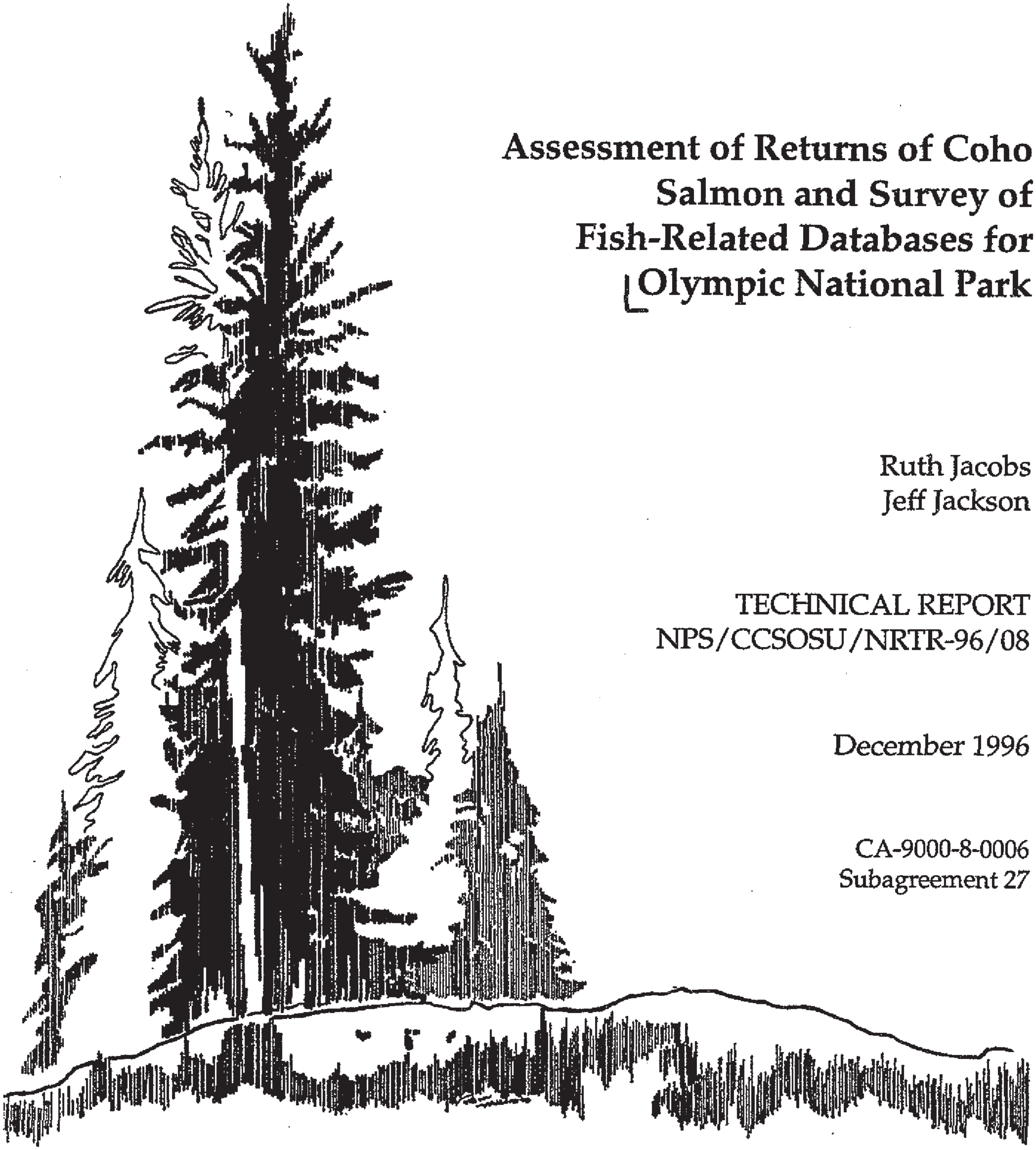


Assessment of Returns of Coho Salmon and Survey of Fish-Related Databases for Olympic National Park

Ruth Jacobs
Jeff Jackson

TECHNICAL REPORT
NPS/CCSOSU/NRTR-96/08

December 1996

CA-9000-8-0006
Subagreement 27

United States Department of Interior - National Park Service - Columbia Cascades System Support Office

The National Park Service Cooperative Park Studies Unit (CPSU) at Oregon State University was established in 1975. The Unit is located in the College of Forestry. The purposes of the Unit are: (1) to conduct original research on topics of importance to the management of natural and cultural resources; (2) to encourage and facilitate scientific research in national parks of the Pacific Northwest Region; and (3) to disseminate research results within the management system of the National Park Service.

The National Park Service disseminates results of biological, physical, or social science research through the Natural Resources Technical Report Series. Natural resources inventories and monitoring activities, scientific literature reviews, bibliographies, and proceedings of technical workshops or conferences are also disseminated through this series. Documents in this series usually contain information of a preliminary nature and are prepared primarily for internal use within the National Park Service. This information is not intended for use in open literature.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

Copies are available from the following:

Denver Service Center (303) 969-2130
Technical Information Center
P.O. Box 25287
Denver, Colorado 80225-0287

National Technical Information Service (703) 487-4785
U.S. Department of Commerce
5285 Port Royal
Springfield, Virginia 22161

Assessment of Returns of Coho Salmon and Survey of Fish-Related Databases for Olympic National Park

Technical Report
NPS/CCSOSU/NRTR-96/08
December 1996

Ruth Jacobs
Biological Resources Division
Forest and Rangeland Ecosystem Science Center
Department of Forest Resources, OSU
Corvallis, OR

and

Jeff Jackson
Olympic National Park
Port Angeles, WA

National Park Service
Columbia Cascades System Support Office
909 First Avenue
Seattle, WA 98104

Cooperative Agreement No. CA-9000-8-0006
Subagreement 27

Table of Contents

List of Tables

List of Figures

Assessment of Returns of Coho Salmon to the Soleduck River and Survey of Fish-Related Databases for Olympic National Park

In 1994 Oregon State University and the National Park Service initiated a project to assist Olympic National Park with the development of an escapement goal for summer coho salmon *(Oncorhynchus kisutch)* in the upper Soleduck watershed and to assist with a survey of state and regional databases containing fish and fish-habitat information of interest to the park. This work was conducted under Subagreement 27 of Cooperative Agreement CA-9000-8-0006 between the National Park Service Columbia Cascades System Support Office and Oregon State University. Four separate tasks were defined under this subagreement, all related to fish resources of Olympic National Park: a problem analysis of the Lake Ozette population of sockeye salmon, the coho salmon survey, the database survey, and a study of bull trout (*Salvelinus confluensus*). The results of the problem analysis were reported in Jacobs et al. (1996). This is the final report for the coho salmon and database surveys. The bull trout research was integrated into a graduate research program at Oregon State University, and results will be reported upon completion of the student's thesis.

A comment is in order on the format of this report. The subject matter of the coho survey is distinct from the subject matter of the database survey. Thus this report has been prepared as two distinct reports except for consecutive page numbering. Tables, figures, and appendixes are separately numbered for each report to facilitate distribution of the two sections of the report as separate documents if appropriate.

Assessment of Returns of Coho Salmon to the Soleduck River
Jeff Jackson, Fisheries
Olympic National Park

Objectives

Olympic National Park, in conjunction with tribal and state entities, is gathering information to develop an escapement goal for summer coho salmon (*Oncorhynchus kisutch*) (hereafter "coho") in the upper Soleduck watershed. The upper watershed is considered to be that portion of the watershed above Salmon Cascades, a falls at river mile 56.5 which is 3-4 m in height. Information needed to develop the escapement goal includes knowledge of where the fish spawn, when they spawn, and relative abundance by sections within the larger watershed.

In the fall of 1995, Olympic National Park and Oregon State University initiated a cooperative study of coho salmon in the Soleduck watershed to assist with the development of an escapement estimate. The original intention of the study was to tag returning adult coho and then to conduct weekly surveys of spawning grounds to recover tagged and untagged fish. Returning coho were to be captured with gillnets below Salmon Cascades, tagged with high visibility disks, and then released upstream of the nets to continue their migration to their spawning grounds. During spawning surveys to be conducted at weekly intervals, observed fish were to be noted as tagged or untagged, and all tags found on carcasses were to be recovered. The expectation was that the ratio of tagged to untagged fish could be used to estimate the spawning escapement above the trap site.

Modification of the scope of work occurred once attempts began in September, 1995 to capture and tag returning coho. Several instances of earlier-than-average high stream flows occurred in early October due to a series of warm, wet storms. This triggered an early coho spawning season, and the park staff assigned to this project were obligated to conduct spawning-ground surveys rather than tag coho. Additional complications existed with plans for capturing coho. It was presumed that the pool immediately below Salmon Cascades would be a good area to capture large numbers of fish, with the expectation that coho would congregate there until suitable stream conditions prompted a mass exodus upstream. Gillnets were to be set immediately above and below this pool. Park fisheries staff conducted snorkel surveys in the pool in order to judge when the fish were beginning to accumulate in sufficient numbers for netting. In bimonthly surveys conducted from late August to early October, no more than nine coho were ever observed at one time in the pool. This abundance was insufficient for a quick and concentrated tagging effort, and based on these findings, the tagging activity was abandoned. Thus the project was conducted with the objective of assessing number and distribution of coho adults and redds in designated sections of the watershed using spawning-ground surveys.

Methods

Fifteen sections were delineated for data gathering and reporting purposes, 14 in the upper Soleduck River and its tributaries and another on the South Fork Calawah River. Data collected for each section included number of live fish, carcasses, and redds observed, and notes of any wildlife sightings. The channel type was also classified for each section in one of four categories: 1) mainstem, 2) side channel (sc), 3) overflow channel (ofc), and 4) tributary. All tributaries to the Soleduck River included in the survey were classified as channel type 4 "tributary", that is, no mainstem or side channel delineations were made for these sections. Additionally, for data analysis, data for channel type designations 2 and 3 were always combined due to inconsistencies among observers in classifying these types. The channel type and section codes provided a degree of spatial cataloging of the data that allowed for a greater depth of data analysis to be performed than possible without the classification. All reference to left bank and right bank was based on a downstream orientation of the surveyor. The sections, corresponding codes, section location descriptions, and directions to some of sections are in Appendix A.

For sections 1-8, all side channels and tributaries that connected with the mainstem section and that were not separately classified as one of sections 9-15, were also surveyed as part of that section. Surveys of such tributaries progressed until the surveyor judged that a barrier to upstream coho migration was reached.

Typically at least two people conducted a survey involving sections 1-8 for both practical and safety reasons. These survey sections were of the mainstem river, and therefore, they typically contained braided channels and tributary junctions. A two-person crew allowed for division of tasks and a shortened time for a section survey. In addition to counts and wildlife observations during surveys, coho carcasses were measured and sexed. Tails of carcasses were cut off to identify them in future surveys and avoid duplicate counting. Redds were marked with flags tied to riparian vegetation or woody debris along the stream bank. Surveyors noted whether or not a redd was still visible when flagged redds were encountered in subsequent surveys. If a redd was deemed not visible, the number of the redd and date of observation were recorded, and the flag was removed. The visibility criterion for an old redd was simply whether a given redd could still be called a redd at the moment of surveying.

Results

The survey effort was successful in very generally describing the type of habitat and the spawning activity within each of the sections (Appendix A). The original desire to conduct surveys of all section on a weekly time interval was too ambitious. Staff time assigned to the project was insufficient for this frequency of surveys, especially when poor weather and stream conditions also were factored in as limiting factors.

Surveys were conducted from October 2nd to November 22nd (Appendix B). The total redd count for all surveys was 353. Due to the varying amounts of survey effort for the different sections, the number of redds within the various sections provided only a general idea of the relative summer coho spawning effort taking place in these sections (Table 1) and the distribution of redds and carcasses by channel type (Tables 2 and 3).

Table 1. The distribution of coho redds by section in the upper Soleduck watershed.

Section #	Section Dscription	Total Number of Redds
1	ABOVE INDEX	84
2	STANDARDIZED INDEX	108
3	BELOW INDEX	58
4	RM 60.2 TO CASCADES	0
5	BELOW CASCADES	4
6	UPPER N.F. Soleduck	0
7	LOWER N.F. Soleduck	7
8	S.F. CALAWAH	0
9	CANYON CREEK	0
10	MINK LAKE CREEK	40
11	BLACKWOOD CREEK	8
12	MUNDEN CREEK	0
13	ALKEE CREEK	25
14	GOODMAN CREEK	6
15	BEAR CREEK	13

Table 2. Total number of redds detected based on channel type.

Channel Type	Total # of Redds
MAINSTEM	24
S.C/O.F.C.[1]	164
TRIBUTARIES	158

[1]Side channels and overflow channels.

Table 3. Total number of carcasses by channel type.

Channel Type	Total # of Carcasses
MAINSTEM	15
S.C/O.F.C.[1]	50
TRIBUTARIES	38
UNKNOWN	3

[1]Side channels and overflow channels.

The sporadic nature of the spawning survey, indicated by Appendix B, was of concern when attempting to conduct any anaysis of time of spawning. The standardized index section (#2), which was surveyed every week except statistical week 46, provided the best data to describe timing of redd creation (Figure 1). Appendix C includes a number of tables showing redd life (days lapsed between first and last detection), number of fish, number of carcasses, and redd counts. Analysis was done both for the index section alone and for all sections combined, and was broken down by statistical week. Additionally, for the index section, the number of redds observed was classified by channel type and statistical week.

