6450-01-P

DEPARTMENT OF ENERGY

Bonneville Power Administration

Finding of No Significant Impact for Lower Columbia River Terminal Fisheries Research Project

AGENCY: Bonneville Power Administration (BPA), Department of Energy (DOE).

ACTION: Finding of No Significant Impact (FONSI)

SUMMARY: This notice announces BPA's decision to fund the Oregon Department of Fish and Wildlife (ODFW), the Washington Department of Fish and Wildlife (WDFW), and the Clatsop Economic Development Committee for the Lower Columbia River Terminal Fisheries Research Project (Project). The Project will continue the testing of various species/stocks, rearing regimes, and harvest options for terminal fisheries, as a means to increase lower river sport and commercial harvest of hatchery fish, while providing both greater protection of weaker wild stocks and increasing the return of upriver salmon runs to potential Zone 6 Treaty fisheries.

The Project involves relocating hatchery smolts to new, additional pen locations in three bays/sloughs in the lower Columbia River along both the Oregon and Washington sides. The sites are Blind Slough and Tongue Point in Clatsop County, Oregon, and Grays Bay/Deep River, Wahkiakum County, Washington. The smolts will be acclimated for various lengths of time in the net pens and released from these sites.

The Project will expand upon an existing terminal fisheries project in Youngs Bay, Oregon. The Project may be expanded to other sites in the future, depending on the results of this initial expansion. BPA has determined the project is not a major Federal action significantly affecting the quality of the human environment, within the meaning of the National Environmental Policy Act (NEPA) of 1969.

Therefore, the preparation of an environmental impact statement is not required, and BPA is issuing this FONSI.

ADDRESS: For copies of this FONSI, please call BPA's toll-free document request line: 800-622-4520.

FOR FURTHER INFORMATION, CONTACT: Kelly Kittel, Environmental Project Manager, ECN, Bonneville Power Administration, P.O. Box 3621, Portland, Oregon, 97208-3621, phone number 503-230-4960, fax number 503-230-5699.

Public Availability: This FONSI will be distributed to all persons and agencies known to be interested in or affected by the proposed action or alternatives.

SUPPLEMENTARY INFORMATION: BPA is responsible for funding measures consistent with the Northwest Power Planning Council's (Council) 1994 Columbia River Basin Fish and Wildlife Program (Program), as amended. The goal of the Program is to increase the average annual returns of adult anadromous fish (salmon and steelhead) to the Columbia River Basin by approximately 2.5 million fish. The Council recently amended its Program, and two amendment measures request the investigation of terminal fishing opportunities to reduce potential mainstem harvest pressure on depressed salmon stocks. The need for this proposed action is based upon the Council's language recommending a study of "terminal fishing opportunities to harvest abundant stocks while minimizing the incidental harvest of weak stocks."

Beginning in 1993, BPA initiated the Project, a 10-year comprehensive program to investigate the feasibility of terminal fisheries in Youngs Bay and other sites in Oregon and Washington. Terminal fisheries are being explored as a means to increase the sport and commercial harvest of hatchery fish, while providing greater protection of weak wild salmon stocks. BPA prepared an Environmental Assessment (EA) (DOE/BP-2024, April 1993) for the funding of the establishment of net pens in Youngs Bay, Oregon, for coho rearing and release. BPA also prepared a Categorical Exclusion in May 1994, to perform research activities to identify and evaluate potential sites for expansion of this program.

This Project is designed to continue research on terminal fisheries in Youngs Bay and at three additional terminal sites within the lower Columbia River. These studies involve net pen culturing of various species or stocks (early coho and late coho (*Oncorhynchus kisutch*), Willamette spring chinook, Cowlitz spring chinook, Rogue River bright fall chinook, upriver bright fall chinook, and Tule fall chinook (*Oncorhynchus tshawytscha*)) under varying management and rearing regimes. Net pen rearing regimes evaluated under this demonstration project include: (1) 2-week net pen acclimation (all species); (2) overwinter net pen rearing (coho and spring chinook); and (3) full-term net pen rearing (fall chinook). Additional studies will evaluate fish survival, rearing densities in net pens, stock release timing, stock composition in terminal fisheries, incidence and implications of any adult salmon "straying", continued water quality monitoring, and test fishing. For further discussion of the need for the project and a description of environmental effects, please refer to the EA.

This Project enables the participating entities to continue with their research on terminal fisheries as a means to halt the decline in the salmon fishery and to protect depleted wild stocks from harvesting. The additional sites were selected based on research which showed they had the lowest incidences of bycatch.

Consultation with the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service, the ODFW, and the WDFW revealed no controversial or unusual environmental concerns. Assessment of the action did not reveal any unknown or unique risks or any highly controversial effects. Resources which may be potentially affected, as addressed in the EA, include water quality, biological resources, recreation, and aesthetic resources. The impacts are expected to be minor and/or temporary, and monitoring will be implemented where necessary.

Water quality could be affected from nutrients and suspended solids added to the water from uneaten fish food, waste products, and net cleaning. The fish food and waste products are not expected to increase turbidity enough to exceed water quality standards and will be controlled by limiting the number of pens deployed and the density of fish per pen. The natural flushing actions of these areas should also minimize any opportunity for adverse effects. The net pens will be removed from the water for cleaning if there is a chance of exceeding the water quality standards.

Biological resources in the form of native salmon stocks may be impacted by competition for food and habitat when the smolts are released or when the adults return, but there is little conclusive evidence to suggest that this is likely to occur due to limited interactions and timing constraints. Benthic communities could be affected by particulate organic inputs from uneaten food and fish waste products and by inorganic material deposition. Monitoring and experience at Youngs Bay have not detected any adverse effects due to natural flushing. Monitoring will continue at Youngs Bay and will be implemented at the new sites.

Several species of non-anadromous fish and shellfish could be beneficially affected due to increased habitat and cover for fish and increased food sources from uneaten fish food, as well as a variety of species which attach to the submerged portions of the net pens. These same species could be adversely affected if the net pens are placed over important habitat areas and smothered, but there are no known sensitive habitats in the proposed areas, and any impacts would be mitigated by natural flushing.

NMFS has been consulted annually regarding potential impacts on listed salmon stocks. NMFS' annual biological opinions have found these actions would not jeopardize any listed species. These annual consultations will continue throughout the project's eight-year time frame. Test fishing and harvesting pose the only potential impact to other listed marine species, but no significant adverse impacts are anticipated due to past history and the small size and shape of some species. The potential for disease transmission will be minimized by using known salmon stocks and through a comprehensive disease detection and diagnosis program. The lower fish densities in net pens as compared to hatchery settings reduce the opportunity for disease outbreak and transmission. There is also a concern about straying, but an aggressive coded-wire tag program has indicated that this has not been a problem in the past and is therefore unlikely to present a problem in this research program. For the Rogue River fall chinook stock, all smolts will be ventral fin clipped in addition to coded-wire tagging.

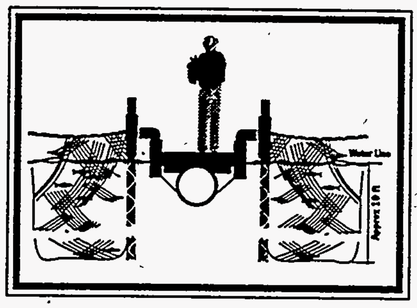
Water-dependent recreation and navigation could be impacted due to the presence of net pens, but the sites have been chosen where there is a minimal chance of disruption. Aesthetic resources could be affected via minor alterations in visual quality, odor, and noise, but all of these are considered negligible or not significant.

DETERMINATION: BPA determines that this project is not a major Federal action significantly affecting the quality of the human environment within the meaning of NEPA, 42 U.S.C. 4321 <u>et seq</u>. Therefore, an environmental impact statement will not be prepared and BPA is issuing this FONSI.

Issued in Portland, Oregon, on

LOWER COLUMBIA RIVER TERMINAL FISHERIES RESEARCH PROJECT

Final
Environmental Assessment



U.S. Department of Energy
Bonneville Power Administration
Environmental Project Manager—ECN-1500
P.O. Box 3621
Portland, Oregon 97208

April 1995

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1.0 INTRODUCTION

1.1 Proposed Action

The U.S. Department of Energy, Bonneville Power Administration (BPA), is responsible for funding measures consistent with the Northwest Power Planning Council's (Council's) 1994 Columbia River Basin Fish and Wildlife Program (Program), as amended. The goal of the Program is to increase the average annual returns of adult anadromous fish (salmon and steelhead) to the Columbia River Basin by approximately 2.5 million fish.

Beginning in 1993, BPA initiated the Columbia River Terminal Fisheries Research Project (Project), a 10-year comprehensive program to investigate the feasibility of terminal fisheries in Youngs Bay and other sites in Oregon and Washington (BPA 1993). Terminal fisheries are being explored as a means to increase the sport and commercial harvest of hatchery fish while providing greater protection of weak wild salmon stocks.

BPA proposes to fund actions designed to continue research on terminal fisheries in Youngs Bay and at three proposed additional terminal sites within the lower Columbia River: Tongue Point Basin, Blind Slough, and Grays Bay/Deep River (Figure 1). These studies might involve net pen culturing of various species or stocks (early coho and late coho [*Oncorhynchus kisutch*], Willamette spring chinook, Cowlitz spring chinook, Rogue River bright fall chinook, upriver bright fall chinook, and Tule fall chinook [*Oncorhynchus tshawytscha*]) under varying management and growout regimes. All fish culture regimes would be conducted under the criteria and policies of the Integrated Hatchery Operations Team.

Net pen rearing regimes that would be evaluated under this demonstration project include: (1) 2-week net pen acclimation (all species); (2) over-winter net pen rearing (coho and spring chinook); and (3) full-term net pen rearing (fall chinook) (Figure 2). Additional studies will evaluate fish survival, rearing densities in net pens, stock release timing, stock composition in terminal fisheries, incidence and implications of any adult salmon "straying," continued water quality monitoring, and test fishing.

Youngs Bay net pens could increase from 72 to 100. Between 5 to 30 net pens would be deployed at Blind Slough and Grays Bay/Deep River. Between 10 to 50 net pens would be deployed at Tongue Point Basin. The actual number of pens that would be deployed is a function of research design, water quality, and other site-specific environmental conditions, fiscal priorities, and availability of hatchery fry.

1.2 Purpose and Need for Action

The Council recently amended its Columbia River Basin Fish and Wildlife Program in response to the urgent need to protect, conserve, and rebuild Snake River salmon stocks that have been listed as endangered and threatened under the Endangered Species Act (ESA). Two program amendment measures request investigation of terminal fishing opportunities to reduce potential mainstem Columbia River harvest pressure on depressed Columbia River Basin salmon stocks (Council 1994). The need for the proposed actions is based upon the Council's specific amendment language recommending a study of "terminal fishing opportunities to harvest abundant stocks while minimizing the incidental harvest of weak stocks."

1.3 Goals and Objectives

The goal of the Project is to determine the feasibility of creating or expanding terminal, known stock fisheries in the Columbia River Basin to allow harvest of strong anadromous

FIGURE 1
Site location map.

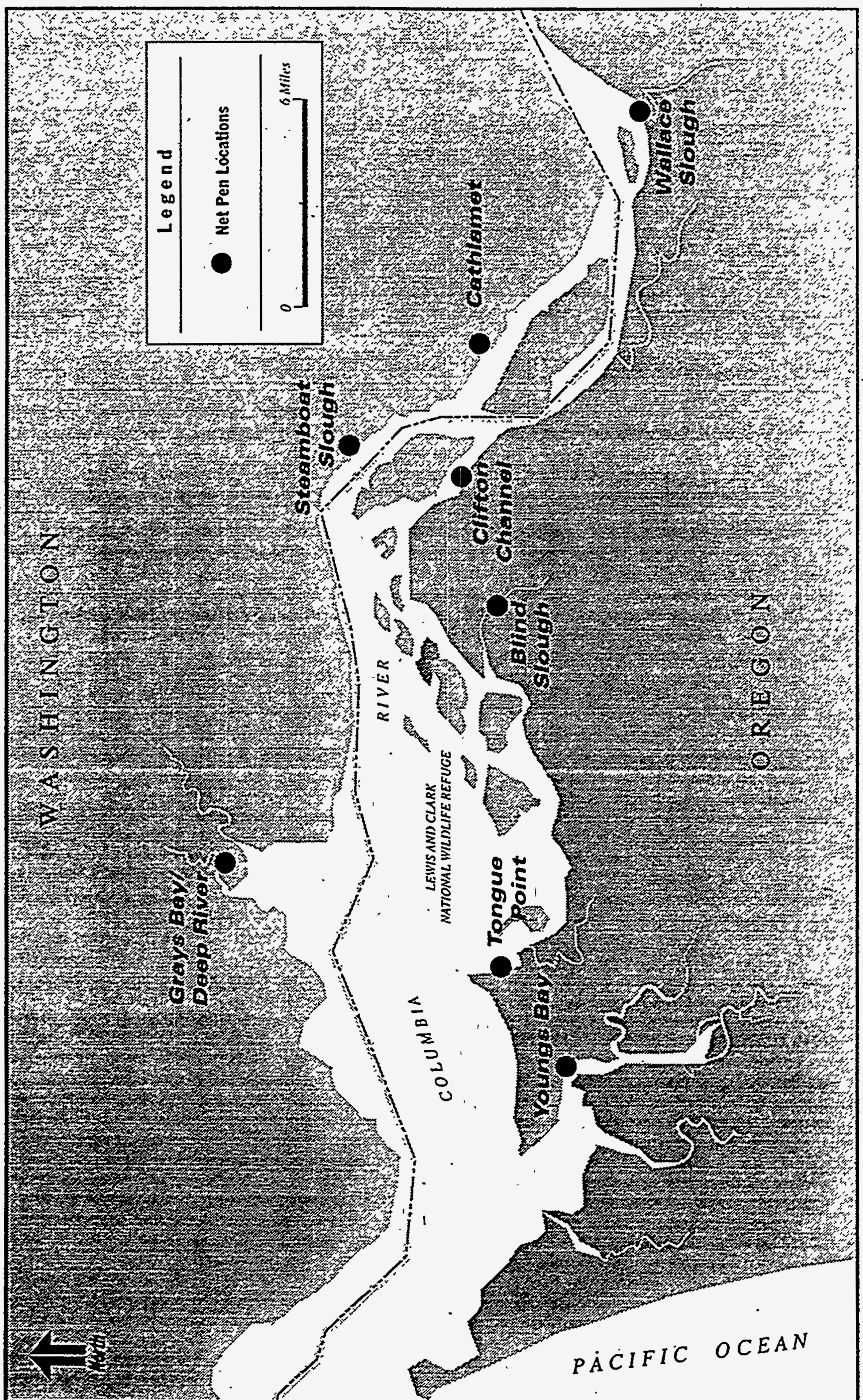
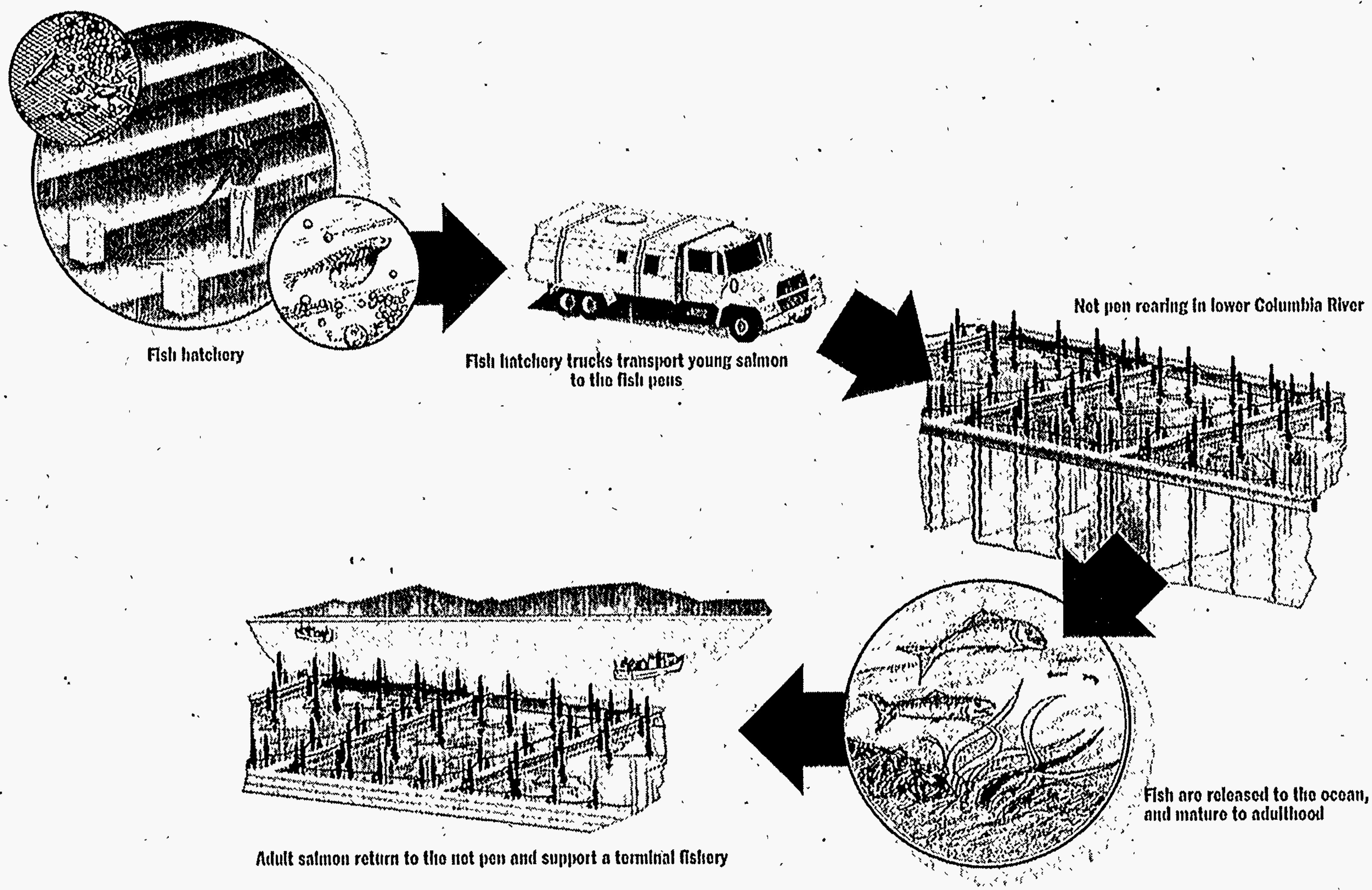


FIGURE 2
Net pen cycle.



salmonid stocks while providing greater protection to depressed fish stocks. This goal is to be accomplished by addressing 12 defined project objectives:

1. Survey and categorize potential terminal fishing sites in the Columbia River Basin for basic physical characteristics (low, medium, and high).

