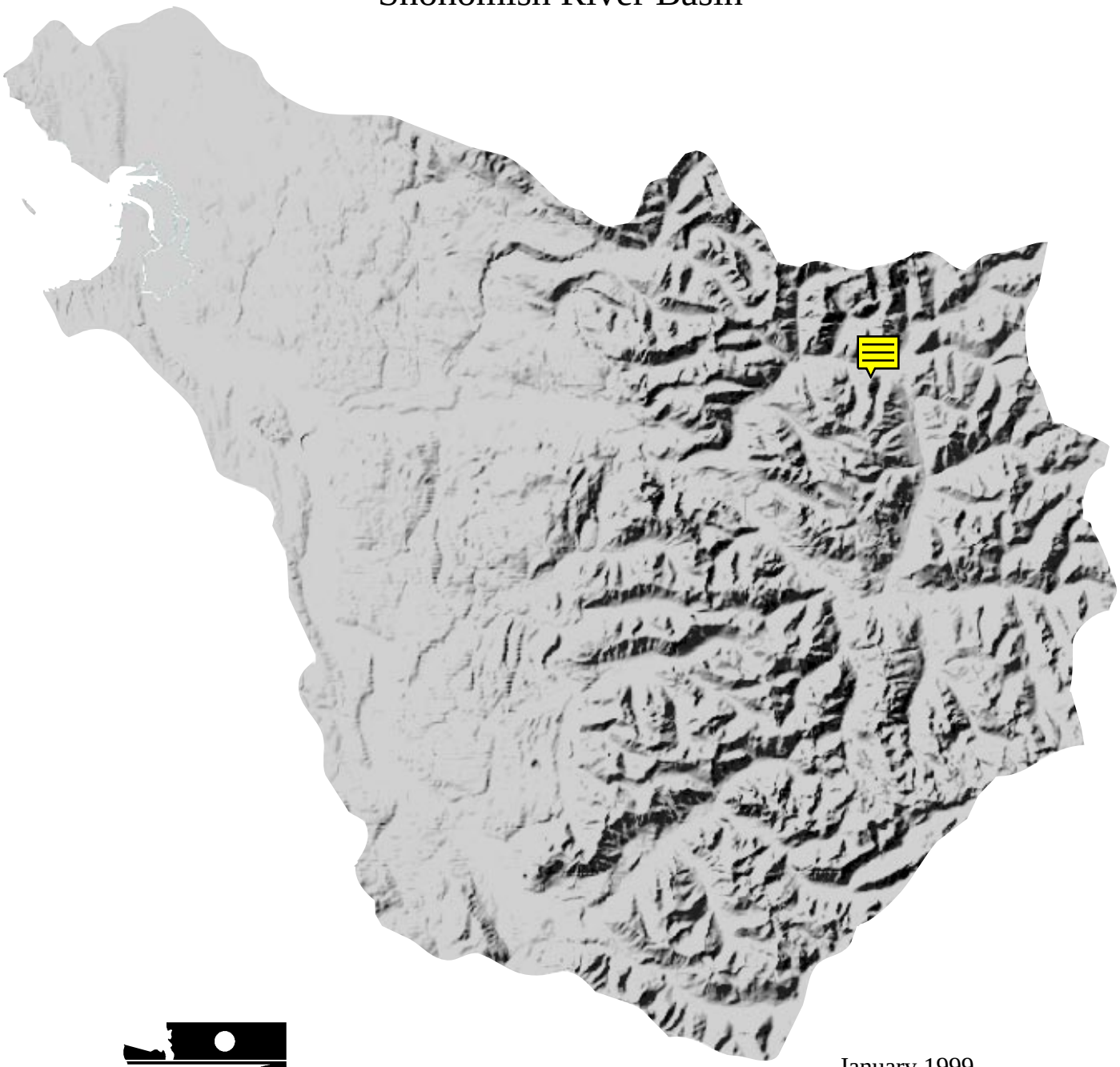
Pacific Northwest Salmon Habitat Indicators

Pilot Project

Snohomish River Basin



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Pacific Northwest Salmon Habitat Indicators

Pilot Project
Snohomish River Basin

by
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Abstract

Representatives from Northwest environmental management agencies recommended 15 salmon habitat indicators be used to evaluate Northwest streams. The Washington State Department of Ecology tested these indicators during a three-month study using existing data from the Snohomish River Basin near Seattle. The results of this study show that many of the indicators can be useful tools in evaluating Northwest streams. However, there were a number of challenges which prevented or hindered the analyses. These challenges included data availability, documentation, and formats. Recommendations for data standards are provided to promote information sharing among groups monitoring salmon habitat.

Acknowledgments

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- Mike Woodall, Joy Denkers, John Tooley, Dan Saul, and Carlie Reese of the Ecology Geographic Information System (GIS) Technical Services Group for their assistance in using GIS to show indicator results.

- Greg Pelletier of the Ecology Environmental Assessment Program for his help in obtaining and evaluating USGS flow records.

- Kathy Thornburg of Snohomish County, Kurt Nelson of Tulalip Tribe, and Catie Mains of the Washington Department of Fish and Wildlife for their efforts in obtaining data from previous water quality studies.

- Will Kendra, Lynn Singleton, Joy Denkers, and Glenn Merritt of Ecology for reviewing this study and providing valuable comments and suggestions.

- Randy McIntosh and the Northwest Indian Fisheries Commission for providing access to the Salmon and Steelhead Habitat Inventory Assessment Project (SSHIAP) database.

- Lynn Singleton and the Ecology Information Integration Project for providing funding to assist with development of the indicators.

- Shirley Rollins for formatting the final report.

Introduction

The purpose of this project was to test a short list of regional salmon habitat indicators using existing data from a pilot watershed located in Washington State. The Snohomish River basin was selected for this project because, when compared to other river systems, it had considerable data collected by local, state, tribal, and federal agencies.

The regional salmon habitat indicators were identified and developed by a work group consisting of representatives from seven Northwest environmental management agencies:

- Alaska Department of Environmental Conservation;
- British Columbia Ministry of Environment, Lands and Parks;
- Environment Canada, Pacific and Yukon Region;
- Idaho Division of Environmental Quality;
- Oregon Department of Environmental Quality;
- Washington Department of Ecology (Ecology); and
- U. S. Environmental Protection Agency, Region 10 (PNWEIWG, 1998).

The work group originally identified 113 candidate salmon habitat indicators for Northwest rivers, which were then pared down to "a small, but powerful" set of 15 indicators for the region. The 15 indicators were placed into the following five functional categories:

Fish Abundance	Water Quantity	Water Quality
1.1 Salmonids	2.1 Instream Flow	3.1 Temperature
	2.2 Flow Hydrology	3.2 Biological Water Quality Index
		3.3 Chemical Water Quality Index

Land Use/Land Cover	Physical Habitat
4.1 Land Use Conversion	5.1.1 Impediments and Accessibility to Salmon Habitat
4.2 Transportation Impacts	5.2.1 Large Woody Debris
4.3 Impervious Surface	5.2.2 Stream Depth
	5.3.1 Sediment
	5.3.2 Spawning Area
	5.4.1 Habitat Type Associated with Water

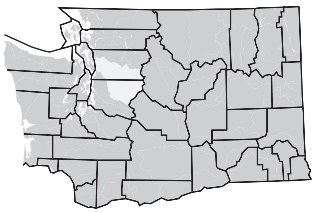
Methods

Several federal, state, local and tribal sources of indicator data were identified. The most significant source of indicator data was the Ecology GIS spatial database, which contained land use/land cover, transportation, hydrography, and salmon spawner information from several state and federal agencies. Other significant data sources included the United States Geological Survey (USGS) stream flow database, the Ecology Ambient Monitoring Section database on streams, the Ecology Watershed Assessment Section water quality studies, Snohomish County water quality studies, Tulalip Tribe water quality studies, and Washington Department of Fish and Wildlife (WDFW) ambient water temperature data. Some indicator data were also available from the Northwest Indian Fisheries Commission – Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP).

Collected data were analyzed to determine their potential usefulness in addressing a specific indicator or a combination of indicators. This analysis included an evaluation of where and when the data were collected, the types of data collection and characterization methods, and whether the data were available in an electronic form for analysis. The analysis also included the development of figures, tables, and maps generated from GIS software.

Snohomish Watershed WRIA #7

Geographic Location Map



Representational Feature Source:

Hydrology: 1:100,000 WDFW (WARIS)
Watershed Boundaries: 1:24,000 Ecology (BASINS)
Transportation: 1:100,000 WOFM (TIGER)

/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/BASE-MAP

Results and Discussion

This section provides a brief description of the information available on each indicator, followed by either a figure showing the indicator on a basin map, or by tables or graphs showing indicator data. In some cases indicators could not be developed due to data availability or data comparability issues. At the end of this section, several indicators are combined on basin maps to explore potential relationships among them.

Fish Abundance

1.1 Salmonids

change in # of fish by life stage, by species

The Salmon and Steelhead Stock Inventory (SASSI) database maintained by the Washington Department of Fish and Wildlife (WDFW) was identified as the most useful information source for characterizing this indicator. The focus of the database is to characterize naturally spawning anadromous salmon stock trends (chinook, chum, coho, pink, sockeye, and steelhead). The SASSI data were last summarized into a statewide report in 1993 (WDF *et al.*, 1993).

The SASSI spawner distribution GIS coverage for all chinook stocks was depicted on the Snohomish River Basin map (facing page). The data includes critical/depressed, healthy, and unknown stock status categories. The indicator depicts the potential range for naturally spawning chinook salmon stocks in the Snohomish River Basin and also shows areas within the range where the chinook stocks are in trouble. This analyses has the potential to characterize trends in the status of salmon stocks in the basin when compared to future SASSI statewide reports.