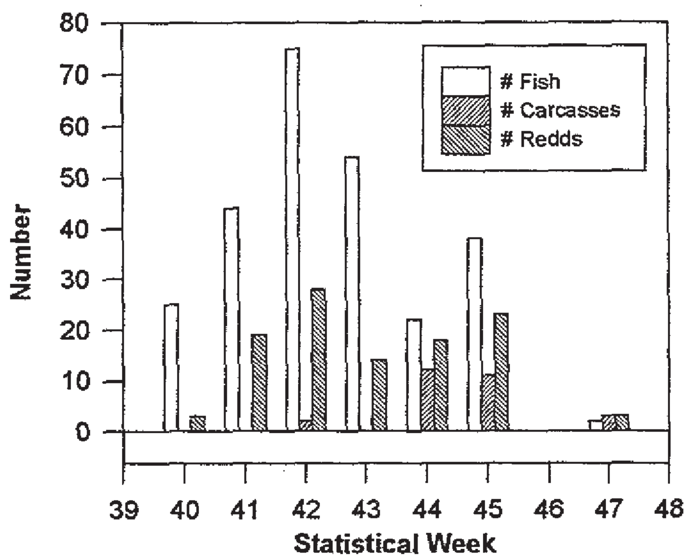


Figure 1. Changes in numbers of live fish, carcasses, and redds observed in the index section.

Although no flow data were collected in conjunction with the spawning survey work, it would perhaps prove interesting as a follow-up to obtain flow data from the automated flow station nearest to the upper Soleduck. The flow data could be used to check for a correlation between river flow fluctuations and spawning activity. An effort was made to obtain flow records from the U.S. Geological Survey's Calawah River gauge station, but unfortunately the data were judged to be improperly reported for much of October and November, 1995.

Discussion

Spawning-survey efforts were well short of what would have been required to allow for an accurate estimate of the number of summer coho spawning in the 15 sections surveyed. Detection of spawning adults was insufficient, plus detection of redds was problematic. With the wet fall, there were a number of high-flow events, which scoured the channel making it difficult to detect redds. There were likely a large number of redds constructed and subsequently destroyed prior to being surveyed. Even with weekly surveys, it was possible under conditions like those present in the fall of 1995 that redds could be formed and destroyed within the time interval of the surveys, especially in large, unsheltered channels. Thus, the mainstem was most likely the channel type in this survey with the largest ratio of missed-to-counted redds. Also there was a high probability that some redds were built and scoured prior to the initial surveys in each section.

With a number of the sections such as the South Fork Calawah and the North Fork Soleduck, it was likely that all the area with suitable habitat was not surveyed. Surveys were concluded in these sections based on time and safety-related factors rather than based on the presence of a barrier to movement of anadromous fish. Additionally, with some of the tributaries and side channels where an effort was made to conclude surveys once a migration barrier was encountered, surveyors had difficulty characterizing what was a barrier. Some barriers identified under low stream flows were discovered later to be passable by fish. High flow events caused surface flow to exist in normally dry regions of these channels, allowing fish to pass upstream. It was mid-November by the time it was realized that fish had actually been able to pass upstream in some channels beyond so called "anadromous barriers". In fact, some channels that contained isolated pools except during extreme high flows contained evidence of spawning activity. Collectively, these factors made it likely that an unknown quantity of undocumented spawning took place.

One other problem that the surveyors encountered was loss of the flagging that marked redd sites. In addition to the high flows, there were a number of high-wind events. The loss of flags, most prevalent in statistical weeks 46 and 47, prevented a thorough analysis of redd life by decreasing the number of marked redds for which the visibility test could be applied. During statistical weeks 46 and 47, a special effort was made to only count redds that looked fresh (i.e. formed within the period since the last survey of that section). This was done to insure that duplicate counting of previously marked redds was not taking place.

APPENDIX A

SECTION LOCATION, HABITAT, AND SUMMER COHO ACTIVITY SUMMARIES

1) Above index. Soleduck River from the Soleduck Falls (RM 65) down to the top of the standardized index (≈RM 63.8). Also, the entire side channel system exiting the mainstem left bank at ≈RM 64, with the downstream most channel of the side channel system dumping into Mink Lake Creek approximately 500 meters from the mouth of the creek.
Beginning at Soleduck Falls (RM 65) and progressing downstream, the Soleduck River consists of a canyon confined mainstem, highly susceptible to scour in higher flow situations. In this area fish were noted early on, approximately 100 meters below Canyon Creek, but successive surveys noted no fish and no redds were ever noted.
Approximately 100 meters above the confluence of Hidden Lake Creek and the Soleduck provided the first sheltered habitat with small tributaries entering both left and right bank. Shortly downstream from the confluence with Hidden Lake Creek, the Soleduck floodplain broadens and there are some side channels and tributaries with good habitat. Coho spawning activity occurred here in moderate amounts.
Continuing downstream, approximately 600 meters downstream of the confluence with Hidden Lake Creek, and just past a clearing/meadow on the right bank, the Soleduck forks three ways. The left-most fork represents the beginning of a side channel system meandering the floodplain, with the downstream most channel of this system emptying into Mink Lake Creek approximately 500 meters up from the mouth of Mink Lake Creek. This area was very active. There was an abundance of good habitat with a plethora of woody debris, suitable substrate and a wide variety of flow regimes amongst the numerous channels in this area.

2) Standardized index. Soleduck River from ≈RM 63.8 down to ≈RM 62. Also, Mink Lake Creek from its mouth up to the Lover's Lane bridge.
This section is the standardized summer coho spawning index which has been conducted for several years now. It has been divided into 3 reaches: upper (above the resort riprap), the riprap, and below the riprap (lower). Both the upper and lower reaches had areas of high activity, while the riprap reach, devoid of side channels and tributaries, has never shown any coho spawning activity.

3) Below index. Soleduck River from ≈RM 62.0 down to ≈RM 60.2.
This section has a fairly wide floodplain throughout, and as a result, braiding exists periodically throughout this section. Two hotspots for spawning activity are the tributary system that enters the Soleduck ≈ 800 meters downstream from the start of this section, and the side channel system which begins left bank ≈ 350 meters further downstream.

4) ≈RM 60.2 down to Salmon Cascades. Soleduck River from ≈RM 60.2 down to the upstream side of the Salmon Cascades.
Soleduck River from ≈RM 60.2 downstream has a confined mainstem channel, with one side channel above the cascades. There were some good holding pools, but very little good coho spawning substrate. Except for a few isolated pockets, the substrate was primarily boulder, with

some bedrock as one gets closer to the cascades. This section was only done once, with a number of fish but no spawning activity noted.

5) Below Salmon Cascades. Soleduck River below the Salmon Cascades. Although no downstream end to this section is noted, no survey effort was made below the Forest Service Road 2918 bridge.
Like section 4, there is limited suitable spawning habitat here. A large portion of this section consists of a confined mainstem. However, there were redds noted in both a right bank side channel above and one below the mouth of the North Fork Soleduck River below the Salmon Cascades. Other than the side channels, there is very little suitable coho spawning habitat.

6) Upper North Fork Soleduck. North Fork Soleduck River above the North Fork Soleduck River Trail bridge. Although no upstream end to this section is noted, no survey effort was made above ≈ 3.0 miles upstream of the bridge.
Heading upstream from trail bridge, river has boulders, bedrock, large cobble, and lots of whitewater. Tributaries entering river exhibit similar characteristics. No fish or redds observed.

7) Lower North Fork Soleduck. North Fork Soleduck River below the North Fork Soleduck River Trail bridge down the mouth.
Heading downstream from trail bridge, river mainstem is largely confined. Most side channels consisted of large substrate and fast water. Tribs entering the mainstem were steep, most having a waterfall barrier very near to the mouth. Isolated pockets of suitable substrate were primarily along the edge of the river, behind log jams and in the side channels. The one time that this section was surveyed, seven redds and 6 coho were noted.

8) South Fork Calawah River. This year this section was only visited twice. If this section is done regularly in the future it should probably be split into at least two sections: above and below the Rugged Ridge Trail Intersection.
To get to the river, take Forest Service road 29 south from 101. Park pick-up vehicle near faint trailhead ≈.6 miles after crossing Hyas Creek. Stay on 29 with the other vehicle up to second fork and then go right. At the next fork, go left on 070 and follow it to the Rugged Ridge trailhead parking area. Access the river by walking the trail for ≈3.2 miles. Follow the river, being careful to skirt around the canyon ≈0.5 miles down from the trail bridge, to about 200 yards downstream of the confluence with the Sitkum. There is a flagged trail on the right bank that will take you back to 29.
Entire length from bridge down, except for canyon ≈ 0.5 miles down from the trail bridge, has numerous pool tailouts sprinkled throughout, but last mile of survey is best with frequent tailouts. There was just one coho noted in this section in the single survey conducted.

9) Canyon Creek. Canyon Creek from the mouth up ≈ 75 meters to the anadromous barrier, an ≈ 7 meter falls.
The short stretch of Canyon Creek below the anadromous barrier consists of cobble ridden and fast moving water. No redd, live fish, or carcass was ever seen in this section.

10) Mink Lake Creek. Mink Lake Creek above the Lover's Lane bridge up ≈ 0.6 miles to large

woody debris jam. Just downstream of this woody debris jam Mink Lake Creek splits into two channels that parallel each other briefly then diverge. Above the jam the creek becomes treacherous to follow.
Mink Lake Creek has good spawning habitat up to approximately 200 meters short of where the survey is ended. There are braided channels, plenty of good substrate, and a high density of spawning activity was noted. In the upper 200 meters, the water speeds up and the substrate size increases. No redds or fish were noted in this upper stretch.

11) Blackwood Creek. Blackwood Creek from mouth up to 75 meters past 2 meter high woody debris jam located ≈ 0.75 miles upstream. Above this point the creek enters a canyon and would be treacherous to follow.
Blackwood Creek is a moderately fast moving, cobble loaded stream from the mouth up to the end of the survey boundary. The best patch of spawning gravel exist above the woody debris jam just short of the upper end of the survey. Above this point the creek enters a canyon with boulder and cobble substrate and cascades. There were a few redds noted on Blackwood Creek, with most of those located in the patch of gravel above the jam.

12) Munden Creek. Munden Creek from mouth up to ≈0.7 miles upstream, where the creek is a series of cascades, boulders, and lots of woody debris. It was deemed too treacherous to continue. At the downstream end of Munden Creek, the creek fans out and goes underground the last 300 - 400 meters. The typically dry channel of Munden Creek intersects the left bank of the Soleduck River mainstem in a couple of spots, one ≈ 800 meters below the end of the standardized index, and another ≈ 1100 meter below the end of the standardized index.
Munden Creek above the end of the survey is a series of cascades, boulders, and lots of woody debris. There are patches of substrate, but there is a question whether the coho can access it given the fact that Munden Creek does go underground for the last 300 - 400 meters. Even during high flows, Munden never was noted as maintaining surface flow all the way to the Soleduck River mainstem. No redds or coho were ever noted in this section.

13) Alkee Creek. Alkee Creek from mouth up to anadromous barrier falls ≈ 3.0 - 3.5 miles upstream.
To access this creek, take 101 to Forest Service Road 2918 (the South Fork Soleduck Road). Follow 2918 and take a left on the 110 spur. At the next fork take a right on the 100 spur, following it to the gate. Park and walk the road past the gate for ≈ 2 miles, skirting one large clearcut, entering the forest and then coming to another clearcut to the right off the road. As soon as you get to this clearcut, follow the tree line down the slope to the creek (there is a 15-30 meter buffer zone of trees along the creek. The falls are right there. Downstream of the falls ≈ .5 miles is a channel entering right bank that is similar to the size of the channel that you are on. This channel has never been surveyed, but should be looked at in the future.
For the lower ≈ 1.5 miles of Alkee Creek from the mouth up to where the creek lines up with the park boundary, there was spotty good coho spawning habitat. This lower half is has rather large substrate, with increasing amounts of good habitat as you progress upstream.
The upper ≈ 1.5-2.0 miles of the survey starts out with some good spawning habitat, but the amount decreases as you head upstream to where the upper end is largely bedrock and cascades. There was a moderate amount of spawning activity noted in both halves of this section.

14) Goodman Creek. Goodman Creek from mouth up to ≈ 3.0 miles upstream. As of this time, an anadromous barrier woody debris jam exists ≈ 1.5 miles up from the mouth. The 1.5 miles above the jam is also done as there is no good access to the point of the jam and given the relatively temporary nature of woody debris jams.
To access the creek, take 101 to Forest Service Road 2918 (the South Fork Soleduck Road). Follow 2918, and take the 2931 spur (right) up to a gate. Park and walk past the gate for ≈ 3.0 miles. Most of the walk will be with a clearcut below you and old growth above you. Walk to a point where there is old growth on both sides and proceed until the old growth ends with a clearcut. Follow the treeline down the slope to the creek. Just downstream from where you access the creek, the falls will appear.
Like Alkee Creek, Goodman Creek is fast with rather large substrate, but with a number of pools with tailouts and the accompanying good spawning gravel.
There was a light to moderate amount of spawning activity noted in Goodman Creek. At least one survey was conducted on Goodman by the Quileute surveyors.

15) Bear Creek. Bear Creek from the Bear Creek-West Twin Rd./ spur 200 fork downstream to Forest Service road 3018 bridge.
To access the creek, take 101 to the Bear Creek-West Twin Rd. (≈2.5-3.0 miles west of the Hungry Bear Cafe). Follow the road ≈3.5-4.0 miles to the double culverts (Bear Creek) and continue past to spur 200. Park at the fork and head down the hill to the creek.
Bear Creek from the Forest Service road 3018 bridge up to the double culverts has great spawning habitat, and above the culverts up to the end of the survey is similar just in smaller quantities.
There was a moderate amount of spawning habitat noted in this section.