2. Determine the capability of the medium and high terminal fishing sites for rearing and acclimating anadromous fish species in net pens or other facilities.

3. Determine the capacity of the medium and high terminal fishing sites to allow manageable and economically competitive harvest of returning fish.

4. For the medium- and high-terminal fishing sites, determine the potential for harvest of non-targeted fish species.

5. Determine the generic costs and logistics of a large-scale net pen rearing program (overwinter rearing and short-term acclimation) and estimate the variables for each of the medium- and high-terminal fishing sites.

6. Describe the economic and social benefits of a large-scale terminal fishery program compared to a future condition without such a program.

7. Evaluate the suitability of various anadromous fish stocks for use in the medium- and high-terminal fishing sites.

8. Evaluate the effects of a large-scale net pen rearing program (overwinter rearing and short-term acclimation) for terminal fishing on hatchery production programs.

9. Determine potential environmental effects of net pen rearing and terminal harvest on physical and biological variables (including straying) for permits, ESA, and National Environmental Policy Act (NEPA) processes.

10. Determine the effects on upriver fish runs, escapements, and Zone 6 fisheries of shifting various levels of historical Zone 1-to-5 commercial fisheries to terminal sites (see Figure 3 for delineations of commercial fishery zones).

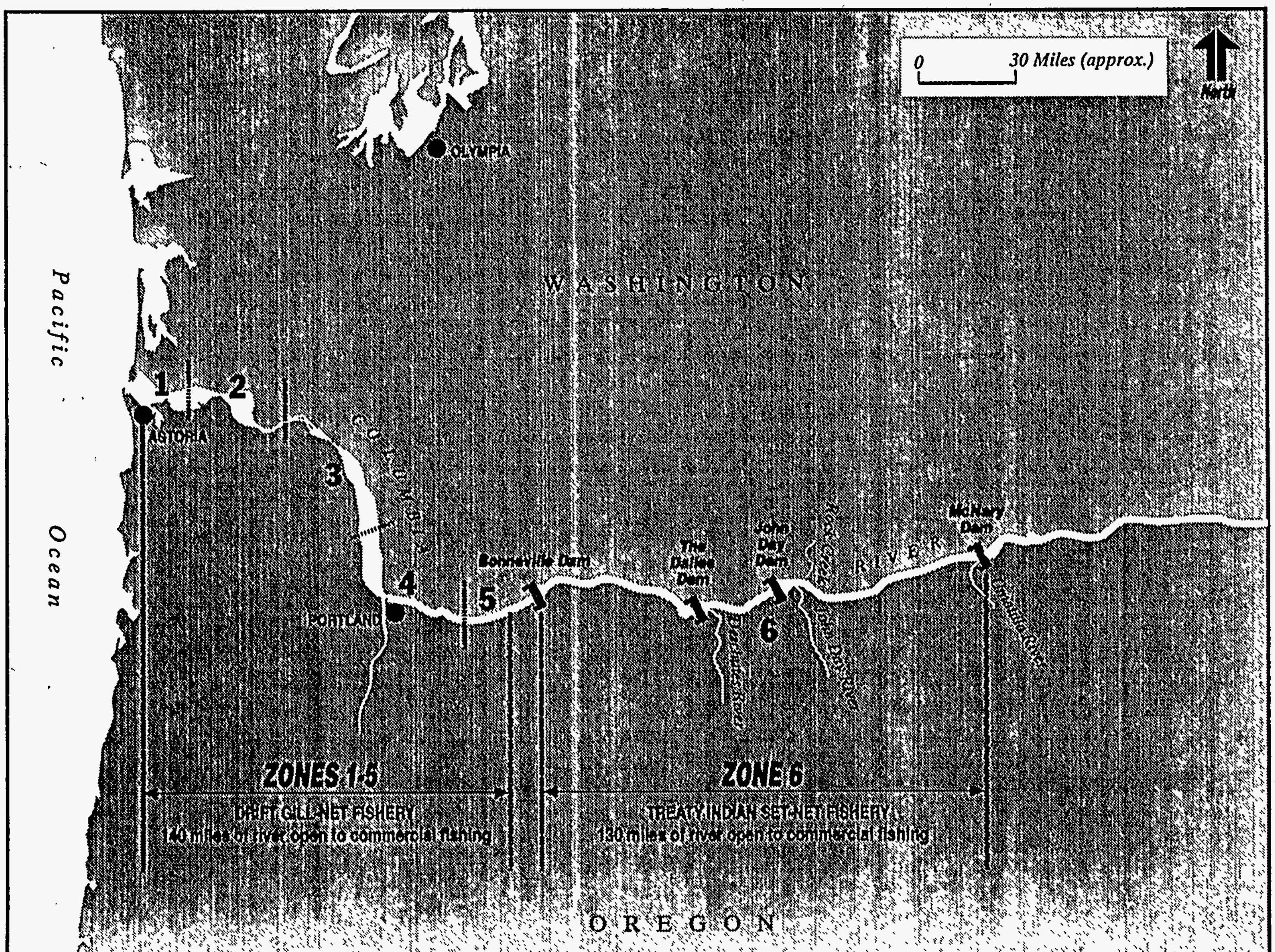
11. Describe state legislative and regulatory changes, and Federal ocean management guidelines necessary to facilitate and support a terminal fisheries program.

12. Evaluate the potential role of fisher and processor financial contributions in maintaining a terminal fishery program, including options for cooperative associations.

The actions proposed in this environmental assessment (EA) are designed to address the objectives described above through various planned or ongoing research, development, and demonstration activities that would be conducted during the remaining 8 years of the Project.

FIGURE 3

Map of the Columbia River below McNary Dam showing areas open to commercial fishing.



2.0 BACKGROUND

2.1 Results of Previous Investigations

Investigations of terminal fisheries in the lower Columbia River began in the early 1970s with releases of Mitchell Act hatchery coho salmon smolts into Youngs Bay (Vreeland et al. 1975, Vreeland and Wahle 1983). The Clatsop Economic Development Council's (CEDC) first hatchery and smolt rearing sites were land-based facilities located on two tributaries of Youngs Bay: Tucker Creek and the South Fork Klaskanine River. These facilities consisted of three earthen rearing ponds, egg incubation, and early rearing facilities. Study results showed that smolts imprinted to Youngs Bay and homed there as returning adults with minimal straying. Coho released in 1971 from earthen ponds into Youngs Bay survived and contributed to ocean and in-river fisheries at a much higher rate than the control fish released directly from the North Fork Klaskanine River Hatchery.

The CEDC facilities used a volitional smolt-release rearing program in which retaining screens were removed and pond levels maintained at or near full capacity to allow outmigration to occur when such activity was naturally triggered (Hill and Olson 1989). These smolts augmented the quantity of salmon produced by Oregon Department of Fish and Wildlife's (ODFW's) North Fork Klaskanine River Hatchery, which has operated since the 1930s to enhance Youngs Bay fish production.

In 1977, CEDC began a hatchery program of rearing and releasing chinook, coho, and chum salmon (*O. keta*) into Youngs Bay to augment the terminal fishery. Total CEDC and ODFW releases of salmon into Youngs Bay grew from 1.18 million coho smolts in 1977 to 5.06 million coho smolts in 1993 (Table 1). Fall chinook releases peaked at 7.34 million in 1986 and declined to zero in 1993 (Table 2). Funding for the terminal fisheries project has come from numerous sources, including ODFW, Youngs Bay fishers and processors, BPA, Clatsop County, Port of Astoria, National Coastal Resources Research and Development Institute, and the U.S. Economic Development Administration.

In 1987, CEDC began a net pen rearing program in Youngs Bay. This program was established to expand rearing capacity, to augment production, to improve local imprinting, and to enhance adult salmon returns to Youngs Bay. The first experimental net pens were deployed approximately 800 meters (m) (0.5 mile [mi]) above the old Youngs Bay Bridge near Tide Point. Eight pens were initially deployed at this site.

The design configuration of the net pen has evolved through trial and error. Today, the standard net pen uses a 6.1-m by 6.1-m (20-ft by 20-ft) inside dimension frame of plastic pipe (33 centimeters (cm) [13 inches (in.)] in diameter) filled with styrofoam for flotation. A walkway of untreated lumber is secured to the perimeter of the frame. Within the frame a 3.06-m-deep (10-ft-deep) net is secured to confine the smolts during the rearing period (Figure 4). Fourteen plastic standpipes secure the perimeter of the net, provide structural support, and minimize water current deformation of the pen during high-flow periods. The net pen rearing volume is about 975 cubic meters (m^3) (3,400 cubic feet [ft^3]).

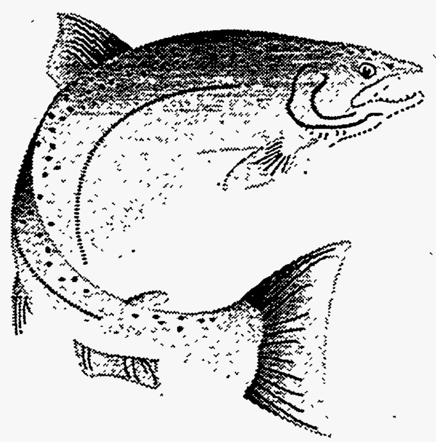


TABLE 1
Releases of coho into Youngs Bay, 1977 to 1993.[1/]

Year of Release	Numbers of Released (Millions) CEDC[2/]	ODFW	Total	Year of Adult Return
1977	0.05	1.13	1.18	1978
1978	0.00	1.29	1.30	1979
1979	0.00	1.24	1.24	1980
1980	0.20	1.41	1.61	1981
1981	0.09	2.49	2.58	1982
1982	0.30	1.49	1.79	1983
1983	0.32	2.18	2.50	1984
1984	0.30	2.44	2.74	1985
1985	0.30	2.76	3.06	1986
1986	0.40	1.93	2.33	1987
1987	0.30	1.67	1.97	1988
1988	0.20	1.61	1.75	1989
1989	0.43 (0.15)	1.68	2.11	1990
1990	1.56 (0.78)	1.39	2.95	1991
1991	2.93 (2.14)	1.26	4.19	1992
1992	3.08 (2.42)	1.02	4.10	1993
1993	4.21 (3.47)	0.85	5.06	1994

1/ Source: ODFW 1994

2/ Net pen releases are shown in parentheses and included in CEDC total.

When operating at full capacity, the CEDC Project proposes to use 160 net pens capable of producing up to 225,000 kilograms (kg) (496,000 pounds [lb]) of salmon smolts. As of February 1995, 72 net pens have been constructed; more than double the number of pens deployed in 1992.

Fall salmon harvests in Youngs Bay averaged 158,303 kg (349,000 lb) from 1979 to 1993 (Table 3). The 1993 fall catch was 52,090 kg (114,840 lb), including chinook and coho. Ex-vessel value (dockside value) of the fishery reached $1.54 million in 1988, but has dropped to only $0.1 million in 1992 through 1993 (Table 4) (ODFW 1994). This terminal fishery has recently been extended into April and May with returns of experimental releases of spring chinook salmon.

Extensive sampling of the 1992 and 1993 Youngs Bay spring fisheries has shown that the salmon catches consist of 98 percent targeted hatchery fish and less than 2 percent upriver fish (ODFW 1994). The fall fisheries harvest a wider range of salmon stocks. All of the harvested coho probably originated from the hatchery as evidenced by the lack of wild spawners in and around Youngs Bay and because wild fish spawn two months later than the hatchery fish (BPA, 1993). From 1980 to

TABLE 2

Releases of fall chinook into Youngs Bay, 1977 to 1993.[1/]

Year of Release	Numbers of Released (Millions) CEDC Tule	CEDC Rogue	ODFW Tule	ODFW Total	Year of Return [2/] 3s	Year of Return 4s
1977	0.00	.000	7.19	7.19	1979	1980
1978	0.85	.000	4.29	5.14	1980	1981
1979	1.40	.000	5.57	6.97	1981	1982
1980	2.02	.000	3.55	5.57	1982	1983
1981	3.16	.000	3.94	7.10	1983	1984
1982	2.74	.000	3.31	6.05	1984	1985
1983	2.48	.050	3.51	6.04	1985	1986
1984	2.87	.013	4.08	6.96	1986	1987
1985	3.00	.082	1.60	4.68	1987	1988
1986	3.01	.251	4.08	7.34	1988	1989
1987	1.34	.020	3.76	5.12	1989	1990
1988	3.08	.080	3.76	6.92	1990	1991
1989	0.02	.097	4.03	4.15	1991	1992
1990	0.00	.128	0.00	0.13	1992	1993
1991	0.00	.000	0.00	0.00	—	—
1992	0.00	.056	0.00	0.06	1994	1995
1993	0.00	.000	0.00	0.00	—	—

1/ Source: ODFW 1994

2/ These fish are 3 years old and 4 years old, respectively.

1992, fall chinook harvests in Youngs Bay consisted of an average of 81 percent targeted hatchery stocks; the remaining fish harvested were wild stocks and lower Columbia River hatchery fish (Table 5) (ODFW 1993).

Commercial harvest rates of hatchery coho salmon returning to Youngs Bay have averaged 87 percent of the minimum run (minimum run based on total sport catch, hatchery returns, and commercial harvest), while mainstem Columbia River harvest rates of coho have averaged 37 percent of the minimum run between 1979 and 1993 (Table 6) (ODFW 1994).

In 1987, CEDC reared and acclimated coho salmon in net pens in Youngs Bay. Brood coho released from net pens in 1988 contributed 41,250 fish to ocean and in-river fisheries (Hill 1992). These fish contributed to the fishery at a rate 2.8:1 over similar coho releases directly from hatcheries. By 1993, the net pen program represented about 69 percent of the total Youngs Bay salmon releases. This improvement is thought to result from the lower population densities in net pens compared to hatchery rearing ponds or raceways, availability of "natural" prey organisms from riverine production (which supplements pelleted

FIGURE 4

Isometric illustration of a net pen.

