UNIT 4E. SALMON SUPPLEMENTAL INFORMATION

In the STUDENT HANDOUTS/TEACHER PAGES Section of this unit, we have provided you with a host of information from various sources to supplement not only this unit, but also the entire curriculum. Please read through this section and use the various articles, tables, charts and maps to enhance your teaching about salmon.

EXTENSION CURRICULUM

1. Have your students make "Salmon Cards," which are "baseball cards" for salmonid species. Explain to your students that you are making cards for many fish, with special cards for salmon species. Use fish in an aquarium, in the classroom, a pet shop, or the zoo for the student models. If there are no living fish available, then use pictures. Like baseball cards, these Salmon Cards should have a drawing on one side and facts on the other. Facts used should be compiled from a list generated by the class and supplemented by you. When students get the idea, ask them to find out about the species of salmon, and make special cards for them.

   When students have made their cards, ask them to use them to identify pictures of fish or living fish. Consider having students exchange cards, use them for identification, and then evaluate their ease of use. Finally, ask your students to share their favorite card with the rest of the class. Then, after gathering facts about salmonid species ask them to use their cards to answer questions you ask and that they have made up. Finally, make a class poster with a place for each student's favorite card.

   Explore salmon fry adaptations by looking at the physical appearance of salmonids at different stages in their life cycle. These stages can be compared across species as well. Ask students to identify how a salmon's appearance helps it to survive in its changing habitat.

2. Have students write their own 'CLUE' game for the different species of salmon. Ask them to review the rules for the CLUE game, and play the game once to understand it. Then, in groups, they should design their own game based on salmonid species. When the games are completed, have pairs or groups exchange games and play them. As they play, they should evaluate the game they are playing. Evaluative criteria should cover the construction of the materials, clarity of directions, ease of play, and factual integrity of questions and protocols involving salmon.

3. Salmonids in the Classroom. Canadian Department of Fisheries and Oceans, B.C. Both the Primary and Intermediate editions of this curriculum contain similar activities; the Intermediate version contains more activities and vocabulary. Pages 298-312 cover salmonid anatomy and dissection and the functions of anatomical features. Activities suggested here are taken from the Intermediate edition. You can look up their counterparts in the Primary edition if they seem to be too difficult for your students. This curriculum is available from Lesson Aids Service, B.C. Teachers' Federation, 2235 Burrard Street, Vancouver, B.C., Canada, V6J 3H9, (800) 663-9163, FAX 737-9593.

4. Fashion a Fish, Project Wild Aquatic, pp. 56-60. This is an activity in which students learn about the evolutionary adaptations of fish, which help them to survive in their environments. Students design a particular fish whose adaptations are determined from "adaptation cards" which depict coloration, mouth type, body shape and reproductive adaptations. They fashion their fish from these adaptive characteristics, then report their fish to the class. You can then use these learning's about evolutionary adaptations to open a discussion of the anadromous life cycle of the salmon as a particular adaptation. (See the Bibliography for ordering address.)

5. Have students research various physical adaptations that salmon species exhibit throughout their life cycle which change their appearance or behavior such as: coloration, physiological adaptations, or mating behaviors. You can organize students into groups by species or adaptation. They should make posters, which communicate their assigned information, and provide written descriptions detailing the adaptation or behavior. The posters and written descriptions should be posted on the bulletin board so that students can refer to them during other Salmon Watch activities.

6. California's Salmon and Steelhead, Our Valuable Natural Heritage, pp. 18-36, contains a series of dissection and recitation activities on salmonid anatomy, finishing with a fish printing activity in which students make ink or paint prints from an actual salmon, and generate a life-sized drawing of a salmon from a smaller picture. (See the Bibliography for ordering address.)

7. Look up the World Wide Web address, http://www.streamnet.org/, for a very useful source of information about salmon. This is the StreamNet home page that contains an online database of information about salmon, the life history and ecology of species, color species of a male and female of each species listed, and extensive data on salmonids and their habitats. It might be used to organize Units 1-3 for your students.

8. Order the 25-minute film, Life of the Sockeye Salmon. Show the film, and then set out reference material on salmonid species. Introduce or review the names of all the species of Pacific Salmon (coho, sockeye, chinook, pink, chum, and the two sea-run trout: steelhead and cutthroat). Explain that their life cycles are similar to the sockeye, but differ in number of eggs deposited, length of time spent in the ocean, weight, length, and use (commercial, sport, subsistence). A detailed study of life cycle differences can be done using the Field Guide to the Pacific Salmon and other reference materials.

