breaks are identified by a change in gradient, pool spacing, or quantity of wood in the channel.

Table 5. Channel types from Montgomery and Buffington (1997)

Channel type	Typical gradient	Description
pool:riffle	< 2%	low gradient channels characterized by an alternating sequence of riffles and pools. Pools form naturally as a result of lateral scour during high flows. These channels have a pool spacing of > 4 channel widths per pool and less than half of the pools are formed by obstructions such as LWD, bedrock, or boulders.
forced pool:riffle	1- 4 %	moderate gradient channels where pools are formed primarily due to obstructions such as LWD, bedrock, or boulders. Pool spacing is < 4 channel widths per pool and more than half of the pools are formed by obstructions.
plane bed	2 - 4 %	moderate gradient channels dominated by riffle area and characterized by an absence of pools and LWD. Pool spacing is > 4 channel widths per pool.
step pool	4 – 8 %	steeper gradient channel characterized by plunge pools alternating with channel-spanning steps formed by boulders organized into small dams. Pool spacing is < 4 channel widths per pool.
steep	> 8 %	steep gradient cascades with little habitat value.

Flow

Streams that are dry in the summer may still provide valuable habitat in the winter for coho and other species that over-winter in freshwater. It is important to evaluate habitat conditions either both in the summer and winter or at least during the season where they are likely to provide the most benefit to fish. The methods described here are intended to quantify habitat conditions during the summer low flow season.

Streams selected for this survey are expected to provide mostly summer habitat, so streams that are discovered in the field to be dry in summer should not be surveyed using these methods. Evaluate the stream for several hundred meters upstream from the culvert before determining there is no flow. Where streams have summer flow but are dry in some reaches, complete the full survey where the stream has water and note the locations where the stream starts and stops being dry. Record only length, bankfull width, and gradient measurements for the dry reaches (as described below).

Channel Width and Gradient

Measure wetted width and bankfull width (to the nearest 0.1 m) perpendicular to the channel at approximately 5-10 channel widths for channels > 3 m wide and at approximately 10-20 channel widths for channels < 3 m wide. The bankfull channel is formed by flood flows that occur once every one to two years on average and is identified in the field by a change in substrate materials, a clear break in slope, and a transition to perennial vegetation. Record the hip chain distance where width measurements are taken and record width measurements on a single line on the data form.

Measure gradient (to the nearest 0.1 percent) using a laser rangefinder, laser level, or hand level. This is done by measuring horizontal distance along the stream thalweg and measuring the change in vertical elevation using the leveling device and stadia rod. Gradient is calculated by dividing the change in elevation by the horizontal distance. Measure elevations from water surface to water surface and take measurements over as long a distance as practical given visibility in the channel. Ideally, include several pool:riffle sequences for each measurement and take measurements between similar channel features, such as from the downstream end of a riffle to the downstream end of another riffle or from the center of a beaver pond to the center of the next beaver pond. Take each measurement over similar distances for each reach and measure approximately 25% of the channel length. For example, take a gradient measure for approximately 25 m distance, skip 75 m, then take another measure over approximately another 25 m and so on. It should usually be possible to take gradient and width measurements from the same location. Record the hip chain distance at the downstream end of the gradient measurement and record distance and elevation measurements on a single line on the data form.

Habitat Units

Record wetted surface area and other information on habitat units for each reach < 8 % gradient. Habitat units include pools, riffles, sloughs/ponds, and glides. Record the hip chain measurement at the downstream end of each habitat unit. The upstream end of the habitat unit is assumed to be the beginning of the next habitat unit (or other field form entry) and this will be used to calculate the length. Take several wetted width measurements for each habitat unit to calculate an average width, and multiply the result by the length to calculate surface area. Definitions and additional measurements needed for each habitat unit are described below. For channels > 8 %, the channel type is assumed to be cascades and no information needs to be collected on habitat units, only length, width, and gradient of the channel. However, if there are short lower gradient reaches that contain pools and/or riffles, these should be identified and measured as habitat units within the cascade reach. If these lower gradient reaches are > 50 m, be sure to also record the gradient so they can be later broken out as separate reaches.

Pools are defined as topographic depressions in the stream channel, and are characterized by areas of deeper, slower moving water. Pools need to occupy at least half the wetted channel width and meet a minimum residual pool depth to be included. Calculate residual pool depth by measuring the maximum depth and the tailwater depth of the pool and then subtracting the tailwater from the maximum. If the residual depth does not meet the minimum specified in Table 6, then do not break out the pool as a separate habitat unit.

Table 6. Minimum residual depth for pools from TFW Monitoring Manual (1994).