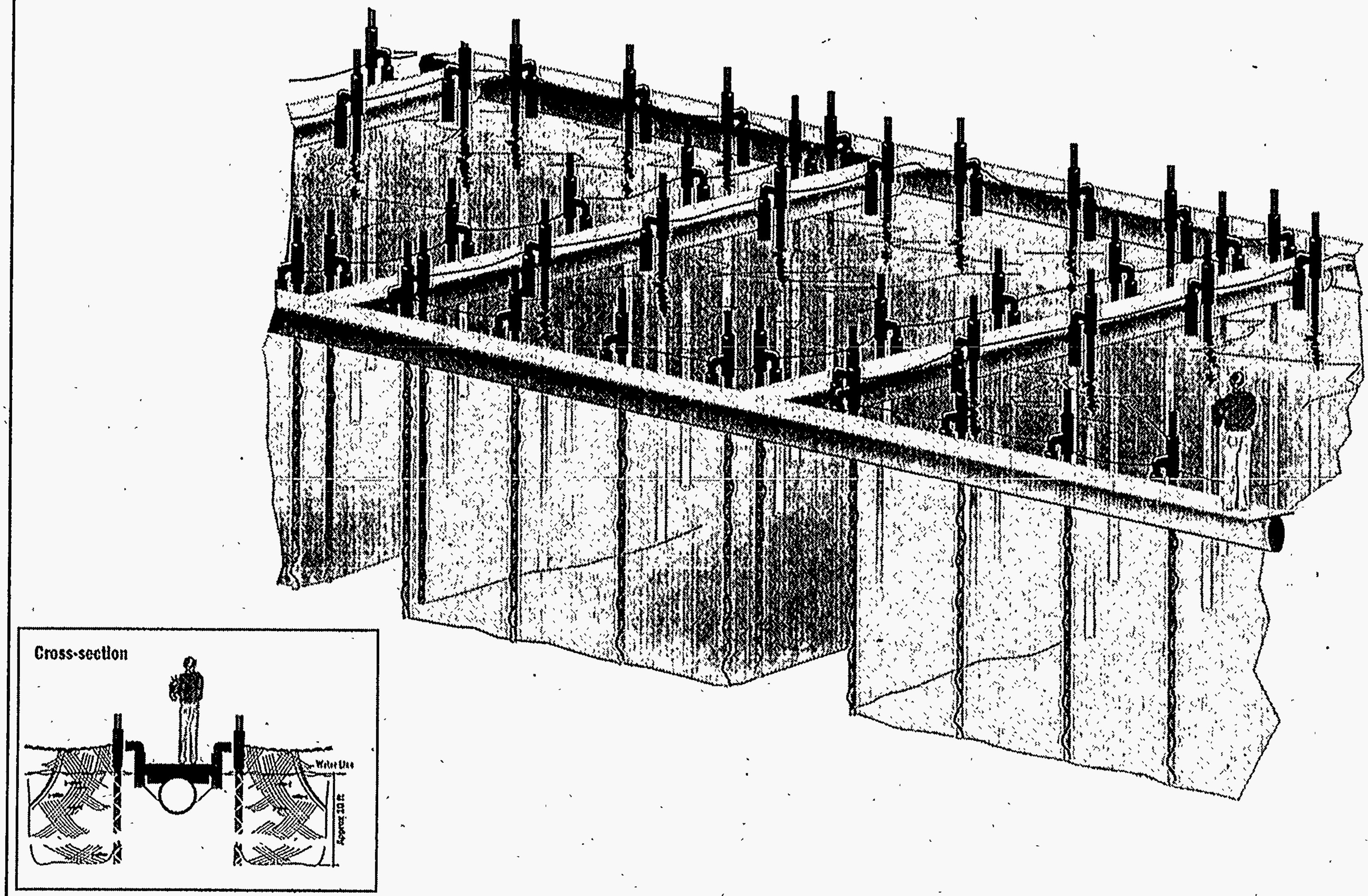


TABLE 3

Youngs Bay seasons and landings, 1979 to 1993.[1/]

Year	Season	Days	Chinook		Coho		Chum		White Sturgeon		Green Sturgeon	
			Pounds	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds	Number
1979	Aug 22-Oct 31	70	28,358	1,585	190,321	22,542	65	5	463	20	0	0
1980	Aug 24-Oct 31	68	112,883	5,900	103,422	12,526	468	39	1,952	70	412	16
1981[a/]	Aug 17-Nov 12	87	113,279	4,688	67,197	8,110	2,402	181	1,245	46	0	0
1982[b/]	Aug 16-Nov 5	81	101,722	5,129	109,742	12,258	3,237	264	805	28	145	5
1983[b/]	Aug 22-Oct 18	57	66,002	3,553	23,484	3,550	60	5	470	17	18	1
1984	Aug 20-Nov 2	74	74,179	3,696	374,768	40,620	2,212	177	563	21	87	3
1985	Aug 19-Nov 1	74	64,393	3,466	473,873	51,202	209	19	428	16	115	5
1986[c/]	Aug 10-Nov 7	89	94,548	5,447	410,568	55,575	56	5	422	16	79	3
1987	Aug 9-Nov 6	89	374,241	22,186	109,725	16,113	37	4	232	8	0	0
1988	Aug 21-Oct 31	71	408,185	19,711	383,231	51,221	577	57	377	12	26	1
1989	Aug 20-Oct 31	72	133,283	6,665	178,385	28,066	30	2	623	20	345	12
1990	Aug 19-Oct 31	73	62,917	3,226	147,027	27,596	262	21	212	8	127	4
1991	Aug 18-Oct 31	74	39,100	2,241	528,197	82,123	130	13	751	31	453	23
1992	Aug 16-Oct 31	76	23,419	1,553	93,264	19,552	382	46	927	31	117	6
1993	Aug 22-Oct 31	70	5,121	365	109,719	15,458	39	4	385	17	30	1

1/ Source: ODFW 1994

a/ Emergency extension of last week. Scheduled to close November 6.
b/ Emergency closure of fishery scheduled to close November 4.
c/ Emergency extension of last week. Scheduled to close October 31.

TABLE 4

Ex-vessel value of the Youngs Bay gill-net catch and price per pound, 1981 to 1993.[1/]

	Chinook		Coho		Chum		White Sturgeon		Green Sturgeon		Total
Year	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Value
1981	$0.58	$65,557	$1.00	$67,298	$0.60	$1,429	$1.00	$1,243	--	$0	$135,527
1982	0.69	66,808	0.87	95,012	0.54	1,744	0.98	792	$0.39	56	164,412
1983	0.73	47,936	1.03	24,092	0.53	32	1.10	515	0.28	5	72,580
1984	0.83	61,751	1.12	421,038	0.52	1,156	1.25	706	0.49	43	484,694
1985	0.88	56,735	0.96	454,594	0.46	96	1.44	616	0.52	59	512,100
1986	0.78	74,896	0.98	404,076	0.33	18	1.31	551	0.25	20	479,561
1987	1.13	422,917	1.61	176,108	1.11	41	1.52	292	--	0	599,358
1988	1.69	689,589	2.22	852,222	0.68	391	1.65	622	0.50	13	1,542,837
1989	0.58	77,145	0.81	144,273	0.37	11	1.80	1,124	0.65	224	222,777
1990	0.83	52,297	1.11	162,868	0.59	154	2.08	440	0.66	84	215,843
1991	0.63	24,818	0.80	421,094	0.35	45	1.87	1,401	0.75	341	447,699
1992	1.03	19,956	0.89	83,177	0.20	76	1.51	826	0.21	25	104,060
1993	0.78	4,215	0.84	92,246	0.64	25	1.24	477	0.20	6	98,486

1/ Source: ODFW 1994

TABLE 5

Adult chinook stock composition in the Youngs Bay fishery catch, 1979 to 1993.[1/]

Year	Lower River Hatchery	Lower River Wild	Bonn. Pool Hatchery	Upriver Bright	Rogue River Bright	Mid-Colum. Bright	Non-Colum. Stock	Total
1980	3,790	300	1,202	250	--	2	2	5,546
1981	4,065	0	301	86	--	53	0	4,505
1982	4,162	0	0	169	--	0	114	4,445
1983	2,991	71	6	430	--	0	0	3,498
1984	3,556	34	0	42	0	0	0	3,632
1985	2,422	0	0	0	999	0	0	3,421
1986	2,285	278	188	939	951	0	13	4,654
1987	16,616	757	0	3,838	553	388	0	22,142
1988	13,676	557	0	2,191	929	2,252	4	19,609
1989	3,941	0	1,057	545	125	946	0	6,614
1990	2,758	0	25	198	84	74	0	3,139
1991	1,627	0	0	20	179	177	140	2,143
1992	671	0	0	406	430	5	17	1,529
1993	24	0	0	46	272	0	0	342

1/ Source: ODFW 1994

diets), larger size at release, and enhanced predator avoidance abilities among released smolts.

Straying of coho reared in Youngs Bay net pens is minor (Hirose 1992). From 1990 to 1991, returns of 1988-brood coho showed only 7 tagged fish recovered outside the terminal fishing (escapement) area compared to 2,154 tagged fish sampled in the fishery (BPA 1993).

The terminal fishery provides a protected coastal site to harvest salmon that are not mixed with mainstem Columbia River depressed salmon stocks. In recent years, this fishery has become more important and contributes significantly to the Clatsop County local economy. Table 4 shows the commercial ex-vessel value (landed dockside wholesale value of the catch) of gillnet salmon landings in Youngs Bay from 1981 to 1993. The success of this terminal fishery program is shared by the approximately 100 to 300 Oregon and Washington gillnet vessels that commercially harvest salmon in Youngs Bay on an annual basis (Hill 1995).

2.2 CEDC PERMITS

2.2.1 Water Pollution Control Permit

The Youngs Bay net pen project has been operating under controls stipulated in an Oregon Department of Environmental Quality (ODEQ) Water Pollution Control Permit. The permit (ODEQ Permit #101198) issued to the CEDC Fisheries Project on June 7, 1989, allowed CEDC to

TABLE 6

Minimum run of adult coho entering Youngs Bay and maximum percentage harvested in the Youngs Bay commercial fishery, 1979 to 1993.[1/]

Year	Sport Catch	Hatchery Returns	Commercial Catch	Minimum Run	Maximum % Harvested in Commercial Fishery
1979	222	5,487	22,542	28,251	80
1980	110	1,127	12,526	13,763	91
1981	66	916	8,110	9,092	89
1982	122	1,771	12,258	14,151	87
1983	46	1,489	3,550	5,085	70
1984	348	4,405	40,620	45,373	90
1985	76	4,172	51,202	55,450	92
1986	361	19,809	55,575	75,745	73
1987	10	988	13,545	14,543	93
1988	40	3,143	49,807	52,990	94
1989	135	3,329	26,225	26,689	88
1990	44	2,106	18,539	20,689	90
1991	164	4,723	80,382	85,269	94
1992	33	2,874	15,845	18,752	85
1993	144	1,158	14,950	16,252	92

1/ Source: ODFW 1994

annually rear up to 225,000 kg (496,000 lbs) of salmon smolts using net pen confinements in the Youngs Bay estuary. ODEQ established monitoring and reporting requirements to ensure that water quality, bottom sediment, and benthic community conditions are not significantly affected and, if adverse effects are detected, proper mitigation measures are enacted. Special provisions included:

- Inspecting (using visual or core sample techniques) the area within the mixing zone on a quarterly basis to determine if unused food or fecal material has accumulated.
- Conducting a benthic baseline survey, including infauna sampling, prior to stocking in the area where the net pens would be located. Analysis and documentation during a winter and a summer prior to stocking the pens are required.
- Conducting substrate infauna sampling, analysis, and documentation each summer following the benthic survey, until the ODEQ determines that the activity is no longer necessary.

Reporting requirements stipulate the following:

- A sedimentation grid log, which establishes fixed sampling stations would be maintained and submitted to the ODEQ annually. The grid log format would be approved in advance by the ODEQ.

- Benthic baseline survey results and subsequent infauna sampling data would be submitted to the ODEQ within 120 days following sampling. Analysis of sampling, tabulation of data, and interpretation of results is the responsibility of the permittee.

2.2.2 Conditional Use Permit

The CEDC Project operates under Conditional Use Permit (CUP) No. 86-PC72 issued by Clatsop County. This permit ensures that the project complies with all necessary land use, public access, water quality, navigation, visibility, and other pertinent standards required by Clatsop County. Other Washington and Oregon permits may be required, together with authorizations under the ESA.

2.2.3 Hydraulic Project Approval Permit

The WDFW issued a Hydraulic Project Approval Permit (No. 00-A0112-01) on March 27, 1995, encompassing net pen installation and removal in the Deep River channel.

2.2.4 Exemption from the Shoreline Management Act of 1971

The Wahkiakum County Planning Department (Washington) has exempted the proposed project (Exemption EX3-95, issued April 23, 1995) from the Shoreline Management Act of 1971 (Chapter 90.58 RCW).

2.2.5 Department of the Army Nationwide Permit

Department of the Army coordination is underway for a Nationwide Permit Verification under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 401 et seq.) for placement of structures in navigable waters of the United States.

3.0 PROPOSED ACTIONS INCLUDING ALTERNATIVES

3.1 Site Selection Criteria

Defining candidate net pen sites in addition to the existing Youngs Bay site, was the first step in expanding the terminal fishery research program. A combination of historical data from previous test and commercial fisheries, and meetings with the Salmon for All (SFA) organization yielded 25 potential sites: 12 on the Washington side of the lower Columbia River and 13 from the Oregon side (Table 7). All of the candidate sites were found between river mile 5 (Baker Bay) and 135 (Wahkeena Pond). The 25 sites were then individually ranked according to rearing and harvest potential. Each site was evaluated using 5 rearing and 5 harvest criteria. For the evaluation, each criterion received a rating of zero through 5 according to its level of potential, thus allowing a maximum rating of 50 for a site considered ideal. Any site that received a zero rating in any criterion was eliminated from further consideration. These criteria are found in Appendix A.

Table 8 lists the results of the site review including a ranking of high, medium, or low priority to indicate locations that should be given current or future consideration. Nine sites, three on the Washington shore and six on the Oregon shore, were considered to have high priority, with an overall ranking sufficient for immediate consideration. These sites include Grays Bay/Deep River, Steamboat Slough, Cathlamet Channel, Tongue Point Basin, Svenson Island, Big Creek, Blind Slough, Clifton Channel, and Wallace Slough.

3.2 Test Fisheries

Following this ranking, gillnet test fisheries were conducted in seven of the nine areas designated as having highest terminal fishery potential. The areas sampled were: Tongue Point Basin, Grays Bay/Deep River, Blind Slough, Steamboat Slough, Clifton Channel, Cathlamet Channel, and Wallace Slough (see Table 9). Test fishing was conducted to assess the harvest potential in terms of catch and timing of non-target fish stocks, variation in gear type, and fishing area boundaries. Particular interest focused on upriver salmon stocks that might be affected. Gillnet fishing was conducted from April 20 through June 2, 1994 with each site fished weekly for a total of 6 trips per site. One local gillnetter fished each site for all 6 weeks, while a person from ODFW or WDFW observed and recorded data. Generally, three drift locations were fished at each site weekly in order to spread the effort geographically. Fishing was conducted during high and low tides and during the daylight and dark.

The sampling effort was distributed between both small (13- to 15-cm [5- to 6-in.]) and large (18- to 20-cm [7- to 8-in.]) mesh nets in order to determine occurrence of the larger spring chinook and smaller steelhead (*Oncorhynchus mykiss*). Gear specifications are presented in Table 10. Data were also collected on net specifications and fathoms fished, set location, weather, water temperature and turbidity, net layout and pickup times, and catch of all fish species. Total catches and catch per unit effort (CPUE) at each site are displayed in Table 11.

The results of the test fisheries showed that Tongue Point Basin, Blind Slough, and Grays Bay/ Deep River had the lowest salmonid harvest and CPUE (<4 fish or 0.3 fish per hour per 100 fathoms [fm] of net). As a result of the test fisheries and numerical ranking of sites, these three sites constitute the preferred sites for further research. Test result summaries conducted in the spring of 1994 for these three sites are summarized below.

3.2.1 Tongue Point Basin, Oregon

Fishing was conducted with a conventional floater drift net. No chinook were caught, although one live chinook was observed escaping. Three

TABLE 7

River mile locations of candidate sights for terminal fisheries. 1/

Washington	River Mile	Oregon	River Mile
Grays Bay	22	Baker Bay	5
Steamboat Slough	34	Skipanon Waterway	11
Elochoman River	36	Youngs Bay Expansion	12
Cathlamet Channel	40	Tongue Point Basin	18
Coal Creek Slough	56	Svensen Island	23
Fisher Island Slough	60	Big Creek	27
Cowlitz River	68	Blind Slough	28
Carrolls Channel	70	Clifton Channel	36
Martin Slough	80	Coffee Pot Island	43
Lewis River	87	Westport Slough	44
Lake River	89	Wallace Island	49
Camas Slough	120	Bradbury Slough	55
		Wahkeena Pond	135

1/ Source: ODFW 1994

steelhead were caught; all were hatchery summer run. Two of the three steelhead did not survive. The white sturgeon (*Acipenser transmontanus*) catch of 71 fish was also lower than anticipated. Five shad (*Alosa sapidissima*) were also caught.

3.2.2 Blind Slough, Oregon

Fishing was restricted to heavy leaded gear because of the bottom debris from log raft storage. Two sites were located within Blind Slough while one site was at the Knappa dock approximately 80 km (0.5 mi) below the mouth of Blind Slough. One chinook of lower river origin and 43 white sturgeon were caught at the Knappa dock. No steelhead were caught.