Snohomish Watershed WRIA #7

SASSI Spawner distribution
Chinook Stock Status

- Critical/Depressed
- Healthy
- Unknown
- Streams
- County

Scale 1:520,000

Miles

0 4 8

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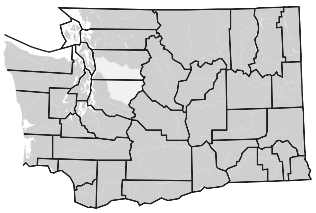


Representational Feature Source:

Hydrology: 1:100,000 WDFW (WARIS)
Watershed Boundaries: 1:24,000 Ecology (BASINS)
Salmon And Steelhead Stock Inventory 1:250k WDFW (SASSI)

/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/CHIN_SASSI-BW

Water Quantity

2.1 Instream Flow

% of stream miles with instream flow meeting instream water rights, seasonal flow requirements for salmonids, and/or sufficient to allow salmon access

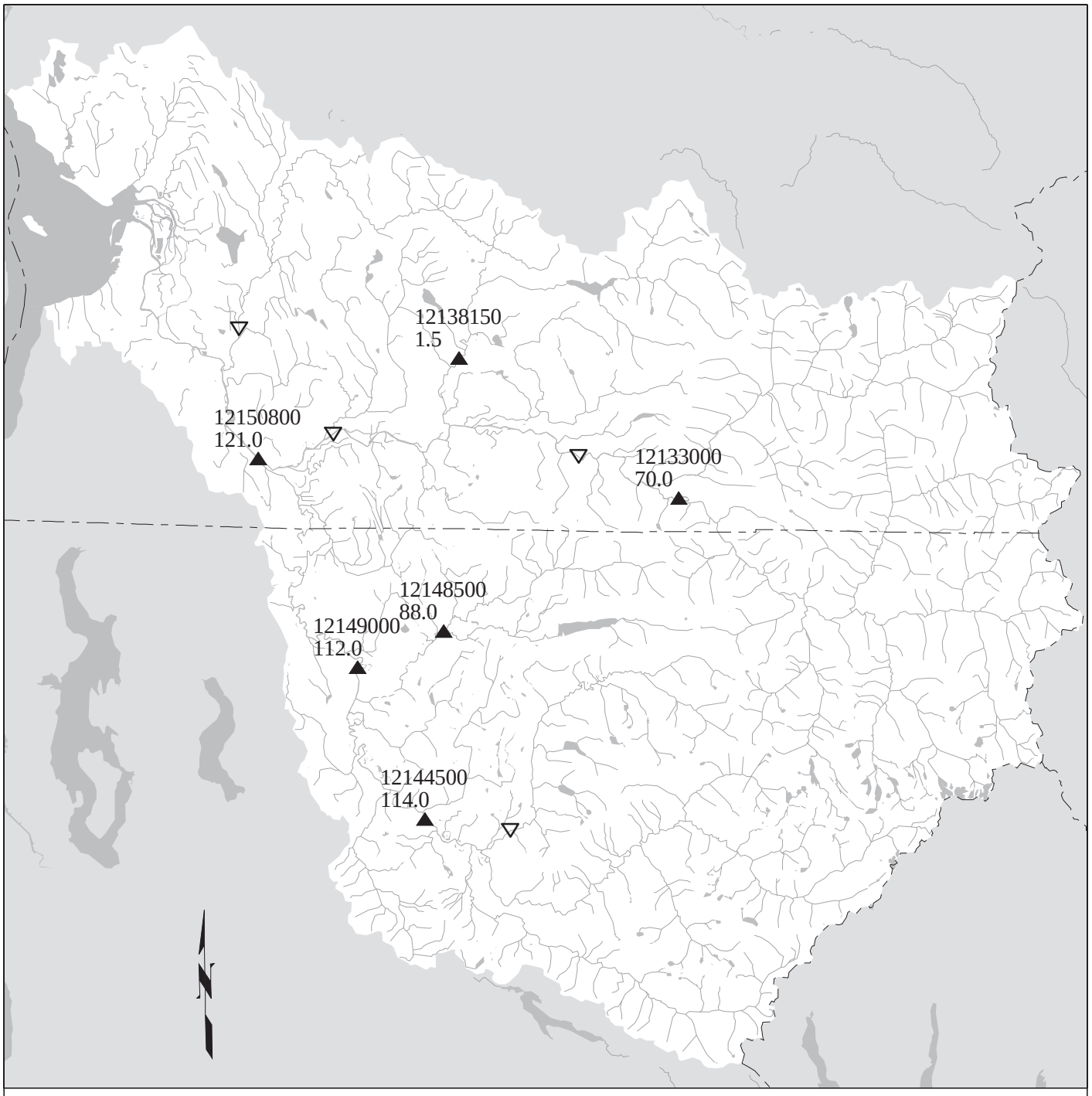
The minimum instream base flow requirements, established under Chapter 173-507 WAC for several stream management units of the Snohomish River Basin, were used to develop this indicator. The purpose of this regulation is to provide sufficient instream flow to protect fish and other beneficial uses of streams. The stream management control stations are shown on the opposite page.

The method selected to determine if instream flow requirements were being met was to compare the stream management unit base flow requirements to flow data from a nearby United States Geological Survey (USGS) monitoring station. The advantages of the USGS database were that it could readily be accessed through the Internet, and it had long-term records for several of the minimum instream flow stations.

The Pacific Groundwater Group had already performed this type of comparison for Ecology in 1995 (Pacific Groundwater Group, 1995). Their results indicated that many minimum instream flow requirements were not being met. The table below and figure opposite indicate the average number of days per year the stream management unit base flow requirements were not met at each site. However, based on the limited number of stream management control stations, we were unable to fully characterize this indicator by calculating the percent of stream miles in the basin with instream flow meeting seasonal flow requirements for salmonids.

Stream management control stations not meeting minimum instream flow requirements.

Control Station Number	Control Station Name and Location	Average Days/Yr. Regulatory Flows were not met	Water Years
12.1330.00	So. Fk. Skykomish River near Index	70	1979-81
12.1381.50	Sultan River near Sultan	1.5	1979-92
12.1445.00	Snoqualmie River near Snoqualmie	114	1979-92
12.1485.00	Tolt River near Carnation	88	1979-92
12.1490.00	Snoqualmie River near Carnation	112	1979-92
12.1508.00	Snohomish River near Monroe	121	1979-92



Snohomish Watershed WRIA #7

Regulatory Instream Flow Control Stations

Scale 1:520,000

Miles

0 4 8

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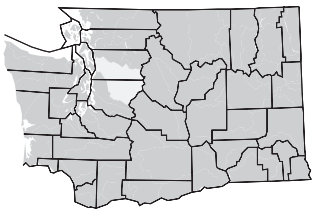
▽ Other USGS Stream Gaging Stations

▲ Stream Stations not meeting requirements
* Station number
* Number of noncompliant days

Streams

County



Representational Feature Source:

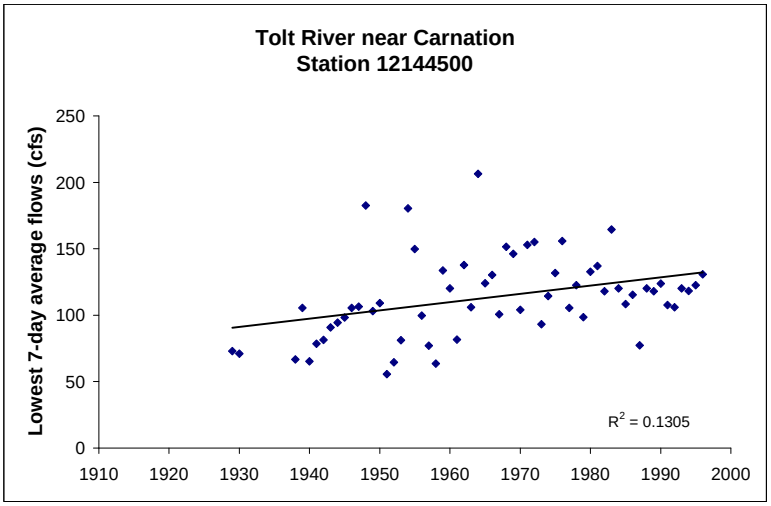
Hydrology: 1:100,000 WDFW (WARIS)
Instream Flow Stations 1:24k USGS (USGS_GAGES)

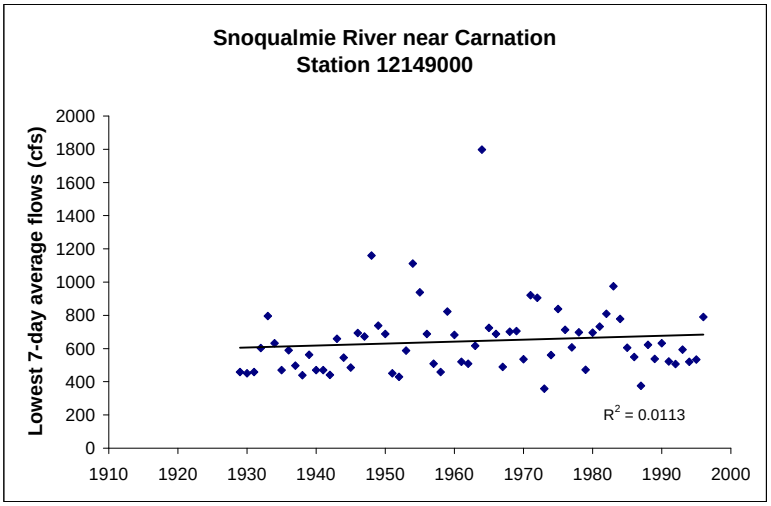
/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/FLOW

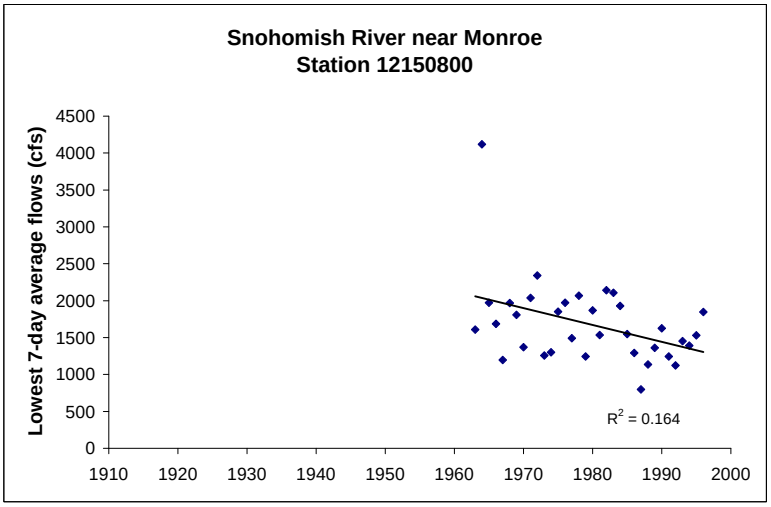
2.2 Flow Hydrology

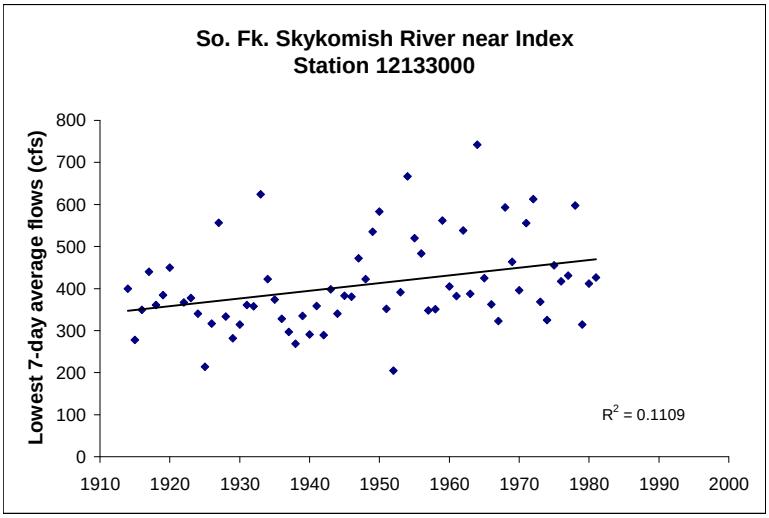
% of waterbodies with minimal, moderate, extreme changes in hydrology from historical patterns (captures low and high flow extremes–deviation)