Bankfull Width (m)	Minimum Residual Pool Depth (m)
0 - 2.5	0.1
2.5 - 5	0.2
5 - 10	0.25
10 - 15	0.3
15 - 20	0.35
> 20	0.4

For pools that do meet the residual depth requirement, record the maximum depth and tailwater depth (to the nearest .01 m). Identify the type of pool (lateral scour, trench pool, dam pool, plunge pool) and document the pool forming feature (free form, wood, boulder, bedrock). Where a log is forming a pool, measure the diameter of the log (to the nearest centimeter) and record in the notes. Where multiple logs or a log jam is forming a pool, measure the height of the obstruction from the bottom of the logs to the top on the downstream side. Stop the measurement at the bankfull channel height if the log jam extends above the channel. In some cases, logs may form two pools: a plunge pool on the downstream side and a dam pool on the upstream side. These should be measured as two separate pools and the height of the obstruction will be the same. In step pool channel types, the pools will generally be plunge pools formed behind boulder dams and it is not necessary to measure the height of the boulder dams forming the pools.

Riffles are areas of channel where the stream drops in elevation. They are characterized by larger substrate materials, shallow water flowing at relatively high velocity, and turbulence visible on the surface at low flows. Take several wetted width measurements to calculate average width. Boulders > 0.3 m in diameter found in riffles can form pocket water which provides valuable rearing habitat for steelhead. The percent surface area occupied by pocket water should be estimated for riffle habitats. This can be calculated by estimating the average surface area of the small pools formed by the boulders and multiplying by the number of boulders in the riffle.

Sloughs/ponds include beaver ponds, lakes, wetlands, and sloughs characterized by relatively deep and very slow moving water generally impounded behind some kind of obstruction and not formed by scour during high flows. The wetted width is generally much larger than for riffles and pools measured in adjacent reaches. Record the presence of a beaver dam or other cause for the impoundment. Record an average depth along with each wetted width measurement for the unit. Average depth is calculated by measuring depth ¼, ½, and ¾ across the channel width and averaging the results. For large ponds and lakes, depth measurements may not be possible, and it may be easier to take surface area measurements from aerial photographs.

Glides are areas of deeper water flowing at moderate velocity with no defined topographic depression. They are distinguished from riffles by a lack of surface turbulence at low flows. Glides are not expected to be common in the smaller streams blocked by culverts and should only be used to classify habitat units that are absolutely and without question not one of the other types! Record an average depth along with each wetted width measurement for the unit.

Average depth is calculated by measuring depth ¼, ½, and ¾ across the channel width and averaging the results.

Step pool channels generally occur at > 4% gradient and contain a relatively large number of small plunge pools alternating between organized boulder dams. These pool units can be lumped together into a longer step pool habitat type and the surface area of calm water in the pools between boulder dams should be measured as pocket water by using the stadia rod to measure length and width of the individual pools. This reduces the time spent recording hip chain lengths and measuring the residual pool depth of each pool. Continue taking average widths and tallying wood for the step pool habitat type. Take regular gradient measurements to be sure the channel remains steep enough to indicate a step pool channel type. Where the gradient flattens briefly and there are larger pools formed by lateral scour or wood, be sure to break these into individual habitat units and take all the appropriate measurements. If these lower gradient reaches continue for several pool-riffle sequences or more then they will likely be classified as a different reach with a different channel type, so be sure to document the gradient. If the channel type is questionable, then measure all of the pools individually. Pools in step pool channels are classified as plunge pools formed by boulder dams.

A side channel is separated from the main channel by a vegetated island with a width greater than twice the combined bankfull channel width of the two channels. Where these occur, mark the hip chain locations on the main channel where the side channel starts and stops. The side channel should be surveyed independently for habitat units. Where there are multiple channels not separated by a large enough island, the wetted and bankfull channel widths should be taken separately for each channel and then added together and treated as one measurement.

Large Woody Debris (LWD)

For each habitat unit, record the number of pieces of LWD protruding into the bankfull channel by size class: Small: 10-20 cm diameter and > 2 m length; Medium: 20-50 cm and > 3 m length; Large: > 50 cm diameter and > 5 m length. Diameter should be measured at the midpoint of the piece. For large logs that are also greater than twice the channel width in length, record the measured diameter in the notes (but still include the piece in the tally). If a portion of the piece intrudes into the bankfull channel, the piece should be tallied and the size determined by considering the whole piece, including the portion outside the channel. Spanning logs that are mostly outside the bankfull channel should not be included.