3.2.3 Grays Bay/Deep River, Washington

Fishing was conducted with a large (18-cm [7.25-in.]) or small (15-cm [6-in.]) mesh net at three sites. The Deep River site was fished at high tide (because of shallow entry for boats to this site) with small mesh nets, whereas the two Grays Bay sites were fished at either high or low tide with large mesh net. The lower Deep River site was deep enough at high tide for gillnets, but sunken logs from old rafts makes this fishing impossible. Although Grays Bay is mostly shallow, it is deep enough to be fished. Future test fishing will expand into new sites, with smaller meshed gear, to better represent fish abundance by species and size. During the fishery

TABLE 8

Ranking of potential terminal fishery sites below Bonneville Dam.

Terminal Site	Rearing Criteria 1	2	3	4	5	Harvest Criteria 1	2	3	4	5	Grand Total	Rank
Washington												
Grays Bay[a]	3	3	3	3	2	2	2	3	3	3	27	H
Steamboat Slough[a]	3	3	2	2	3	3	3	2	3	2	26	H
Cathlamet Channel[a]	3	3	2	2	3	3	3	2	1	2	24	H
Coal Creek Slough	2	0	2	1	2	1	1	2	2	3	16	<M
Fisher Slough	2	1	1	1	1	1	1	0	2	3	13	<L
Cowlitz River	1	1	1	1	3	1	1	0	2	1	12	<L
Carrolls Channel	3	2	1	0	1	2	2	1	1	1	14	<L
Martin Slough	2	2	2	0	1	2	2	0	2	2	15	<L
Lewis River	1	2	2	1	3	1	2	1	2	1	16	M
Lake River	1	2	2	2	2	1	1	1	2	1	15	L
Camas Slough	3	1	1	0	3	2	2	1	2	3	18	<M
Oregon												
Skipanon Waterway	1	1	3	2	3	0	3	0	3	3	19	<M
Baker Bay	1	2	0	0	1	1	3	0	2	2	12	<L
Tongue Point Basin[a]	3	3	3	3	2	3	2	1	2	2	24	H
Svensen Island	1	3	3	2	3	1	2	2	2	2	21	H
Big Creek	2	2	2	2	3	3	2	2	3	2	23	H
Blind Slough[a]	2	3	3	3	3	2	2	3	3	3	27	H
Clifton Channel[a]	3	2	2	3	2	3	2	2	3	2	24	H
Coffee Pot Island	1	2	1	0	1	1	0	2	3	1	12	<L
Westport Slough	1	2	3	2	3	1	1	0	3	3	19	<M
Wallace Island[a]	3	2	2	3	3	2	2	2	3	2	24	H
Bradbury Slough	1	2	2	2	1	1	1	2	2	2	16	M

a Site chosen for further study

Notes: H = High priority sites
M = Medium priority sites
L = Low priority sites
< = Site conditions fail to meet one or more rank criteria

TABLE 9

Areas sampled for gillnet test fisheries.[1/]

Site	State	River Mile
Tongue Point Basin	Oregon	18
Grays Bay/Deep River	Washington	22
Blind Slough	Oregon	27
Steamboat Slough	Washington	34
Clifton Channel	Oregon	36
Cathlamet Channel	Washington	40
Wallace Slough	Oregon	49

1/ Source: ODFW 1994

1 chinook of lower river origin, 1 steelhead (hatchery fish), 48 sturgeon, 2 shad, and 1 starry flounder (*Platichthys stellatus*) were caught.

3.3 Alternative Sites Considered

Test fishery catches were considerably higher at Clifton Channel, Oregon; Wallace Slough, Oregon; Steamboat Slough, Washington; and Cathlamet Channel, Washington than at the preferred locations. However, these alternative sites offer some advantages based on location and logistics, and they also represent potential future sites for continued expansion of the net pen research program. One or more of the alternatives described below could be substituted for the preferred sites if unforeseen technical or logistical problems arise precluding net pen deployment and/or operations at one or more of the preferred sites. One or more of the alternative sites could be added to the net pen rearing project if continued data collection at the three preferred sites continues to show improved environmental and economic conditions compared to status quo hatchery and harvest programs.

3.3.1 Clifton Channel, Oregon

The Clifton Channel site, an established fishing drift, is located at the former Bumble Bee fish cannery and is owned by Mr. A. Marincovich. Test fishing was conducted using a 19-cm (7.5-in.) mesh diver gillnet during ebb tide and a 14-cm (5.5-in.) floater gillnet during high and low water slack current periods. Sixteen chinook were caught, including three of upriver origin. All but one were caught in the large mesh gear. Three steelhead were caught with small mesh gear. Of the 412 white sturgeon, 383 were caught in the first half of the program, and all except 15 were caught with large mesh nets. Seven shad were the only other species caught.

3.3.2 Wallace Slough, Oregon

The Wallace Slough site is located at a small marina about 0.32 km (0.2 mi) inside of the upstream confluence of Wallace Slough and the mainstream of the Columbia River. This marina is co-owned by G. Viuhkola and G. Poysky. Fishing was conducted with floater gillnets of

Table 10

Net specifications for 1994 spring terminal test fishery, by site.

Site	Net Type	Mesh Size (in.)1/	Length (fm)2/	Net Details3/
Tongue Point	1. Floater	5 1/2	200	14-17' deep
	2. Floater	7	>250	18' deep
Deep River	1. Floater	7 1/4	120	30' deep
	2. Floater	6	50	16' deep
Blind Slough	1. Floater	5 3/4	100	15' deep w/ heavy lead line
	2. Floater	7 1/2	100	15' deep w/ heavy lead line
Steamboat Slough	1. Floater	5 1/4	20	15' deep
		7 1/2	40	30' deep
	2. Floater	5	200	24' deep
	3. Floater	8	100	22' deep
		7 7/8	100	34' deep
	4. Floater	5 1/4	60	15' deep
Clifton Channel	1. Floater	5 5/8	100	60 meshes
	2. Diver	7 1/2	190	60 meshes w/ 12' slacker
Cathlamet Channel	1. Floater	8	100	22' deep
		7 7/8	100	34' deep
	2. Floater	5	200	24' deep
Wallace Slough	1. Floater	5 3/8	153	16' deep
	2. Floater	7 1/4	150	16' deep

Source: ODFW 1994

1/ To convert to centimeters, multiply inches by 2.540.
2/ To convert to feet, multiply fathoms (fm) by 6.
3/ To convert to meters, multiply feet by 0.3048.

TABLE 11

Spring terminal test fishery harvest and Catch Per Unit Effort (CPUE), by area, 1994.[1/]

Area	Chinook			Steelhead	White Sturgeon	Shad
	Lower Area	Upper Area	Total			
Harvest (in numbers)						
Tongue Point	0	0	0	3	71	5
Deep River	1	0	1	1	48	2
Blind Slough	1	0	1	0	43	0
Steamboat Slough	5	0	5	6	5	18
Clifton Channel	13	3	16	3	412	7
Cathlamet Channel	17	1	18	7	145	17
Wallace Slough	15	1	16	1	1,100	13
Total	52	5	57	21	1,824	62
CPUE (Numbers/hour/100 fm)						
Tongue Point	0.0	0.0	0.0	0.1	3.3	0..2
Deep River	0.1	0.0	0.1	0.1	4.0	0.1
Blind Slough	0.1	0.0	0.1	0.0	2.6	0.0
Steamboat Slough	0.4	0.0	0.4	0.5	0.4	1.2
Clifton Channel	0.6	0.1	0.7	0.1	17.6	0.2
Cathlamet Channel	0.7	0.1	0.8	0.3	6.5	0.7
Wallace Slough	0.8	0.1	0.9	0.1	59.0	0.7
Total	0.4	0.0	0.4	0.2	13.9	0.5

1/ Source: ODFW 1994

large (18-cm [7.1-in.]) and small (14-cm [5.5-in.]) mesh web. No problems were encountered on the Wallace Slough drift. Sixteen chinook salmon were caught, and 15 were lower river chinook. All but one were caught in the first half of the test fishery. Only one steelhead was caught. Of the 1,100 white sturgeon caught, 582 were caught with a small mesh net during a short period on April 21. Except for 13 shad, the remaining fish were caught in Wallace Slough. Other fish species caught were 7 northern squawfish and 2 carp.

3.3.3 Steamboat Slough, Washington

The Steamboat Slough site is located approximately 183 m (200 yd) upstream of the confluence of Skamokawa Creek and the Columbia River at Mr. D. Silverman's dock in Steamboat Slough. Test fishing sites of the Steamboat Slough area included a drift within the slough, another at Skamokawa, and two in the mainstem gap between Steamboat and Elochoman sloughs. Because of the variety of fishing conditions, a number of floater nets were used. The size of the nets ranged from 13 to 20 cm (5.1 to 7.9 in.). The

Skamokawa and Steamboat drifts were fished with short (60 fm) nets, while the gap drifts were fished with 200-fm nets extending into the main channel. Five chinook, of lower river origin were caught; four were caught during the first half of the test fishing. Six steelhead, 5 white sturgeon, 18 shad, and 1 northern squawfish were also caught. All but one fish were caught in the small mesh nets. Chinook salmon were caught fairly evenly throughout the test period; steelhead were all caught in daylight hours; and all sturgeon were caught at night.

3.3.4 Cathlamet Channel, Washington

The Cathlamet Channel site is located approximately 183 m (200 yd) downstream of the Cathlamet-Puget Island Bridge at Mr. F. Johnson's dock. Small floater gillnets with 13-cm (5.1-in.) mesh were used; large floater gillnets had 100 fm of 20-cm (7.9-in.) and 100 fm of 20.3-cm (7.9-in.) mesh web. Four drifts were fished: one drift just above the Cathlamet-Puget Island Bridge and three evenly spaced along the downriver end of Cathlamet Channel. A total of 18 chinook (1 upriver), 7 steelhead, 145 white sturgeon and 17 shad were caught. The majority of chinook (16) and sturgeon (101) were caught in the large net. Over the 6-week test period, more fishing was conducted during nighttime, although day and night success was fairly equal for chinook and sturgeon. Six of the seven steelhead were caught during daytime.

3.4 No Action

Under the no action alternative, BPA would not provide funding and assistance for the expansion of a known stock terminal salmon fishery research project in the lower Columbia River. Moreover, planned activities to transfer, rear, and release additional smolts in 1995 and 1996 would likely be terminated, and proposed new studies involving acclimation, overwinter rearing and full-term rearing would cease. Revitalization programs targeted at economically depressed urban and rural communities along the lower Columbia River would have to focus on alternative funding resources for economic development scenarios. For example, the CEDC would likely continue the existing program in Youngs Bay. However, if all net pen rearing and terminal fisheries (including the CEDC program) were discontinued, this would likely result in the continued decline in the salmon fishery and the further decline of a tradition that is an integral part of the lifestyle along the lower Columbia River. Cessation of the program would likely produce more mixed stock harvesting, resulting in an increase in ESA-listed salmon stocks being caught by commercial and recreational fishers. In addition, continued demonstration of increased salmon survival using net pen rearing would be limited, denying a cost-effective means of achieving a portion of the Northwest Power Planning Council's goal of doubling salmon runs in the Columbia River Basin.

4.0 AFFECTED ENVIRONMENT

4.1 Water Currents and Circulation

Oceanic processes and the regional climate influence the physical attributes of the Columbia River estuary. Strong ocean tides and a powerful riverflow meet in the shallow narrow basin of the estuary to produce turbulent and very rapid currents. This highly energetic water circulation strongly affects other important physical characteristics of the estuary, such as salinity and sediment distribution (Fox et al. 1984). The tide moves the saline ocean water into the estuary, but the strong riverflow restricts the upriver extent of the ocean water. The estuary can become completely freshwater during high riverflow seasons when strong ebb tides flush all of the saline water from the estuary.

Most sediments in the estuary are composed of sand rather than silt. Sandy sediments are indicative of strong turbulent currents, which tend to flush out the silty sediments. Silty bottom sediments are largely restricted to the protected embayments of the estuary. The sediments are constantly shifting in response to the strong water flows. Sediment transport in the Columbia River estuary involves the movement of sand waves along the bottom and the movement of finer sediment (very fine sand, silt, and clay) in suspension (suspended transport) (Fox et al. 1984).

Generally, the physical characteristics of the Columbia River estuary differ from those of most other estuaries in the Pacific Northwest. River discharge is much greater, salinities are much lower, and the sediment is less stable. Because of the large volume of riverflow into the Columbia River estuary, its flushing time is only about 1 to 5 days (Fox et al. 1984). This flushing time contrasts with many other estuaries, in which water may take weeks or months to reach the ocean.

4.2 Water Quality

Water quality could be degraded in the immediate area of the net pens as organic matter and nutrients are introduced during fish rearing activities. High concentrations of ammonia, nitrates, phosphates, and reduced levels of dissolved oxygen are known to adversely affect water quality. Adverse effects on water quality because of Puget Sound mariculture operations were most pronounced in areas of extremely limited flushing or water circulation (Weston 1986). Moreover, field studies have demonstrated little or no changes in water quality outside the floating culture structure in well flushed areas (Gretchell 1988). In areas with deeper water and faster currents, organic and inorganic wastes tend to be more dispersed, sediments remain oxidized, and invertebrate organisms have plentiful food supplies (Gretchell 1988).

The three proposed sites for net pen rearing and expansion in the lower Columbia River should have flow and velocity characteristics that would prevent degradation of water quality. The Tongue Point Basin is affected primarily by tidal flushing with minor freshwater inflow from the John Day River and the South Prairie Channel. Runoff from Gnat Creek and tidal action dictate flow and velocity characteristics in Blind Slough. Flushing action would vary depending on rainfall during the late fall through spring and it would be at its lowest during the summer through early fall period. However, summer net pen rearing is not proposed in this research project.

Water quality was monitored by the WDFW at the proposed test and alternative sites by sampling during 24-hour intervals every 1 to 2 weeks during spring (May to June) and fall (November) 1994. Water quality testing will continue in 1995. Water was sampled with a Hydrolab H20 Multiparameter Water Quality Instrument. The instrument measures turbidity, temperature, dissolved oxygen, pH, salinity, and nitrogen. Additionally, researchers measured water velocity and depth during various tidal stages. Data results are listed in Table 12. Only two data values seem to be significant: the mean pH value of 5.49 at Blind Slough, and the mean specific conductance of 6,401.41 micro Siemens/centimeter (μS/cm) at Youngs Bay. All other values fall within expected standards for clean freshwater ecosystems.

The abnormally low mean pH value for Blind Slough might be attributable to the site's location. Blind Slough is the most inland site. Sampling was performed at about the time when the leaves fall in the autumn and flows were low. Tannic acid in leaves is a possible source of the increased acidity. The high mean specific conductance reading at the Youngs Bay site is possibly due to the estuarine water at this location.

4.3 Fish and Shellfish Resources

Chinook salmon, coho salmon, and white sturgeon are the principal species caught by commercial fishermen in the lower Columbia River. American shad, Pacific herring, (*Clupea harengus pallasi*) and eulachon (*Thaleichthys pacificus*) also contribute to the commercial harvest. The principal fish caught by recreational anglers include the species mentioned above, as well as steelhead trout, sea-run cutthroat trout (*Oncorhynchus clarki*), perch (*Perca flavescens*), starry flounder, tomcod (*Microgadus proximus*), rockfish (*Sebastodes* spp.) and lingcod (*Ophiodon elongatus*).

The fish species of the Columbia River estuary are classified as either marine or freshwater. Marine species, such as Pacific herring and northern anchovy (*Engraulis mordax*), spend much of their life in the ocean, but use the estuary during parts of their life cycles. Freshwater fish species, such as peamouth (*Mylocheilus caurinus*) and large scale sucker (*Catostomus macrocheilus*), move into the estuary from the river.

Shellfish resources in the project area support a limited commercial and recreational fishery. Target species include crayfish.

4.4 Lower Columbia Wild Coho Salmon Populations

Naturally spawning populations of coho salmon were once abundant throughout the Columbia River Basin and its tributaries. Historical natural coho runs exceeded 600,000 fish annually (Johnson et al. 1991). Two-thirds (over 400,000 fish) of the historical Columbia River coho salmon production is thought to have originated in the lower Columbia River (defined as the Columbia River and its tributaries below Bonneville Dam [Mullan 1984]). By the late 1950s, once abundant natural lower Columbia River coho runs were drastically reduced to less than 6 percent of their estimated historical abundance. A variety of factors contributed to the decline in wild coho salmon populations, including logging, poor watershed management practices, excessive fishery harvest practices, and loss of spawning and rearing habitat (Johnson et al. 1991).