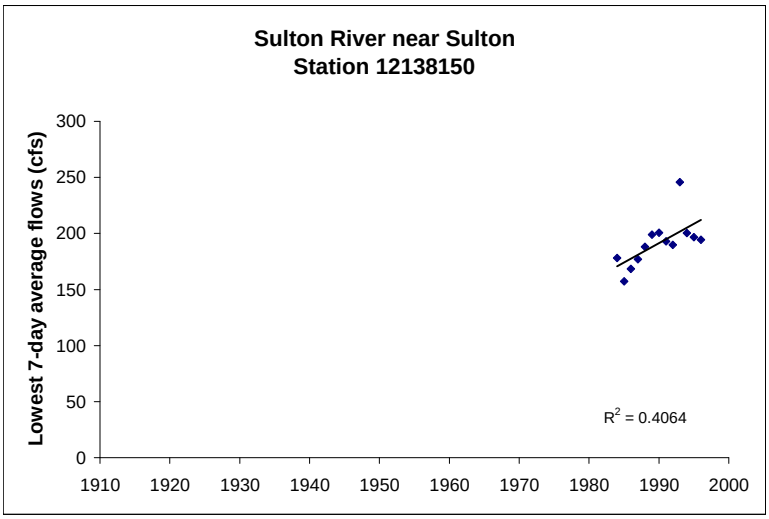
The USGS flow monitoring database was used to determine if a pattern of extreme hydrological changes might be occurring in the Snohomish River Basin. The data were analyzed to identify annual average seven-day low and high flows. The results of this analysis were plotted as trend graphs, which follow. In some instances there is evidence of an increasing or decreasing flow trend, but further analysis would be needed to determine if these were related to climatic factors, land cover changes, trends in consumptive water use, or other factors.

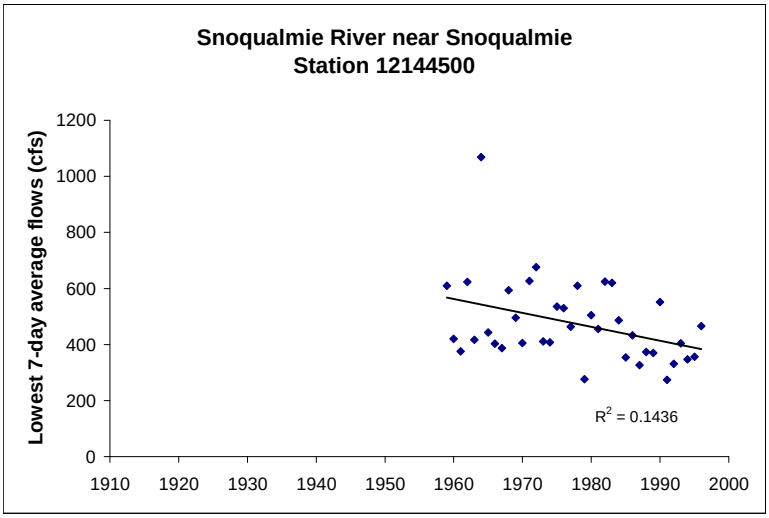

Tolt River near Carnation
Station 12144500
Lowest 7-day average flows (cfs)
250
200
150
100
50
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
R2 = 0.1305

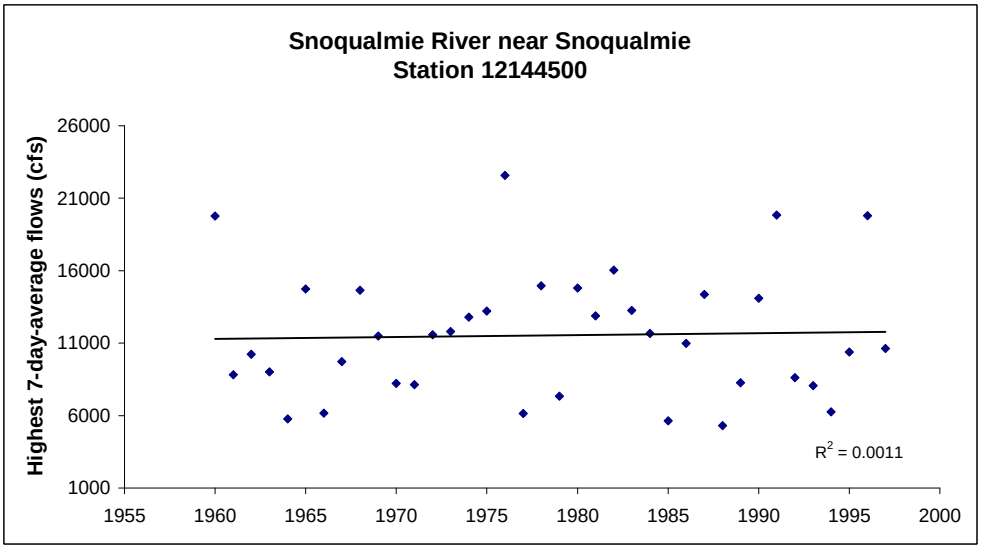

Snoqualmie River near Carnation
Station 12149000
Lowest 7-day average flows (cfs)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
R2 = 0.0113

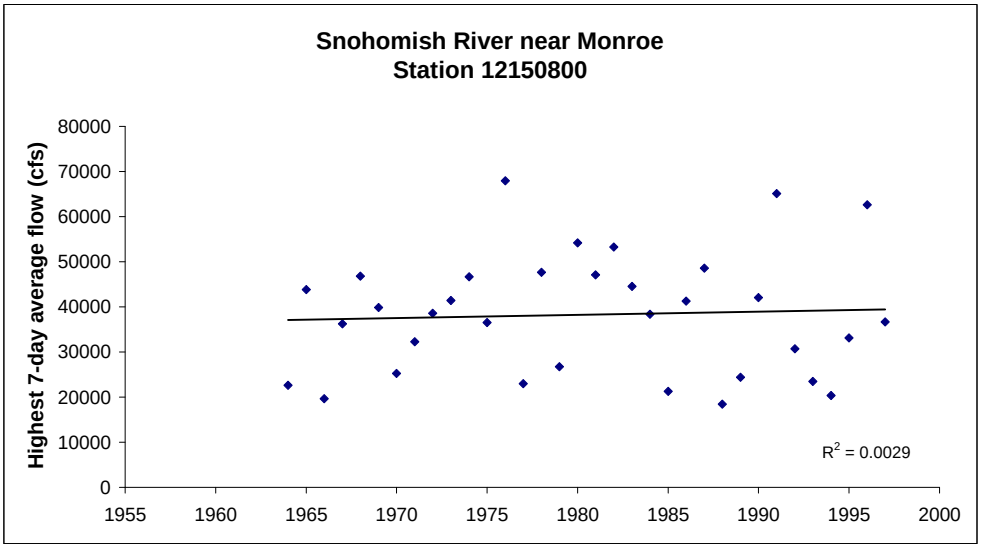

Snohomish River near Monroe
Station 12150800
Lowest 7-day average flows (cfs)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
R2 = 0.164


So. Fk. Skykomish River near Index
Station 12133000
Lowest 7-day average flows (cfs)
800
700
600
500
400
300
200
100
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
R2 = 0.1109


Sulton River near Sulton
Station 12138150
Lowest 7-day average flows (cfs)
300
250
200
150
100
50
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
R2 = 0.4064


Snoqualmie River near Snoqualmie
Station 12144500
Lowest 7-day average flows (cfs)
1200
1000
800
600
400
200
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
R2 = 0.1436


Snoqualmie River near Snoqualmie
Station 12144500
Highest 7-day-average flows (cfs)
26000
21000
16000
11000
6000
1000
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
R2 = 0.0011


Snohomish River near Monroe
Station 12150800
Highest 7-day average flow (cfs)
80000
70000
60000
50000
40000
30000
20000
10000
0
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
R2 = 0.0029

Water Quality

3.1 Temperature

% of assessed waterbodies where the daily maximum falls into; <10 degrees C – no impairment; 10-15 degrees C – potential impairment to sensitive species; 15-20 degrees C – moderate impairment; >20 degrees C – severe impairment

Several data sources were identified for this indicator. Overall, most of the available data were from the lower (western part) of the Snohomish River basin. The Ecology Ambient Monitoring Section had the most useful data for this indicator because it was available electronically, contained a long-term record, and sample locations were already entered into the spatial data base.