APPENDIX B - COMPLETED SPAWNER SURVEYS, BY SECTION

STAT. WEEK	INDEX	ABOVE INDEX	BELOW INDEX (DOWN TO RM 60)	NORTH FORK Soleduck	TRIBS (MLC,B,M, A,BR,G)*	SOUTH FORK CALAWAH	RM 60 DOWN TO CASCADES	BELOW CASCADES
40	✓	✓	✓	≈1.5 miles up from mouth	MLC	--------	--------	----
41	✓	-------	---------	-------	MLC	--------	--------	----
42	✓	From top of index up ≈0.8 miles	✓	≈2.0 miles above trail bridge	B	--------	--------	-----
43	✓	From top of index up ≈0.8 miles	✓	≈3.0 miles above trail bridge	A(lower ½), MLC, B, M	--------	✓	Down ≈1.0 miles
44	✓	Mostly completed	✓	--------	A,MLC,B,M, BR,G	Trail down to Sitkum	--------	Start ≈1.0 miles Down to 2918 bridge
45	✓	--------	✓	Trail bridge down to mouth	--------	--------	--------	S.C. above N.F. Sold. mouth
46	----	From top of index up ≈0.8 miles	Some s.c.'s and tribs (poor cond.)	--------	A(upper ½),MLC(stopped due to cond.)	--------	--------	-----
47	✓	✓	✓	-------	A,MLC,B,M, BR,G	≈1.0 miles up from trail	--------	----

*NOTE: THE TRIBUTARIES REFERRED TO BY THE ABBREVIATIONS ARE AS FOLLOWS:

MLC = Mink Lake Creek — M = Munden Creek — BR = Bear Creek
B = Blackwood Creek — A = Alkee Creek — G = Goodman Creek

APPENDIX C - DATA ANALYSIS
CUMULATIVE ANALYSIS AND STANDARDIZED INDEX ONLY

CUMMULATIVE ANALYSIS

CHANNEL TYPE	AVG. REDD LIFE (DAYS)
MAINSTEM	16
S.C/O.F.C.	20
TRIBUTARIES	20

STATISTICAL WEEK[1]	# FISH	#CARCS	#REDDS
40	359	0	10
41	56	0	28
42	305	2	46
43	319	9	96
44	158	34	106
45	75	32	34
46	11	17	12
47	17	12	14

STANDARDIZED INDEX ANALYSIS

CHANNEL TYPE	AVG. REDD LIFE (DAYS)
MAINSTEM	13
S.C/O.F.C.	22
TRIBUTARIES	21

STATISTICAL WEEK[1]	# FISH	#CARCS	#REDDS
40	25	0	3
41	44	0	19
42	75	2	28
43	54	0	14
44	22	12	18
45	38	11	23
46	N/A	N/A	N/A
47	2	3	3

	# REDDS BY:		
STATISTICAL WEEK[1]	MAINSTEM	S.C./O.F.C	TRIB.
40	0	2	1
41	2	6	11
42	0	11	17
43	0	6	8
44	2	10	6
45	6	11	6
46	N/A	N/A	N/A
47	0	2	1

[1] The actual dates for the statistical weeks noted for the year 1995 are as follows: 40 = Oct. 1 - Oct. 7, 41 = Oct. 8 - Oct. 14, 42 = Oct. 15 - Oct. 21, 43 = Oct. 22 - Oct. 28, 44 = Oct. 29 - Nov. 4, 45 = Nov. 5 - Nov. 11, 46 = Nov. 12 - Nov. 18, and 47 = Nov. 19 - Nov. 25.

Survey of Fish-Related Databases

Ruth Jacobs
Forest and Rangeland Ecosystem Science Center

The second task under Subagreement 27 was to assist Olympic National Park with a survey of databases containing information that characterized populations and habitats of salmon, trout, and char in streams and lakes of the Olympic Peninsula in Washington State. Oregon State University staff (Ruth Jacobs, Faculty Research Assistant) and Olympic National Park staff (John Meyer, Fish Biologist) met in December, 1994 at Olympic National Park to discuss the strategy for approaching the project. The final report was to include recommendations for a system of information storage and retrieval that would be suitable for use by the park for managing an array of data collected in the park by park staff and by other management agencies. The list of fish species and aquatic systems to be considered was determined (Table 1). The initial approach to the project was to distribute a letter explaining the project to federal, tribal, and state fisheries management staff in Washington State. The expectation was that individual visits to various agency offices would follow from the initial contact made with the letter. Printouts or electronic files containing pertinent fisheries data would then be assembled and restructured into a format suitable for addressing park information needs. A small amount of data would be compiled in the data system to start the process of archiving the information in the park. The park would then carry on with the task of incorporating additional data into the system as time permitted.

The need for critical evaluation of the expectations of this project rapidly became apparent once the work began. Many existing programs for management and reporting of fisheries data were identified as telephone calls were made following the initial letters of inquiry.

Table 1. Aquatic systems and fish species to be considered in the database survey.

Aquatic systems	
Quinault River and tributaries above and below Quinault Lake	
Quinault Lake	
Queets River exclusive of Clearwater River and its tributaries	
Hoh River	
South Fork Hoh River	
Kalaloch Creek	
Cedar Creek	
Mosquito Creek	
Goodman Creek	
Bogachiel River	
Calawah River	
Soleduck River exclusive of Dickey River and its tributaries	
Ozette River	
Lake Ozette	
Lake Crescent and its tributaries	
Elwha River	
Dungeness River	
Gray Wold River	
Dosewallips River	
Lake Cushman and its tributaries	
High-mountain lakes of Olympic National Park	
Fish Species	
Chinook salmon (*Oncorhynchus tshawytscha*)	Chum salmon (*Oncorhynchus keta*)
Coho salmon (*Oncorhynchus kisutch*)	Pink salmon (*Oncorhynchus gorbuscha*)
Sockeye salmon (*Oncorhynchus nerka*)	Steelhead (*Oncorhynchus mykiss*)
Cutthroat trout (*Onchorhynchus clarki*)	

Most biologists and database managers contacted were willing to cooperate with Olympic National Park in identifying data sets to address specific management questions, but a commonly stated opinion was that any broad effort to assemble a complete array of fisheries databases by the park and to keep these sets current would be a monumental undertaking and, more importantly, also would duplicate or overlap ongoing efforts. Several contacts provided information on data systems to which raw or summarized data were routinely submitted. Three generalizations rapidly emerged as a result of the inquiries. First, a vast array of fisheries data exist, collected by state, federal, and tribal agencies, as well as some regional organizations. Second, the data exist in a wide variety of formats. Third, there are many systematic efforts already underway to coordinate and consolidate some of the information systems into local and regional data systems. Based on these generalizations, it was concluded that the best approach to management of fisheries data in Olympic National Park would be for the park to integrate its efforts with ongoing efforts rather than to start another data system.

Ruth Jacobs, Gary Larson (National Biological Service), John Meyer, and Jeff Jackson (Olympic National Park) met in February, 1996 in Olympia, Washington and agreed that a modified approach to the database project was in order. Oregon State University proceeded to develop a written report that described the data systems of interest to the park that were detected during the initial inquiries. Jeff Jackson, a fisheries technician assigned to the park, proceeded to work with staff of the Washington Department of Fish and Wildlife to obtain access to some of the data systems archived at the University of Washington to determine if information relevant to a current park information need was available. The specific task was to summarize data that described population characteristics of winter steelhead in rivers and streams of the Olympic Peninsula.

The Washington Department of Fish and Wildlife (WDFW), the Pacific States Marine Fisheries Commission (PSMFC), and the Northwest Indian Fisheries Commission (NWIFC) have taken major strides to develop electronic data storage systems. These are key organizations for the park to work with in order to accomplish data access and storage needs. Many of the data systems maintained by these organizations are in a state of transition due to technological changes in management systems and ongoing efforts to bring old data into new systems. Several data sets maintained by these agencies of interest to fish management staff at Olympic National Park, and these are described in the following.

Washington Department of Fish and Wildlife

The WDFW is charged with the protection and enhancement of the state's fish and wildlife. Related to this mission, the state has many programs that acquire and manage fisheries data. These data are reported in many forms, ranging from reports to electronic data systems (Figure 1 and Table 2). The types of fisheries data can be classified in a number of ways, although common categories are harvest, escapement, production, tagging, run size, biological characteristics, and habitat. Some of the sets are current and ongoing, others are obsolete, and still others are no longer in existence because they have been subsumed by something else or have simply been abandoned. The reorganization of the Washington Department of Fisheries and the Washington Department of Game into one agency, the WDFW, in the recent past has complicated access to some of the information, although one particular division within the department has maintained broad expertise with historical and current fisheries data sets -- the Resource Assessment Division. The information provided in Table 2 and Figure 1 was obtained from Resource Assessment Division staff, Peter Hahn and Richard O'Connor. Both caution that some of the data sets described, particularly those in Table 2, are not current, but these lists provide a good starting point for searches for particular information. Both individuals are available for consultation regarding data searches, and both are working on consolidation of some of the fisheries data sets managed by WDFW. This is an ongoing process, in part because the data systems are in a phase of refinement as new software and hardware emerge and in part because the agency merger brought information and expertise together that previously was segregated by agency administrative boundaries.

Figure 1. Washington data system.

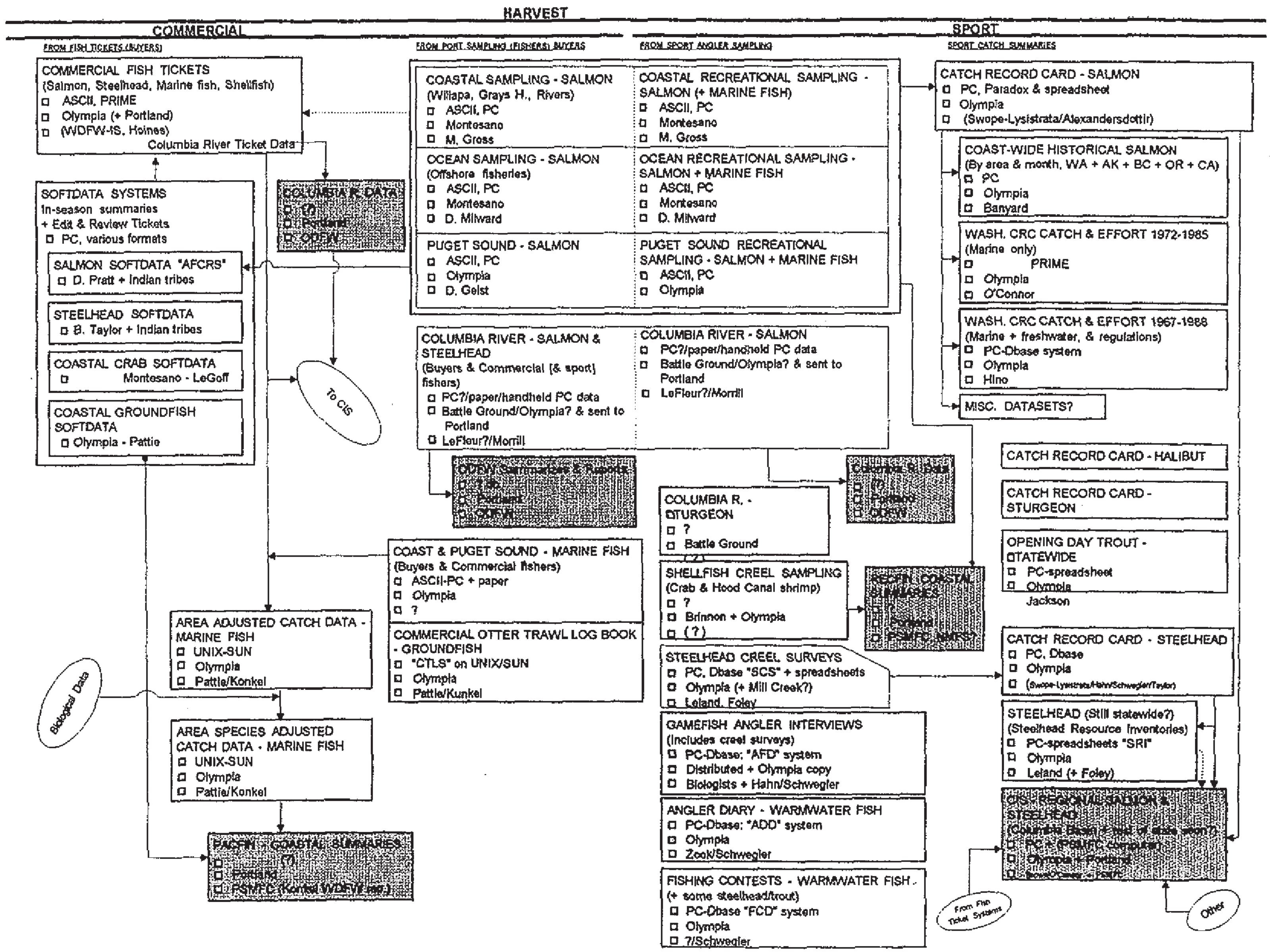


Figure 1. (continued)