In response to this production decline, several groups petitioned NMFS in 1990 to list lower Columbia River coho salmon as a threatened or endangered species and designate critical habitat for the species under the ESA. NMFS recently decided not to list lower Columbia River coho under ESA, based upon the available scientific information regarding the status of the species (Johnson et al. 1991). The NMFS decision was based upon findings suggesting that lower Columbia River coho stocks (1) are not reproductively isolated from other coastal populations in Washington and Oregon; and (2) do not represent an important component in the evolutionary legacy of the species, defined by NMFS as an Evolutionary Significant Unit. Similarly, NMFS analyzed information on coho salmon habitat use, life-history characteristics, and morphological and genetic traits, but found only inconclusive evidence to demonstrate that lower Columbia River coho salmon are genetically distinct from other wild coho salmon populations. Thus, the hatchery-reared fish and any returning remnant natural coho salmon are considered genetically similar and are not defined as separate stocks under ESA.

TABLE 12

Physiochemical data collected in November 1994 at eight terminal fisheries sites on the lower Columbia River basin.[1/]

		Temp (°C)	pH (Units)	SpCond (uS/cm)	DO (mg/l)	Turbidity (NTU)	Redox (mV)
Washington Sample Sites							
Deep River 11/08/94	Mean	8.39	6.11	87.84	8.33	89.01	550.08
River Mile 22	S.D	0.38	0.36	8.09	0.35	28.18	27.08
Steamboat Slough 11/07/94	Mean	10.06	6.87	117.37	8.45	80.69	571.98
River Mile 34	S.D.	0.11	0.03	1.24	0.13	31.48	9.49
Cathlamet Channel 11/03/94	Mean	10.48	6.77	104.04	7.33	19.66	436.75
River Mile 40	S.D.	0.23	0.02	2.01	0.54	1.58	6.95
Oregon Sample Sites							
Young's Bay 11/09/94	Mean	8.6	7.2	6401.14	8.7	55.61	495.78
River Mile 12	S.D.	0.35	0.23	1962.09	0.22	9.31	26.41
Blind Slough 11/14/94	Mean	7.17	5.49	59.85	8.6	29.15	506.35
River Mile 27	S.D.	0.14	0.06	3.91	0.18	6.49	25.72
Clifton Channel 11/15/94	Mean	9.46	6.98	137.3	8.8	22.63	487.36
River Mile 36	S.D.	0.32	0.22	11.1	0.17	19.43	16.72
Tongue Point 11/17/94	Mean	8.4	7.28	389.18	7.5	52.58	528.63
River Mile 18	S.D.	0.17	0.06	142.41	0.41	8.56	66.8
Wallace Slough 11/16/94	Mean	9.25	7.19	147.04	9.08	42.67	523.88
River Mile 49	S.D.	0.12	0.03	1.46	0.14	7.52	12.11

1/ Source: Kaufman 1994

Notes:
- DO = dissolved oxygen
- Redox = reduction-oxidation potential
- mV = millivolts
- SpCond = specific conductance
- µS/cm = micro Siemens per centimeter
- S.D. = standard deviation

ODFW has determined that wild populations of coho salmon may be in very low abundance and identified several lower Columbia River tributaries as suspected locations where naturally breeding remnant populations might exist. However, the results of spawning ground surveys conducted by ODFW during the fall and winter 1990-to-1991 and 1991-to-1992 spawning seasons indicated that no distinct breeding populations of coho salmon exist. These surveys observed coho salmon in only one creek, Hartill Creek. During the 1990 to 1991 spawning season, the count peaked at 8 adults and 10 jacks (early maturing male fish). During the 1991 to 1992 spawning season, 2 adults and 2 jacks were counted (BPA 1993). However, these fish are regarded as hatchery strays. ODFW failed to observe other naturally spawning fish after mid-December in any of the test years.

4.5 Other Lower Columbia Anadromous Fish Stocks

ODFW has conducted one survey in recent years to assess the spawning success of wild chum salmon populations returning to lower Columbia River tributaries. A wild fish spawning survey was completed in 8 Youngs Bay streams and 11 lower Columbia River tributaries in 1991. ODFW (1992) observed only two chum salmon spawning in the South Fork Klaskanine River.

Other remnant naturally spawning populations of steelhead (anadromous rainbow trout) and cutthroat trout are known to occur in lower Columbia River tributaries. Trotter (1989) found evidence that competition between coastal cutthroat trout (*O. clarki*) populations and coho salmon exists in some rivers. Coho salmon often spawn in the immediate vicinity of the off-channel pools and riffles commonly used by cutthroat trout during the spawning and rearing stages. Coho salmon may be dominant in some situations, and force young cutthroat trout out of their preferred habitats (i.e., low-velocity margins, backwaters, and side channels) into mainstream riffle areas where survival rates might decrease. However, Johnston (1981) suggested that these interactions might actually be minimized because cutthroat trout prefer small tributaries for spawning and, therefore, are spatially isolated from salmon nurseries. Salmon nurseries are usually found immediately downstream from cutthroat trout nursery zones.

4.6 Biological Resources

The biological resources of the Columbia River Basin are diverse. Regional bio-diversity and species abundance are reflected in the habitat diversity associated with the lower Columbia River. Coastal intertidal mudflat, salt marshes, and estuarine habitats dominate the river's tidally influenced lower reaches. These habitats are host to a variety of migratory and non-migratory bird and water fowl species, and a diversity of marine, estuarine, and terrestrial flora and fauna.

Above Tongue Point, riverine conditions (inclusive of aquatic, riparian, fresh-water marsh and swamp, and floodplain habitats) are dominant. These habitats frequently intermix with farming and rural agricultural operations, often providing a favorable mix of habitats, food resources, and open space for native species such as deer, elk, fox, coyote, bald eagle, and Canada goose.

The Lewis and Clark National Wildlife Refuge provides a regionally important protected area hosting a diversity of aquatic, wetland, and riparian species.

4.7 Recreation

Recreational pursuits on the lower Columbia River are diverse and include both water- and non-water dependent activities. Sailing, fishing, jet skiing, water skiing, boating, and swimming constitute the primary water-dependent activities. Sightseeing, bird and wildlife watching, hunting, camping, trail biking, walking and jogging are the principal non-water dependent activities practiced along the river basin and in adjacent upland areas.

4.8 Aesthetics

The lower Columbia River is an aesthetically rich area dominated by expansive viewplanes, a mix of aquatic, wetland, and upland habitats, stands of secondary forests, and agricultural activities associated with the river's fertile floodplain. The unspoiled Lewis and Clark Federal Wildlife Refuge, home to a diversity of migratory waterbirds and mammalian fauna, contrasts with a mix of urban (Astoria, Oregon), maritime, and rural turn-of-the century towns and hamlets located along the Oregon and Washington sides of the Columbia River.

4.9 Threatened and Endangered Species and Species of Special Concern

The wildlife habitats within the general vicinity of the proposed project sites include tidal flats, marshes, swamps, upland habitats, and agricultural lands. Many species listed by the U.S. Fish and Wildlife Service (USFWS) or identified by the Washington Department of Fish and Wildlife (WDFW) and/or Oregon Department of Fish and Wildlife (ODFW) as having special status occur or potentially occur in these areas. Terrestrial habitats would not be affected because the proposed net pen installations use existing infrastructure such as roads, piers, and docks; therefore, no significant equipment mobilization or on-site construction is expected. Only aquatic or aquatic feeders could be potentially affected.

4.9.1 Endangered and Threatened Species

Three federally listed endangered salmon stocks transit through the lower Columbia River: Snake River sockeye, Snake River spring/summer chinook, and Snake River fall chinook salmon. The Snake River sockeye salmon was listed as endangered on November 20, 1991. The chinook salmon were officially listed by NMFS as endangered on August 18, 1994. Three bird, two mammal, one plant, and one butterfly species listed as federally threatened or endangered occur or potentially occur within the lower Columbia River Basin. These species include the brown pelican (*Pelecanus occidentalis*), bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), Columbian white-tailed deer (*Odocoileus virginianus leucurus*), Steller sea lion (*Eumetopias jubatus*), Howellia (*Howellia aquatalis*), and the Oregon silverspot butterfly (*Speyeria zerene hippolyta*).

Howellia (water Howellia) is an emergent aquatic plant that was listed as threatened in 1994. Although once occurring in wetlands throughout the Pacific Northwest, it is currently known to be distributed near Spokane, Washington and Swan Valley, Montana (U.S. Department of Agriculture 1994). Small remnant populations could still occur within former river oxbows along the lower Columbia River. The Oregon silverspot butterfly is a threatened species with a historical distribution near Astoria, Oregon.

The green sturgeon (*Acipenser medirostris*), river lamprey (*Lampetra ayresi*), and the Pacific lamprey are candidate species that occur in declining numbers throughout the lower Columbia River. The green sturgeon currently supports a very limited commercial fishery. There is no commercial fishery for lampreys, and Tribal leaders have expressed alarm in recent years over declining populations of river lampreys within the Snake River system.

4.9.2 Species of Special Concern

Several species that have been identified as candidate federal endangered or threatened species or are defined "species of special concern" within Oregon and/or Washington might occur in the lower Columbia River Basin.

Several mollusks of special concern could potentially occur within the project area. These include the Newcomb's littorine snail (*Algamorda newcombiana*), California floater (*Anodonta californiensis*), giant Columbia River limpet (*Fisherola nuttalli*), and the great Columbia River spire snail (*Fluminicola columbiana*).

The Oregon Natural Heritage Program lists two species, the Willamette floater (*Anodonta wahlametensis*) and the rotund physa (*Physella columbian*), as species of special concern.

Nine species (7 birds and 2 marine mammals) of special concern that prey on fish potentially occur in the general project area. The birds include the horned grebe (*Podiceps auritus*), red-necked grebe (*Podiceps grisegena*), western grebe (*Aechmophorus occidentalis*), Clark's grebe (*Aechmophorus clarkii*), Brandt's cormorant (*Phalacrocorax penicillatus*), osprey (*Pandion haliaetus*), and the Caspian tern (*Sterna caspia*). The two mammal species are the California sea lion (*Zalophus californianus*) and the harbor seal (*Phoca vitulina*).

Although these species are listed as candidates for federal listing or species of special concern, their current status does not warrant protection under the ESA.

4.9.3 Critical Habitat

The entire Columbia River is a designated ESA critical habitat for the Snake River sockeye spring/summer chinook, and fall chinook salmon. The Oregon silverspot butterfly has an ESA-designated critical habitat located near Astoria, Oregon.

5.0 POTENTIAL ENVIRONMENTAL EFFECTS

5.1 Water Quality

Salmonid rearing requires high water quality but also has the capacity to adversely influence water quality. The culture of salmonids requires oxygen-rich water. However, fish culture introduces nutrients and suspended solids to the water (from uneaten fish food and waste products). These nutrients and suspended solids can alter existing water quality conditions. Fish rearing in net pens could directly or indirectly affect several water quality variables such as turbidity, pH, fecal coliforms, nutrients, and dissolved oxygen.

During net pen cleaning and maintenance activities, turbidity could increase beneath and downcurrent of the rearing area. The degree of turbidity increase would depend on the amount of material washed from submerged structures. The amount of material would depend on the settlement and growth rates of biofouling organisms on submerged structures and on how often the nets were cleaned. Cleaning severely fouled nets could increase turbidity by more than 5 nephelometric turbidity units (NTU) over ambient conditions (a level of 5 NTUs is considered low, with little effect on ambient turbidity). If water quality monitoring indicates that the applicable water quality standard for turbidity (or other standards) might be exceeded as a result of net cleaning or maintenance operations, all subsequent cleaning and maintenance activities would be conducted after relocation of fish and transportation of the net to the North Fork Klaskanine River Hatchery, or other sites where water quality would not be degraded.

Uneaten fish food and waste products might also increase turbidity, but to a much lesser degree than net cleaning. It is unlikely that food and wastes would increase turbidity enough to exceed water quality standards. Higher turbidity levels would not adversely affect aquatic organisms, but would reduce water clarity in the vicinity of the pens.

Fish waste products include carbon dioxide and ammonia passed through the gills, fèces, and uric acid (Lagler et al. 1962). Because carbon dioxide is a weak acid and ammonia is a weak base, the net pH effect of excretion through the gills would be neutralized. In addition, because of tidal and riverine dilution and the natural buffering capacity of the water, fish waste products would not measurably change pH underneath or down current of the rearing pens. The lower than expected baseline pH reading at Blind Slough could, however, limit the number of net pens deployed at this site and the density of fish in each pen.

Fecal coliform bacteria are produced in the intestines of warm-blooded animals and are a relative measure of sanitary quality (APHA 1985). Fecal coliform levels could indirectly increase near the net pens from increased bird and mammal activity. For example, herons have been attracted to the existing Youngs Bay net pens because of the food source (salmon smolts), and they can be observed on and near the rearing pens in the evening.

Net pen rearing also releases nutrients into the water from fish waste products and from uneaten fish food. The primary nutrients of interest are nitrogen and phosphorus. Under conditions of limited water circulation, these nutrients have the potential to cause excessive phytoplankton growth. Phytoplankton blooms might increase dissolved oxygen levels through photosynthesis during the day, and decrease oxygen levels by respiration during the night. However, the lower Columbia River is subject to both tidal and riverine flushing, which should minimize any opportunity for development of a phytoplankton bloom that could prove deleterious to cultured fish or natural aquatic fauna. The water quality monitoring program at the Youngs Bay facility has not detected any increase in phytoplankton levels over seasonal baseline conditions.

Ammonia in the un-ionized form (NH_3) is toxic to fish at high concentrations, depending on water temperature and pH (Trussel 1972, EPA 1986). Salmonids are more sensitive to the effects of ammonia toxicity than most invertebrates. Although exposure to low concentrations of ammonia might not produce lethal effects, if concentrations are sufficiently high, ammonia can cause chronic adverse effects, including reduced vigor, growth, and disease resistance (Burrows 1972). Although slight increases in dissolved nitrogen (including ammonia) are expected in the immediate vicinity of the net pens, tidal and riverine flushing are expected to dilute any such pollutants so that ammonia levels remain well below harmful concentrations.

Dissolved oxygen concentrations could be lowered slightly in the immediate vicinity of the rearing pens during low river or tidal flow because of fish consumption and microbial decomposition of fish wastes and excess food. Most of the microbial decomposition would be associated with organic materials that settle to the bottom (Institute of Aquaculture 1988). Thus, oxygen levels could decrease to some degree as a result of smolt respiration in the pens and microbial decomposition of benthic organic materials beneath the pens. Any decrease in dissolved oxygen concentrations would be minor and would depend on the water exchange rate, fish density, net cleaning schedule, and feeding rates.

None of the activities associated with the rearing and feeding of juvenile salmon are expected to significantly affect dissolved oxygen concentrations at the existing or proposed net pen sites.

5.2 Biological Resources

5.2.1 Competition with Native Salmonid Stocks

Although there are differences in the time of spawning and location of spawning and rearing habitats between pen-reared salmon, upriver salmon, wild steelhead, and sea-run cutthroat populations, some degree of interspecies and/or intraspecies competition for food and habitat might occur when smolts are released or when adults (strays) return to non-terminal areas. However, geographic differences in the location and time of spawning and rearing between cultured and wild salmonid stocks generally mitigate potential negative interactions (Trotter 1989, Johnston 1981).

The proposed expansion of the lower Columbia River terminal fisheries research program would provide additional information to contribute to an understanding of interspecies and intraspecies competition between anadromous and non-anadromous stocks in the lower Columbia River and northeast Pacific Ocean. The research will continue to fully examine potential straying and whether any straying adults successfully spawn and compete with natural spawners.

According to the Columbia River Basin Fish and Wildlife Program, BPA will initiate funding in 1995 of a more comprehensive basin carrying capacity study to, in part, gather additional information on competition. Prior to the initiation of that study, BPA and others are completing a comprehensive environmental analysis of the hatchery program in the entire Columbia River Basin. The analysis will examine existing information on hatchery/wild fish interactions.

Until additional information is available, there is little conclusive evidence to suggest that interspecies or intraspecies competition is likely to occur between pen-reared and naturally produced salmonid stocks (Lichatowich 1993). Whatever interactions may be occurring between hatchery fish and naturally produced fish, they are most likely reduced by the proposed research program because hatchery fish used in net pen research are separated from naturally produced fish in time and space by transferring them from upstream hatcheries to lower river terminal sites.

5.2.2 Benthic Communities

Salmon rearing operations could affect benthic (bottom dwelling) communities in three ways: particulate organic inputs from uneaten food and fish waste products, inorganic sediment deposition, and organic matter contributed by biofouling organisms during pen cleaning and maintenance activities. The organic material originating from these sources has the potential to affect the chemical composition of bottom sediments and the organisms on (epibenthos) and within the bottom sediment (infauna) (Pearson and Rosenberg 1978).