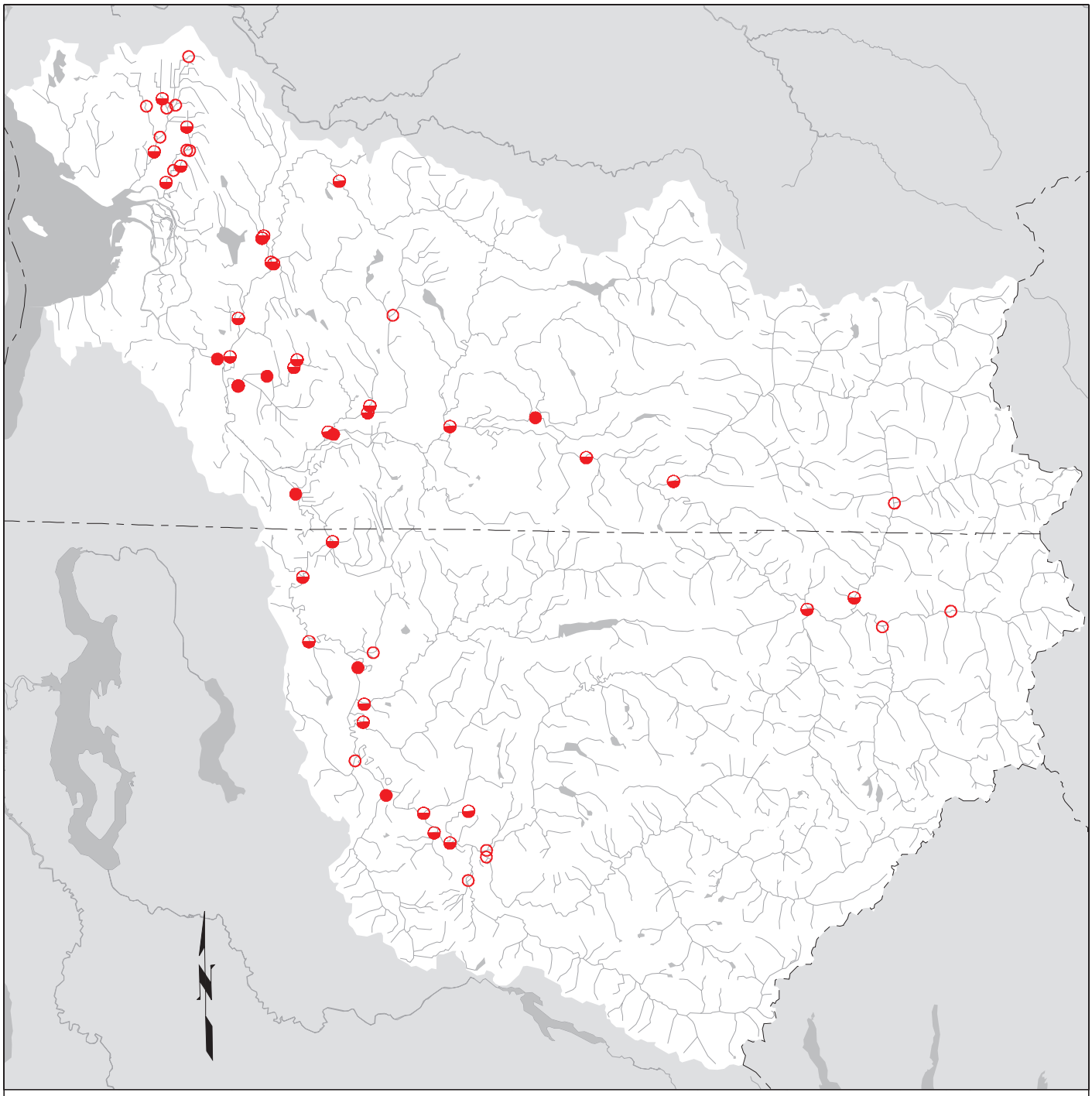
Other identified data sources used for the temperature indicator included short-term water quality studies conducted by Ecology, Snohomish County, the Tulalip Tribe, and a Department of Fish and Wildlife long-term temperature data record for two locations upstream of the Wallace River Hatchery.

The U.S. Forest Service was also identified as a potential source of temperature data from the upper (eastern) Snohomish River basin. Unfortunately, their data were not available in time to use on this project.

The process to develop this indicator was somewhat labor intensive. Most of the data were obtained from printed reports, which were visually scanned to determine peak daily temperatures. Further, the locations of most of the stations needed to be digitized into a coverage at a 1:24,000 scale from either a written description or simple map. Once the station location was digitized, the temperature rating for the station could be assigned. The temperature indicator is summarized in the table below, and displayed on the basin map opposite.

Summary of Temperature Ranges in the Snohomish River Basin

Daily Maximum Temperatures in Degrees Centigrade	Estimated Degree of Impairment	Percent of Assessed Waterbodies
<10	None	0%
10.1-15	Potential	30.4%
15.1-20	Moderate	55.3%
>20.1	Severe	14.3%



Snohomish Watershed WRIA −7

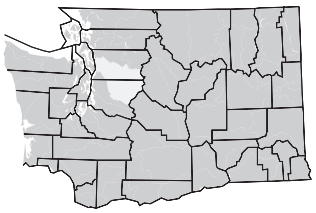
Temperature Range Data

Scale 1:520,000

Miles

0 4 8

- 10 −15 degees C. − Potential Impairment
- 15.1 −20 degrees C. − Moderate Impairment
- 20.1+ degrees C. − Severe Impairment
- Streams
- County



Representational Feature Source:

Hydrology: 1:100,000 WDFW (WARIS)
Transportation: 1:100,000 WOFM (TIGER)
Temperature Stations 1:24k Ecology/EILS (SNOH_WQ)

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/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/TEMP-BW

3.2 Biological Water Quality Index

% of water rated excellent, good, fair, poor (possible parameters would include fish community and benthic macroinvertebrate species or taxa composition and richness using similar bioassessment protocols)

There were two benthic macroinvertebrate studies that were conducted in the Snohomish River basin at the time of this report. The earliest study was conducted by Ecology as part of a water quality - low flow assessment of the lower Snoqualmie River during the summer of 1989. Snohomish County conducted the second study in 1997 in three lower basin tributaries. These studies were limited in scope, represent only a small portion of the watershed, and used different bioassessment protocols. Consequently, no further analysis was conducted.

Insufficient Data

Precluded Indicator Development

3.3 Chemical Water Quality Index

% of waters rated excellent, good, fair, poor (possible parameters would include temperature, dissolved oxygen, biological oxygen demand, pH, ammonia + nitrate nitrogen, total phosphorus, total suspended solids, and bacteria to produce a single number)

There were few data sources for this indicator, and these were mainly focused on the lower (western part) of the Snohomish River basin. Ecology's Ambient Monitoring Section had the most useful data for this indicator because it was available electronically, contained a long term monitoring record, and the sample locations were already entered into the GIS database.

The other identified data sources for the indicator included short-term water quality studies conducted by Ecology, Snohomish County, and the Tulalip Tribe. These data sources were not used for characterizing this indicator because the data record was limited to only a few months or years.

There are several possible methods for developing chemical water quality indices. Due to the limited scope of this project, a simple index was used to test the available data. The index consists of two of the recommended water quality parameters, temperature and dissolved oxygen. These parameters were selected because numeric criteria exist for them under State Water Quality Standards (WAC 173-201A), data were available, and these parameters directly affect salmon health. The criteria were applied during the high temperature/low dissolved oxygen period of June-September. The results of this analysis are plotted on the following pages as the percent compliance at each monitoring station for both parameters. However, due to the low number of assessed waters, this indicator was not converted into a rating of excellent, good, fair, or poor.

Snohomish Watershed WRIA #7

Selected Ambient Monitoring Stations

Scale 1:520,000

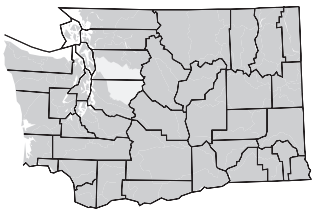
Miles

0 4 8

Ambient Station

Streams

County



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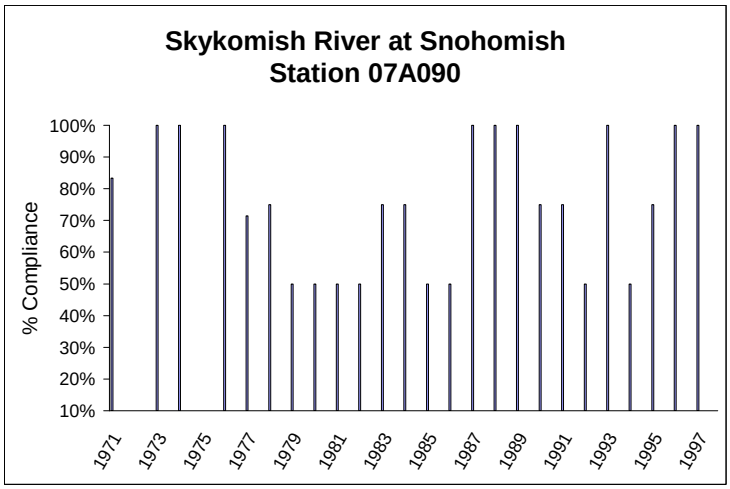
GIS Technical Services
12/30/98

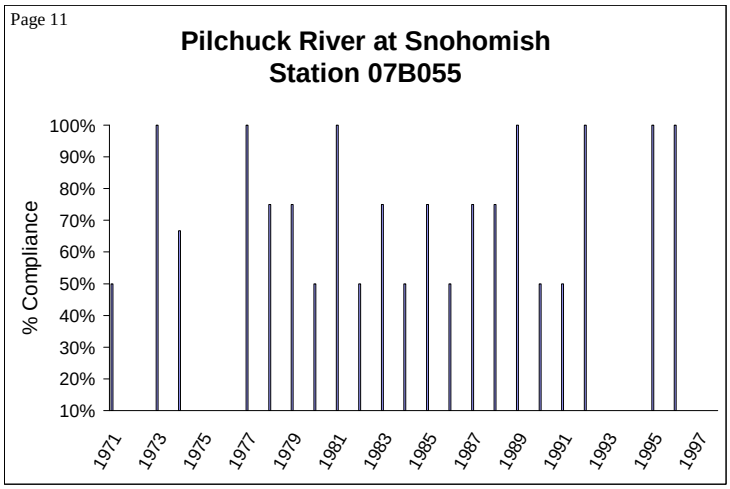
Representational Feature Source:

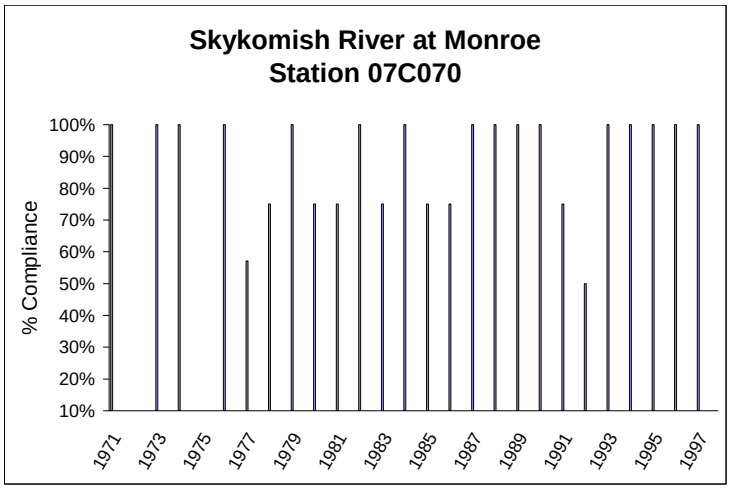
Hydrology: 1:100,000 WDFW (WARIS)
Ambient Stations 1:100,000 Ecology/EILS (AMBIENT)