Other Information

Record the upstream and downstream end of culverts and measure the following characteristics: structure type, length, span, rise, presence of bed material, slope, and outfall drop. Or, confirm that these data have been collected as part of the original inventory, verify that the measured characteristics have not changed, and identify which structure it is in the original inventory.

Record the hip chain locations of roads, landmarks, significant changes in land use, the location of tributaries (record whether tributary enters on right or left bank while facing downstream on the main channel), and potential natural barriers that do not quite meet the criteria for stopping the survey. Habitat conditions in tributaries will also need to surveyed. Document the location of obvious changes in channel condition (width, gradient, pool spacing, LWD quantity) that could indicate reach breaks. Actual reach breaks will be determined at the end of the survey based on the information collected, but field calls will make this process easier.

Document the location of the surveyed stream on aerial photographs and include a written description of road crossing locations, start and end of the survey, and other landmarks in addition to information described in the comments. GPS could be useful for locating the stream and survey location if it is available.

WDFW Methods

Two additional pieces of information need to be collected to generate a priority index using WDFW methods: spring influence on low flow conditions, and spawning habitat conditions. Spring influence refers to the amount of groundwater/spring activity that maintains flow conditions during the summer dry season (Table 7). Identify the spring influence factor for the stream immediately upstream of the barrier and document this on the field form. If the spring influence changes over the course of the survey, then record the hip chain measurement where the change occurs and document the new spring influence factor.

Table 7. Criteria used to assign a spring influence factor from WDFW methods (WDFW 2000)

Spring Influence	**Spring Factor**	**Criteria**
Absent	0	normal channel morphology with evidence of a range of flows (scoured pool-riffle sequence)
Slight	1	rectangular cross section with minor variations in depth (less evidence of scour and bed transport than above) (summer low flow width = 1/3 channel width)
Moderate	2	as above but even less sediment transport and scour with low flat floodplains and little evidence of freshet activity (summer low flow width = 2/3 channel width)
Pronounced	3	bank vegetation established with a distinct line a small distance above the water surface during summer flow period, heavy moss growth on the exposed stream rocks can indicate freshet activity is very weak. Must flow at nearly constant flow level year round. (summer low flow width = channel width)

Spawning habitat can be quantified by estimating the substrate composition in riffles according to WDFW methods. This will only need to be done where there are chum that might use the habitat. There are not many barriers in the inventory where this is the case, so this can be handled on a case-by-case basis.

Identifying Natural Barriers

Surveys should be stopped at the natural barrier. Natural barriers can consist of a discrete falls or a sustained gradient barrier. Falls are defined as a vertical falls > 3.7 m in height or a sloping or vertical drop > 2.0 m in height with no plunge pool. Gradient barriers consist of a sustained gradient of > 20% for 100 m of stream length or > 16% for 100 m if the channel is < 0.6 m in width. Surveys should also stop at the complete upstream extent of a stream channel or at a location where there is not likely to be flow for most of the year.

Appendix B: Field Notes and Comments

Red Cabin AR9.1.1

Red Cabin Creek at Hamilton Cemetery Road is a partial barrier to juveniles all adult species pass through fine. Culvert built during a county emergency in the 80'sis undersized, and needs replacement. The upstream rock "roughened channel" will need to be dealt with to minimize head cut. This channel section, and crossing at Cemetery. Road has very likely been relocated west of the "original" crossing. The slough to the east has also been blocked off, or throttled down, at the river, and at both Lyman-Hamilton Rd and Cabin Creek Road. Now a dismal tributary to Muddy Creek. Lots of cutthroat in this slough.

Lorenzen GR18.1.1, GR22.1.1

WDFW Brett Barkdull has entire Lorenzan Creek system mapped out. A major barrier is under the County road shop just south of SR 20. That one needs opening before anything further upstream gets done. This seems unlikely at this time. The RB Lorenzan tributary that goes through the waterwheel and comes under Grassmere Road and the old railroad grade is the one I would spend my time on. This channel has perennial flow, with cutthroat. There are at least three culverts to replace, and a sediment/dredging issue along SR 20 involving DOT. Creek has been moved to the east – old channel went approx. through the grocery store parking lot.

Little Mannser AR4.1.1

Mannser tributary – in west roadside ditch of Cemetery Road. It is not a total barrier but is often partially submerged throughout. recommend removing this culvert rather that replacing it. It provides access to a one-time Christmas tree plantation that drowned out when Jones Creek jumped and flowed out this way; past flooding. A better habitat project would be to relocate the crossing under Cemetery Rd, to the north of SR 20. This creek has been redirected out of the wet field north of SR 20, and east of Cemetery. Road, and been forced to flow along in the roadside ditch. On occasion, Skagit County has to dredge it out both upstream and downstream of SR 20. Coho spawn upstream of this diversion, on Chris Trotter's property. Kristi at SCD has done a project up there. One project proposal would be to put the creek back into the pasture, and join it to Mannser Creek somewhere between SR 20 and the toe of the plateau to the north.