9. Use the film to compare the life cycle of the sockeye with other species of Pacific Salmon. The film explores the needs of the sockeye during each stage of its life cycle, the fishing industry, which is dependent on sustained fish runs, and the hazards, which may prevent salmon from living out their life cycles. It is available for rent from:

   Continuing Education Film Library 1633 SW Park Avenue
   PO Box 1383
   Portland, OR 97207
   (503) 229-4890
   (Refer to film no. 12240)

10. Salmon Life Cycle, Stream Scene, pp. 169-172. This section contains more information on the salmonid life cycle, which students can use in a class work or homework activity.

11. Hooks and Ladders, Project Wild Aquatic, pp. 43-48. This is a kinesthetic activity, which introduces the student to some of the hurdles fish must overcome during migration. Students play the roles of fish or obstacles to the migration of fish such as a dam or rapids.

12. California's Salmon and Steelhead, Our Valuable Natural Heritage, pp. 37-75, contains several interesting life cycle activities for students at all levels. Included are drawings, readings, art constructions, poetry, and mathematics vehicles for delivering information about salmonid life cycles.

UNIT 4E. SALMON SUPPLEMENTAL INFORMATION LIST

#	INFORMATION	PREPARED BY
4E-1	*A Changing Columbia Basin, 1770-Present*	Oregon State University
4E-2	*Causes of Salmon Mortality 1770 –Present*	Oregon State University
4E-3	*Table 1. WHERE ARE THE SALMON, WHEN?*	Pacific States Marine Fisheries Commission
4E-4	*Table 2. Salmonid Habitat Requirements*	Various Authors

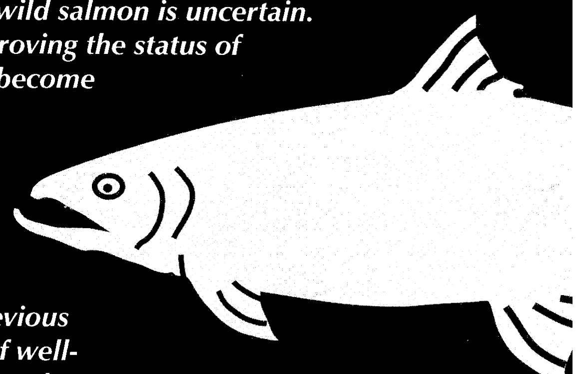
SALMON HANDOUT 4E-1

A Changing Columbia Basin, 1770-Present

Since the 1700s, when the human impact on salmon was limited to native fisheries, salmon have been increasingly affected by the Northwest's growing population and economy.

The first major European impact on the natives of the Columbia River occurred in the 1770s; by the mid-1800s, European diseases had reduced their population by 90% and the Columbia's resources were being exploited for the benefit of the European population. By the 1890s, dams were significantly affecting salmon runs; hydroelectric and flood-control projects eventually reduced the area available to salmon by half. Salmon of the Columbia are also affected by grazing, irrigation, logging, mining, overfishing, pollution, urbanization, ocean conditions, and predators.

As the Northwest's population and economy grow, the future of wild salmon is uncertain. Plans for improving the status of salmon have become increasingly common, but many projects simply undo the damage caused by previous generations of well-intentioned developers. A historical perspective is essential for understanding the current and future status of salmon and steelhead in the Columbia Basin.

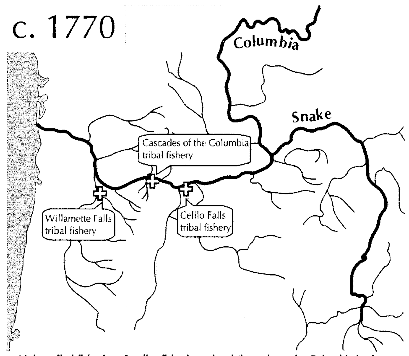


How has the Columbia changed from 1770 to the present? These maps and graphs illustrate how humans have altered the river and how these alterations have affected salmon survival.