Organic sediments could affect benthic organisms (benthos) by two mechanisms. One is the physical effect of the continual deposition of organic or inorganic particles. At low deposition rates, organic matter might provide an additional food source for certain benthic organisms. At high deposition rates, particulate matter might clog the filtering apparatus of filter-feeding organisms. At very high rates, benthic organisms might be buried. Monitoring at Youngs Bay has not detected any adverse effects on benthic communities, suggesting that adverse effects on benthic organisms are unlikely at the expansion sites.

Second is the deposition of organic material from fish rearing facilities. These deposits could reduce dissolved oxygen levels by increasing the demand for oxygen, and by decreasing both diffusion and water flow within bottom sediments. As increasing amounts of fine sediment accumulate, the depth to which oxygen penetrates can also be reduced, and the underlying sediment layers might become anoxic and unable to support infaunal (burrowing) organisms. Similarly, in areas with poor circulation, oxygen demand by anoxic sedimentary materials could potentially reduce the dissolved oxygen level in the overlying water column. However, because a buildup of organic or inorganic materials has not been detected at the existing Youngs Bay net pen site, it is unlikely to constitute a problem at other locations that, like Youngs Bay, are well flushed.

Net pen rearing operations are unlikely to adversely affect existing benthic communities at Tongue Point, Blind Slough, or Grays Bay/Deep River because the twice daily tidal flushing and/or riverine water flows dilute and disperse organic and inorganic materials over a wide area. Similarly, expanded net pen rearing at Youngs Bay is unlikely to adversely affect benthic communities because of strong tidal flushing associated with the site's location near the mouth of the Columbia River.

5.2.3 Non-Anadromous Fish and Shellfish Resources

Several species of non-anadromous (resident) fish and shellfish are found in the vicinity of Youngs Bay and the three proposed expansion sites. The net pens could beneficially affect these populations in several ways. The net pen structure can provide increased habitat and cover for fish, thereby increasing fish diversity and abundance in the vicinity of the net pens. Resident fish could feed on the uneaten pelleted food. In addition, the submerged portions of the net pens would provide surface areas that algae, invertebrates, and other biofouling organisms would attach to, and resident species are likely to use them as food sources. These additional food sources might increase the abundance of certain species in the area of the net pens.

On the other hand, fish and shellfish resources could be adversely affected if organic and inorganic sediments originating from fish rearing are deposited over important habitat areas. For example, Parametrix Inc. (1990) determined that commercial fish farms located over shallow water clam or geoduck beds could deplete oxygen levels and kill shellfish within the deposition zone. Similarly, if sedimentation were to occur over important fish or invertebrate spawning areas, eggs or larvae could be smothered and species abundance could be adversely affected.

The proposed expanded net pen operations are not located over any known sensitive habitats that resident fish or shellfish use, and all sites demonstrate either tidal and/or riverine flushing. Thus, the proposed actions are not expected to adversely affect resident fish and shellfish populations in the lower Columbia River.

5.2.4 Endangered Species Act Listed Salmon Stocks and Other Species

The earlier Youngs Bay releases and their potential impacts on the critical habitat of listed Snake River stocks was assessed in National Marine Fisheries Services' (NMFS) Biological Opinion released on April 2, 1993. NMFS concluded that operation of BPA-funded hatcheries, including the release of Youngs Bay net pen reared coho smolts, is not likely to jeopardize the continued existence of endangered Snake River salmon species. The NMFS Biological Opinion evaluated the effects of Mitchell Act coho salmon releases in the lower Columbia River migration corridor and included potential impacts from competition for food and space in both estuarine and ocean environments.

Additional impacts on listed species could occur as a direct result of the incidental take of listed species at Youngs Bay and at the proposed terminal fishery research sites. As in earlier test fisheries, NMFS will issue a Biological Assessment and Biological Opinion on the adult harvest-related impacts of the expanded fishery on listed Snake River salmon species.

Test fishing at terminal sites was approved in the NMFS Biological Opinion for the 1994 winter gillnet fishery. The contractors (ODFW and WDFW) have included results from these potential catches in their Biological Assessments submitted to NMFS. If catch becomes excessive on non-target species, particularly upriver salmon stocks (Snake River sockeye, spring/summer and fall chinook) listed under ESA, test fishing would be modified or halted immediately.

The proposed expansion of terminal fisheries in the lower Columbia River is consistent with the *Proposed Recovery Plan for Snake River Salmon* (U.S. Department of Commerce 1995). One of the Biological Objectives (Section 3.4) identified in the *Plan* is to "protect all listed species through development of alternative harvest methods," through improvements in the productivity of ESA-listed stocks, to gain access to viable, non-listed stocks, and to reduce mixed-stock fisheries to protect listed stocks. The proposed project is consistent with this objective. Moreover, Subobjective 3.4.b, "opportunities to increase terminal area fisheries," specifically recommends terminal fisheries as a method to reduce impacts on depressed ESA-listed stocks in mixed stock fisheries. The proposed project is consistent with this subobjective.

Consultations have been held with NMFS on the potential effect of this proposed terminal fisheries research project on listed salmon species. Test, sport, and commercial fishing in the terminal sites are not believed to jeopardize listed salmon. Net pen rearing and release of research fish have also been included in annual Biological Opinions of NMFS and are not believed to jeopardize the continued existence of listed salmon species. These annual consultations with NMFS will continue throughout the project's eight-year time frame.

Table 13 includes a list of candidate species being reviewed for listing under the ESA. Of the candidate species listed, some potential exists for the proposed project to affect the green sturgeon, river lamprey, and Pacific lamprey. The chance for any such impact is thought to be remote and would only occur during test fishing at existing and proposed terminal sites, and during the commercial or recreational terminal fishery. Because the total Youngs Bay landings for the green sturgeon averaged 5 fish per year between 1979 and 1993, effects to this species are considered negligible. Minor disturbances to the river lamprey and Pacific lamprey could occur during test and commercial net fisheries. However, because of their small size and shape, it is unlikely that lamprey would be captured in commercial gillnets. Effects on other candidate mammals, birds, amphibians, and plants are not expected. Test fishing to date has had little or no adverse effect on ESA-listed salmon or other species. Therefore, the expanded net pen program is not expected to adversely affect ESA-listed upriver salmon stocks or other sensitive species.

TABLE 13

Federally listed endangered and threatened species and candidate species that might occur in the area of the proposed Youngs Bay fisheries project.

Listed Species and Sightings[1,2]	Latin Name	Designation
FEDERALLY LISTED ENDANGERED AND THREATENED SPECIES		
Mammals		
Columbian white-tailed deer	*Odocoileus virginianus leucurus*	LE
Documented neaer Wallace Slough		
(T8N, R4W, Section 28-31)		
(T8N, R5W, Section 35)		
Documented near Clifton Channel		
(T8N, R6W, Section 16)		
(T9N, R6W, Section 32)		
Humpback whale	*Megaptera novaeangliae*	LE
Blue whale	*Balaenoptera musculus*	LE
Fin whale	*Balaenoptera physalus*	LE
Sei whale	*Balaenoptera borealis*	LE
Sperm whale	*Physeter macrocephalus*	LE
Steller sea lion	*Eumetopias jubatus*	LT
Birds		
Bald eagle	*Haliaeetus leucocephalus*	LT
Documented nest near Wallace Slough		
(T7N, R4W, Section 1)		
Documented nest near Clifton Channel		
(T9N, R6W, Section 19, 31)		
Documented wintering near Clifton Channel		
Documented nests near Blind Slough		
(T9N, R7W, Section 24, 25, 32, 33)		
(T8N, R7W, Section 5)		
Documented nest near Tongue Point		
(T8N, R9W, Section 2, 14)		
Documented nest near Youngs Bay		
(T8N, R9W, Section 16, 21)		
Peregrine falcon	*Falco peregrinus*	LE
Brown pelican	*Pelecanus occidentalis*	LE
Reptiles		
Leatherback sea turtle	*Dermochelys coriacea*	LE
Loggerhead sea turtle	*Caretta caretta*	LT
Fish		
Snake River chinook salmon	*Oncorhynchus tshawytscha* (CH)	**LE
Spring/summer runs in the Snake River		
(Petitioned June 7, 1990; proposed June 27, 1991 in 56 FR 29542-29544; listed April 22, 1992 in 57 FR 14653)		
Snake River chinook salmon	*Oncorhynchus tshawytscha* (CH)	**LE
Fall runs in the Snake River		
(Petitioned June 7, 1990; proposed June 27, 1991 in 56 FR 29542-29544; listed April 22, 1992 in 57 FR 14653)		

TABLE 13 (CONTINUED)

Listed Species and Sightings[1,2]	Scientific Name	Designation
Snake River sockeye salmon Salmon River tributary to the Snake River, Idaho. (Petitioned April 2, 1990; proposed April 6, 1991 in 56 FR 14055; listed November 20, 1991 in 56 FR 58619	*Oncorhynchus nerka*	(CH) **LE
Invertebrates		
Oregon silverspot butterfly Historical collection near Astoria	*Speyeria zerene hippolyta*	CH LT
Plants		
Howellia	*Howellia aquatalis*	LT
CANDIDATE SPECIES[3,4]		
Mammals		
White-footed vole	*Arborimus albipes*	C2
Pacific fisher	*Martes pennanti pacifica*	C2
Long-eared myotis (bat)	*Myotis evotis*	C2
Fringed myotis (bat)	*Myotis thysanodes*	C2
Yuma myotis (bat)	*Myotis yumanensis*	C2
Pacific-western big-eared bat	*Plecotus townsendii townsendii*	C2
Birds		
Little willow flycatcher	*Empidonax traillii brewsteri*	C2
Amphibians and Reptiles		
Tailed frog	*Ascaphus truei*	C2
Northern red-legged frog	*Rana aurora aurora*	C2
Fish		
Green sturgeon	*Acipenser medirostris*	C2
River lamprey	*Lampetra ayresi*	C2
Pacific lamprey	*Lampetra tridentata*	C2
Plants		
Howell's montia	*Montia howellia*	C2

Notes:
(LE) - Listed Endangered (LT) - Listed Threatened (CH) - Critical Habitat has been designated for this species
(C2) - Category 2: Taxa for which existing information indicates may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

* If a vertebrate or plant, a single asterisk indicates taxon is possibly extinct. If an invertebrate, a single asterisk indicates a lack of information for taxon since 1963.
** Consultation with NMFS required.

Sources: 1 U.S. Department of Interior, Fish, and Wildlife Service, August 23, 1993, *Endangered and Threatened Wildlife and Plants*, 50 CFR 17.11 and 17.12.
2 Federal Register Vol. 59, No. 134, July 14, 1994, Final rule - *Howellia aquatalis*
3 Federal Register Vol. 59, No. 219, November 15, 1994, Notice of Review - Animals
4 Federal Register Vol. 59, No. 188, September 30, 1993, Notice of Review - Plants

5.2.5 Disease

Concerns about disease in fish rearing involve the potential for introducing harmful pathogenic organisms (e.g., bacteria, fungi, and viruses) living in eggs imported from other geographic areas, transferring of diseases from hatchery to wild stocks, and transmitting diseases from cultured fish to other economically important native and non-native fish and shellfish resources.

Some fish diseases are restricted in geographic distribution because the affected fish are limited to their natural geographic range. Thus, a risk of introducing exotic fish pathogens (that is, those that do not exist in an area receiving imported fish) exists when fish are transported to a new location. Occurrences of exotic fish pathogenic parasites and diseases in new locations have often been attributed to the transfer of fish. However, the actual geographic and host distribution of many fish diseases is unknown.

In the aquatic environment, wild fish can act as reservoirs for diseases of cultured fish. For example, infectious hematopoietic necrosis (IHN) infects returning sockeye salmon in all major populations in Washington State (Amend and Wood 1972). Disease has also been transmitted from hatchery fish to wild fish. Such diseases are generally passed either after hatchery fish are stocked into natural waters, or from a hatchery containing diseased fish to wild fish downstream.

The potential for disease occurrence or transmission will be minimized by using known salmon stocks and through a comprehensive disease detection and diagnosis program. Routine diagnostic analyses would be conducted for all cultured stocks before the stocks leave the hatchery and before smolts are released. In most cases, infectious disease can be treated through routine treatment measures, such as incorporating specific antibiotics in pelleted foods. As a result of careful disease monitoring and over-winter rearing (when water quality and temperature are optimal for salmonid growth), the potential for a disease outbreak in net pen stocks, or transmission of disease organisms from cultured to wild stocks, is thought to be low. Because of the lower fish densities in net pens, the opportunity for disease outbreak and transmission is considerably less than in a hatchery setting.

5.2.6 Stray Evaluation

Pacific salmonids demonstrate a remarkable ability to home to their natal stream for spawning. However, a small portion of the salmon also spawn elsewhere; these fish are known as strays. One conventional explanation for straying is that these salmon are "lost." That is, all salmon are presumed to have the same general homing tendency, but sensory or memory failures or fatigue might prevent some from locating their natal streams (Quinn 1984). Others have suggested that straying is a natural mechanism of population dispersal (Labelle 1992).

Since the inception of the Youngs Bay net pen rearing program, CEDC project personnel and ODFW have worked together to monitor and evaluate the rate of hatchery straying into Oregon rivers from the lower Columbia River. Each year, a percentage of each lot of coho salmon have been marked with coded wire tags before release into Youngs Bay. ODFW analyzes coded-wire-tag recoveries from escapement areas to estimate straying rates and the stock composition of coho adults caught in the Youngs Bay terminal gill net fishery.

An ODFW analysis of coded-wire-tag recoveries of 1988-1990 brood coho released at Youngs Bay net pen site indicated that recoveries from escapement areas are of minor magnitude (Hirose 1994). Of 2,660 tagged fish, only 22 tagged fish (0.8 percent) were recovered from non-Youngs Bay fisheries. These 22 fish were detected at local hatcheries. No fish were found during intensive spawning ground surveys. Based on tag-recovery data, straying does not appear to have been a problem in past rearing programs and is, therefore, unlikely to present a problem in this research program.

For other fish stocks used in net pen experiments, similar straying studies will be conducted. Typically, one-third of all release groups are coded-wire tagged for subsequent stock recognition in returning adults. For the Rogue River fall chinook stock, all smolts will be ventral fin clipped in addition to CWT tagging. The ventral fin clipping will allow positive identification in fisheries and during spawning ground surveys.

Some straying has been documented for the Rogue River fall chinook stock released from the Big Creek Hatchery. Rates of straying from Youngs Bay net pens should be significantly less than hatchery releases since smolts will be river-acclimated over the range of 2 weeks to full term and acquire greater imprinting to the bay. Also, adults will return to more favorable water conditions in Youngs Bay compared to Big Creek, which should lessen straying tendancies. With the intense sport and commercial fishery in Youngs Bay, returning adults may also not have an opportunity to stray to local hatcheries or streams.

5.3 Recreation

5.3.1 Water-Dependent Recreation

Net pen structures have the potential to affect recreational activities by obstructing access to areas traditionally used for water-dependent recreation. If pens are deployed in areas used for recreational boating or fishing, they could restrict the use of these areas. The use of docks, piers, or other land-based structures or facilities associated with the net pens could be reduced.

Gillnetters could be most affected by the placement of net pens because more anglers use this fishing method and they often fish at night when visibility may be limited. Placing a fixed object, such as a net pen, in the middle of a drift would force gillnetters to avoid the immediate area, or to retrieve their nets to avoid entanglement. However, the gillnetters who are able to fish close to the pens might actually benefit because commercially or recreationally valuable fish and shellfish could be attracted to the pens. For example, crayfish could be attracted to the net pens because of the availability of uneaten fish food. Migratory fish might also be concentrated to some degree as they navigate around the pens. Thus, fish pen operations might positively affect recreational fishing by causing localized increases in the number of finfish near the rearing site.

Impacts on water-dependent recreation are expected to be negligible and, in most cases, positive because both commercial and recreational fishers would gain from the expanded fishery. All of the proposed sites for expanded net pen rearing, and the existing Youngs Bay site, have existing docks (and for Youngs Bay and Blind Slough, existing net pens) in place that are well known to commercial and recreational fishers. Access to adjacent shorelines and lands would not be altered significantly at any of the preferred sites, and recreational use of lands adjacent to the pens would not directly or indirectly change because of the proposed expansion program.

5.3.2 Navigation

Net pen facilities could affect navigation if sited in established navigation lanes, narrow channels, or areas in which boats would have difficulty navigating. In addition, if net pens break loose from their moorings during severe weather conditions, they could become a hazard to vessel traffic. If the pens are inadequately lighted or made visually unobtrusive, they pose an additional risk to vessels and smallcraft and might constitute a safety hazard, especially at night or during inclement weather.