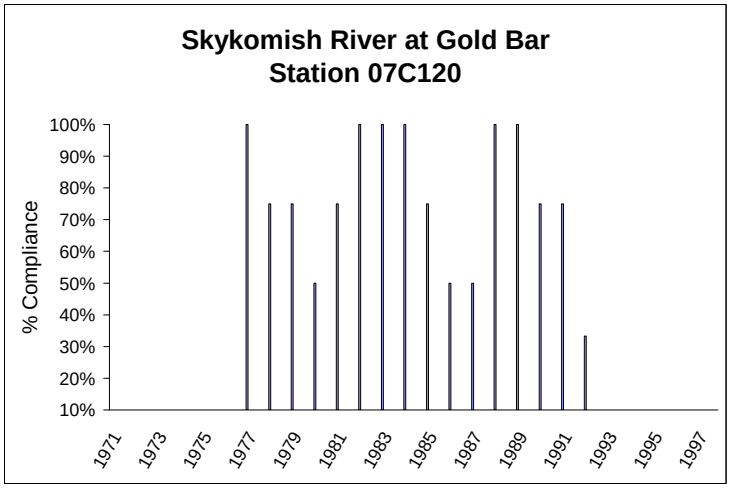
/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/AMBIENT

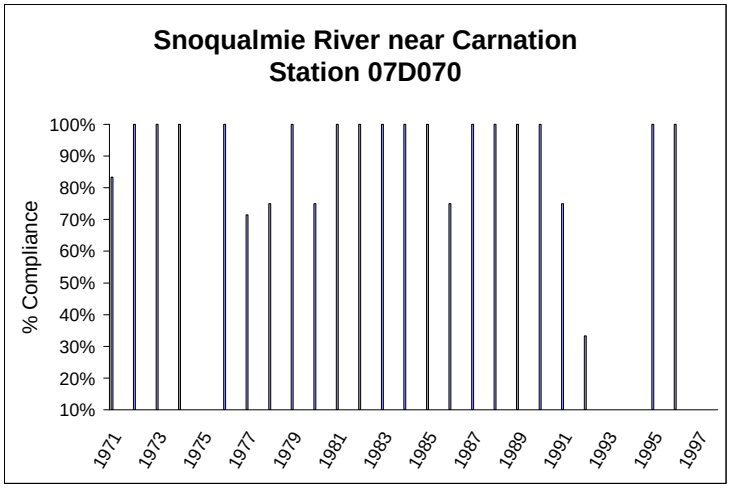

Skykomish River at Snohomish
Station 07A090
% Compliance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997

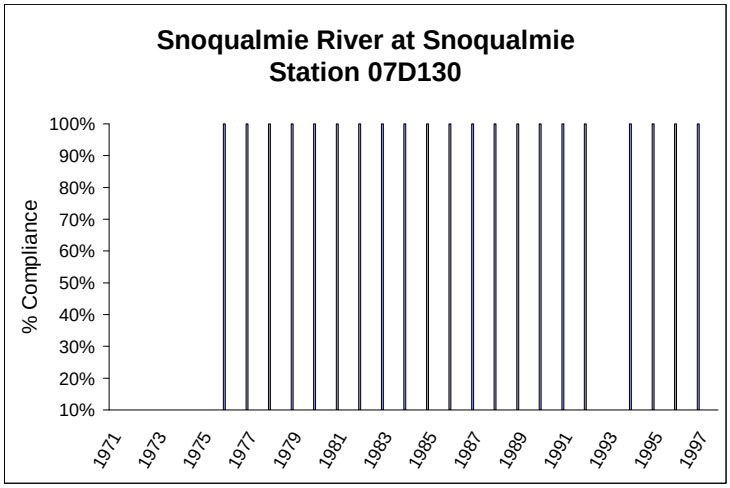
Page 11


Pilchuck River at Snohomish
Station 07B055
% Compliance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997


Skykomish River at Monroe
Station 07C070
% Compliance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997


Skykomish River at Gold Bar
Station 07C120
% Compliance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997


Snoqualmie River near Carnation
Station 07D070
% Compliance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997


Snoqualmie River at Snoqualmie
Station 07D130
% Compliance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997

Land Use/Land Cover

4.1 Land Use Conversion

# of acres in a watershed converted from land use/land cover classifications (e.g., forestry, agriculture, rural, residential, industrial, protected status, etc.) to other land use/land cover types over time with emphasis on floodplain to riparian area

There were two GIS land use/land cover (LULC) sources that could be used to determine recent changes in land use. These sources were the United States Geological Survey (USGS) 1975 LULC data at a 1:250,000 scale, and the Puget Sound Regional Council 1992 LULC data at a 1:24,000 scale.

The land use comparison was made using GIS analysis capabilities. The results show major land use conversions having occurred in the Snohomish River Basin, especially between the Forest to Open categories (207,889 acres). There were other notable results, such as agriculture to open (18,776 acres) and open to forest (17,544 acres). However, the results must be qualified because of the different LULC data scales used (1:250,000 and 1:24,000). For example, the Urban to Forest land use conversion of 13,503 acres seems highly unlikely.

Results of the analysis are shown below. The figure opposite contrasts the conversion of land from forest to open versus open to forest.

Summary of Land Use/Land Cover Conversions Using 1975 LULC to 1992 LULC Data[1]

1975 LULC Class Name[2]	1992 LULC Class Name[2]	No. Acres Converted
Agriculture	Forest	5,000
Agriculture	Open	18,776
Agriculture	Urban	2,141
Forest	Agriculture	1,915
Forest	Open	207,889
Forest	Urban	6,481
Open	Agriculture	139
Open	Forest	17,544
Open	Urban	780
Urban[3]	Agriculture	2,642
Urban	Forest	13,503
Urban	Open	34,618

[1] Glacier comparison to these categories was omitted from table
[2] Open category includes water
[3] Data in gray-shaded rows likely reflect differences in the LULC scales

Scale 1:520,000

Miles

0 4 8

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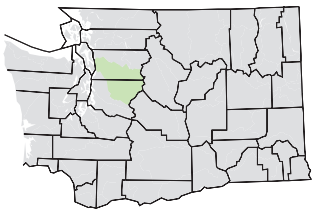
Snohomish Watershed WRIA −7

Salmon Habitat Indicators

Modeled Land Use Change/Conversion 1975 −1992

- Forest to Open
- Open to Forest
- Streams
- Highways
- County



Representational Feature Source:

Land Use/Land Cover Change Analysis:
1975 1:250,000 USGS GIRDAS files (LULC)
1992 1:24,000 PSRC Landsat TM Image (PSLULC)
Hydrology: 1:100,000 WDFW (WARIS)
Transportation: 1:100,000 WOFM (TIGER)
Watershed Boundaries: 1:24,000 Ecology (BASINS)
Salmon And Steelhead Stock Inventory 1:250k WDFW (SASSI)

/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/LULC-CHG

4.2 Transportation Impacts

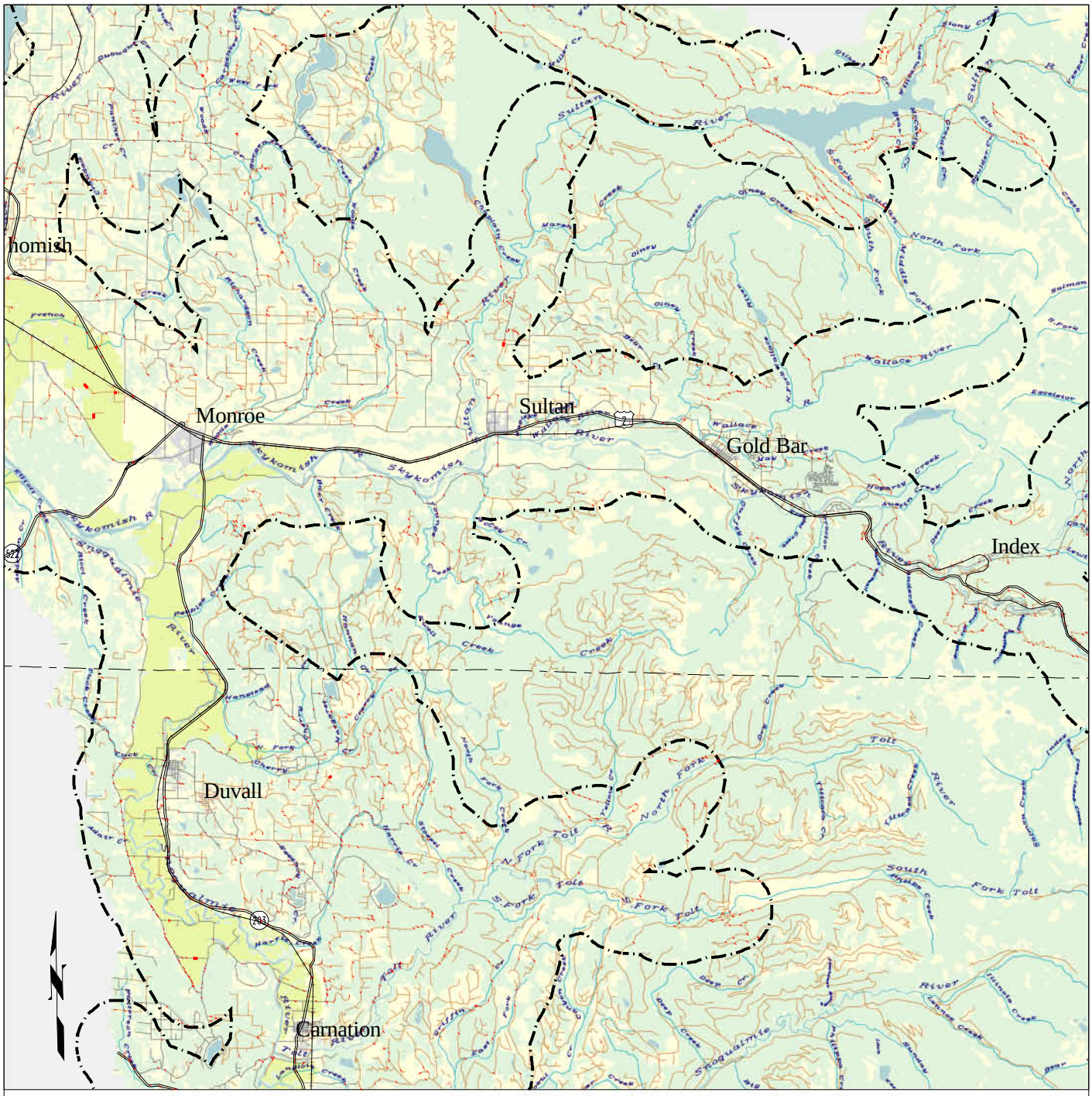
Miles of road by type and road crossings within one mile of historically anadromous salmon streams, floodplains, and marine shorelines

The Washington Department of Natural Resources (DNR) 1996 digital transportation coverage (1:24,000 scale) was edited by Ecology GIS staff to obtain the roads by class type. The results were as follows:

Road Class	**Miles**
Interstate Highway	185.4
State Highway	121.8
Paved Road	1,045.1
Unpaved Road	2,851.9
Total	4,204.2

The calculation of the number of road crossings required the use of several GIS digital data sets: the DNR 1996 Hydrography (1:24,000), the WDFW 1992 SASSI (1:100,000), and the Federal Emergency Management Agency – Floodway (1:24,000). The DNR 1996 transportation layer was then added to identify the number of road crossings within one mile of historically anadromous salmon habitat. The geographic analysis calculated that there were 2,821 road crossings of salmon streams, floodplains, and marine shorelines in the Snohomish River Basin.