GN18.1.1

Gilligan Creek at South Skagit Highway. Steelhead are known to mostly use this high gradient creek. A PUD intake is located upstream and limits anadromous access, if not ended by gradient before. The water withdrawal tends to dry up the creek.

AR43.1.1

Main Mannser under Cemetery Road south of SR 20. This crossing may not be a complete barrier. There is known juvenile rearing further upstream. Somehow the fish get through the pipe and the canary grass swamp fine as far as I know. The Mannser system is hugely productive for Coho, and probably cutthroat trout as well.

DB3.1.1

(SFEG field notes)

DB3.1.1 is located on Dexter Lane off of Diobsud Creek Road. The culvert is 1M by 1.38M 12.3M long perched 1.6 M. The creek is currently dry, but shows evidence of very high velocity flow based on the bank full width and the cobble size. There is a 0.7M deep pool 3.5M long 4.4M wide with no visible fry below the culvert. The stream has low flow below the culvert at approximately 4% grade. Above the culvert the channel is 4-5% grade with mixed gravels (.05-.3m). Bank full width just above the culvert is 7.1M with evidence of overflow to an old spillway across the road and into a separate channel down stream (see map). The average bank full is 5M upstream.

RC2.1.1

Sauk tributary at Concrete Sauk Valley Road. Comes from old Hurn Shingle mill vicinity. There is reported to be a rock/riprap cascades somewhere not far upstream of county road. There are cutthroat well upstream. Once you get near the pasture and then towards the once forested hills, the gradient flattens and may provide good anadromous habitat. The county road culvert dropped off the downstream end in the last flood, but county shored it up again. Only a matter of time before the whole road flushes out. Total barrier.

(SFEG field notes)
RC2.1.1 is located under the Concrete Sauk Valley road. The culvert is 1.4m wide and approximately 30m long. It is not perched and contains some bed material. The culvert looked like it may be passable by migrating fish. Habitat above the culvert is very good, but we came to a natural barrier after 387m. The stream contains good spawning gravels and lots of LWD. Gradient is between 3%-6% on average with a cascade section of 20% at 169m for 7m that looked passable. The natural barrier is a waterfall 4.0m tall that is about 5.0m long. It is made up of very large boulders and LWD resting on bedrock. The falls spill onto rocks. Habitat above the falls returned to low gradient and looked good.

RC3.1.1

Sauk tributary at Concrete Sauk Valley Road. This looks like the tributary that was actually dammed and used to power the old Hurn mill. Highly modified from mill UPSTREAM. Crown Pacific logged the headwaters above the dam, and the pond filled up in the 89, and 90 floods. I have no idea what has happened since, nor the general state of this creek throughout its length.

RC6.1.1

(SFEG field notes)
RC6.1.1 is located under the Concrete Sauk Valley Road. Spawning Coho were observed trying to pass through the culvert, but they would be washed out due to high velocity. Habitat above the culvert looks good. There is good spawning gravel and lots of LWD. The stretch of fish accessible habitat is rather limited though, there is a 6m barrier falls 308m upstream.

RC4.1.1/ RC5.1.1

Hobbit house creek at Concrete Sauk Valley Road. There are three creeks in this bend of the road, any one of which can be highly productive for Coho, in any year. Usually not all three, and the primary producer can vary each year. WDFW Index streams for a long time. All culverts are passable, but much undersized. Watersheds have been heavily logged by Crown Pacific, mostly. The sections of each creek downstream of county road have been dug out and straightened over the decades, either by landowners, or by county roads dept. There is one house and junk that should not be where it is, and the creek keeps trying to flood him out. All these creeks together, particularly downstream of county road, have opportunity for habitat improvement and plantings. Last I looked; the river was eroding through the forest edge towards the bare grass pasture.

(SFEG field notes)
RC5.1.1 is located under the Concrete-Sauk Valley Road. The culvert is 1.6m wide 13.5m long, with 3% gradient and does not appear to be a significant barrier. The stream flows to m 783 with an average gradient of 6% (2%-14%). At 783 meters, a 1.3m wide metal culvert and 11m long is 0.4m perched with 7% gradient. The creek flows under a logging road. Above the culvert the stream splits to A and Aa both streams are relatively short at 374m and 320m consecutively. The main channel continues to m 1235 where it ends in a gradient barrier.