Placing net pens in an embayment might affect safe anchorages. During inclement weather, recreational boaters and fishers might seek sheltered sloughs for protection from storms. If the net pens restrict the use of a sheltered bay or slough for anchorage by blocking channels or limiting maneuverability, boaters might have to travel to the next available safe anchorage, potentially at some risk.

Pens located near shore could affect navigation in a manner similar to a dock, jetty, or a series of anchored boats. The farther offshore the fish pens are located, the greater the navigational risk because reference points might not be obvious, boat traffic might be heavier, and vessels and smallcraft are usually moving at a faster speed.

Because of the proposed placement of net pens along or abutting existing private (Blind Slough, Grays Bay/Deep River), public (Tongue Point), and commercial (Youngs Bay) docks, piers, and anchorages, effects to navigation are expected to be minor. Similarly, all existing and proposed net pen sites are located in embayments or sloughs at some distance from mainstem Columbia River navigational channels.

5.4 Aesthetic Resources

Minor changes in aesthetic resources resulting from the placement of net pens and fish rearing is likely to occur. These changes could include minor alterations in visual quality, odor, and noise.

5.4.1 Visual Quality

Impacts to visual quality resulting from placement and operation of net pens depends on several variables, including location, size, and design of the facility, and the environmental characteristics of the surrounding environment.

The net pens have floats and pipes that extend about 1.5 m (5 ft) above the water when fully deployed. At some sites (Blind Slough and Grays Bay/Deep River), a small shed used to store feed and supplies might have to be constructed. Such a structure could extend about 3 m (10 ft) above the water and have a surface area of roughly 9.3 square meters (m^2) (100 square feet [ft^2]).

The visual impact of the net pens would depend on the distance between the observer and the pens, the altitude of the observer, and on the surrounding views. In general, only individuals within about 610 m (2,000 ft) are likely to see the net pens as anything more than a thin line on the horizon (EDAW and CH2M HILL 1986). Viewers in the immediate vicinity of the net pens could have their viewplane slightly altered, but overall the change would be one compatible with existing, long-established, shoreline, water, and land use.

Net pen design is dominated by straight lines and a regular pattern. These characteristics contrast with the water surface and might tend to draw the attention of observers. Observer attitudes would be affected by the overall visual environment near the net pen sites. Observers in an area with few built structures (such as at Blind Slough) might perceive the pens as visually intrusive. Net pens located in a complex landscape dominated by built structures and urban areas such as Tongue Point and Youngs Bay are likely to be regarded as visually unobtrusive to the observer. The overall effect of the proposed actions on visual quality is, therefore, considered negligible.

5.4.2 Noise

Potential noise impacts would occur primarily during daytime hours when fish feeding and pen maintenance operations take place. Sources of noise include boats servicing the pens, outboard motors, and incidental noise from project personnel. Some noise would also result from vehicles used by project personnel and an occasional tanker truck used for stocking pens with hatchery fish.

Noise would also be generated during seasonal fishery stock surveys and during commercial and recreational fishing activity. At Youngs Bay and Tongue Point, an incremental increase in noise levels would likely be masked by the existing noises associated with human activities. Noise would be more noticeable at Grays Bay/Deep River and Blind Slough, although noise is unlikely to exceed existing background noise levels associated with agricultural activities, boat maintenance, and vehicular traffic.

Wading birds, migratory ducks, and seabirds attracted to the fish in the net pens might increase the natural ambient noise levels above existing conditions during routine rearing operations. Such bird noises could become a temporary nuisance when smolts are released and when bird feeding activities are likely to be concentrated on schools of smolts. Any such disturbances can be mitigated by releasing fish after dark when bird activity is reduced.

Overall, noise levels are not expected to exceed those associated with existing on-site activities and are not considered significant.

5.4.3 Odors

Because organic matter and living organisms are associated with marine facilities and fish rearing, net pen operations could be a source of additional odors. Most of these odors are similar to those occurring naturally on beaches and within estuaries as a result of tidal exposure and organic material decay. Principal sources of potential odors are spilled or improperly stored fish food, nets fouled with attached marine life, excretory products of birds attracted to net pens, and dead fish. Boats servicing the net pens would contribute a minor amount of exhaust fumes to the immediate area of the pens, and these fumes would be detectable a short distance downwind.

Any nuisance odors associated with the net pens or fish rearing would be temporary and intermittent, and not significant. In most cases, attributing particular odors to pen rearing operations at any of the locations might be difficult, because other activities in the area, both human-made (vessel haul-out) or natural (exposed intertidal beaches and mudflats), might produce similar odors. Proper facility maintenance and management measures are already or would be implemented at each site to ensure that odors do not constitute a problem.

5.5 Threatened and Endangered Wildlife

5.5.1 Birds and Mammals

Federally listed and proposed endangered and threatened species and candidate species that may occur in the area of the proposed projects are listed in Table 11. The USFWS provided the information in Table 11 to fulfill the consultation requirements under Section 7 of the ESA (USFWS 1995).

The peregrine falcon is an endangered species that might occur in the area of the lower Columbia River. Earlier studies (BPA 1993) determined that the peregrine falcon would not be adversely affected by net pen operations at Youngs Bay. Adverse effects are not anticipated from expanded net pen operations at Youngs Bay or at proposed upriver net pen sites.

The bald eagle is a threatened species that is widespread and relatively common throughout much of the lower Columbia River Basin. Many areas are used for over-wintering and nesting. Documented bald eagle nests occur in the vicinity of Wallace Slough, Blind Slough, Tongue Point and Youngs Bay; documented over-wintering occurs near the Clifton Channel (Pesek 1995).

Earlier studies (BPA 1993) have determined that the bald eagle would not be adversely affected by net pen operations at Youngs Bay, and is therefore unlikely to be affected by expanded net pen operations at Youngs Bay or at the proposed upriver locations. Bald eagles have nested in an urbanized upland setting near the tip of Tongue Point for many years and are frequently observed diving for prey off commercial wharfs in downtown Astoria. The proposed expansion project would not significantly change land use in the affected areas, and actions disruptive to the bald eagle would be avoided. Released smolts and returning adults could provide supplemental prey for bald eagles.

The brown pelican is an endangered species that may be found up to and in the area of Tongue Point during the summer, but only rarely farther upriver (Pesek 1995). This species is not known to nest in the area. Earlier studies (BPA 1993) determined that although the brown pelican can occasionally be found within the Tongue Point and Youngs Bay region, it would not be adversely affected. The expanded net pen program is unlikely to affect this species at either Youngs Bay or Tongue Point. Salmon smolts released from net pens at Tongue Point and Youngs Bay might provide an additional food source for brown pelicans.

The Columbian white-tailed deer is a threatened species that has been documented in the vicinity of Wallace Slough and Clifton Channel and in other regions of the lower Columbia River. The Julia Butler Hanson Columbia White-tail Deer Refuge, located in Wahkiakum County, Washington, was recently created to provide protected habitat for the Columbian white-tailed deer. Minor disturbances to the Columbian white-tailed deer could result from increased vehicular traffic and human activities at the proposed Grays Bay/Deep River net pen site, which is located near the southern boundary of the refuge. Overall, effects to the Columbian white-tailed deer are thought to be remote because salmon rearing operations would not directly affect foraging areas, food stocks, or change the existing or abutting land use at any of the proposed project sites.

The Steller's sea lion, a federally threatened species, is known to occur in the lower Columbia River. Unidentified sea lions or seals have occasionally been observed on the docks at the existing Youngs Bay net pen site. The possibility of the Steller's sea lion becoming entangled in the nets exists; however, it is unlikely because of small mesh size and use of knotless web.

Smolts released from net pens and returning adult salmon could provide an additional source of prey for the Steller's sea lion and other marine pinnipeds.

5.6 Critical Habitat

The entire Columbia River is a designated critical habitat for the Snake River sockeye salmon, spring/summer chinook salmon, and fall chinook salmon. The expansion of net pen facilities and release of salmon smolts is not expected to adversely affect the critical habitat of ESA-listed stocks.

The proposed net pen sites are not located in or adjacent to any defined ESA terrestrial or upland critical habitat, any known sensitive habitat, or in the vicinity of any known unique species or population assemblage. Thus, the proposed action would have no adverse effects on the any known critical or sensitive habitat.

5.7 Archeological, Historical, and Cultural Resources

The proposed action is not expected to adversely affect any known archeological, historical, or cultural resource. No properties (i.e., sites, buildings, structures, objects) of archeological, historical, or cultural significance, as designated by Federal, State, or local governments or properties eligible for listing on the National Register of Historic Places would be affected. If any such resources are discovered, activity would be immediately stopped and the appropriate state's Historic Preservation Officer would be contacted. If needed, a mitigation plan would be prepared for documenting and mitigating any potential effects on the resource. This plan would ensure that the proposed project complies with Section 106 of the National Historic Preservation Act of 1966.

5.8 Cumulative Effects

The potential cumulative effects of an expanded terminal salmon fishery in the lower Columbia River would be largely beneficial. This determination is based on knowledge gained from earlier Youngs Bay net pen salmon releases and likely harvest restrictions required in ocean and in-river mixed-stock fisheries to protect depressed, ESA-listed salmon stocks. Collectively, these cumulative effects are expected to directly enhance lower Columbia River fisheries and indirectly stimulate Astoria and other economically depressed towns and rural areas within Oregon and Washington. Another positive cumulative benefit of the proposed action is the expected revitalization of a tradition and lifestyle that is an integral part of the lower Columbia River Basin and the Pacific Northwest.

An expanded terminal fishery also offers the cumulative benefit of more efficient and cost-effective production and use of hatcheries and hatchery fish and their contribution as adult returns to local economies. For example, Youngs

Bay acclimated-and-imprinted smolts survive and return to terminal fisheries at rates 2 to 4 times better than fish released directly from hatchery facilities. Thus, terminal known-stock fisheries offer the opportunity to make better economic use of Mitchell Act and other public hatchery fish.

Return of pen-reared fish to terminal sites allows their harvest with minimal economic cost by independent fishers. Capital investments, labor, and operating expenses by licensed fishers can be expected to decrease, because salmon would return to a restricted area and not require the more substantial investment and fuel costs associated with traditional search and capture fisheries. Terminal fisheries also allow harvest of salmon at their maximum weight and ensure a high quality, high market value product. Additionally, stock selection and rearing programs associated with terminal fisheries can allow some degree of matching supply of salmon to market needs, thereby perhaps stabilizing wholesale and retail salmon prices over the long term.

Table 14 provides an estimate of the potential economic benefits of an expanded terminal fisheries program. If ongoing research, together with the actions proposed herein demonstrate that sites other than Youngs Bay perform in a similar manner, an estimated 50 million juvenile coho and chinook salmon, from existing hatcheries, could be reared and released at these sites. On average, an annual sport and commercial catch of about 1.8 million salmon worth close to $87 million could be expected. With greater harvest rates and survival resulting from the use of net pens at terminal sites, over 50 percent of these benefits ($43 million) would be directly attributable to the terminal fishery. Any BPA involvement in establishing an ongoing terminal fisheries program beyond the current research phase, would be preceded by a comprehensive environmental analysis in compliance with NEPA. The analysis would be based on information collected during this research phase.

The potential to alleviate harvest rates in mixed-stock ocean and in-river fisheries by having cultured salmon return to known terminal sites is another positive cumulative effect of the proposed program. Terminal fisheries allow managers to reduce or eliminate some mixed stock harvest to protect weak stocks, yet still harvest the hatchery fish for regional economic gain in the known stock terminal fisheries. Thus, ESA-listed stocks can be conserved while still allowing for commercial and recreational harvesting.

There are, however, potential adverse cumulative effects which could result from the proposed action. With increased numbers of hatchery fish being reared, there is an increasing opportunity for disease transmission from cultured stocks to wild stocks. This potential could increase as a greater number of salmon species are used in both hatchery and growout operations. Although some salmonid diseases are species-specific, some infectious diseases are not host-specific. Although existing disease and parasite diagnostic procedures followed in hatchery and growout areas appear to minimize disease occurrence, an increased number of fish being cultured may, over the long term, increase the potential for disease transmission to cultured and wild salmon and trout stock, as well as certain ESA-listed and candidate species. Although of potential concern, disease or parasitic infections have not been identified in previous net pen rearing studies at Youngs Bay.

Another potential cumulative impact is the increase in the incidental (accidental) take of ESA-listed and candidate stocks, such as the green sturgeon. Although this potential impact is offset to some degree by having cultured salmon return to known terminal sites, thereby alleviating incidental harvests in mixed-stock ocean and in-river fisheries, the incidental take of ESA-listed stocks could increase. This risk to listed or candidate species might be minimized through the annual Columbia River biological assessment process conducted by NMFS. If NMFS ascertains that ESA-listed stocks are being jeopardized, appropriate management interventions would be implemented to reduce or eliminate adverse impacts.

Increased interspecies and intraspecies competition for food and habitat, particularly in the North Pacific Ocean, could occur as a result of expanded

TABLE 14
Value of full lower Columbia River terminal fisheries program implementation.

Species (Stock)	Area	Number Released (millions)	Total Survival to Fisheries (%)	Catch Number ($ Value, in thousands) Ocean Sport	Ocean Commercial	River Sport	River Commercial	Projected Catch and $ Value (in thousands)
Spring Chinook	Youngs Bay	2.0	2	600 ($60)	11,400 ($752.4)	1,400 ($350)	26,600 ($2,048.2)	40,000 $3,210.6
	4 other sites	1.2	2	360 ($36)	6,840 ($451.4)	840 ($210)	15,960 ($1,228.9)	24,000 $1,926.3
Coho	Youngs Bay	6.0	5	72,000 ($4,500.0)	18,000 ($198.0)	42,000 ($2,100.0)	168,200 ($2,587.2)	300,000 $9,385.2
	4 other sites	16	5	192,000 ($12,000.0)	48,000 ($528.0)	112,000 ($5,600.0)	448,000 ($6,899.2)	800,000 $25,027.2
Fall Chinook (RRB)	Youngs Bay	4.0	3	7,800 ($780.0	70,200 ($1,390.0)	16,800 ($4,200.00)	25,200 ($1,455.3)	120,000 $7,825.3
	4 other sites	9.0	3	17,550 ($1,755.0)	157,950 ($3,127.5)	37,800 ($9,450.0)	56,700 ($3,274.4)	270,000 $17,606.9
(URB)	Youngs Bay	4.0	2	3,200 ($320.0)	28,800 ($1,900.8)	4,800 ($1,200.0)	43,200 ($3,326.4)	80,000 $6,747.2
	4 other sites	9.0	2	7,200 ($720.0)	64,800 ($4,276.8)	10,800 ($2,700)	97,200 ($7,484.4)	180,000 $15,181.2
TOTAL		51.2		300,710 (420,171.0)	405,990 ($12,624.9)	226,440 ($25,810.0)	880,960 ($28,304.0)	1,814,000 $86,909.9

Source: ODFW 1994

hatchery and pen-rearing operations in the Columbia River and other locations bordering the North Pacific. Once at sea, cultured fish could compete directly for food and habitat with native as well as hatchery salmon and steelhead stocks, and other commercial and non-commercial coastal and pelagic species. In the long term, such releases could potentially affect the carrying capacity of fishery resources within the North Pacific Ocean. Such effects might also be expressed in reduced numbers of marine mammals, seabirds, and other species that are directly or indirectly dependent upon the productivity of coastal and ocean waters. Although the carrying capacity of nearshore and oceanic fishery stocks is a subject of increasing concern among fishery managers, conservationists, and regulators, currently available information has not provided convincing evidence of a link between fishery enhancement efforts and any known adverse impacts to wild salmonid populations, other native fish stocks, or the complex marine community that comprises the North Pacific Ocean ecosystem (Lichatowich 1993).

5.9 Federal Consistency Requirements with States' Coastal Zone Management Program

Based on consultation with the Washington Department of Ecology (WDOC) and the Oregon Land Conservation and Development Commission (LCDC), it has been determined that the proposed project, project-related operations, and releases of pen-reared salmon are actions consistent with the respective state coastal zone management programs. The states of Oregon and Washington have concurred with this determination. The WDFW issued a Hydraulic Project Approval Permit (No. 00-A0112-01; issued March 27, 1995) encompassing net pen installation and removal in the Deep River channel. Wahkiakum County (Washington) Planning Department has exempted the proposed project (Exemption EX3-95; issued April 23, 1995) from the Shoreline Management Act (SMA) of 1971 (Chapter 90.58 RCW). When consistent with control of pollution and prevention of damage to the environment, aquaculture activities are a "preferred" shoreline use under the SMA. All project-related activities are included under an ODEQ Water Pollution Control Permit (ODEQ Permit No. 101198) issued to the CEDC project on June 7, 1989. Clatsop County approved the project under CUP No. 86-PC72.