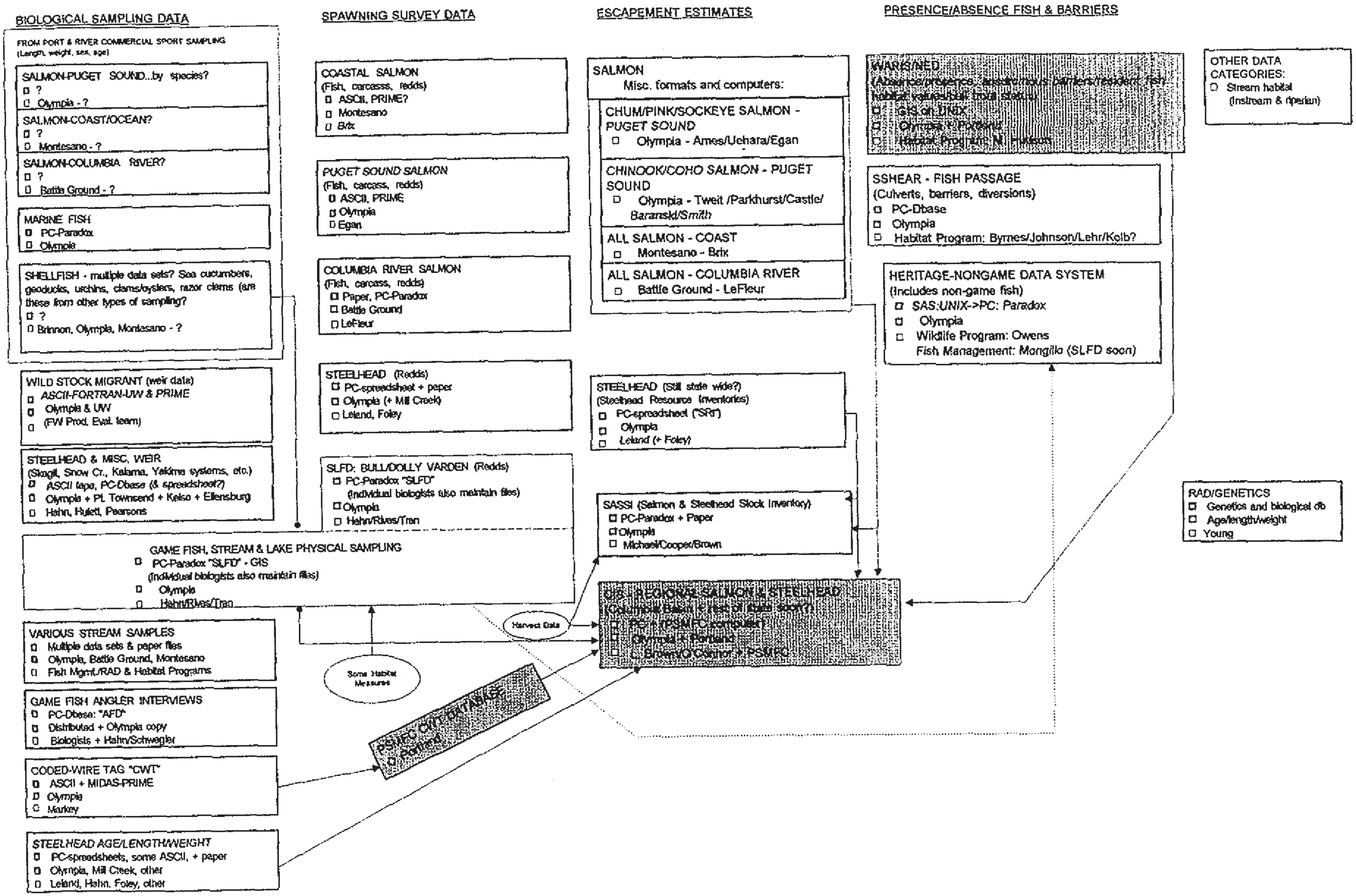


Table 2. Major information sources used for salmon and steelhead management in the Pacific Northwest as identified in a 1986 survey of electronic data systems and reporting series. (D. O'Connor, WDFW, pers. comm. Mar. 1996).[1,2]

Category	Subcategory	Source	Data type	Agency
Commercial & sport catch	Commercial salmon statistics	Tribal fish tickets	CDS	NWIFC
		Historical catch & landing system	CDS	NWIFC
		Historical Commercial catch/effort	CDS	WDFW
		Auxiliary fish-catch recording systems	CDS	WDFW
	Ceremonial & subsistence salmon statistics	Tribal estimates	Paper	Tribes
		NWIFC estimates	Paper	NWIFC
	Commercial steelhead statistics	Commercial steelhead ticket system	CDS	WDFW
		Winter steelhead resource inventory	DMS	WDFW
		Tribal Fish Tickets	CDS	NWIFC
		Annual Reports	Paper	WDFW
	Ceremonial & subsistence steelhead statistics	Commercial steelhead ticket system	CDS	WDFW
		Tribal & state reports	Paper	WDFW, Tribes
		Winter steelhead resource inventory	DMS	WDFW
	Sport salmon/ steelhead statistics	Sport catch & effort	CDS	WDFW
		Steelhead punchcard data system (SPDS)	CDS	WDFW
		Winter steelhead resource inventory	DMS	WDFW
		Annual Reports	Paper	WDFW

Hatchery & wild escapement information	Wild populations	Wild salmon escapement estimating files	CDF	WDFW
		Spawning-ground survey database	CDF	WDFW
		Indian tribal escapement estimates	CDF	
		PSMFC (agreed-upon data from tribes & WDFW)	Paper	PSMFC
		Winter steelhead resource inventory	DMS	WDFW
		Annual reports (steelhead)	Paper	WDFW
	Hatchery	Returns (WDFW hatcheries only: salmon)	CDF	WDFW
		Winter steelhead resource inventory	DMS	WDFW
		Hatchery evaluation database (HED) - federal returns of both salmon & steelhead	DMS	USFWS
		Annual reports (steelhead)	Paper	WDFW
Production	Hatchery salmon	Equilibrium brood document	CDS	WDFW
		HISTORY	CDS	WDFW
		HATPLAN	CDS	WDFW
	Hatchery steelhead	Stocking records	CDF	WDFW
		Winter steelhead resource inventory	DMS	WDFW
		HISTORY	CDS	WDFW
Tagging	Releases	PSMFC	CDF	PSMFC
		Coded wire tags	CDS	NWIFC
		Micro-tag information system for research (MISR)	DMS	WDFW
		Winter steelhead resource inventory	DMS	WDFW

	Recoveries	PSMFC	CDF	PSMFC
		CATCHYR	CDS	WDFW
		Salmon Stock Assessment (SSA)	DMS	Canada/DFO
		Winter steelhead resource inventory	DMS	WDFW
		Micro-tag information system for research (not current)	DMS	WDFW
		Pacific salmon treaty coded wire tag recovery database	DMS	US/Canada
	Sampling	Fish sampling files	CDF	WDFW
		PSMFC	CDF	PSMFC
		Creel census	Paper	WDFW
		Other reports	Paper	WDFW
Run-size	Salmon	Run reconstruction tables & models	CDF	WDFW; NWIFC
		Tribal management reports	Paper	Tribes
	Steelhead	Winter steelhead resource inventory	DMS	WDFW
Stock-specific biol. data	Run timing	Nothing computerized	Paper & CDF	WDFW; Tribes
		Winter steelhead resource inventory	DMS	WDFW
		Reports	Paper	WDFW
	Stock/Recruitment	CRPMPs, misc. files	Paper & CDF	WDFW, Tribes
		Winter steelhead resource inventory	DMS	WDFW
		Reports	Paper	WDFW
	Disease	Coded-wire-tag Documentary	CDF	WDFW
		HED	DMS	USFWS
		Reports	Paper	WDFW

		Augmented Fish Health Monitoring Database	DMS	Northwest Fish Health Protection Committee
	Age Composition	Winter steelhead resource inventory	DMS	WDFW
		Management reports	Paper	Tribes
		CRPMPs	Paper	WDFW, Tribes
		PSMFC documents	CDF	PMFC
		MISR	DMS	WDFW
	Sex Ratios	Winter steelhead resource inventory	DMS	WDFW
		CRPMPs	Paper	WDFW, Tribes
		PSMFC data	CDF	PMFC
		Management Reports	Paper	Tribes, WDFW
Habitat	Stream Inventory	W. Washington Stream Inventory Data	CDF	NWIFC
	Spawning Areas	CRPMPs	Paper	Tribes, WDFW
	Rearing Areas	CRPMPs	Paper	Tribes, WDFW
	Hydrologic Information	Flow data	CDF	USGS
		Stream characteristics	CDF	WDFW
		Reports	Paper	WDFW
		Temperature	CDF	USGS

[1] Acronyms used: CDS Computer Data Systems, CDF Computer Data Files, CRPMP Comprehensive Resource Protection and Management Plans, DMS Data Management Systems, NWIFC Northwest Indian Fisheries Commission, PSMFC Pacific States Marine Fisheries Commission, WDFW Washington Department of Fish and Wildlife.

[2] This summary was prepared in 1986 and does not reflect current efforts to consolidate information. A more current summary is not available from the WDFW.

Thanks to the assistance of Richard O'Conner with the WDFW, Olympic National Park was able to obtain access to a data system at the University of Washington that contains archived WDFW data. Unfortunately, the information found proved to be disappointing both in scope and variety. The only two WDFW data systems which continue to be maintained on the University of Washington computer system are the Historical Commercial Catch/Effort Data System (HCCE) and a spawning-grounds-survey database. The latter was of great interest to the park, but when a search was conducted on this database for information on the Quillayute and Hoh river systems, there was no information available for dates after 1980. Richard O'Conner suggested that Olympic National Park contact the regional WDFW offices directly in an effort to fill this information gap.

Following additional data inquiries of WDFW by Olympic National Park, it was learned that the following databases are in the development stage: Historic Hatchery Plants (including all species) and sport-catch statistics for salmon and steelhead. Until final supported database systems are constructed with this information, specific data inquiries regarding salmon and steelhead sport catch can be filled by contacting Richard O'Conner, and hatchery plant information can be obtained from Dave Knutzen (WDFW hatchery program).

Several state-managed databases may be of particular use to the park both as a source of information and as a repository for information collected in the park. Even if the park chooses to develop data systems separate from those managed at state or regional levels, adoption of a format and data reporting standards consistent with those of other major systems would greatly facilitate the exchange of information in the future. Several of these systems are described in this report.

Stream, Lake and Fish Data System (SLFD)

The Stream, Lake and Fish Data System (SLFD) is a new electronic system managed by WDFW. Database structure and data standards for this system are well designed, and this system may be a good candidate for storage of some of the park's data. Most data in the SLFD came from paper files within the former Washington Department of Wildlife (previously Washington Game Department). Relatively little data from the former Washington Department of Fisheries or from Native American Tribes has been entered. Some data originating from the U.S. Forest Service has been entered, primarily from cooperative sampling efforts with Washington State, and primarily related to bull trout surveys. The database contains biological information on freshwater fish species, both resident and anadromous species, and geographical, physical, and chemical data describing lake and stream habitats in the state. Data entry in this system is an ongoing activity. Guidelines for using this system are available from the Resource Assessment Division of WDFW under a publication authored by the previously Washington Department of Wildlife (Appendix A).

Angler-Fish Data System

The Angler-Fish Data System is a computerized data system managed by WDFW. It contains information from field interviews of anglers and measurements of their catch in the state. The initial application of the system is to freshwater fish classified as game species by the state. The data system describes the location of the angler interview, the characteristics of the anglers and their fishing trip, species of fish caught and released, and the length of the fish kept. Information about this system is also available from the Resource Assessment Division of WDFW under a publication authored by the previously Washington Department of Wildlife

(1994) and under another publication authored by Hahn (1992). Copies of these two reports have been provided to Olympic National Park along with this report.

Northwest Indian Fisheries Commission

The Northwest Indian Fisheries Commission (NWIFC) was established in 1974 by the treaty tribes in western Washington as a result of the U.S. versus Washington litigation that affirmed fishing rights reserved by the tribes in treaties signed with the federal government in the 1850's. The commission's role is to coordinate an orderly and biologically sound treaty Indian fishery in the Pacific Northwest and provide member tribes with a single, unified voice on fisheries management and conservation matters. The commission includes the Quantitative Services Division which strives to assist tribal fishery management programs by providing relevant data, quantitative tools and analyses, and technical consulting services to tribal and NWIFC projects. Updated databases are maintained primarily for tribal access, although other users can also gain information through requests to the Quantitative Services Division (Table 3).

As part of this project, Olympic National Park staff tried to obtain steelhead information from tribal entities located on and off the Olympic Peninsula. The results were mixed. In a discussion with Keith Lutz, at the NWIFC, it was revealed that steelhead information is often maintained by individual tribes instead of by the NWIFC because the individual tribes work closely with the state in the management of steelhead runs. Ten tribes were directly asked for information of which two did not collect any of the information of interest to the park and two responded with some data. The varying degrees of receptivity to the request reinforced the general conclusion that centralized data services are needed, such as the systems being developed by the WDFW Resource Assessment Division.

Table 3. Databases available through the NWIFC in Olympia, Washington that contain information related to salmonids found on the Olympic Peninsula.

CBIRD93

Source:	NWIFC
Site:	NWIFC
Size:	550 cases; less than 0.5 megabytes
Contents:	1993 observer study of gillnet by catch
Usage:	Restricted to tribal technical staff; others may submit requests

GNOB94

Source:	NWIFC
Site:	NWIFC
Size:	approximately 600 cases in primary tables
Contents:	Observer study of gillnet fishery by catch beginning 1994
Usage:	Restricted to tribal technical staff; others may submit requests

Fish Health Database

Source:	NWIFC
Site:	NWIFC
Size:	unknown
Contents:	Begins in 1980; tracking of hatchery-fish monitoring, health certification, and treatment by NWIFC pathologists
Usage:	Access requires permission from NWIFC Fish Health Manager

Coho Cohort Run Reconstruction Analysis Database

Source:	NWIFC
Site:	NWIFC
Size:	unknown
Contents:	Database still in data design phase; once completed will contain calculated catch and escapement data for coho; contact biometrician at NWIFC for additional information

Treaty Fish Ticket Database

Source:	NWIFC and Washington Department of Fish and Wildlife
Site:	NWIFC and Washington Department of Fish and Wildlife
Size:	several gigabytes
Contents:	Database begins in 1970; contains tribal and non-tribal fish ticket dat for commercial and non-commercial catch of salmon (mostly), marine fish, and shellfish
Usage:	Open access

Continued

Table 3. Continued

NWIFC Ambient Monitoring database

Source:	NWIFC
Site:	NWIFC
Size:	currently about 50 megabytes of data
Contents:	Database begin in 1989; field-surveyed data on stream and habitat conditions.
Usage:	Available through standard summarized reports or in original form from NWIFC

Run Reconstruction Database

Source:	Originates from Washington Department of Fish and Wildlife
Site:	Washington Department of Fish and Wildlife in Olympia or NWIFC
Size:	27 K records
Contents:	Database begin in 1959 (pink salmon only); other species begin in 1968; summarized and calculated catch and escapement data for salmon
Usage:	Standard reports available through NWIFC

NWIFC CRAS Database

Source:	NWIFC
Site:	NWIFC
Size:	64.5 megabytes data and programs
Contents:	Database begin in 1971 for salmon releases, 1972 for chinook recoveries, and 1977 for coho recoveries; INGRES files and programs of releases, recoveries, and cohort analysis recovery statistics for all tagged coho and chinook salmon released into western Washington waters exclusive of the Columbia River
Usage:	Access to database is through NWIFC bulletin board.