This stream is a higher gradient stream. After m202 the gradient increases to 6% and maintains this or higher to the natural barrier. Adequate pool habitat is available to allow for fish passage to the natural barrier, but ideal spawning habitat is not as abundant because of the high gradient

RC10.1.1 Lyle Creek

(SFEG field notes)
RC10.1.1 is a box culvert under SR 530. It doesn't appear to be a significant barrier. There is no fill material in it and may benefit from weirs to slow velocity. Habitat on Lyle Creek looks good; there are lots of good spawning gravels and a large abundance of WD. Some fry were observed during the survey. For the first approximately 400M there is extensive black berry growth in the riparian area. The first (A) tributary at 40M is muddy and 105M long. It flows from a wetland that is fed by high gradient flow. Tributary B at 468M offers good habitat, it ends at 230M. Tributary C at 1481M is steep and only 65M long. Gradient on the main channel stars to pick up at 1190M and remains relatively high till the end at 1822M.

RC12.1.1Beverly Creek

Unclear where this is, by MP under SR 530. There is a creek crossing west to east, maybe about 3 miles north of Darrington; it runs for awhile along Giles Road. It is intermittent and dries up early in the summer/late spring. It crosses SR 530 in a box. The bed is mostly sand by SR 530 – the gravel is further upstream. This creek looks good in the winter, but it only flows near the toe of the hill as summer progresses.

IL12.1.2

(SFEG field notes)
IL 12.1.2 is located under Martin Ranch road; the culvert is .65M wide. The culvert is undersized helping to create a slough. The slough continues to approximately meter (M) 463 where a channel begins to be defined. The slough does not appear to support year round flow and is vegetated throughout with shrubs, alders, and cottonwoods. Between M 463 and M685 the channel becomes more defined but has 5-10 year old alders growing throughout the channel indicating only seasonal flow is present. From M685 to M1521 the gradient increases to 1-2% pools, riffles, and gravel substrate are present and of high quality. No fish were recorded in this section, however 1 Redd was recorded and ideal spawning conditions are present. This section also appears to support year round

flow or pools on some level. At M1521 the creek crosses the Rockport-Cascade Road through a 1M wide metal culvert which is perched .54M and 12M long with no bed material in the culvert. During the peak winter flows a velocity barrier could occur, however little habitat is present above the culvert. Flow enters the culvert from 2 directions and 3 channels in a roadside ditch along the Rockport-Cascade Road. All 3 channels flow out of one large wetland. Flow out of this wetland is divided between two systems (see attached map for more detail). It should be noted that the survey was conducted after several days of heavy rain.

Morgan GN13.1.1

Morgan Creek – Any culvert removal in Morgan Creek is a great idea. Not clear which this is, but there is more than one to remove. There is nothing bad north of So. Skagit I know of. South, there is at least one coming from the old SFEG Don Winter project, on the old abandoned railroad grade. On the eastern fork of Morgan, there is another under the same abandoned railroad grade, and another close to the head of anadromous use, at an E-W property line. The anadromous barrier is next to a private home where Potts Road turns to become a logging road. The ditched creek upstream as been alive with cutthroat, in the past.

PN5.1.1

(SFEG field notes)

PN5.1.1 is located on a private logging road 4100 approximately 1 mile from the South Skagit Highway. The culvert is 4.55m wide, perched 0.27m into a 0.6m pool with a 5% grade. Above the culvert the main channel and all tributaries provide 2km of potential habitat to the natural barriers. 1500m of this is on the main channel and tributary D, both of which end shortly after road 4210 with gradient barriers. These two streams are heavily utilized by trout, with 6 trout being recorded during the course of our survey.

This area has been recently logged as evidenced by strong invasive vegetation presence in many areas. With the removal of the lower barrier the stream could be accessed by many more sea-run Cutthroat as well as Coho.

Pipeline HC88.1.1

This barrier should not be the highest priority. Every one of the Pipeline Rd culverts is a barrier, and each can be a total barrier dependent on flow. Each culvert needs removing and replacing with something much larger. This is a county road and therefore a county job. There are private barriers just upstream of the mapped location, where Pipeline Creek gets back to a nicer gradient. Intermittent up this high. Cutthroat everywhere at one time. Nice system to work on, but very expensive for what you may get out of increased production. Might better spend it further downstream in the diked and ditched section as it goes to Jones Creek. Just upstream of the 1996 SFEG project.