The map on the opposite page depicts the one-mile overlay and associated road crossings in a small part of the lower basin.



Snohomish Watershed WRIA - 7
Road/Stream Crossing Analysis

Scale 1:231,000
Miles
0 2 4

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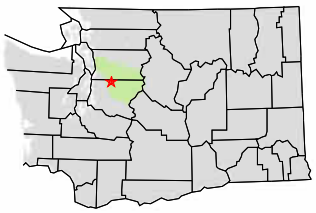
- 10 Urban/Developed
- 20 Agriculture
- 30 Open/Non Forested
- 42 Forest(All)
- 50 Water
- 90 Glacier

- Streams
- Highways
- Local paved roads
- Unpaved roads
- Rail
- Road/Stream Crossings
- Floodplain/Salmon Stream 1 mile Buffer



Representational Feature Source:

Land Use/Land Cover 1992: 1:24k PSRC Landsat TM Image (PSLULC)
Hydrology: 1997 1:24kEcology(King Co.Hydro/DNR Data96-HYDRO)
Transportation: 1:24k Ecology (edited DNR Data96-TRANS)
Flood Plain: 1:24k FEMA Digital Floodway data (FLOOD)
Salmon Streams 1:24k WDFW (SASSI)

/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/RSX

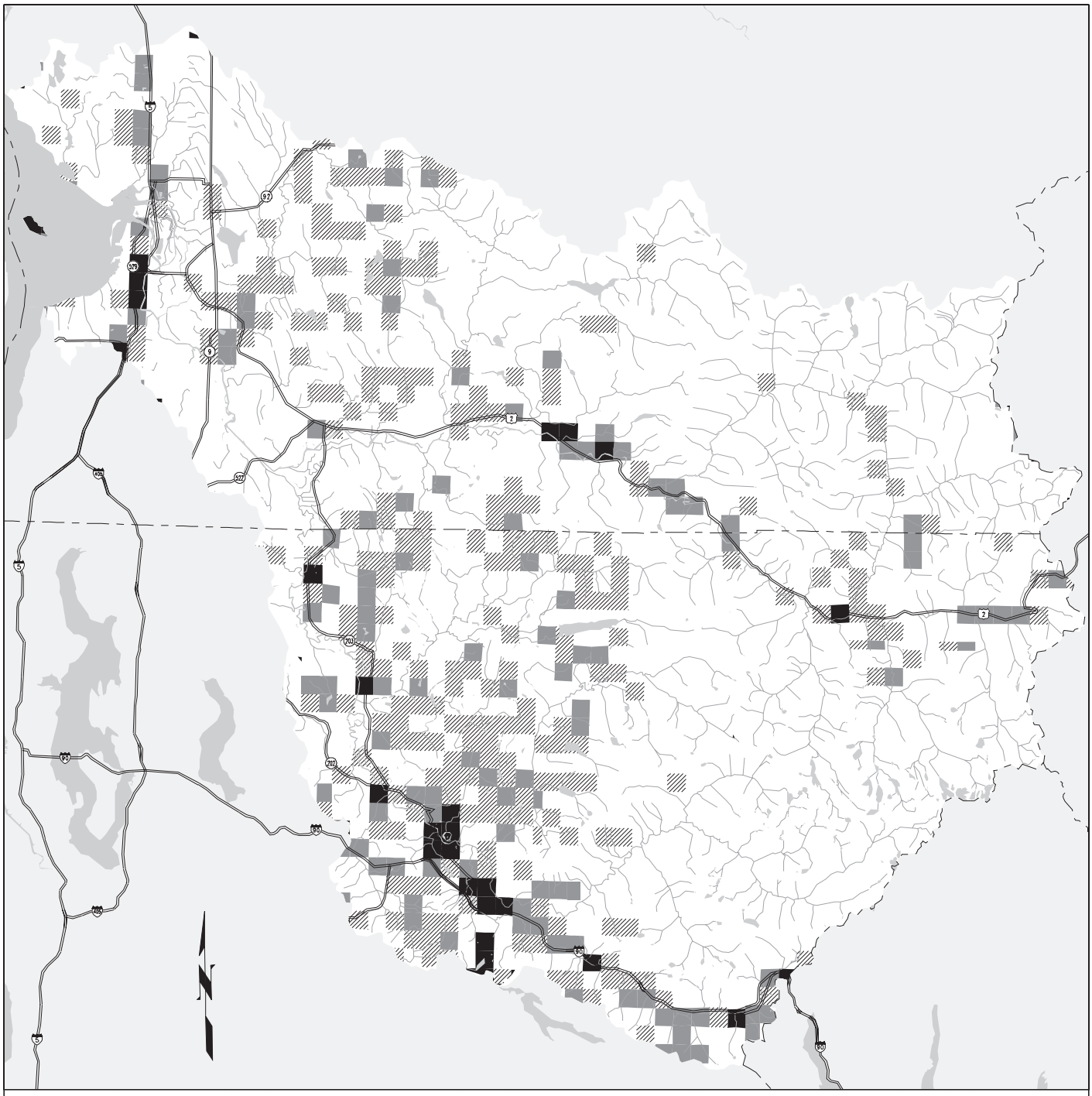
4.3 Impervious Surface

% of impervious surface (roads, rooftops, and parking lots) in a watershed

There was a limited amount of detailed land use information available to calculate the percent total impervious area (% TIA) for this indicator. As a result, a less complicated measure of the % TIA was developed using road density (kilometers of road/square kilometer of basin) as a surrogate. Road density was calculated using the DNR 1996 digital transportation coverage (1:24,000 scale). Road density was then related to % TIA using a method modified from May *et al.*, 1997, as shown in the table below. The resulting indicator of impervious surface is depicted in the opposite figure.

Development categories, the ranges of %TIA, road density, and % impervious surface in the watershed (Modified from May *et al.*, 1997).

Development Category	% TIA Range	Road Density (km/km^2)	% of Basin
Undeveloped/Reference	<5	<2.6	80 %
Rural	5-10	2.6-3.5	13 %
Low-Density Suburban	10-20	3.5-5	6 %
Medium-Density Suburban to Urban	>20	>5	1 %



Snohomish Watershed WRIA −7

Salmon Habitat Indicators
Modeled Road Density (km/sq.km)

- < 5%
- 5% −10%
- 10.1% −20%
- > 20%
- Streams
- Highways
- County

Scale 1:520,000

Miles

0 4 8

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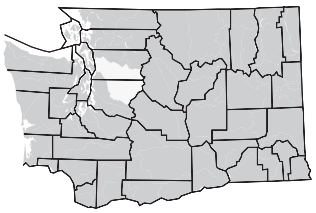
12/21/98



Representational Feature Source:

Hydrology: 1:100,000 WDFW (WARIS)
Road Density 1:24k Ecology/ISSGIS (WRIA7SEC)
Land Use/Land Cover 1992: 1:24,000 PSRC (PSLULC)

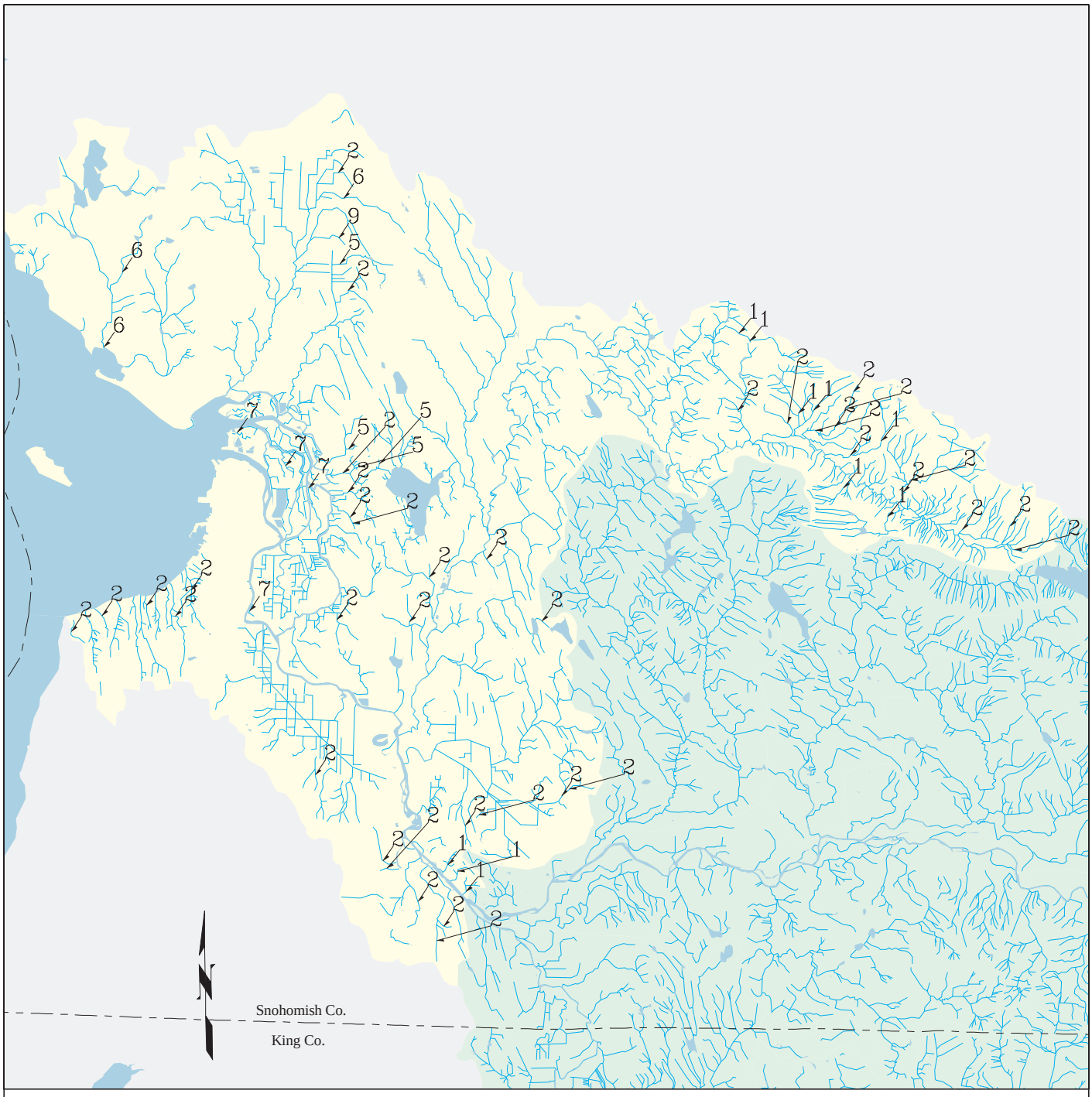
/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/RD_DEN

