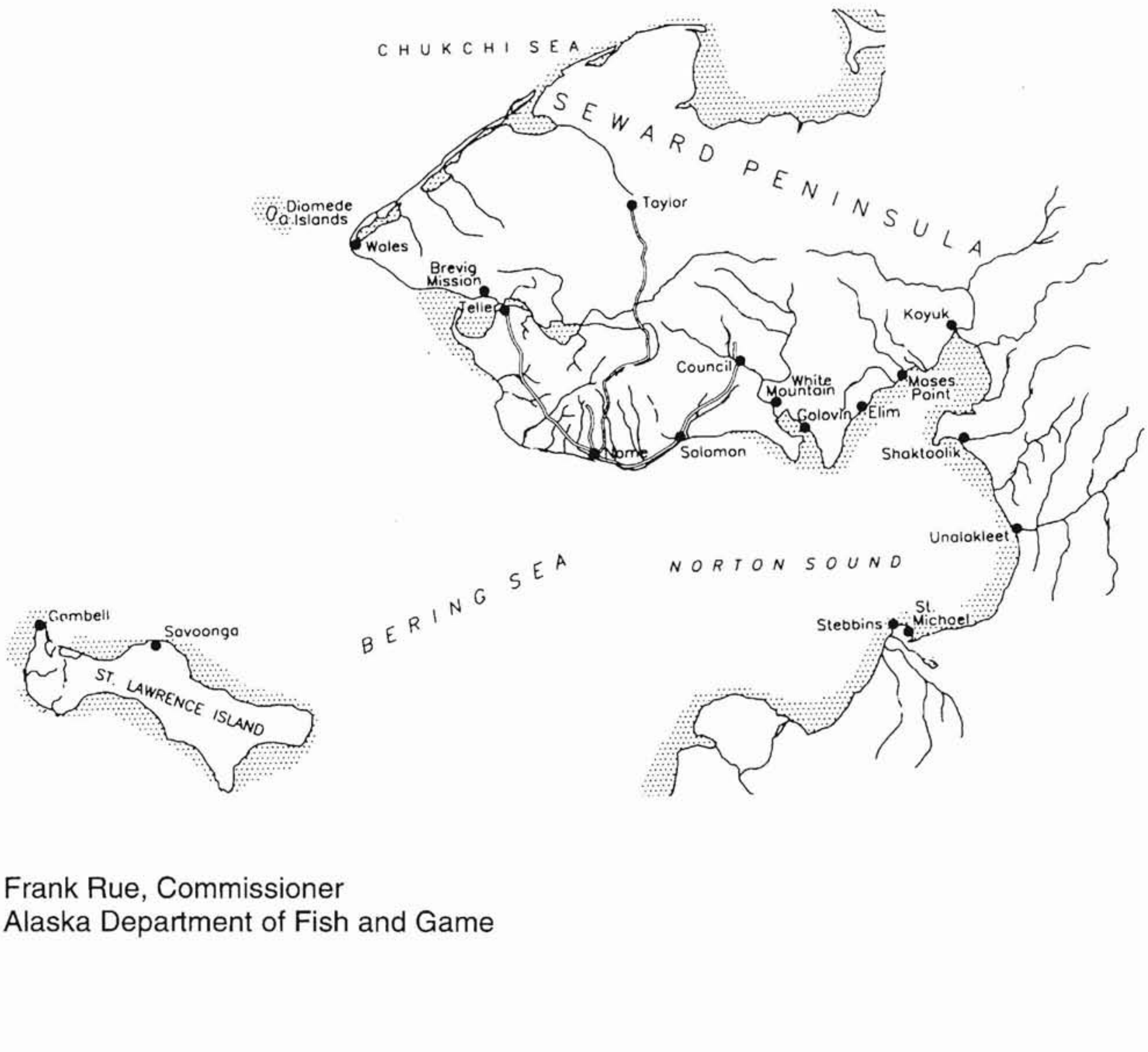
# NORTON SOUND/BERING STRAIT REGIONAL COMPREHENSIVE SALMON PLAN 1996–2010