HC16.1.2

(SFEG field notes)

HC16.1.2 is located under a farm access road immediately south of the SR 20 weigh station. The barrier consists of two corrugated metal culverts (.65 and .45 respectively) which insufficiently drain a large wetland. The wetland is approximately 70M wide and is fed by 3 culverts under SR 20. The culvert for tributary A enters directly into the wetland. The two other culverts, which drain much larger areas, are on the main channel and channel B. Both of these streams enter the wetland through a large beaver pond at the east end of the wetland. All culverts under SR 20 are fully submerged and appear to drain inadequately. The main cannel extends to M1461 where it ends in a falls and gradient barrier. There is significant habitat available to cutthroat, Coho and potentially other species on the main channel. There are 3 culverts before the natural barrier all of which are significant or full barriers to fish passage.

Channel B continues to M1785 where it ends in a gradient barrier.   In this distance Channel B has 3 tributaries for a total of 670 M. Above SR 20 there are 5 additional culverts before the natural barrier.

Channel A is a ditched channel that serves to drain the base of a hillside. For additional detail refer to the map for HC16.1.2

HC63.1.1

This barrier is a definite problem. Coho have spawned in the ditch, and further upstream during past years.   Channel access to Coal Creek was downstream of gravel pond, and was a problem. There are other passage problems as a result of dredging and ditching, as well as a probable passage issue at SR 20. There is a dam, and private culvert system north of SR 20. I have never investigated the length of this stream. Bret Barkdull/WDFW I believe has looked it over more closely. Channel goes dry at Minkler Road some summers.

(SFEG field notes)
HC63.1.1 is located under Minkler Road east of Sims Road and coal creek. The 1.2 M wide culvert flows at an angle through the road grade and joins coal creek downstream. The stream flows in a ditch adjacent to Minkler road for 545 meters. There are 4 culverts which provide access to private residences. At M184 gravel substrate replaces mud and silt, several redds were observed. The main channel turns N at M545 into a thick blackberry patch. Channel A continues on from M 545 for an additional 45M and then turn to the N where it rejoins the main channel at M 128 (see map). At M 608 the main channel leaves the dense blackberry thicket and runs in a shallow mud bottom depression through an active cattle pasture. For the entire length of the pasture cattle have full access to cross and use the stream. There is significant impact to the stream. At M691 in the pasture the channel becomes more defined and gravel substrate is present. At M 1058 the channel becomes defined above a short area of braided channels, gradient increases and gravel substrate is present. The pasture ends at M1067 and flows under SR 20 at M1170.

Channel B enters at M1200 and flows W along SR 20 to a 1M high perched culvert which creates a pond with stocked fish. Another perched culvert ends the pond at M272 this culvert is a barrier and the stocked fish were observed trying to pass the culvert. Above the pond gradient increases quickly and ends in a falls at M 425, B ends here.

Above the confluence with B the main channel gradient increases to 4% and flows past a rental property to M 1478 where a perched culvert (1.6M high) flows under and old road bed. Immediately above this culvert the gradient increases to a barrier at M1522. There are several manmade sandbag dams on the rental property.

John Eastman a local resident and wildcat steelhead club member reported that usually 150 or more carcasses are present from the Minkler road crossing to the end of the pasture. This is an ideal fencing/ planting project opportunity if landowner willingness allows.

HC109.1.1

Unnamed to Skiyou. There have been serious water quality issues in the past at this location. The dairy has apparently cleaned up their act, and gotten an award for it. Multiple fish kills in Skiyou as a result of water quality issues. Water quality in Skiyou has serious low DO problems in summer, unless recent Skagit floods have further opened the slough to perennial flows. Private crossing on Skiyou itself just upstream of this location has been a past problem. Landowner owns a Russian tractor. I would be surprised to find this location's culvert a worthwhile place to put passage money.

HC44.1.1

This culvert is a definite problem. Creek is decent, but intermittent, further upstream. Coho and cutthroat access this stream. County had a project here once, when creek jammed up the culvert and hopped over the old grade (still used as a private road at that time). I think they put in a bigger pipe, rather than just clean out the old one and rebuild the road. Probably in WDFW permit file.

HC93.1.1

Hansen tributary at SR 9. There are worse barriers downstream, multiple ones. I have not walked out this tributary system entirely, only in pieces, years ago. Perhaps tribe has during watershed analysis. Now that SFEG took care of the old dam barrier on this tributary at Northern St., this whole system should be responding well to increased production. Tributaries are what produce well in Hansen, not so much the main creek.

HC101.1.1

Flap gate confluence at Red Creek The flap has been a problem since day one, as has the on-going problems of flooding/dredging/sediment all along Hansen Creek. SFEG is not likely to get parties to agree on solution. Landowner upstream can be a gun-wielding problem! His property south of SR 20 contains many remnant wetlands downstream and channels for both Red and Hansen Creek's. Ducks Unlimited has looked at duck rearing ponds on this property; County looked at buying property for another part of the Hansen Creek flooding solution. Quagmire to stay out of.