SALMON HANDOUT 4E-1

A Changing Columbia Basin, 1770-Present

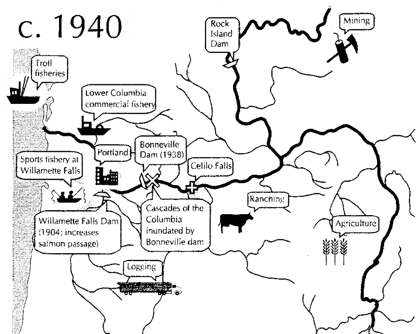
c. 1770



Major tribal fisheries. Smaller fisheries existed throughout the Columbia basin.

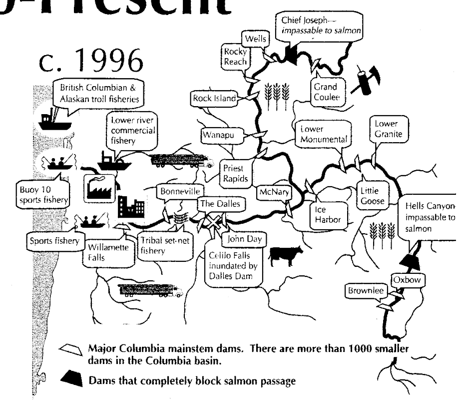
"We were but few, while the white men were many . . . we could not hold our own with them. We were like deer. They were like grizzly bears. . . . We were contented to let things remain as the Great Spirit Chief made them. They were not; and would change the rivers and mountains if they did not suit them." — Chief Joseph of the Nez Percé, c. 1879

c. 1940



"To build an industrial empire from the wasted power of the Columbia . . . They moved mountains and froze a land slide. . . . Bonneville and Grand Coulee are only the beginning. Ten million horsepower of new energy swiftly can be harnessed on America's mightiest stream. Tame the hazardous rapids. Open the Columbia waterway to navigation 500 miles inland. Provide endless water power . . . Reclaim another million acres of dry but fertile land." —BPA film "The Columbia," c. 1950

c. 1996

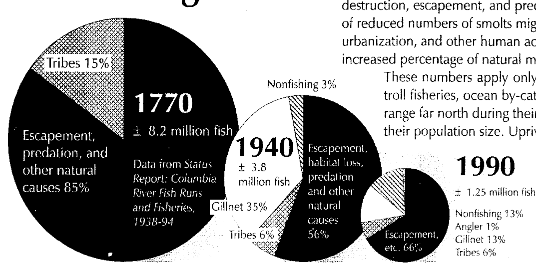


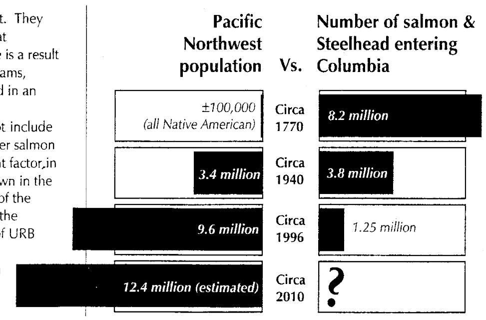
"Fish are to the northwest what wheat is to Kansas. Fish are this big integrator. They spawn 900 miles inland and they travel to the ocean all along the coast. They bind this region together." —Ed Chaney (Idaho fishery consultant). "Salmon are part of the heart and soul of the Pacific Northwest. They have defined its history, and its culture, and hopefully its future." —Will Stelle Jr. (National Marine Fisheries Service)

Diminishing Returns

These pies show the relative size of returning salmon runs from 1770 to the present. They compare in-river harvest, dam-induced mortality, and other losses caused by habitat destruction, escapement, and predation. In addition to adult mortality, run decline is a result of reduced numbers of smolts migrating to the ocean (due to habitat destruction, dams, urbanization, and other human activities). Fishing reductions in 1990 have resulted in an increased percentage of natural mortality.

These numbers apply only to returning Columbia River salmon and do not include troll fisheries, ocean by-catch, El Niño or other factors. Since Columbia River salmon range far north during their life in the ocean, ocean mortality is an important factor,in their population size. Upriver bright fall Chinook salmon (URBs), which spawn in the Hanford Reach—the last undammed stretch of the Columbia—are a good example. In 1985-94 the Canadian fishery was responsible for 48.9% of URB fishing mortality, while Alaskan trollers accounted for 29.8%. (*Source*: Pacific Salmon Commission Joint Chinook Technical Committee 1994 Annual Report).