Salmon and Steelhead Habitat Inventory and Assessment Project

Coinciding with the onset of this project of compiling data for the park, the NWIFC initiated a major data-compilation project known as the Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP). The SSHIAP was conceived as a logical outgrowth of the Salmon and Steelhead Stock Inventory (SSASI), a cooperative project to document the results of an initial stock-status inventory of salmon and steelhead stocks and fisheries in Washington State (Washington Department of Fisheries et al. 1993, WDFW and Western Washington Treaty

Indian Tribes 1994). The SSASI effort resulted in a written set of reports and integration of some of the results into some electronic data systems, including StreamNet (see below). The SSHIAP is a two-year project of the NWIFC, with cooperation and support from the WDFW, to characterize current habitat conditions, to assess the effects of habitat degradation on the status of salmon and steelhead stocks, and to suggest protection and restoration strategies (NWIFC 1995). Data are being compiled in an electronic data system which presumably will be managed by the NWIFC.

Regional Data Systems

Ultimately it is essential for Olympic National Park staff to become involved in regional fisheries data management and distribution efforts. The PSMFC has taken a leadership role in the development of some regional approaches to data management, largely through its administration of StreamNet and staff support for this program in the form of the Regional Project Manager and Regional Data Manager. State, federal, and tribal representatives regularly meet to coordinate efforts to consistently collect data and to make these data available to address management questions. Although the focus of many of the regional efforts has been heavily biased toward the Columbia River and the complex information needs for management planning for this system, many of the data standards and reporting systems have application elsewhere. StreamNet especially and the Regional Mark Information System, less so, constitute the two major regional data systems that could meet some of the park's information needs.

<u>StreamNet</u>

StreamNet was established in 1996 through the consolidation of earlier data projects associated with the regional Fish and Wildlife Program of the Northwest Power Planning Council. It is a cooperative, regional effort of this council, the Bonneville Power Administration, PSMFC, U.S. Geological Survey, Idaho Department of Fish and Game, Montana Department of Fish, Wildlife, and Parks, Oregon Department of Fish and Wildlife, WDFW, U.S. Fish and Wildlife Service, the Columbia River Inter-Tribal Fish Commission, and the Shoshone-Bannock Tribes. The mission of StreamNet is twofold: (1) to create, maintain, and enhance a high-quality, regionally consistent set of fish and wildlife data that is directly applicable to regional policy, planning, management, and research; and (2) to provide these data to users in an efficient, timely, and cost-effective manner. StreamNet focuses on technical information related to aquatic resources within the four-state region of Oregon, Washington, Idaho and Montana. The project is based on interagency cooperation in the collection, compilation, and dissemination of fish and wildlife information. Data gathering focuses on species distribution, production, habitat, management, and other aquatic resource factors. Information from the StreamNet system is available in a variety of ways including Internet access and a stand-alone personal computer application. The regional project manager (Stan Allen) is based in PSMFC and the Washington State coordinator (Richard O'Connor) is based in the Resource Assessment Division of WDFW. Information about the system is readily available on the World Wide Web, and some original and summarized data can be retrieved directly through this medium.

StreamNet consolidates data compilation and management activities that were previously conducted through the Coordinated Information System (CIS), the Northwest Environmental Data Base (NED), the Pacific Northwest Hydropower Data Base and Analysis System (NWHS), and other regional projects. These projects were created by the Northwest Power Planning Council to provide information necessary for implementation of the Council's Fish and Wildlife Program: CIS for anadromous fish productivity and management, NED for Protected Areas and a range of region-wide policy and planning requiring information on stream-based environmental factors, and NWHS for dam impacts and energy analysis. The project is primarily funded by the Bonneville Power Administration under the Fish and Wildlife Program of the Northwest Power Planning Council, but other entities provide funding for select project components. In addition to the "Fish and Wildlife Program", which serves as the primary mechanism for providing fish and wildlife data related to the Northwest Power Planning Council's Northwest Conservation and Electric Power Plan and Fish and Wildlife Program, StreamNet also provides data and services to activities external to the Fish and Wildlife Program but that are related to the conservation of fish and wildlife resources and thereby complement the Program. These include, but are not limited to National Marine Fisheries Service and U.S. Fish and Wildlife Service endangered species activities, Forest Service and Bureau of Land Management fish and wildlife habitat management activities, state-level policy and planning, tribal fish and wildlife management activities, regional environmental review activities, and local and watershed-based planning.

Although StreamNet presently offers a wide variety of current information on anadromous salmonids in the Columbia River Basin, in 1996 this information is being expanded to coastal Oregon and Washington. Region-wide information is also being developed for resident salmonids. The system also includes data compiled on other river-related features throughout the region during the past ten years.

Regional Mark Information System

The coded wire tag is widely used by fisheries agencies on the Pacific Coast as a major information collection tool for stocks of salmon and steelhead. The PSMFC Regional Mark Information System (RMIS) houses information pertaining to the mark, release, and catch of Pacific salmonids throughout the Pacific region involving the coded-wire-tag marking project.

The Regional Mark Processing Center (RMPC) is involved in ongoing regional tag and mark coordination activities, management and reporting of data, and exchanging data with Canada in accordance with the Pacific Salmon Treaty. Users of the RMIS application must be familiar with the document "Specification for Reporting Salmonid Production and CWT Data", which is available from the RMPC.

Specific Recommendations for Olympic National Park

Several steps can be taken by the park to begin the task of meeting park needs for data access and data storage. Staff time, travel, and computer equipment for use by the park's fish biologist and his staff are the primary expenditures required. The park has expertise with electronic data management through its geographic information system staff. Close communication and coordination with this expertise will greatly facilitate some of the tasks identified below.

1. Develop a working relationship with the StreamNet Coordinating committee. This could take the form of active participation in the committee or park participation could be conducted through the State of Washington coordinator for StreamNet.
2. Actively seek the support of the Resource Assessment Division of Washington Department of Fish and Wildlife to acquire information currently managed by Washington State.
3. Begin the process of adopting data reporting formats and standards of an existing data system for information collected by park staff. Specifically explore the adoption of the Stream, Lake and Fish Data System of the Washington Department of Fish and Wildlife for this purpose. Also, check with WDFW regarding standardized formats for collecting other

types of data including spawning ground surveys, creel, electrofishing, and stream habitat.

4. Invest in computer equipment for the park fish biologist that is capable of temporarily storing and manipulating large data sets, and integrate this system into a network that allows for exchange of data with other users.

5. Begin the process of incorporating paper and electronic data files into a consolidated electronic data management system. First, all data in existence at the park should be thoroughly documented, including noting storage format (paper, spreadsheet, database, etc.), location, information contained, etc. With this information a data library can be created. Secondly, one can begin the process of entering these fragments of data into larger collective databases containing similar information. Other agencies' efforts should be considered when creating these collective databases (see #3). This process will be time consuming and complex involving combining a variety of data formats and file types. Given the nature of the work, it is suggested that Olympic National Park consider hiring an individual with an extensive computer science background to conduct this task.

Literature Cited

Hahn, R.K.J. 1992. Angler interview and fish database development within WDW. Report # 92-17. Washington Department of Wildlife, Fisheries Management Division, Olympia, Wash. 70 pp.

Jacobs, R. G. Larson, J. Meyer, N. Currence, J. Hinton, M. Adkison, R. Burgner, H. Geiger, and L. Lestelle. 1996. The sockeye salmon *Oncorhynchus nerka* population in Lake Ozette, Washington, USA. Technical Report NPS/CCSOSU/NRTR-96/04. U.S. Department of Interior, National Park Service, Columbia Cascades System Support Office, Seattle, Wash. 140 pp.

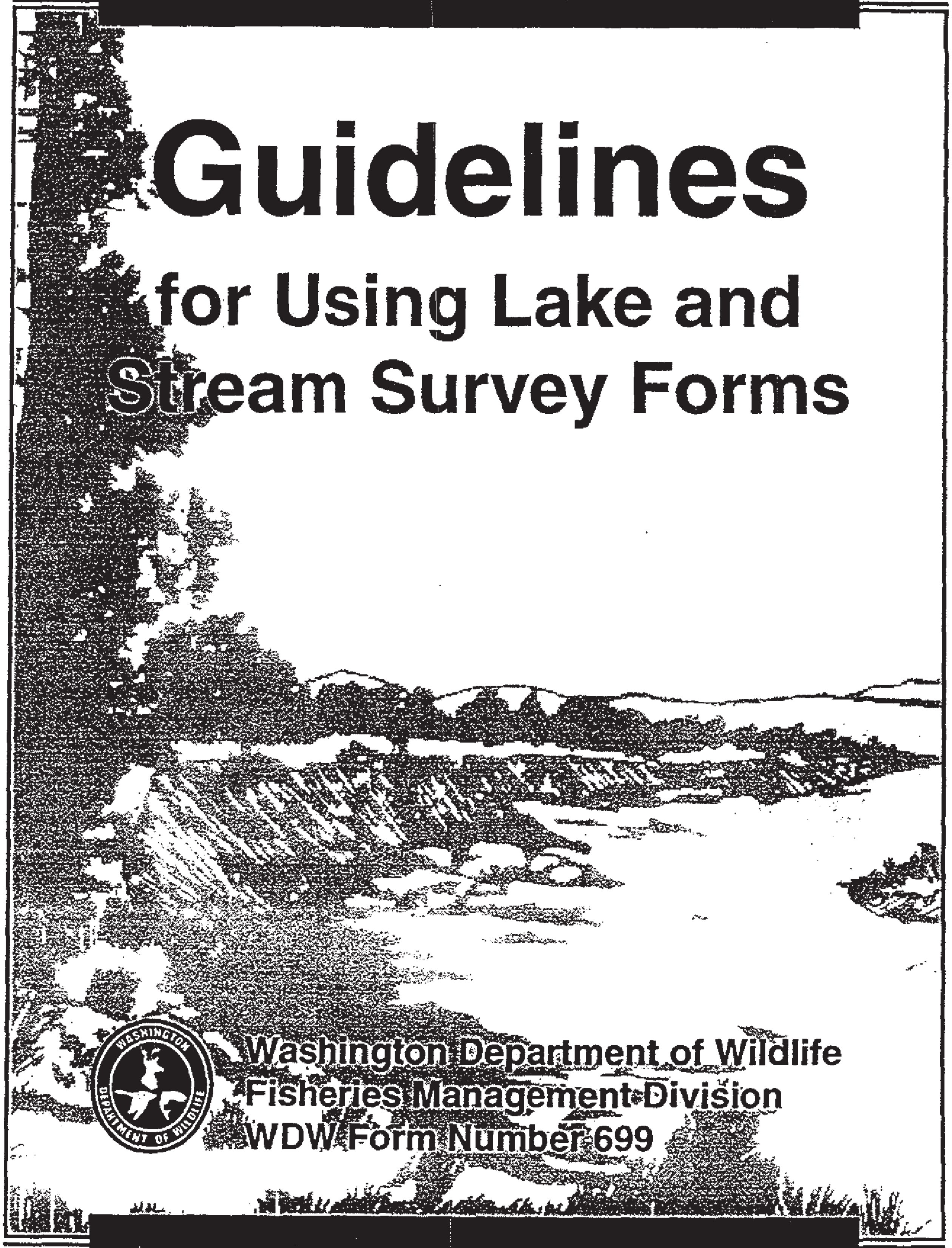
Northwest Indian Fisheries Commission. 1995. Wild salmon stock restoration initiative: Salmon and steelhead habitat inventory and assessment project (SHIAP). Northwest Indian Fisheries Commission, Olympia, Wash. 13 pp.

Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Tribes. 1993. 1992 Washington State salmon and steelhead stock inventory. Washington Department of Fisheries, Olympia. 212 pages.

Washington Department of Fish and Wildlife and Western Washington Treaty Tribes. 1994. 1992 Washington State salmon and steelhead stock inventory, appendix two, Coastal Stocks. Washington Department of Fish and Wildlife, Olympia. 588 pp.

Washington Department of Wildlife. 1994. Angler fish database information system users guide, AFD Version 2.5. Fisheries Management Division, Washington Department of Wildlife, Olympia, Wash. 49 pp.

Appendix A



Guidelines

for Using Lake and Stream Survey Forms

Washington Department of Wildlife
Fisheries Management Division
WDW Form Number 699

CURT SMITCH
Director

STATE OF WASHINGTON
DEPARTMENT OF WILDLIFE
600 Capitol Way North • Olympia, Washington 98501-1091 • (206) 753-5700

October 4, 1993

TO: Management and Research, Fish and Habitat Biologists

FROM: Peter Hahn, Fish Research (& Data) Manager
Fisheries Management Division

SUBJECT: **LAKE AND STREAM SURVEY FORMS**

Please insert this memo into your "Guidelines for Using Lake and Stream Survey Forms". Note the following additions or clarifications for using the lake and stream data collection forms:

1. Write the **township, range and section** onto every form #WDW699-A ("Sample Site Identification", use the comments section or the designated area on subsequent versions of the form). You can also add the **quarter-quarter section** if you want.

2. Prior to sending any forms to Olympia for keypunching, **make a photocopy of a 7.5 minute topographic map or the appropriate map from the Washington Topographic Atlas, mark the location of every sample site, then send the copies in with the forms.** The photocopy must include the name and scale of the map. Keep a photocopy of your forms for backup (the originals will be returned). Other maps can be used if the ones described above are not available.