6.0 COMPLIANCE WITH ENVIRONMENTAL STATUTES

Consistent with the requirements of NEPA, and subsequent regulations issued by the Council Environmental Quality (40 CFR 1500), this EA includes a project compliance review of relevant statutes and executive orders listed below:

- Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 et seq., Public Law 97-304. (BPA has consulted with USFWS and NMFS pursuant to Section 7 of the ESA).
- Fish and Wildlife Coordination Act of 1956, as amended, 16 U.S.C. 661 et seq. The proposed actions would be coordinated with Federal and State resource agencies and with Indian Tribes).
- Federal Coastal Zone Management Act of 1972, as Amended, 16 USC 1451 et seq.
- Rivers and Harbors Act, 33 U.S.C. 401 et seq.

There would be no action required under the following regulations if the program is implemented as proposed:

- Executive Order 11593; Archaeological and Historical Preservation Act of 1974, 16 U.S.C. 469 et seq., Public Law 92-291.
- Floodplains and Wetland, Executive Orders 11988 and 11990 and DOE implementation guidelines (10 CFR 1022).
- Farmland Protection Policy Act (7 U.S.C. 4201 et seq.).
- Wild and Scenic Rivers Act, as amended, 16 U.S.C. 1271 et seq.
- Federal Water Pollution Control Act. See 404 as amended.
- Clean Air Act, as amended, 42 U.S.C. 7609 et seq.
- Clean Water Act, as amended, 33 U.S.C. 1251 et seq.
- Safe Water Drinking Act.
- Resource Conservation and Recovery Act 42 U.S.C. 6901 et seq.
- Noise Control Act.
- Federal Insecticide, Fungicide and Rodenticide Act.
- Toxic Substances Control Act, 15 U.S.C. 2601 et seq.
- Energy Conservation Policy, 42 U.S.C. 8241 et seq.

7.0 AGENCIES AND ORGANIZATIONS CONSULTED

This section summarizes the agencies and organizations that were consulted in the preparation of this EA.

- Oregon Department of Environmental Quality
- Oregon Land Conservation and Development Commission
- Clatsop Economic Development Council
- Oregon Department of Fish and Wildlife
- Washington Department of Ecology
- Washington Department of Fish and Wildlife
- Wahkiakum County Planning Department
- U.S. Fish and Wildlife Service
- U.S. Army Corps of Engineers
- National Marine Fisheries Service
- Oregon Trout

8.0 GLOSSARY AND ABBREVIATIONS

Acclimation	Adaptation of a fish species to its aquatic environment.
Anoxic	The condition of having little or no oxygen present.
Anadromous	Fish that migrate up freshwater rivers and streams to reproduce after maturing in the ocean.
BPA	Bonneville Power Administration.
CEDC	Clatsop Economic Development Council.
Coded-wire tag	Coded-wire tags are small pieces of wire that are imbedded with a small applicator or by hand into the snouts of fish. These tags allow recognition of groups either with color-coded markings or with notches that are read externally by a sensitive metal detector.
Council	Northwest Power Planning Council.
ODEQ	Oregon Department of Environmental Quality.
ESA	Endangered Species Act of 1973, as amended.
Flushing time	The amount of time water takes to move through the estuary.
Fry	The life stage of a fish that starts with the hatching of the egg to absorption of the yolk sac through the growth to a size of 1 inch long.
Full-term rearing	Raising juveniles to smolt conditions where they are physiologically and behaviorally adapted for oceanic migration, most often marked by certain morphological and color changes.
Integrated Hatchery Operations Team	A team consisting of Federal, state, and Tribal representatives that coordinates the management and operation of all existing and future hatcheries in the Columbia River Basin.
Imprinting	A learning process occurring in the juvenile stages of life by which fish determine their adult homing location.
Jacks	Early reproductively mature adult males.
Juvenile	Fish from 1 year of age until sexual maturity.
LCDC	Oregon Land Conservation and Development Commission.
Mainstem	The main channel of a river.
NEPA	National Environmental Policy Act.
NMFS	National Marine Fisheries Service.

NTU	Nephelometric Turbidity Unit, a measure of the amount of suspended sediment in water.
Nutrient	An element or chemical essential to life, such as carbon, nitrogen, and phosphorus.
ONHP	Oregon Natural Heritage Program.
Outmigration	Juvenile fish moving from freshwater toward the ocean.
Pelleted diets	Food eaten in the form of small, solid pellets.
Phytoplankton	Small, usually microscopic aquatic plants.
Project	Columbia River Terminal Fisheries Research Project.
Program	Columbia River Basin Fish and Wildlife Program.
Rearing	The life stage of anadromous fish spent in freshwater rivers, lakes, and streams (or hatcheries) before migrating to the ocean.
Run	A group of fish of the same species consisting of one or more stocks migrating at a discrete time.
SMA	Shoreline Management Act (Washington).
Smolt	A juvenile salmon migrating to the ocean and undergoing physiological changes (smoltification) to adapt its body from a freshwater to a saltwater existence.
Spawning	The act of fish releasing and fertilizing eggs.
Stock	The fish spawning in a particular stream during a particular season. These fish to a substantial degree do not interbreed with any group spawning in a different stream or at a different time.
Straying	The action by which adult salmon return to other than the terminal area.
Terminal fishery	A location where a known hatchery salmon stock(s) can be harvested at a high exploitation rate with only insignificant harvest of non-targeted stocks, particularly depressed upriver stocks.
Upriver fish	Any fish stocks originating from regions above net pen locations.
USFWS	U.S. Fish and Wildlife Service.
µS/cm	Micro Siemens per centimeter, a measure of specific conductance in water.
Volitional	The act of smolts willfully choosing to outmigrate when naturally triggered.
WDFW	Washington Department of Fish and Wildlife.
WDOE	Washington Department of Ecology.
Zooplankton	Small, often microscopic, aquatic animals.

9.0 LITERATURE CITED

Amend, D.F. and J.W. Wood. 1972. Survey for infectious hematopoietic necrosis virus (IHN) in Washington State. Progressive Fish Culturist 34:143-147.

APHA (American Public Health Association). 1985. Standard Methods for the Examination of Water and Wastewater. American Public Health Association. Washington, D.C.

Bauer, O.N. and G.L. Hoffman. 1976. Helminth range extension by translocation of fish, pp. 163-172. *In:* Leslie Andres Page (ed.), Wildlife Diseases. Plenum Publishing Corporation. New York, New York.

Becker, C.D. and W.D. Brunson. 1968. The Bass Tapeworm: A Problem in Northwest Trout Management. Contribution No. 266. College of Fisheries, University of Washington. Seattle, Washington.

BPA (Bonneville Power Administration). 1993. Youngs Bay Salmon Rearing and Release Program, Final Environmental Assessment. DOE/EA-0852. U.S. Department of Energy, Bonneville Power Administration. Portland, Oregon. April 1993.

Burrows, J.E. 1972. Salmon husbandry techniques, pp. 375-402. *In:* J.E. Halver (ed.), Fish Nutrition. Academic Press. New York, New York.

Burrows, R.E. and B.D. Combs. 1968. Controlled environments for salmon propagation. The Progressive Fish Culturist. July 1968.

Butz, F. and B. Vens-Cappell. 1982. Organic load from the metabolite products of rainbow trout fed with dry food, pp 73-82. *In:* J.S. Alabaster (ed.), Report of the EIFAC Workshop on Fish-Farm Effluents. 1981, EIFAC Tech. Rep. 41. Silkeborg, Denmark. May 26-28.

EDAW and CH2M HILL. 1986. Aquaculture Siting Study. Report prepared for the State of Washington Department of Ecology. Olympia, Washington..

Edwards, D.J. 1978. Salmon and Trout Farming in Norway. Fishing News Books, Ltd. Farnham, United Kingdom.

EPA (Environmental Protection Agency). 1986. Quality Criteria for Water, 1986. United States Environmental Protection Agency Publication No. EPA 440/5-86-001. Washington, D.C.

Evelyn, T.P.T. 1988. Bacterial kidney disease in British Columbia, Canada: Comments on its Epizootiology and on Methods for its Control on Fish Farms (In Press).

Fox, D.S., W. Nehlsen, S. Bell, and J. Damron. 1984. The Columbia River Estuary. Atlas of Physical and Biological Characteristics. Columbia River Estuary Data Development Program. Seattle, Washington. June 1984.

Gretchell, R. 1988. Environmental Effects of Salmon Farming. Maine Department of Marine Resources. 8 pp.

Gowen, R.J. and N.B. Bradbury. 1987. The ecological impact of salmonid farming in coastal waters: a review. Oceanography and Marine Biology Annual Review 25: 562-575.

Hill, J. 1992. Oregon Recovery of 1988 Brood Eagle Creek Coho Released from Youngs Bay Netpens, Chart. Clatsop Economic Development Committee.

Hill, J. 1995. Personal communication. Project Director, Fisheries Project, Clatsop Economic Development Committee, Astoria, Oregon. 1995.

Hill, J.M. and T. Olson. 1989. Evaluation of a Low-Cost Salmon production Facility. Annual Report 1988. Bonneville Power Administration, DOE/BP-11887-5. Portland, Oregon.

Hirose, P. 1992. Letter communication. Oregon Department of Fish and Wildlife, Clackamus, Oregon to Rick Westerhof, Bonneville Power Administration, Division of Fish and Wildlife. December 6, 1992.

Hoffman, G. L. 1970. Intercontinental and transcontinental dissemination and transfaunation of fish parasites with emphasis on whirling disease (*Myxosoma cerebralis*), pp. 69-81. *In:* S. F. Snieszka (ed.), A Symposium on Diseases of Fishes and Shellfishes. American Fisheries Society. Special Publication No. 5, c1970. Washington, D.C.

Hoffman, G.L. and G. Schubert. 1984. Some parasites of exotic fishes, pp. 233-261. *In:* W. R. Courtenay and J. R. Stauffer (eds.), Distribution, Biology and Management of Exotic Fishes. Johns Hopkins University Press. Baltimore, Maryland.

Institute of Aquaculture. 1988. The Reduction of the Impact of Fish Farming on the Natural Marine Environment. Report prepared by the Institute of Aquaculture, University of Stirling, Scotland. Prepared for the Nature Conservancy Council, Scotland. January 1988.

Johnsen, B.O. and A.J. Jensen. 1988. Introduction and establishment of *Gyrodactylus salaris* Malmberg, 1957, on Atlantic salmon, *Salmo salar* L., fry and parr in the River Vefsna, northern Norway. Journal of Fish Diseases 11:35-45.

Johnson, O.W., T.A. Flagg, D.J. Maynard, G.B. Milner, and F.W. Waknitz. 1991. Status Review for Lower Columbia River Coho Salmon. National Marine Fisheries Service. NOAA Technical Memorandum, NMFS/NWC-202. 95 pp.

Johnston, J.M. 1981. Life history of anadromous cutthroat with emphasis on migratory behavior, pp 123-127. *In:* E.L. Brannon and E.O. Salo (eds.), Proceedings of the Salmon and Trout Migratory Behavior Symposium. University of Washington, School of Fisheries. Seattle, Washington.

Johnstone AK. 1984. Pathogenesis and Life Cycle of the Myxosporean, *Parvicapsula sp.*, Infecting Marine Cultured Coho Salmon. Ph. D. Dissertation, University of Washington. Seattle, Washington.

Kaufman, M.A., 1994. Terminal Fisheries Water Quality Monitoring Project Monthly Status Report: November Physicochemical Parameters. Washington Department of Fish and Wildlife, Columbia River Anadromous Fish Division. Battle Ground, Washington. December 5, 1994.

LaBelle, M. 1992. Straying Patterns of coho salmon (*Oncorhynchus kisutch*) stocks from southeast Vancouver Island, British Columbia. Can. J. Fish. Aquat. Sci., Vol 49.

Lagler, K.F., J.E. Bardach, and R.R. Miller. 1962. Ichthyology. John Wiley & Sons, Inc. New York, New York.

Liao, P. and R. Mayo. 1974. Intensified fish culture combining water reconditioning with pollution abatement. Aquaculture 3:16-85.

Lichatowich, J. 1993. Ocean Carrying Capacity, Recovery Issues for Threatened and Endangered Snake River Salmon. Technical Report 6. U.S. Department of Energy, Bonneville Power Administration. Portland, Oregon.

McIsaac, D. Personal communication. Fish Division, Oregon Department of Fish and Wildlife, Portland, Oregon.

Mullan, J. W. 1984. Overview of Artificial and Natural Propagation of Coho Salmon (*Oncorhynchus kisutch*) on the Mid-Columbia River. U.S. Fish and Wildlife Service Biological Report 84 (4): 1-37.

ODFW (Oregon Department of Fish and Wildlife). 1994. 1994 Youngs Bay Spring Chinook Fishery Fact Sheet and Recommendations.

ODFW (Oregon Department of Fish and Wildlife). 1993. Staff Report, Youngs Bay Salmon Fishery. Oregon Terminal Gill-Net Fisheries Public Hearing.

ONHP. 1993. Rare, Threatened and Endangered Plants and Animals of Oregon. Oregon Natural Heritage Program. Portland, Oregon. 79 pp.

Parametrix, Inc. 1990. Fish Culture in Floating Net-Pens, Final Environmental Impact Statement. Washington Department of Fisheries. 161 pp. plus appendices.

Pearson, T.H. and R. Rosenburg. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Annual Reviews of Oceanography and Marine Biology 16:229-311.

Pesek, J. Personal communication. Oregon Department of Fish and Wildlife, Portland, Oregon.

Quinn, T.P. 1984. Homing and straying in Pacific salmon, pp. 357-362. *In:* J.D. McCleave, G.P. Arnold, J.J. Dodson, and W.H. Neill (eds.), Mechanisms of Migration in Fishes. Plenum Publishing Corporation.

Sano, T., T. Nishimura, N. Okamoto, T. Yamazaki, H. Hanada, and Y. Watanabe. 1977. Studies on viral diseases of Japanese fishes. VI. Infectious hematopoietic necrosis (IHN) of salmonids in the mainland of Japan. Journal of the Tokyo University of Fisheries 63(2):81-85.

Trotter, P.C. 1989. Coastal cutthroat trout: a life history compendium. Transactions of the American Fisheries Society 118:463-473.

Trussel, R.P. 1972. The percent un-ionized ammonia in aqueous ammonia solutions at different pH levels and temperatures. Journal of the Fisheries Research Board of Canada 29:1505:1507.

U.S. Department of Agriculture. 1994. Conservation Measures for the Threatened Plant, Water Howellia (*Howellia aquatilis*), Forest Plan Amendment 20. Environmental Assessment.

U.S. Department of Commerce. 1995. Proposed Recovery Plan for Snake River Salmon. National Oceanic and Atmospheric Administration, National Marine Fisheries Service. March 1995.

Vreeland, R.and R. Wahle. 1983. Homing behavior and contribution to Columbia River fisheries of marked coho salmon, *Oncorhynchus kisutch*, released at two Columbia River locations Fishery Bulletin Vol. 81, No. 1.

Vreeland, R.R. et al. 1975. Homing behavior and contribution to Columbia River fisheries of marked coho salmon released at two locations. Fishery Bulletin U.S. 73:717-725.

WDFW and ODFW (Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife). 1992. Columbia River Fish Runs & Fisheries, 1938-91. Status Report.

WDFW (Washington Department of Fish and Wildlife). 1994. Species of Special Concern in Washington. April 1994. 39 pp.

Weston, D.P., 1986. The Environmental Effects of Floating Mariculture in Puget Sound. Prepared by the University of Washington, School of Oceanography for the Washington Departments of Fisheries and Ecology. Seattle, Washington. 148 pp.

Whittington et al., 1987. Clinical, microbiological and epidemiological findings in recent outbreaks of goldfish ulcer disease due to atypical *Aeromonas salmonicida* in south-eastern Australia. Journal of Fish Diseases 10:353-362.

APPENDIX A

SITE SELECTION CRITERIA

Rearing Site Selection Criteria:

1. Selected sites should have sufficient area and depth characteristics to accommodate a minimum number of rearing units to support an economically viable fishery.

2. Selected sites should have adequate flow and velocity characteristics to prevent degradation of water quality while providing natural food organisms.

3. Selected sites should provide protection from extreme weather and river conditions that would disrupt rearing operations.

4. Selected sites should have land-based access to the rearing site and equipment with potential for development.

5. Selected sites should be located in areas with high probability for attracting returning adults.

Harvest Site Selection Criteria:

1. Selected sites should have sufficient area, depth, and proximity to attract local and nonlocal fishers.

2. Selected sites would be accessible and accommodating to fishing vessels and fish buyers.

3. Selected sites should minimize the interaction between commercial fishers and other river user groups.

4. Selected sites should have definable boundaries for enforcement and biological monitoring activities.

5. Selected sites should maximize the harvest of target fish stocks in the terminal area while minimizing the impacts on nontarget species and sensitive fish stocks.