Physical Habitat

5.1.1 Impediments and Accessibility to Salmon Habitat

# of locations where salmon are impeded, by type, and the amount by type, of historically anadromous salmon habitat rendered inaccessible by these impediments

This indicator was developed using Northwest Indian Fisheries Commission (NWIFC) Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP) data. The figure opposite depicts types of salmon habitat barriers in river segments of the lower Snohomish River Basin and nearby tributaries to Possession Sound. In this limited geographic area, the most common barrier types were cascades and falls, as opposed to constructed barriers like dams, dikes, and culverts. At the time of this report, SSHIAP data were not available in a GIS coverage for upper portions of the Snohomish basin, consequently the number of locations where salmon are impeded basinwide was not tallied, as required for this indicator.



Snohomish Watershed WRIA −7

Salmon Habitat Indicators

Barrier Types

1	Falls
2	Cascades
5	12% Gradient
6	Dam
7	Dike/Levy
9	Culvert
	Streams

Scale 1:280,000

Miles

0 2 4

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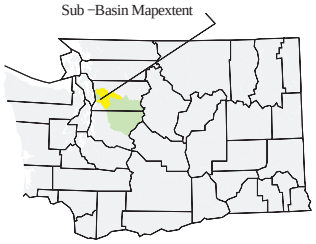
Sub −Basin Mapextent



Representational Feature Source:

Hydrology: 1:24k DNR/Ecology (WTRCRS)
Barriers: 1:24k NWIFC/Ecology (SSHIAP)
Watershed Boundaries: 1:24k Ecology (BASINS)

/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/BARRIERS

5.2.1 Large Woody Debris

Counts of debris pieces with lengths equal or greater than channel widths, noting presence/absence of root wads, per historically anadromous salmonid stream mile

5.2.2 Stream Depth

variance of thalweg depths (flow path of the deepest water in a stream)

5.3.1 Sediment

change in sediment loading rates

5.3.2 Spawning Area

% change in spawning areas

Data sources were located for some of these parameters in the Snohomish River basin. However, data availability or comparability issues precluded indicator development.

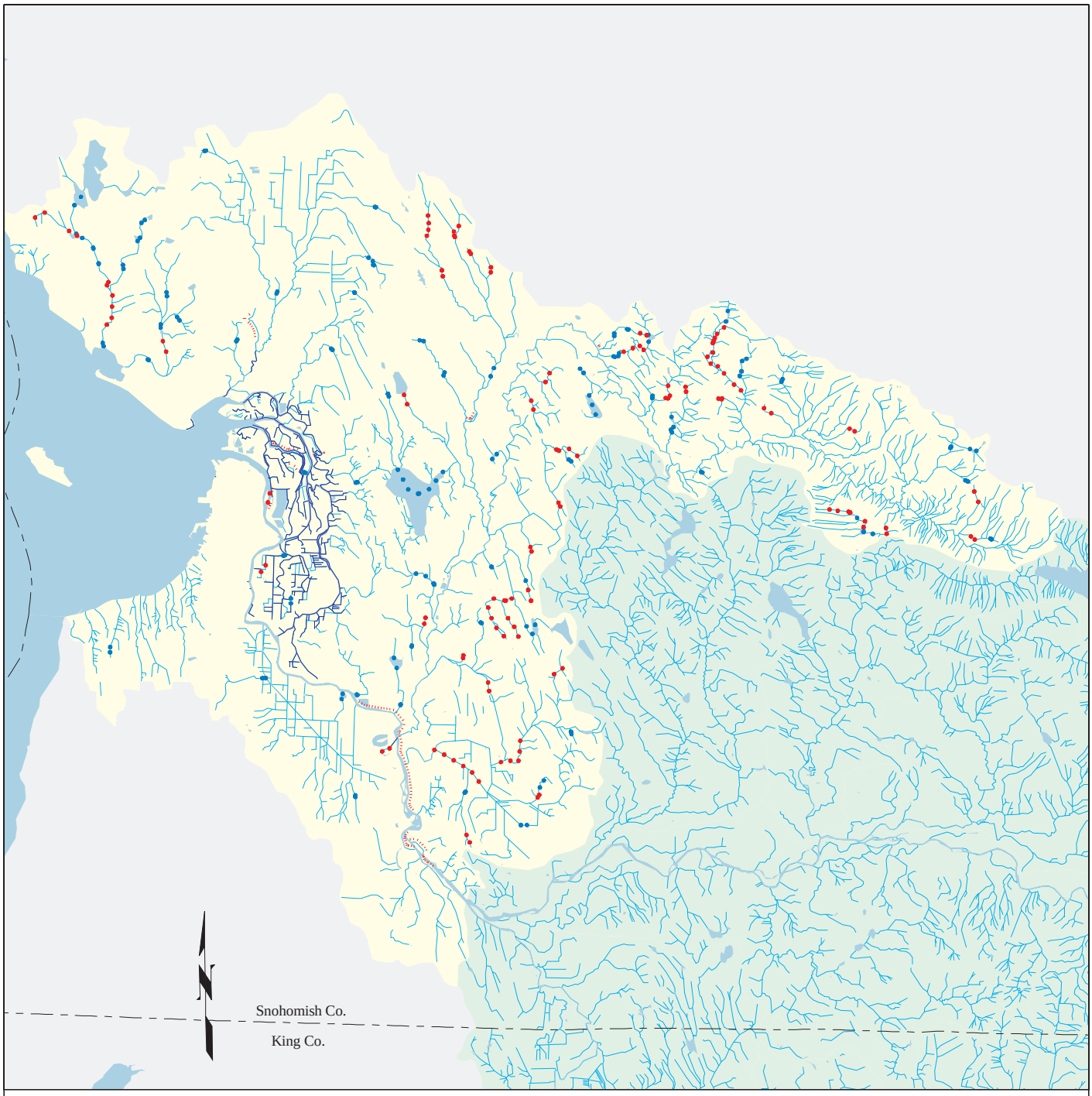
Insufficient Data

Precluded Indicator Development

5.4.1 Habitat Type Associated with Water

the amount of habitat, by category (e.g., riparian forest, off-channel, wetland, and estuary) associated with the water margins of the water course in a watershed and the value of the habitat to the salmonid life-cycle

This indicator was developed using Northwest Indian Fisheries Commission (NWIFC) Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP) data. Results are depicted on the opposite page for the lower portion of the Snohomish Basin, as well as for other nearby drainages to Possession Sound. At the time of this report, SSHIAP data were not available in GIS coverage for the upper portions of the basin, consequently the amount of habitat basinwide by category was not calculated, as required for this indicator.



Snohomish Watershed WRIA −7

Salmon Habitat Indicators
Habitat Types

- Tributary
- Side Channel
- Distributary Slough
- Lake/Pond
- Wetland

Scale 1:280,000

Miles

0 2 4

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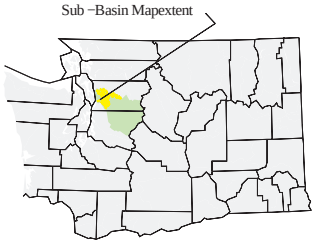
Sub −Basin Mapextent



Representational Feature Source:

Hydrology: 1:24k DNR/Ecology (WTRCRS)
Barriers: 1:24k NWIFC/Ecology (SSHIAP)
Watershed Boundaries: 1:24k Ecology (BASINS)