3. You do not have to add "Physiographic Province" codes to the form (it will be added in Olympia after the sample sites are digitized). The agency standards have not yet been settled anyway.

4. **Add "Old Stream Type"** to the form above the "Stream Type", the current box on the form is thus the "New Stream Type".

Please note that the process for keypunching and returning forms and data is not yet completely in place, but we can process some data now. I am hiring a half time Computer Information Consultant 1, who can help with this process. Please call me for estimate of turn-around time.

Also, remember that every field on the forms does not have to be filled out for every sample you take. For example, habitat biologists may fill out the sample site identification and the single field "Stream Type" on the reverse side (but documenting what you catch during electrofishing for HPA permit evaluation is desirable).

Planning (i.e. definition of purpose and methodology) still needs to occur for the "physical attributes" listed on the form.

If you did not receive a copy of the manual and a stack of the forms, please contact Peter Hahn at (206) 664-0434 or Terry Jackson at (206) 586-9025.

PH:jbt

cc: Bruce Crawford
Chris Drivdahl
Fish and Habitat Resource Managers (Regions and Headquarters)
Terry Jackson
Dan Fender
Sue Clynch

c:\research\hahn\1335surv.wpm
(HAHN) 1993\SLDFORM1.wpm

GUIDELINES FOR USING LAKE AND STREAM SURVEY FORMS

SAMPLE SITE IDENTIFICATION

WATER NAME: Enter stream or lake name on which sample site is located.

SECTION NAME: Enter in predefined subsection of stream or lake listed above. Examples might be predetermined index areas, management units, or numbered sectioned off sample sites. "Section Name" may be entered as a name or number, or left blank.

COUNTY: Enter in name of county. Listing "county" narrows down duplicate water names to specifics. "County" is only entered on the survey forms, not into the database.

MANAGEMENT UNIT CODE: WDW identifier for lakes and streams which are digitized and linked to the Geographical Information System (GIS).

PHYSIOGRAPHIC PROVINCE: Enter in code as listed in Appendix G.

STREAM HABITAT UNIT TYPE: Enter in code for habitat unit type as defined in Appendix F. Used only when the entire sample occurs within specified habitat type.

SITE SPECIFICS: Comment field used to specify land marks, etc. which will more clearly define location of sample site. This field is important when one sample site will be used repetitively and boundaries need to be consistent.

SAMPLE DATE: Enter in start date for survey.

INTERNATIONAL TIME: Enter in international (military) time. Example: Use 1400 hrs, not 2:00 pm.

SAMPLER LAST NAME: Enter in last name of person directing the sampling crew. May write in other names; however, only first name is entered in data base.

AGENCY: List code for primary agency conducting survey. Examples: WDW, WDF, DOE, DNR.

COMMENTS: Comment field for listing notable conditions affecting the stream or lake survey. Examples might be weather conditions, flooding, detrimental impacts, or beaver activity.

CHEMISTRY FOR STREAMS AND LAKES

METHOD: The shaded "Method" column to the right is used for inputting the specific method used to obtain data. As different methodologies provide varying degrees of accuracy, it is important to know how the data was gathered, especially when the data may be gathered and used by different divisions and agencies. Appropriate "method" codes for each chemistry parameter are listed below and also in Appendix A.

DEPTH: Up to ten spaces for depths are provided for lake surveys. Chemistry measurements for streams should be entered under "Depth 1" only. Enter depth in meters to the nearest centimeter starting from the water surface and going towards the bottom.

WATER TEMPERATURE: Expressed as Degrees Centigrade. Fill in blanks corresponding to each depth where temperature was measured.

pH:

METHODS:
1) ME – pH Meter
2) PP – pH Indicator Paper
3) HK – Hach Kit Colorimetric samples

DISSOLVED OXYGEN: Expressed as mg/liter. Fill in blanks corresponding to each depth that dissolved oxygen was measured.

METHODS:
1) ME – DO Meter
2) HK – Hach Kit
3) WT – Winkler Titration

TOTAL ALKALINITY: Measure of lake's buffering capacity to neutralize acids. Total Alkalinity is a measure of the sum of each component making up alkalinity, being hydroxides, carbonates, and bicarbonates. Total alkalinity is expressed as mg $CaCO_3$/liter.

METHODS:
1) HK – Hach Kit
2) LB – Laboratory

TDS: Total dissolved solids expressed as mg/liter.

METHODS:
1) LW – Laboratory Filter/Dry Weight Method -Greater or lesser than Salinity, depending on whether loss of bicarbonates in weight analysis is more than offset by the presence of dissolved organic carbon.
2) LS – Laboratory Summation Analyses -Summing results of separate analyses for all major ions (analogous to salinity).

CONDUCTIVITY: A measure of the ability of a solution to carry an electrical current, dependent on the total concentration of ionized substances dissolved in water. Closely linked to TDS as indicators of productivity; both measure nutrient material dissolved in water. (Stoker, D.G. et al.) Expressed in micromhos/cm.

METHODS:
1) ME – Conductivity Meter
2) LB – Laboratory

WATER CLARITY (for LAKES): The measure of light transmission through the water expressed in meters.

METHODS:
1) SD – Secchi Disk
2) MS – Measuring Stick

WATER CLARITY (for STREAMS): Water Clarity is more often known as "Turbidity" in streams. Turbidity is the expression of the optical property of the tendency of light to scatter or be absorbed rather than be transmitted in a straight line. Expressed in Jackson Turbidity Units (JTU's).

METHODS:
1) ME – Turbidimeter

NITRATE NITROGEN: Although in low concentrations, nitrogen is the most abundant inorganic form of the element found in waters. Important in plant production. Rarely exceeds 10 mg/liter in natural concentrations, and usually less than 1 mg/liter. Found to be hazardous at greater than 20 mg/liter. Recorded as mg/liter.

METHODS:
1) HK – Hach Kit
2) LB – Laboratory

PHOSPHATES: Nutrient which works with carbon and nitrogen to stimulate plant growth. Often measured in relation to excessive production and problems with eutrophication. Recorded in mg/liter.

TOTAL PHOSPHATES: To prevent development of biological nuisances and to control accelerated or cultural eutrophication, total phosphates should not exceed 50 µg/liter in any stream at the point where it enters a lake or impoundment, or 25 µg/liter within the lake or reservoir. A desired goal for prevention of plant nuisances in streams not discharging to lakes or impoundments is 100 µg/liter. (Quality Criteria for Water, U.S. Environmental Protection Agency, Washington, DC, 1976)

METHODS:
1) HK – Hach Kit
2) LB – Laboratory

ORTHO PHOSPHATES: Form of phosphorous utilized by algae and other plants.

METHODS:
1) HK – Hach Kit
2) LB – Laboratory

CHLOROPHYLL 'A': Indicator of lake productivity. Expressed as mg/liter.

METHODS:
1) HK – Hach Kit
2) LB – Laboratory

OTHER CHEMICAL MEASUREMENTS TAKEN: Comment field for additional chemical measurements taken which are not covered on the survey form.

STREAM PHYSICAL ATTRIBUTES

METHOD: The shaded "Method" column to the right is used for inputting the specific method used to obtain data. As different methodologies provide varying degrees of accuracy, it is important to know how the data was gathered, especially when the data may be gathered and used by different divisions and agencies. Appropriate "method" codes for each physical attribute are listed below and also in Appendix A.

STREAM TYPE: Stream Typing is defined by the Washington Forest Practices Board Rules and Regulations (See definitions in Appendix E). Enter stream type as 1, 2, 3, 4, 5, or U for unknown.

ELEVATION: List as meters.

GRADIENT: Specify percent gradient at sample site, to the nearest 0.1 percent.

METHODS:

1) CL – Clinometer (Suunto Optical Clinometer)-Usual method is to stand with feet placed at the water surface level, and to flag a nearby branch, etc. at eye level. By walking as far as possible up or downstream within the area under study and again standing at water level, the clinometer is sighted back to the previously flagged location. Two or three measurements are made along the reach and the average recorded. The further the distance between flagging and sighting, the greater the accuracy of measurement.
2) HL – Hand Level
3) TO – Topographical Maps
4) VJ – Best Visual Judgement as last option

SITE LENGTH: Specify sample area length in meters (to the nearest centimeter) where appropriate.

METHODS:

1) HC – Hip Chain
2) RF – Range Finder
3) ST – Surveyor's Tape
4) VJ – Best Visual Judgement as last option

AVERAGE MAXIMUM RIFFLE DEPTH: For each individual riffle area, record the maximum depth on the worksheet "Pool/Riffle/Run/Other Worksheet" (see Appendix I), and then average all maximum depths. Measured in meters to the nearest centimeter.

AVERAGE MAXIMUM POOL DEPTH: For each individual pool area, record the maximum depth on the worksheet "Pool/Riffle/Run/Other Worksheet" (see Appendix I), and then average all maximum depths. Measured in meters to the nearest centimeter.

METHODS FOR RIFFLE/POOL DEPTHS:

1) MS – Measuring Stick
2) VJ – Best Visual Judgement as last option

AVERAGE STREAM CHANNEL AND WETTED WIDTHS: Measured at right angles to direction of stream flow. Take multiple equally spaced measurements along stream sample area and record on "Stream Width and Depth Worksheet" (see Appendix I). Then average all widths and record in meters to the nearest centimeter.

Channel Width: The mean width of the channel from rooted vegetation to rooted vegetation (terrestrial). Mean annual high water level is used in the absence of vegetation.

Wetted Width: Width of the hydraulic unit at time of inventory. (de Leeun, A.D., 1981)

<u>METHODS:</u>
1) HC – Hip Chain
2) RF – Range Finder
3) ST – Surveyor's Tape
4) VJ – Best Visual Judgement as last option

SUBSTRATE: Fill in percent of area covered of each of the variables listed:

Bedrock		
Boulders	- over 256 mm	(10 in.)
Rubble (Cobble)	- 64 - 256 mm	(2.5 10 in.)
Gravel	- 2 - 64 mm	(0.08 2.5 in.)
Sand	- 0.062 - 2 mm	(< 0.08 in.)
Silt/Mud	- < 0.062 mm	
Organic/Detritus		

Substrate definitions taken from Glossary of American Fisheries Society.

<u>METHODS:</u>
1) TM – Actual Transect Measurements in percentages (Worksheet provided; see Appendix I)
2) VJ – Best Visual Judgement of area as a whole

EMBEDDEDNESS: The amount of fine sediment that is deposited in the interstices between larger stream substrate particles. Measurement represents a qualitative, visual judgement of how much of the surface area of the gravel, cobble, and boulder is surrounded or covered by sands and silts. Mostly applies to spawning areas, which are usually comprised of riffles and runs. On the form, circle one of the following:

High > 50%
Medium 25-50%
Low < 25%

COMPACTION: Represents a qualitative, personal judgement on the "looseness" of spawning substrate. Obtained by dislodging the substrate with one's foot and assessing degree of compaction. Circle either: High, Medium, or Low.

POOL/RIFFLE/RUN/OTHER RATIO: List relative abundance to the nearest 5 percent. The following definitions are taken from the American Fisheries Society's Aquatic Habitat Inventory Glossary.

Pool: A portion of the stream with reduced current velocity, often with water deeper than the surrounding areas, and which is frequently usable by fish for resting and cover.

Riffle: A shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation, but standing waves are absent.

Run: An area of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.

Other: Habitat components of a stream that do not consist of pool, riffle, or run (e.g. rapids, chutes, marsh, slough, pocket water).

METHODS:

1) AM – Actual Area Measurements. Obtained by walking length of stream sample area. For each unique habitat type, take 1 measurement for length along the longest axis, and 3 measurements across the axis to get average width. Sum up areas for each type and obtain percentage. Be careful not to miss smaller pools, etc., which would cause inaccurate ratio. "Pool/Riffle/Run/Other Ratio Worksheet" provided (see Appendix I).
2) LM – Linear Measurements-Obtained by walking length of stream breaking distance into predominant linear habitat units across channel. Linear distance is broken down proportionally and later units are added up to become ratio. Sum of all units measurements = linear distance.
3) VJ – Best Visual Judgement.

INSTREAM COVER: Material which provides fish protection from predation or adverse stream flow conditions. Hiding areas should be large enough to conceal body of primary fish of concern.

Large Organic Debris (LOD): Any large piece of relatively stable woody material (debris piles, stumps, root wads, and fallen trees) having a minimum diameter greater than 10 centimeters (4") and a length greater then 2 meters (6 ft) that intrudes into or lies within the stream.

Boulders: Stream substrate particles > 256 mm (10") in diameter that block stream flow to provide surface turbulence, shade and escape from higher velocity and predation.

Instream Vegetation: Aquatic vegetation which provide protection for fish.

Overstream Vegetation: Any vegetation that projects over the stream that is less than 1 meter above the water surface.

Cutbank: Cover consisting of a stream bank with its base cut away and overhanging part of the stream.

Pools: Deep pools or pool pockets that provide adequate protection for fish. May be formed by debris or boulders.

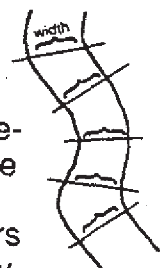
METHODS:
1) AM – Actual Area Measurements. Worksheet for "Substrate" is provided (see Appendix I).
2) VJ – Best Visual Judgement of area as a whole.

RECORDING PROCEDURES:
1) Record the percent of Total Instream Cover within the wetted stream area to the nearest 10%.
2) Then record the percent of each cover component which make up the Total Instream Cover (i.e. LOD, boulders, instream vegetation, overstream vegetation, cutbanks, and pools) to the nearest 10%. The sum of cover components must equal 100% (or greater than 100% if components overlap each other).
3) Record the appropriate method code.

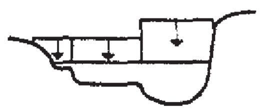
INSTREAM FLOWS/DISCHARGE: Expressed as cubic meters per second to the nearest hundredth.