SALMON HANDOUT 4E-2

Causes of Salmon Mortality 1770 – Present

Mortality Circa 1770:

Natural mortality of salmon was due to factors like natural death after spawning; predators, including mammals, birds and other fish; and naturally occurring population fluctuations caused by ocean and river conditions. Tribal fisheries were the only human impacts at this time.

Mortality Circa 1940:

The ratio of natural mortality declines was due to human activity such as commercial fishing, trapping of beaver which reduced rearing habitat in beaver ponds; overgrazing resulted in damage to streamside vegetation; river corridors and estuaries were affected by urbanization; the use of splash dams for logging destroyed stream beds; hydroelectric facilities and irrigation dams on tributaries blocked access to spawning areas; water drawn for irrigation, industry, cities, and towns reduced river flow; and water quality was degraded by a wide variety of causes.

Mortality Circa 1996:

Mortality in the ocean increased with El Nino conditions and ocean trolling in Alaska and British Columbia. The Chief Joseph and Hells Canyon dams blocked passage to large areas of habitat. Other large dams caused 5% or more mortality (per dam) for smolts descending to the sea and adult salmon returning to spawn. Dams also changed water temperatures, reduced flow of rivers, increased nitrogen levels, and allowed more predation by Northern Pike Minnow and other predators. The destruction and filling of wetlands and estuaries reduced habitat. Forest harvest operations may have resulted in increased silt, reduced shade, and disturbed spawning beds. Urbanization, i.e. the spread of cities, roads, and other development, reduced habitat and increased pollution. Over withdrawal of water for irrigation for agriculture frequently reduced flow of rivers. Unscreened water diversions trapped fish in ditches (in 1990, less than 5% of the diversions in Oregon were screened).

Hatchery fish often increased disease rates and reduced diversity of wild stocks. Improper grazing of livestock harmed inland spawning habitat by destroying vegetation and polluting streams. Physical or natural disasters, such as landslides and floods, also influenced salmon mortality rates.
Out of approximately 1000 original wild native anadromous stocks found in Oregon, Washington, and California, 106 are now extinct and 314 are at risk of extinction. Currently, hatcheries produce two-thirds of the salmon found in the Columbia River.

SALMON HANDOUT 4E-2

Attempts to improve salmon survival include:

Improved fish passage facilities at dams; streamside or riparian buffers in logged areas (specific requirements spelled out in the Oregon Forestry Practices Act); barging or trucking of salmon smolts past dams; habitat enhancement; a Northern Pike Minnow bounty to reduce predation; regulation of commercial and recreational catches; additional spill from reservoirs to increase flow speed during smolt out-migration and to promote more natural riverbeds; improved hatchery practices; and adoption of fish friendly road construction and culvert standards.

(Adapted from: Gilden, Jennifer, Smith, Courtland, Department of Anthropology, Oregon State University. Research funded by Sea Grant Oregon through NOAA. Sea Grant Oregon, Oregon State University 1998.)

SALMON HANDOUT 4E-3

Table 1. WHERE ARE THE SALMON, WHEN?

Generalized Life History Patterns of Salmon, Steelhead, and Trout in the Pacific Northwest