**Developed by the Norton Sound/Bering Strait Regional Planning Team**




Frank Rue, Commissioner
Alaska Department of Fish and Game

June 1996

# STATE OF ALASKA

TONY KNOWLES, GOVERNOR

**DEPARTMENT OF FISH AND GAME**

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June 21, 1996

Mr. Eugene Asicksik
Mr. Pete Velsko
Co-chairmen
Norton Sound/Bering Strait RPT
601 West 5th Avenue, Key Bank Bldg., Suite 415
Anchorage, AK 99501

Dear Sirs:

This letter is to officially inform you and all members of the Norton Sound/Bering Strait regional Planning Team (NSRPT) of my approval of the *Norton Sound/Bering Strait Regional Comprehensive Salmon Plan 1996-2010*.

Prior to the submittal of the plan for my consideration, I have been informed that, in compliance with AS 16.10.375, the NSRPT distributed a public review draft in May 1996 to more than 200 individuals, organizations, and agencies. NSRPT also solicited public comments on proposed revisions through published notices in regional newspapers, public notices posted throughout the region, and a scheduled NSRPT meeting that occurred in Nome on June 11, 1996, to address comments and questions. The plan has also undergone complete technical reviews by staffs from Alaska Department of Fish and Game (i.e., Commercial Fisheries Management and Development, Sport Fish, Subsistence, and Habitat Divisions) and the Bureau of Land Management. I am confident that the NSRPT has been responsive to the comments and suggestions resulting from this thorough review process.

Based on the efforts of the NSRPT in preparing this plan and comments I have received on the quality of those efforts, I believe a viable and responsible document has been produced for the Norton Sound/Bering Straits region that emphasizes habitat restoration, investigative studies, a central incubation facility, and improved management strategies for increasing local production of salmon and equitably providing benefits to all user groups. Therefore, I offer my congratulations and appreciation to you both and all members of the team for cooperating with the department and me in producing this comprehensive plan.

Sincerely,

Frank Rue

Frank Rue
Commissioner

11-K2LH

## EXECUTIVE SUMMARY

Development of a comprehensive salmon plan for the Norton Sound/Bering Strait region was initiated by the Norton Sound Economic Development Corporation (NSEDC) and Alaska Department of Fish and Game (ADF&G) in the spring of 1994 with the organizational meeting of the Norton Sound/Bering Strait Regional Planning Team (NSRPT). This process was initiated in compliance with the commissioner's statutory mandate for salmon planning and in response to interests expressed by NSEDC.

Desires and objectives of the area fishermen, as expressed by the Norton Sound/Bering Strait Regional Planning Team (NSRPT), indicate an emphasis on restoring habitat of previously productive salmon systems damaged through mining/dredging activities; reestablishing historic runs of chum salmon through instream incubators, central incubation facilities, and/or fry planting techniques; and practicing better management. There is very little support or desire for large-scale hatchery production of pink and chum salmon stocks, such as that proposed in other regions. There is also strong recognition of the need to (1) protect genetic integrity of local stocks and a desire to (2) promote a more comprehensive understanding of local watersheds and their potential for increased production of chum, sockeye, and coho salmon.

Specific actions promoted by this plan include the following:

> Improve management of existing regional salmon fisheries by (1) increasing monitoring of chum and coho escapements in the region and (2) encouraging knowledge of stock identity of salmon harvested in the region.
>
> Improve projections of salmon production in regional waters by (1) conducting comprehensive surveys of Norton Sound systems and (2) encouraging studies of nearshore and marine environments and their capacity to support salmon populations.
>
> Investigate rehabilitation and enhancement opportunities by (1) evaluating results of fry-stocking, instream incubators, or other rehabilitation or enhancement potentials and (2) assessing area watersheds for removal of barriers to fish migration or repair of damaged spawning/rearing habitat.
>
> Develop central incubation facilities by (1) establishing recirculating incubators in each community and (2) pursuing placement and operation of stream-side incubators in locations identified in the studies outlined above.