METHODS:
1) AV – Average Stream Discharge - When average stream velocity (m/sec) is measured along or parallel to the stream thalweg with a wood chip, the following formula can be used to determine discharge:

Avg Wetted Width x Avg Depth x Avg Velocity x Bottom Coef. = Discharge



Wetted Width is measured at right angles to the direction of flow. Transects should be set up at equally spaced intervals along the stream sample area. Measurements for wetted width are then taken at each transect. The number of measurements needed depends on variability of the stream width. If the transect crosses an island, only include the distance covered by water in the measurement. The width is measured in meters to the nearest centimeter. (A worksheet is provided for simplifying stream width measurements.)



Average water depth is measured by taking 3 or more measurements across the channel (or transect). The measurements should either be equally spaced or weighted according to varying contours of the stream channel. Depth is measured in meters to the nearest centimeter. (A worksheet is provided for simplifying stream depth measurements.)

When using a woodchip to determine velocity, take an average of 3 or 4 measurements along the thalweg of stream. In wider streams, average velocities from several different points across the stream channel can be taken.

When dye is used, use the above formula omitting the bottom coefficient.

When using a flow meter, if depth is no greater than 1 meter, the velocity should be measured at 40% of the water column from the bottom (Example: If depth is 1 meter, measure velocity at 4/10 meter from the bottom). If depth is greater than 1 meter, take average of velocities taken at 20% and 80% of the water column. The bottom coefficient is not necessary when using a flow meter, as variation of velocity along the water column is already accounted for.

The "Bottom Coefficient" is the correction factor for compensating variation of velocity within the water column when calculating discharge from surface-only measurements. The correction factor considers roughness of water flow over the substrate. Surface-only measurements include wood chips, etc. Dyes mix with water column, thus naturally accounting for variation in velocity. Flow meters compensate for variation in velocity by taking measurements at the appropriate location(s) in the water column. Bottom coefficients are listed below:

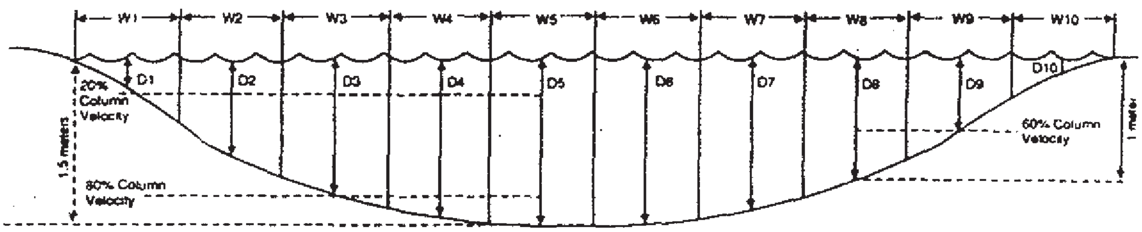
.7 = Very turbulent-large boulders and rubble
.8 = Rough-mostly bedrock, boulders and rubble
.9 = Smooth-mostly gravel, sand and mud

The worksheet "Determining Discharge" provides a simple guide for calculating average stream discharge.

2) CS – Cellular Summation - Preferable method is to split transect into cells and measure depths, widths, and velocity for each cell. The velocity (m/sec) for each cell is best measured with a flow meter. (A worksheet "Determining Discharge" is provided.) When using the "cellular summation" method, the following formula is used for each cell:

Wetted Width x Depth x Velocity (x Bottom Coef.) = Discharge

A bottom coefficient is factored into the equation if a surface-only (wood chip) measure of velocity is taken. (See definition of "bottom coefficient" above under the Average Stream Discharge method.) Surface-only measurements, however, can be more difficult to use in this method depending upon how independent flows are between cells.



When dividing the transect into cells, one should use breaks in hydraulic conformity, such as changes in habitat units from a riffle to a run within a transect, or notable changes in depth, etc.

Wetted widths for each cell are measured in meters to the nearest centimeter.

Depths are measured for each cell. Measurements are taken in meters to the nearest centimeter.

Velocity for each cell is best measured with the use of a flow meter. If depth is no greater than 1 meter, the velocity should be measured at 40% of the water column from the bottom (Example: If depth is 1 meter, measure velocity at 4/10 meter from the bottom). If depth is greater than 1 meter, take average of velocities taken at 20% and 80% of the water column.

After discharge is calculated for each cell, the sum of all cells equals total discharge. The provided worksheet "Determining Discharge" simplifies use of this method.

3) WE – Weir

4) SG – Staff Gage - Sampler should check to see if gage information already exists on stream. USGS can be phoned for records pertaining to the appropriate day; or the staff gage can be read in the field, and USGS can later be called for the rating table conversion.

5) VJ – Best Visual Judgement as last option.

LAKE PHYSICAL ATTRIBUTES

SITE MAXIMUM DEPTH: Specify the survey site maximum depth in meters (to the nearest centimeter, if appropriate).

LITTORAL OR LIMNETIC: Check either littoral or limnetic to specify which zone the survey site lies within.

Littoral: Shallow water region with light penetration to the bottom, typically occupied by rooted plants in natural ponds and lakes.

Limnetic: Open water zone to the depth of effective light penetration. (Odum, 1971)

AQUATIC VEGETATION COVER: List percentage of lake area taken up by submergent, emergent, and floating vegetation.

METHODS:
1) TM – Line Transect
2) AP – Aerial Photographs
3) VJ – Best Visual Judgement

BOTH STREAM AND LAKE PHYSICAL ATTRIBUTES

WATER COLOR: Measurement of water quality, condition, or type. Circle appropriate water color. If "Other" is specified, use comment field to state color.

PERCENT RIPARIAN VEGETATION: Specify the percent of Riparian cover over both banks of the survey site for deciduous, coniferous, shrubs, and grasses. The area included should be from water's edge to 33 meters (100 ft.) inland.

BIOLOGICAL DATA

SURVEY TYPE: List one of the following codes to specify type of sampling conducted:

DN	=	Dip Net	MT	=	Minnow Trap
EB	=	Electrofish (boat)	PO	=	Poison
EF	=	Electrofish (backpack)	SN	=	Seine Net
FK	=	Fish Kill	SK	=	Snorkel
GN	=	Gill Net	TL	=	Trawl Net
HO	=	Hook and Line	WE	=	Weir/Trap
TP	=	Trap Net	RA	=	Radiotelemetry

ELECTRICAL INFORMATION: Show electroshocker readings for volts, frequency (pulses/sec) and elapsed time (hours:minutes) for each pass.

NET INFORMATION:

<u>Mesh Size:</u> For each net used, stretch mesh size should be recorded; do not measure as square mesh. If mesh is experimental (variable in mesh size) record with 'E'.

<u>Elapsed Time:</u> Record elapsed time in hours and minutes.

<u>Set Location:</u> Specify set location as:

SH	–	Shore
SU	–	Surface
BO	–	Bottom
MI	–	Midwater

<u>Depth Range:</u> Record range of depths in which net was set. Depth is recorded in meters with a maximum of 99 meters.

<u>Pass/Net #:</u> Record pass number or net number.

FISH SAMPLE NUMBER: Used for relating individual fish sampled with extraneous data gathered such as scales, otoliths, stomach content analysis, recovery of coded wire data, etc. It is not necessary to number every fish measured.

SPECIES CODE: See Appendix B for list of species codes.

LENGTH: Record individual fish length to the nearest 0.1 centimeter. In column to the right of length measurement, indicate which measurement type (F/T/S) was used. If all measurements are of the same type, an arrow can be drawn down from the first. It is VERY important that measurement type be indicated. Definitions listed below as stated by Wydoski and Whitney (1979).

F	=	Fork Length - distance from most anterior point of fish to the middle fork of caudal fin.
T	=	Total Length- straight line distance from the most anterior point of fish to the tip of the caudal fin when the fin lobes, if any, are compressed.
S	=	Standard Length- distance from the most anterior point of fish to the end of the hypural plate at the base of caudal fin. Hypural plate is located at fold formed by bending caudal fin at its base. Used only on fish having homocereal caudal fin (symmetrical lobes).

WEIGHT: Record weight of individual fish to the nearest gram.

BATCH SAMPLES

When recording batch samples such as young-of-the-year, or when recording fish broken down into categories during snorkel surveys, record data using applicable batch sample columns (i.e. Species, Sample Total, Length Group, Weight, Age Category, Sex).

Number of Fish: Record number of fish in batch category.

Length Range: Record size range category of batch sample to the nearest centimeter (minimum and maximum sizes).

Batch Weight: Record weight of batch sample (used mostly with Young-of-the-Year batch samples) to the nearest gram.

ORIGIN: Origin of fish. Record appropriate code.

W	=	Wild
FØ-3	=	Hatchery Fry Origin
LØ-3	=	Hatchery Legal Origin
FC	=	Hatchery Fry Origin Carryover (age 2+)
LC	=	Hatchery Legal Origin Carryover (year after stocking)

SEX: Expressed as "M", "F", "S" (for Sterile), or "U" (for Unknown).

MATURITY: Record appropriate code as listed below:

M	=	Mature
R	=	Ripe
S	=	Spent
I	=	Immature
U	=	Unknown

TAG: Record code when appropriate.

FA	=	Floy Anchor T-Bar	CW	=	Bergman Coded Wire
FF	=	Floy Fingerling	R2-7	=	Replicated Coded Wire
FC	=	Floy Cinch	PD	=	Peterson Disk
FS	=	Floy Spagetti	PT	=	Pit Tag
JT	=	Jaw Tag	DY	=	Dye Spray
ST	=	Strap Tag	VI	=	Visible Implant
RA	=	Radiotelemetry	FP	=	Fluorescent Polymer

MARKS: Record up to two codes where appropriate under M1 and M2.

AD	=	Adipose Fin	RP	=	Right Pectoral Fin
LV	=	Left Ventral Fin	LM	=	Left Maxillary
RV	=	Right Ventral Fin	RM	=	Right Maxillary
LP	=	Left Pectoral	BR	=	Brand

MARK CODE: Record one of the following "Mark Codes" where applicable:

M	=	Applied Tag
R	=	Recaptured Tag

AGE: Record freshwater years in the first blank. After the decimal, the number of saltwater years and position of Spawning Checks are recorded. 'S' is used to designate a Spawning Check. '+' is used to denote Winter run steelhead.

AGING METHOD: Record appropriate code as listed below:

O	=	Otolith	L	=	Length Frequency
S	=	Scales	P	=	Spines
T	=	Tag	V	=	Vertebrae

COMMENT CODES: See Appendix C for list of possible comment codes. Up to three comment codes can be entered. If necessary comment code does not exist on the list, contact database administrator to add code.

REFERENCES AND OTHER SOURCES OF INFORMATION

Variables and ideas for the Stream Survey Form were primarily taken from a compilation of all previous forms used by the Fish Management Division, Department of Wildlife. Key staff from WDW Fish Management and Habitat Divisions: WDF Habitat Division; Timber Fish and Wildlife, Department of Ecology, Department of Natural Resources and others were consulted.

Many ideas were taken from the Stream Survey Form and Guidelines used by the Ministry of Environment, Recreational Fisheries Branch, "Stream Information Summary System", Victoria, BC.

American Fisheries Society, Western Division, 1981. Acquisition and Utilization of Aquatic Habitat Inventory Information, Proceedings of a Symposium held 28-30 October 1981 in Portland, OR.

American Fisheries Society, Western Division, 1985. Aquatic Habitat Inventory, Glossary and Standard Methods, Habitat Inventory Committee.

Binns, N. Allen. 1982. Habitat Quality Index Procedures Manual, Wyoming Game and Fish Department.

Bisson, P. A., J. L. Nielsen, R. A. Palmason, and L. E. Grove. A System of Naming Habitat Types in Small Streams with Examples of Habitat Utilization by Salmonids During Low Stream Flow. A paper presented at the Symposium on Acquisition and Utilization of Aquatic Habitat Inventory Information, Portland, Oregon 1981.

Colorado State University, 1984. Methods to Estimate Aquatic Habitat Variables, Colorado Cooperative Fishery Research Unit.

de Leeun A.D. 1981. A British Columbia Stream Habitat and Fish Population Inventory System, paper rpesented at the Symposium on Acquisition and Utilization of Aquatic Habitat Inventory Information, Portland OR.

Lind, O. T. 1979. Handbook of Common Methods in Limnology. Published by The C. V. Mosby Company.

Odum, E.P. 1971. Fundamentals of Ecology. Third Edition, W.B. Saunders Co.

Stoker, D.G., M. Agsteribbe, N.R. Windsor, and W.A. Andrews, 1972. A Guide to the Study of Freshwater Ecology. Prentice Hall, Inc., Englewood Cliffs, N.J. Edited by W.A. Andrews.

U.S. Environmental Protection Agency, 1976. Quality Criteria for Water, Washington, DC.

Washington Department of Wildlife, 1988. Field Procedures Handbook; Timber, Fish and Wildlife Program; Characterization of Riparian Management Zones and Upland Management Areas with Respect to Wildlife Habitat.

Washington Forest Practices Rules and Regulations. 1992. Washington State Forest Practices Board.

Wydoski, R.S. and R.R. Whitney, 1979. Inland Fishes of Washington, University of Washington Press.