	ADULTS RETURN TO STREAMS FROM OCEAN	SPAWNING LOCATION	EGGS IN GRAVEL	YOUNG IN STREAM	FRESH WATER HABITAT	YOUNG MIGRATE DOWNSTREAM	TIME IN ESTUARY	TIME IN OCEAN	ADULT WEIGHT (average) English(Metric)
COHO	Sept. –Jan	coastal streams shallow tributaries	Sept -May	1+ years	tributaries, main stem side channels, and slack water	Mar-Jul (2nd year)	few days to one month	2 years	5-20 lb (8)
CHUM	Sept. –Jan	coastal rivers and streams, lower reaches	Sept-Mar	days-weeks	little time spent in freshwater	shortly after young leave gravel	7-14 days	2.5-3 years	8-12 lb. (10)
CHINOOK **Spring run** **Summer run** **Fall run**	Jan. – July Jun-mid Aug Aug. – Nov.	main stem-large and small rivers	Jul-Jan Sept-Nov Sept-Mar	1+ years 1+ years 3-7 months	main stem-large and small rivers	Dec – Mar. (2nd year) Spring (2nd year) Dec. - Mar (2nd year)	days-months	2-5 years	10-20 lb. (15) 10-30 lb. (14) 15-40 lb.
CUTTHROAT (Coastal-Sea Run)	Jul-Dec	tiny tributaries of coastal streams	Dec-Jul	1-3 years (2 avg)	tributaries	Mar-Jun (of 2nd-4th yr)	days-months	0.5-1year	0.5-4 lb (1)
PINK	Jul-Oct	main stem of streams, tributaries, and lower reaches	Aug.-Jan	days-weeks	little time spent in freshwater	Dec-May	few days	1.5 years	3-10 lb (4)
SOCKEYE	Jul-Aug	streams, usually near lakes	Aug. –Apr	1-3 years	lakes	Apr-Jun (of 2nd-4th yr)	few days	1-4 years	3-8 lb (6)
STEELHEAD **Winter run** **Summer run**	Oct-Jun Jun-Oct (Columbia) Apr-Nov (Coastal)	tributaries and small and mid-size streams and rivers	Feb-Jul Dec-May Feb-Jun Feb-Jul	1-3 years 1-2 years 1-2 years 1-3 years	tributaries	Mar-Jun (of 2nd – 5th yr) Spring & Summer (of 3rd- 4th yr) Mar-Jun (of 3rd- 5th yr) Mar-Jun (of 2nd- 5th yr)	less than a month	1-4 years	5-28 lb (8) 5-20 lb 5-30 lb (8)

Adapted by Pacific State Marine Fisheries commission. Sources: Ocean Ecology of North Pacific Salmonids, Bill Pearcy, University of Washington Press, 1992 Fisheries Handbook of Engineering Requirements and Biological Criteria, Milo Bell, U.S. Army corps of Engineers, 1986; Adopting A Stream, A Northwest Handbook, Steve Yates, Adopt-A Stream Foundation, 1988.

SALMON HANDOUT 4E-4

Table 2. Salmonid Habitat Requirements
Oregon Coastal Streams
Spawning (including upstream migration)

	Migration	Spawn Time	Location	Substrate Size	Water Depth	Water Velocity	Dissolved Oxygen	Spawning Water Temp	Percent Fines Tolerable	Notes
Chinook – Fall	Sept-Dec	Oct- Jan	Mainstem and large tributaries	Pea to Orange (1.3-10.2 cm)	Extremely variable 0.05-7 m	0.1 – 1.5m/s; max is 2.4 m/s	> 5 mg/l	5.6-13.9°C	Fines (<6.4 mm) make up less than 25% of substrate	Large body size limits movement over barriers
Chinook-Spring	Mar-Jun	Late Aug -Oct	Upper mainstem streams	Pea to Orange (1.3-10.2 cm)	Extremely variable 0.05-7m	.21-1.5 m/s; max is 2.4m/s	>5 mg/l	5.6 – 13.9°C	Fines (<6.4 mm) make up less than 25% of substrate	Require deep water for travel-pools for summer habitat
Coho	Sept-Jan	Sept - Jan	Small tributaries	Pea to Apple (1.3-9.0 cm)	0.18 – 1 m	0.08 – 0.11 m/sec; max is 2.4 m/s	>8 mg/l	4.4-14°C	Fines (<6.4 mm) make up less than 25% of substrate	Primary target for many sport fisherman
Chum	Oct -Dec	Nov-Dec	Lower mainstem and tributaries	Pea to Orange (0.5-10.2 cm)	13-50 cm; ideal 21cm	0.21-0.83 m/s; max is 2.4 m/s	>5 mg/l; above 80% saturation best	7.2-12.8°C	Fines (<6.4 mm) make up less than 25% of substrate	Strong swimmer but doesn't jump
Steelhead-Winter	Nov-May	Dec -May	Small & mid-size tributaries with moderate gradient	Pea to Apple (0.5-9.0 cm)	> 18 cm	<2.4 m/s	>5 mg/l	3.9-9.4°C	Fines (<6.4 mm) make up less than 25% of substrate	May spawn more than once
Steelhead-Summer	May-Jul	Jan-Jun	Small & mid-size tributaries with moderate gradient	Pea to Apple (0.5-9.0 cm)	>18 cm	<2.4 m/s	>5 mg/l	3.9-9.4°C	Fines (<6.4 mm) make up less than 25% of substrate	May spawn more than once
Sea Run Cutthroat Trout	Jun-Oct	Dec-Feb	Small headwater tributaries 1st & 2nd order streams	Pea to Golf Ball (0.5-7.5 cm)	0.01 –1 m; 10-15 cm best	0.11-0.90 m/s; max is 2.4m/s	>5 mg/l	6-17°C; best is 10°C	Fines (<6.4 mm) make up less than 25% of substrate	May spawn more than once