HC15.1.1

(SFEG field notes)

HC15.1.1 is west of HC16.1.2 on the same creek. HC15.1.1 is a small access road to a pasture off of SR20. The area between HC15.1.1 and HC16.1.2 is primarily a wetland system which does not have a defined channel and flows across a reed canary grass field. In addition to the flow from HC16.1.2 the system is fed by two tributaries. Tributary A flows under SR20 through a completely submerged culvert. This culvert drains a wetland field which has extensive dredging and ditching before it enters a natural stream channel above a private road crossing at M473. The channel continues to M936 where the natural barrier is believed to have been. Extensive fill and dredging makes the natural gradient difficult to determine.

Tributary B flows under SR20 in a submerged culvert and drains a beaver pond and wetland below the Elk Haven development. B ends at M238 where it goes subsurface.

HC123.1.1 Red Creek

Not mapped. There is a farm crossing just east of Helmick Rd, north of SR 20. Culvert is too small, and was perched last I saw it. Juveniles would have problems at lower flows. Just UPSTREAM of this culvert, there is a large wetland field now owned by Skagit Co. Red Creek swamps out through it, and the sediment accumulation and shifting has made led adult stranding prior to spawning. Access Red Creek along the base of the hill, and walk downstream. May not be a problem now, not seen for years. This is downstream of SFEG bridge project at "Alpine Lane"

DC15.1.2

MP 1.9 N Sauk R. Road. Floodplain seep as far as I know. Intermittent. River back floods the area, and goes over the road, during winter high water. Never walked it out. Maybe seasonal rearing. Bret Barkdull WDFW will have info on it if there is much usefulness here.

DC2.1.1

Mouse Creek driveway, crossing 177m UPSTREAM from mouth. Lots of Coho, cuts, some steelhead in some years. All fish get through this pipe. I think it may be a double pipe. Putting a short bridge in, or a lots bigger pipe, will be good for the long run. Mouse Creek has bigger problems than this, including the county too small bridge, and formerly dredged and "diked" section downstream. The creek really wants to go west (LB) here through the Christmas tree farm, and there is a constructed pond that pulls some of the water, and fish, off into nowhere.

SP14.1.1

Everett Creek at Sauk Prairie Road. Again, there is confusion over which creeks have which names up there. The next creek south of gravel creek is often called "Dutch Creek", and yes, that pipe is undersized. Anadromous fish get through it, and the creek has been ditched along a property line upstream. Most Coho used to spawn downstream of this pipe. The next creek to the south (has metal welded bird sculpture up by the house) has sometimes been called Everett Creek but then so has the next one further south after that. The metal bird creek has many problems throughout, mainly from ditching, diking, and moving. The county culvert had baffles in it, and a couple log weirs downstream - the last I looked, the baffles were gone, but the weirs were holding. Pipe is undersized and should be replaced. Have not walked channel upstream, but there were debris flows in the 80's that hosed the creek badly. The next creek further to the south, (just northeast of Les Green's house and associated creek), is most often actually called Everett Creek. Snohomish County replaced this pipe with a much bigger squashed pipe in the early 90's. Very adequate then. Anadromous section upstream not very long I think, but I never completely walked it out.

SP3.1.1

Gravel Creek at Sauk Prairie Road. I would not worry about this culvert. SFEG replaced private culvert, with bridge, in about 1997/8. As far as I know, no anadromous fish, and maybe no fish at all, have been seen in this creek. downstream where it joins the slough near the river, there are piles of Coho and cuts. Why fish have not been using Gravel Creek is unknown. Perhaps something high up in the system, some mineral or metal, has tainted things. This has puzzled me for a long time. I would not bother with replacing the culvert. Leave that to the county when the pipe finally wears out.

(SFEG field notes)
SP3.1.1 is located under the Sauk Prairie Road. The culvert contains two weirs that have trapped fill. There is a 4M long section after the last weir that is a steeper grade and may be a barrier. The stream contains nice gravels and lots of WD. Two fish (likely Cutthroat trout) <6 inches were observed in a pool. Gradient picks up substantially after 449M. It remains relatively high until the end at 2171M. At 1502M and 2000M there are two similarly designed culverts that do not look passable to migrating fish. They both have 15-29% grade and spill onto rip rap.