For more information, contact:

Terry Jackson
Fisheries Management Division
Washington Department of Wildlife
600 Capitol Way North, Olympia, WA
98501-1091 (206/586-9025)

APPENDIX A

METHODOLOGY CODES FOR STREAM AND LAKE SURVEYS

CHEMISTRY

pH	
pH Meter	ME
pH Indicator Paper	PP
Hach Kit	HK
Dissolved Oxygen	
DO Meter	ME
Hach Kit	HK
Winkler Titration	WT
Total Alkalinity	
Hach Kit	HK
Laboratory	LB
TDS	
Lab-Filter/Dry Weight	LW
Lab-Summation	LS
Conductivity	
Conductivity Meter	ME
Laboratory	LB
Water Clarity	
Turbidity Meter	ME
Secchi Disk	SD
Measuring Stick	MS
Nitrate Nitrogen	
Hach Kit	HK
Laboratory	LB
Total Phosphates	
Hach Kit	HK
Laboratory	LB
Orthophosphates	
Hach Kit	HK
Laboratory	LB
Chlorophyll 'A'	
Hach Kit	HK
Laboratory	LB

PHYSICAL PARAMETERS

Gradient	
Clinometer	CL
Hand Level	HL
Topographic Maps	TO
Best Visual Judgement	VJ
Site Length	
Hip Chain	HC
Rabge Finder	RF
Surveyor's Tape	ST
Best Visual Judgement	VJ
Avg Max Riffle/Pool Depth	
Measuring Stick	MS
Best Visual Judgement	VJ
Avg Channel/Wetted Width	
Hip Chain	HC
Range Finder	RF
Surveyor's Tape	ST
Best Visual Judgement	VJ
Substrate	
Transect Measurement	TM
Best Visual Judgement	VJ
Pool/Riffle/Run/Other Ratio	
Area Measurements	AM
Linear Measurements	LM
Best Visual Judgements	VJ
Instream Cover	
Area Measurements	AM
Best Visual Judgement	VJ
Flow/Discharge	
Average Stream Flow (chip/dye)	AV
Cellular Summation (meter)	CS
Weir	WE
Staff Gage	SG
Best Visual Judgement	VJ
Aquatic Vegetation Cover	
Line Transect	TM
Aerial Photo	AP
Best Visual Judgement	VJ

APPENDIX B

FISH SPECIES CODES

GAME FISH SPECIES

Bass, Largemouth	LMB
Bass, Rock	RKB
Bass, Smallmouth	SMB
Bass, Striped	SB
Bluegill	BG
Bullhead (General)	BH
Bullhead, Yellow	YBH
Bullhead, Brown	BBH
Bullhead, Black	BLB
Burbot	BUR
Carp	CP
Catfish, Blue	BCF
Catfish, Channel	CC
Catfish, Flathead	FCF
Char, Arctic	AC
Crappie (General)	C
Crappie, Black	BC
Crappie, White	WC
Eulachon	EUL
Flounder, Starry	SF
Grayling, Arctic	AG
Musky, Tiger	TMK
Peamouth	PMO
Perch, Shiner	SP
Perch, Yellow	YP
Pike, Northern	NP
Pumpkinseed	PS
Salmon, Atlantic	AT
Salmon, Chinook	CK
Salmon, Summer Chinook	CKS
Salmon, Chum	CH
Salmon, Coho	CO
Salmon, Kokanee	K
Salmon, Pacific Unknown	SA
Salmon, Pink	PK
Salmon, Sockeye	SO
Shad, American	AMS
Smelt, Longfin	LFS
Squawfish, Northern	NSF
Steelhead, Summer-Run	SS
Steelhead, Winter-Run	SW
Steelhead, Unknown race	SH
Sturgeon, Green	GRS
Sturgeon White	WS
Sucker (General)	SK
Sucker, Bridgelip	BRS
Sucker, Largescale	LRS
Sucker, Longnose	LNS
Sucker, Mountain	MNS
Sunfish (General)	S
Sunfish, Green	GS
Trout, Brown	BT
Trout, Cutthroat General Unknown	CT
Trout, Cutthroat Coastal Resident	CCT
Trout, Cutthroat Coastal Searun	SCT
Trout, Cutthroat Lahontan	LCT
Trout, Cutthroat West Slope	WCT
Trout, Dolly Varden/Bull Unknown	DB
Trout, Bull (Char)	BLC
Trout, Dolly Varden (Char)	DVC
Trout, Eastern Brook	EB
Trout, Golden	GT
Trout, Lake	LT
Trout, Rainbow Resident	RB
Trout, Rainbow Unknown race	RU
Trout, Unknown	TR
Walleye	WAL
Warmouth	WM
White Amur-diploid	WAD
White Amur-triploid	WAT
Whitefish, Lake	LW
Whitefish, Mountain	WF

NONGAME FISH SPECIES

Chiselmouth	CMO
Chub, Lake	LCH
Chub, Tui	TCH
Dace, General	DAC
Dace, Leopard	LED
Dace, Longnose	LND
Dace, Speckled	SD
Goldfish	GF
Lamprey (General)	LM
Lamprey, Pacific	PL
Lamprey, River	RL
Lamprey, Western Brook	WL
Mosquitofish	MQF
Mudminnow, Olympic	OMM
Pickerel, Grass	P
Sandroller	SAN
Sculpin (General)	COT
Sculpin, Coastrange	CSS
Sculpin, Margined	MRS
Sculpin, Mottled	MTS
Sculpin, Pacific Staghorn	PSS
Sculpin, Piute	PTS
Sculpin, Prickly	PRS
Sculpin, Reticulate	RTS
Sculpin, Riffle	RFS
Sculpin, Shorthead	SHS
Sculpin, Slimy	SLS
Sculpin, Torrent	TRS
Shiner, Redside	RS
Stickleback, Three-Spine	TSS
Tadpole Madtom	TMT
Tench	TNC
Whitefish, Pygmy	PGW

APPENDIX C

COMMENT CODES

CODE	EXPLANATION
1	Eye Fluke
2	Stomach Contents Taken
3	Morphological Abnormality
4	Growth Stunted
5	External Parasites
6	Gillnet Scars
7	Mammal Predation Scars
8	Unreadable Tag
9	Lost Tag
10	Tag Wound
11	White Flesh
12	Pink Flesh
13	Fungus
14	Regenerated Scales
15	Poor Condition
16	Hooking Scars
17	Mortality
18	Eroded Gills/Operculum
19	Fins Eroded
20	Electroshock Bruising
21	Electroshock Broken Spine
22	Species Questionable
23	GSI Taken
24	Scale Unreadable

APPENDIX D

MISCELLANEOUS CODES USED IN STREAM AND LAKE SURVEY FORMS

Survey Type

Dip Net	DN	Minnow Trap	MT
Electrofish (boat)	EB	Poison	PO
Electrofish (backpack)	EF	Radiotelemetry	RA
Fish Kill	FK	Seine Net	SN
Gill Net	GN	Snorkel	SK
Hook and Line	HO	Trawl Net	TL
Trap Net	TP	Weir/Trap	WE

Length Measurement Type

Fork Length	F
Total Length	T
Standard Length	S

Origin

Wild	W
Hatchery Fry Origin	FØ-3
Hatchery Legal Origin	LØ-3
Hatchery Fry Carryover	FC
Hatchery Legal Carryover	LC

Maturity

Mature	M	Immature	I
Ripe	R	Unknown	U
Spent	S		

Tags

Floy Anchor T-bar	FA	Bergman Coded Wire	CW
Floy Fingerling	FF	Replicated Coded Wire	R2-7
Floy Cinch	FC	Peterson Disk	PD
Floy Spaghetti	FS	Pit Tag	PT
Jaw Tag	JT	Dye Spray	DY
Strap Tag	ST	Visible Implant	VI
Radiotelemetry	RA	Fluorescent Polymer	FP

Marks

Adipose Fin	AD	Right Pectoral Fin	RP
Left Ventral Fin	LV	Left Maxillary	LM
Right Ventral Fin	RV	Right Maxillary	RM
Left Pectoral Fin	LP	Brand	BR

Mark Code

Applied Tag	M
Recaptured Tag	R

Aging Method

Otolith	O	Length Frequency	L
Scale	S	Spines	P
Tag	T	Vertebrae	V

APPENDIX E

WATER TYPING CRITERIA

(Forest Practices Board Rules and Regulations, 1992)

WATER TYPE	1	2	3	4	5
CHANNEL WIDTH	N/A	20 ft or greater between ordinary high water marks (OHWM)	Anadromous Fish: 5 ft or wider between OHWM. Resident Game Fish: 10 ft or wider between OHWM.	2 ft or wider between OHWM.	Less than 2 ft between OHWM.
GRADIENT	N/A	Less than 4%	Anadromous Fish: Less than 12%. Not upstream of a falls greater than 10 ft high. Resident Game Fish: Less than 12%.	N/A	N/A
FLOW	N/A	N/A	Anadromous Fish: N/A. Resident Game Fish: Greater than 0.3 CFS at summer low flow.	N/A	N/A
IMPOUNDMENT	N/A	Water surface area of 1 acre more or less at seasonal low flow.	Anadromous Fish: Surface area less than 1 acre at seasonal low flow. Resident Game Fish: Surface area less than 0.5 acres at seasonal low flow.	N/A	N/A
FISHERIES	N/A	Used by substantial numbers of anadromous or resident game fish for spawning, rearing and migration or wall-based channels to a system bearing salmonids and accessible during some period of the year; with drainage less than a 5% gradient.	Used by significent numbers of anadromous or resident game fish for spawning, rearing, or migration.	Not used by significant numbers of game fish.	Not used by significant numbers of game fish.

APPENDIX E CONTINUED

WATER TYPING CRITERIA

(Forest Practices Board Rules and Regulations, 1992)

WATER TYPE	1	2	3	4	5
DIVERSION	N/A	Domestic use for 100 or more residences or campsites, accommodation facilities for 100 or more persons. Includes *upstream reach of* 1500 ft or until the drainage area is <50%, whichever is less.	Domestic use for 10 or more residences or camping units, or accommodation facilities for 10 or more persons. *Includes upstream reach* of 1500 ft or until the drainage area is <50%, whichever is less.	N/A	N/A
OTHER	All waters within their ordinary high water mark inventoried as "shorelines of the state" excluding related wetlands.	Streams flowing through campgrounds available to the public having 30 campsites or more.	Contributes >20% of the flow to a Type 1 or 2 water. Anadromous fish impoundments have outlet to stream with anadromous fish.	Significance lies in their influence on water quality downstream in Type 1, 2, and 3 waters. These may be perennial or intermittent.	All natural waters not classified as Type 1, 2, 3, or 4, or seepage areas, including streams with or without well-defined channels, ponds, natural sinks, and having short runoff periods.

APPENDIX F

HABITAT TYPE DEFINITIONS

(Bisson, P.A. et al, 1981)

RIFFLES

LG	Low Gradient	Depth: <20 cm (shallow) Current: 20-50 cm/sec (moderate) Gradient: 1-4% Substrate: gravel, pepple, cobbles
RP	Rapids	Current: >50 cm/sec (swift) Gradient: >4% Substrate: coarser; boulders
CS	Cascades	waterfalls and shallow pools Gradient: steepest Substrate: bedrock and boulders

POOLS

SC	Secondary Channel	Remaining within bankful margins after freshets; usually associated with gravel bars; usually contain sand and silt substrates; low current velocities.
BP	Backwater	Along channel margins and caused by eddies behind large obstructions such as rootwads or boulders; often quite shallow and dominated by finegrained substrates; low current velocities.
TP	Trench	Long, generally deep slots in a stable substrate; channel cross sections typically U-shaped with coarse-grained bottom flanked by bedrock walls; most swift current velocities with uniform direction of flow.
PP	Plunge	Located where stream passes over complete or nearly complete channel obstruction and drops vertically into streambed below, scouring out depression; often large, quite deep, and possess complex flow pattern; substrate size highly variable.

APPENDIX F CONTINIUED

HABITAT TYPE DEFINITIONS

(Bisson, P.A. et al, 1981)

LS	Lateral Scour	Flow directed to one side of stream by a partial channel obstruction; often associated with undercut bank.
DP	Dammed	Water impounded upstream from a com plete or nearly complete channel blockage (debris jams, rock landslides, beaver dams); low velocity and substrates of smaller gravels and sand.

GLIDES/RUNS

RN	Glides/Runs	Moderately shallow water with even flow lacking pronounced turbulence; usually found in long, low gradient stream reaches with stable banks; typically gravel and cobbles.

APPENDIX G

PHYSIOGRAPHIC PROVINCE CODES

GAP PROVINCES		WDW PROVINCES	
Olympics Southwest WA	OLY SWW	OP	Olympic Penninsula
North Puget South Puget	NPT SPT	PT	Puget Trough
Northwest Cascades Southwest Cascades	NWC SWC	WC	West Cascades
Northeast Cascades Wenatchees Southeast Cascades	NEC WEN SEC	EC	East Cascades
Okanogan Republic Kootney Arc	OKA REP KOA	OH	Okanogan
Yakima Channelled Scablands Palouse	YAK CSL PAL	CB	Columbia Basin
Blue Mountains	BLU	BL	Blue Mountains

APPENDIX H

CONVERSION TABLE

Multiply	By	To Get
Acres	0.4047	Hectares
Cubic Feet	28.3206	Liter
Cubic Feet/Sec	0.02832	Cubic Meters/Sec
Cubic Inches	16.39	Cubic Centimeters
Liters	1000.0	Cubic Meters
Degrees Fahrenheit	5/9 (Deg F-32)	Degrees Centigrade
Feet	30.48	Centimeters
Feet	0.348	Meters
Feet	0.0003480	Kilometers
Gallons (U.S.)	3.7854118	Liters
Gallons (Imperial)	4.546090	Liters
Grains	0.0648	Grams
Grains	0.000648	Milligrams
Inches	25.4	Millimeters
Inches	2.54	Centimeters
Inches	0.0245	Meters
Miles	1.609	Kilometers
Ounces	28.35	Grams
Parts/Million	1.0	Milligrams/Liter
Pounds	453.6	Grams
Pounds	0.4536	Kilograms
Square Centimeters	0.0001	Square Meters
Square Feet	929.0	Square Centimeters
Square Feet	0.0929	Square Meters
Square Miles	2.59	Square Kilometers
Square Miles	2.590×10^{6}	Square Meters
Square Yards	0.8361	Square Meters
Yards	91.49	Centimeters
Yards	9.144×10^{-4}	Kilometers
Yards	0.9144	Meters

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their developement is in the best interest of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-284 December 1996