/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/HABITAT

Combined Indicators

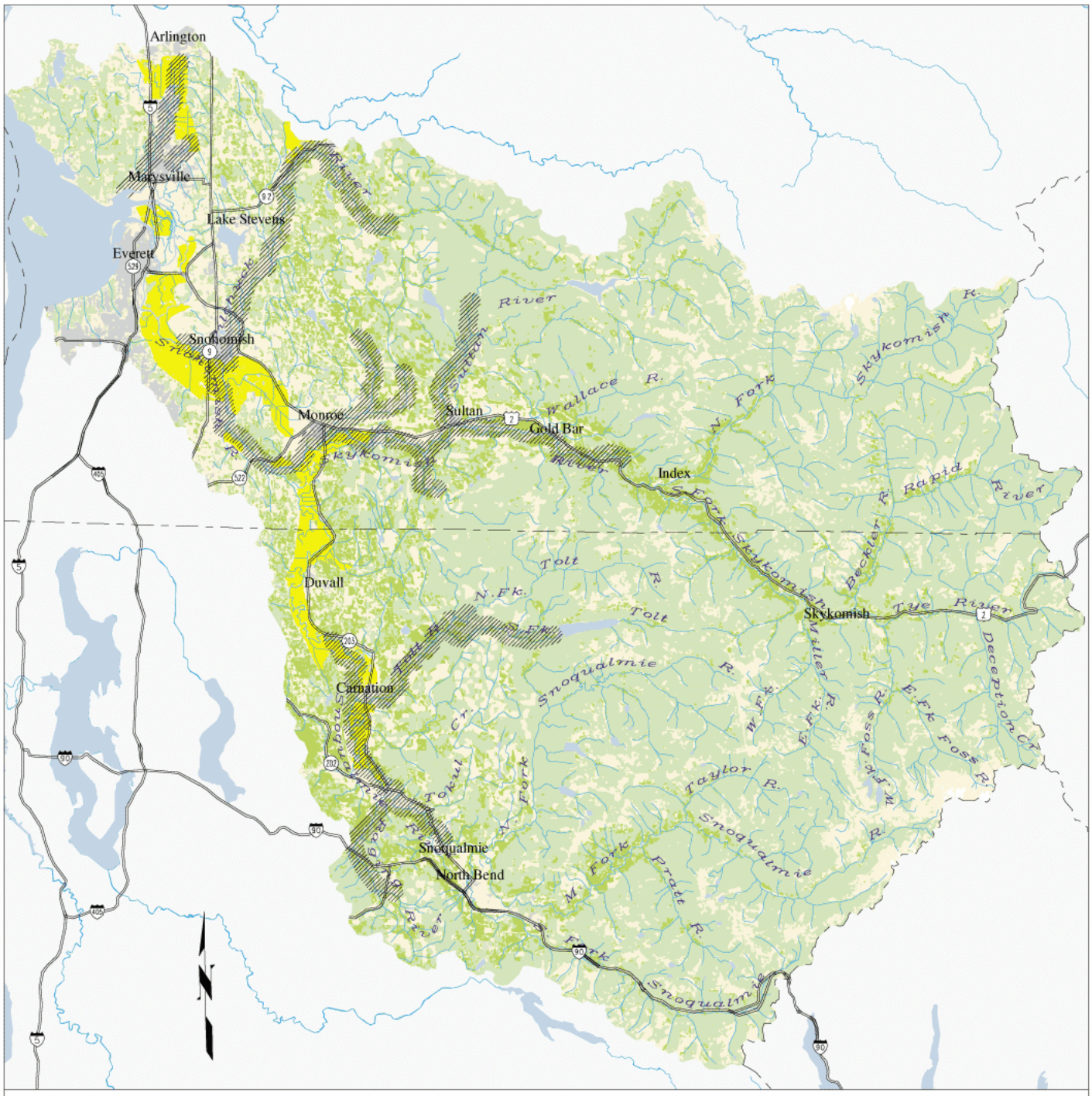
1.1 Salmonids

Summer and Fall Chinook (1993 SASSI Spawner Distribution)

4.1 Land Use

1992 *Land use/land cover (Puget Sound Regional Council)*

The intent of this indicator comparison was to explore how land uses may relate to the distribution of critical/depressed chinook salmon stocks in the basin. This comparison, shown in the figure opposite, indicates that chinook stocks are critical/depressed in nearly all of the land use types, including agricultural, urban, and forest.



Snohomish Watershed WRIA –7

Chinook SASSI Spawner distribution
Land Use/Land Cover

Scale 1:520,000
Miles
0 4 8

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- 10 Urban/Developed
- 20 Agriculture
- 30 Open/Non Forested
- 42 Forest(Evergreen)
- 43 Forest(Mixed)
- 50 Water
- 90 Glacier
- 'Spawner Distribution' Area (Critical/Depressed)
- Streams
- Highways
- County

Representational Feature Source:

Land Use/Land Cover 1992: 1:24,000 PSRC Landsat TM Image (PSLULC)
Hydrology: 1:24,000 Ecology (King Co.Hydro) from DNR (Data96-HYDRO)
Transportation: 1:24,000 DNR (Data96-TRANS)
Watershed Boundaries: 1:24,000 Ecology (BASINS)
Salmon And Steelhead Stock Inventory 1:250k WDFW (SASSI)

/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/CHIN-CD-4.U

Combined Indicators

1.1 Salmonids

Summer and Fall Chinook (1993 SASSI Spawner Distribution)

3.1 Temperature

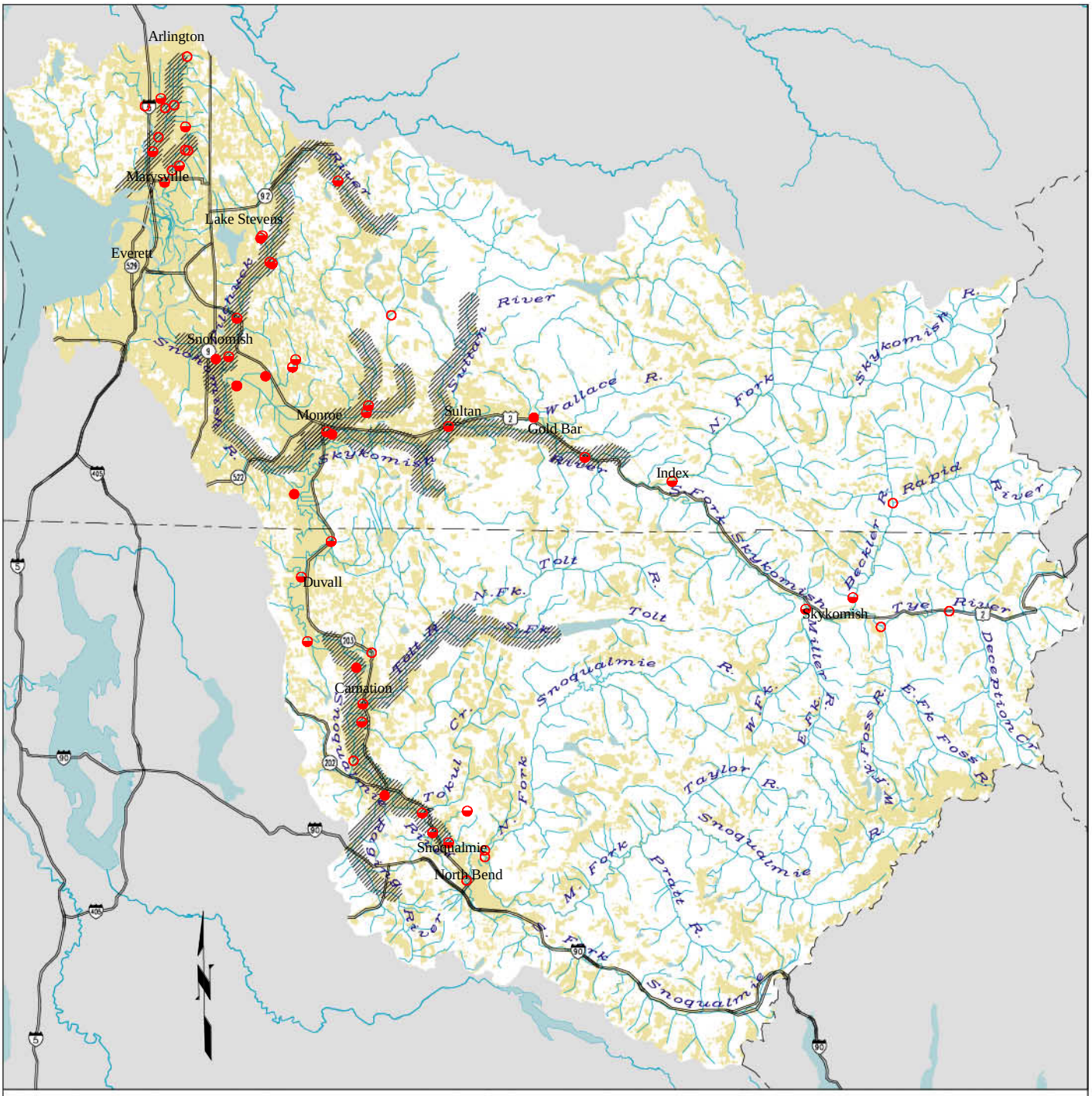
Ecology, Snohomish County, Tulalip Tribe, and WDFW studies

4.1 Land Use Conversion

1992 *Land use/land cover (Puget Sound Regional Council)*
Non-Forested Lands (Agriculture – Urban – Open)

This indicator comparison was designed to explore how land use may relate to stream temperatures and to the distribution of critical/depressed chinook salmon stocks in the basin. In this case, a special non-forested land category was created by combining agriculture, urban, and open land use/land cover categories.

The comparison shown on the opposite page indicates that critical/depressed chinook stocks seem to be located more so in non-forested areas, and that these same areas tend to have water temperatures with the potential for moderate to severe impairment for salmon.



Snohomish Watershed WRIA - 7

SASSI Spawner distribution
Chinook Stock Status and Non-Forested lands

Scale 1:520,000
Miles
0 4 8

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All Non - Forested Lands (Agriculture, Urban, Open)

'Spawner Distribution' Area (Critical/Depressed)

10 - 15 degees C. - Potential Impairment

15.1 - 20 degrees C. - Moderate Impairment

20.1+ degrees C. - Severe Impairment

Streams

Highways

County

Representational Feature Source:

Land Use/Land Cover 1992: 1:24,000 PSRC Landsat TM Image (PSLULC)
Hydrology: 1:24,000 Ecology (King Co.Hydro) from DNR (Data96-HYDRO)
Transportation: 1:24,000 DNR (Data96-TRANS)
Watershed Boundaries: 1:24,000 Ecology (BASINS)
Salmon And Steelhead Stock Inventory 1:250k WDFW (SASSI)

/NET/SHUKSAN/EILS/PROJECTS/FY98/SNOHO/MAPS/CHIN-CD-TEMP-LU

Conclusions

The suite of 15 salmon habitat indicators has the potential to be a useful tool for characterizing salmon habitat changes within or between river basins. However, although the Snohomish River basin was considered to be relatively data-rich, only about half of the indicators could be characterized, and many of those only to a limited extent.

This pilot project was three months in duration. Most of the effort was devoted to acquiring data from diverse sources and converting the data to an electronic format to facilitate comparisons. Data quality and documentation were variable, and data were difficult to represent in a geo-spatial framework. Monitoring for habitat indicators will be integral to salmon recovery efforts and will require improved information data gathering, automation, and management to facilitate sharing among various agencies and organizations.

Recommendations

Local, regional, and state salmon recovery plans should include an effectiveness monitoring component with a variety of habitat indicators (fish abundance, water quality and quantity, land use, and physical features).

Information management needs to be an integral part of future indicator monitoring programs. Information should be managed near the point of origin, by the group having the primary interest, and made readily available in electronic formats. Data should be documented such that secondary users can determine why, how, and where the data were collected.

Monitoring entities should support efforts to agree on standards for the collection of salmon habitat indicator data. Data collection methods will probably never be the same across agencies, but data documentation and transmittal standards should be consistent to facilitate information sharing.

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