CD18.1.1

Olson Creek. Many problems in this watershed, not the least of which is that it used to discharge into Skagit upstream of Cascade River and got moved long ago. Very intermittent. Channel totally dug out from just upstream of SR 20 to develop and dike off a proposed campground which was never built. There is a private rock fish barrier perhaps 200 yards upstream of SR 20, built and maintained by Randy Martin as gravel mine when the creek goes dry in summer. Channel upstream becomes incised and scours badly until the powerline rd (off Ranger Sta. Rd) bridge. The gradient picks up quickly going upstream of this point, and the neighbor may have rebuilt his anadromous barrier also. Mostly a steelhead stream, but they must get dry redds sometimes. And stranding issues. The SR 20 culvert is never backed up by river floods, I think. Just a fire hose.

NC9.1.1 Challenger Creek

Dam at Scout Camp lake, Klahowya Creek I wouldn’t mess with this one. Coho spawn just downstream in the limited gravel, and you could certainly add wood habitat and gravel to that section for some benefit. Gaining fish passage into the lake gains nothing. There are barriers in the inlet water supply ditch upstream Better to let the fish go up the “normal” stream, and spawn there, or further upstream of the new bridge. Some juveniles will get diverted into the lake anyway, get gobbled up, possibly, and go out of the lake when they smolt. Might be better to improve the outlet so that smolts could find it better, rather than residualize in the lake. Don’t really know if that is a problem in the lake or not. Scout camp director would know if scouts catch larger Coho in lake.

NC147.1.1

Murray Creek Undersized to be sure, but only partial barrier last time I looked. The channel downstream had been cleared of all debris, been open to cattle grazing, and had severely downcut into a hardpan chute. This chute would be difficult for passage at many flows. There was reason to do significant channel improvements downstream of the Otter Pond Rd culvert, almost independent of fixing the pipe. As watershed develops further, that old ratty pipe will fail. Pretty easy replacement.

NC184.1.1

Unnamed at Lake Cavanaugh. Road. In the early 1990’s, the railroad had just finished removing their barriers on all these Lake Creek tributaries, well downstream of site. This channel seemed very steep between that grade and Lake. Cavanaugh. Road, and I paid no attention to it. Never walked it out. At that time I was paying more attention to other, higher production tributaries that are now all passable.

(SFEG field notes)
NC184.1.1 is located under Lake Cavanaugh Road. The culvert is 25M long x .92M wide and has approximately 3% grade. It looks like it would be a barrier to fish passage. The stream contains nice gravels after 342M, before this it is a mix of silt and gravel. The majority of the stream is relatively low gradient. There are numerous short sections of wooded wetland type habitat. At 876M to 1173M there is extensive logging impact due to no riparian buffer which has allowed extensive black berry growth. One 8 inch fish was observed in a pool, likely cutthroat.

GR2.1.1, GR32.1.1, GR 33.1.2

All three of these culverts are barriers, to non-anadromous cuts only. The anadromous barrier is a rock cascades well downstream of Grandy Lake. WDFW blasted the cascades, and tried to hang very novel "weirs" in the late 80's. The work did not successfully get anadromous fish over the cascades. The power of Grandy in flood, and the sometimes huge volumes of sediment flows wipe out anything in its path. All three of these barriers are a mess, they need to be re-done, but money for non-anadromous fish passage, in the amounts needed here, may be very unlikely.

NC10.1.1

Klahowya Creek. at Scout Camp. This culvert just went in a few years ago, by SFEG. Was adequate at the time. Something happen? There is a private barrier culvert way down the hill, past the powerline road, and past the section that SFEG crew was once worried about log debris/fish barriers during low flow years. That one is a barrier, and should be removed. May be protecting a waterline in the road fill.

NC 60.1.2

Cold Springs Creek. driveway culvert just upstream of the barrier dam (was finally washed out/filled up completely in 1990 flood). Culvert is undersized, but was passable last I looked. Dam much further upstream on Rottweiler farm was total barrier, as was a culvert to the RB tributary. Landowner was uncooperative, and served prison term for murder on property. Both dam and culvert, and the re-channeled creek, were done illegally. Coho, cuts.

JB38.1.1

Shoemaker Creek. I would not make this one a priority. It is undersized, but passable. Very serious WDFW maint. dredging problems immediately upstream – Shoemaker Creek should really go west towards the hatchery but has been diverted many decades ago. Intent is to maintain it status quo. Would be worth discussions with WDFW Hatcheries Olympia on history, and current management obligations for this creek. Never saw much of any fish presence in this creek, even during "stable" years. Gets steep about ¼ miles south of culvert.

NC190.1.1

Lake Creek at mp 42.39. This pipe does pass adult Coho. This will be very expensive to replace. Probably easier to ensure that bed downstream does not degrade away. Haven't been here for a long time.