SALMON HANDOUT 4E-4

Salmonid Habitat Requirements
Oregon Coastal Streams

	Incubation				**Rearing**				**Status**
	Incubation Temp.	**Fry Emerge**	**Fry Habitat**	**Juvenile Habitat**	**Preferred Temp.**	**Freshwater Residency Period**	**Estuary Residency Period**	**Notes**	**2004 Status**
Chinook – Fall	0.0-20°C; best 5.0-14.4° C	Mar-May	Stream; river edges	Deeper water in main river channel	7.3-14.6° C Growth stops at 20.3° C lethal at 25.2° C	Days to 2 or 3 months Fall smolt	Extensive 5-6 months April-Oct.	Estuaries play a vital role in survival of young	Healthy and stable
Chinook-Spring	0.0-20°C; best 5.0-14.4° C	Feb-Mar	Stream; river edges	Deeper water in main river channel	7.3-14.6° C Growth stops at 20.3° C lethal at 25.2° C	Days to 2 or 3 months Fall smolt	Extensive 5-6 months April – Oct	Large body size limits movement over barriers	Depressed
Coho	4.4-13.3° C	Feb-June	Backwater pools and stream edges	Pools in summer, off channel alcoves, ponds, dam pools with complex cover in winter	11.8 – 14.6° C Growth stops at 20.3° C Lethal at 25.8° C	One year Spring smolt	Move through 2-9 days, sometimes longer	Low pH (<5.01) can be lethal to alevins	Depressed
Chum	4.4 – 13.3°C	Late Mar-Apr	Move directly into estuary	High sediment levels (15.8-54.9 g/l) will kill juveniles	6.7 – 14.6°C Growth stops at 20.3°C lethal at 25.8°C	Hours to few days, leave quickly Spring smolt	2-32 days	Use estuaries immediately for food and adjustment	Depressed
Steelhead Winter	4.4- 13.3° C	May – June	Stream edges	Pools, riffles, and runs of tributary, streams, complex habitat with, large woody debris, (LWD) preferred	7.3-14.6°C Growth stops at 20.3° C Lethal at 24.1° C	2-3 years Spring smolt	Move through in days	Good habitat =small and large wood complexity	Depressed
Steelhead-Summer	4.4 – 13.3°C	May-June	Stream edges	Pools, riffles, and runs of tributary, streams, complex habitat with, large woody debris, (LWD) preferred	7.3 – 14.6°C Growth stops at 20.3° C lethal at 24.1°C	2-3 years Spring smolt	Move through in days	Summer steelhead require deep cool pools to live in before spawning	Primarily hatchery fish
Sea Run Cutthroat Trout	6.1 – 17.2°C	Mar-May	Stream edges and backwater pools, large wood, (LWD) important	Prefer pools but are often displaced by coho or steelhead, low velocity pools, and side channels	9.5-12.9°C Growth stops at 20.3°C lethal at 23.0°C	2-4 Years Spring smolt	Used extensively as adults before upstream migration	Rearing in estuary is common	Depressed

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2. Groot, C. and L. Margolis, 1991. *Pacific Salmon Life Histories*. University of British Columbia Press, Vancouver, British Columbia
3. Nickelson, T., J. Nicholas, A. McGie, R. Lindsay, D. Bottom, R. Kaiser, and S. Jacobs. 1992. *Status of Anadromous Salmonids in Oregon coastal Basins*. Oregon Dept. of Fish and Wildlife. Corvallis, OR
4. Reiser, D.W. and T.C. Bjornn, 1979 Habitat Requirements of Anadromous Salmonids. In W.R. Meehan (editor), *Influence of forest and rangeland management on anadromous fish habitat in western North America*, US Forest Service General Technical Report PNW-96 Pacific Northwest Forest Range Experiment Station, Portland, OR.