The Norton Sound/Bering Strait RPT has set preliminary target common property fishery harvest goals that will result from existing natural production and any rehabilitation or enhancement work conducted under this plan. These goals, which should be achieved by the year 2010, are listed below by species for the entire regional salmon fishery; the recent 15-year (1981-1995) average commercial harvest by species is also included.

| Species | Average Annual Commercial Harvest (1981-1995) | Annual Target Goal (2010) |
|---|---|---|
| Chinook | 7,865 | 20,000 |
| Sockeye | 242 | 10,000 |
| Coho | 54,872 | 90,000 |
| Pink | 133,971 | 1,250,000 |
| Chum | 113,643 | 200,000 |
| **Total** | **310,593** | **1,570,000** |

In all its efforts, the Norton Sound/Bering Strait RPT hopes this plan will initiate equitable benefits to all user groups and increase local production of salmon. To accomplish these goals, the NSRPT realizes that funding from NSEDC and other sources will need to be obtained to support the programs outlined in this plan. Pursuit of this plan will also require conducting a suite of resource inventory and habitat studies of the region's watersheds, accessing some form of central incubation facility or facilities (e.g., community recirculating incubators), and providing adequate funding for the Department of Fish and Game's fishery management and development programs.

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# INTRODUCTION

## Authority for Writing the Plan

The commissioner of the Alaska Department of Fish and Game (ADF&G), in accordance with Alaska Statutes 16.10.375-470, has designated salmon production regions throughout the state. In each region, the commissioner is responsible for the development and amendment of a comprehensive salmon production plan. The commissioner has placed this responsibility with regional planning teams (RPT) that statutorily consist of representatives from ADF&G and the regional aquaculture associations. The mission of RPTs is to plan for the long-term future of the salmon resources within their regions by initiating and continuing orderly processes that examine the full potential of regional salmon production capacities.

During the past few years, the Norton Sound Economic Development Corporation (NSEDC) and other participants in regional salmon fisheries have expressed interest in initiating planning for the restoration, enhancement, and development of salmon production in the region. This interest was initially stimulated by concerns over the dramatic failure of returning runs of fall chum salmon in both 1992 and 1993 to Western Alaska systems. Discussions between NSEDC and ADF&G included establishing a geographic salmon production region and initiating comprehensive salmon planning process..

The NSEDC formally supported the salmon planning concept at its meetings and provided a forum for ADF&G staff to explain the planning process. During other meetings with interested parties, ADF&G staff distributed information and materials on comprehensive salmon planning. Based on this interest, the commissioner of ADF&G on August 1993, initially established boundaries for a salmon production region and for comprehensive salmon planning purposes that complied with the Norton Sound and Port Clarence commercial salmon fishing district boundaries. The Norton Sound/Bering Strait Region includes all waters of Alaska between the latitude of the western-most tip of Cape Prince of Wales and the latitude of Canal Point light, including all waters of Alaska surrounding St. Lawrence and Little Diomede Islands and waters draining into the Bering Sea (Fig.1).

The Norton Sound/Bering Strait Regional Planning Team (NSRPT) was established by the Commissioner on August 30, 1993. The RPT is composed of representatives from the ADF&G Commercial Fisheries Management and Development (CFMD), Sport Fish, and Subsistence Divisions; and Norton Sound Economic Development Corporation. Eugene Asicksik (NSEDC) from Shaktoolik and Pete Velsko (ADF&G, CFMD Division) from Nome were elected co-chairmen for the Norton Sound/Bering Strait RPT. The organizational meeting of NSRPT occurred on May 10, 1994.

Regional planning teams are the only legislatively mandated planning groups with ADF&G and private sector participation. Alaska statutes define certain duties of an RPT as follows:

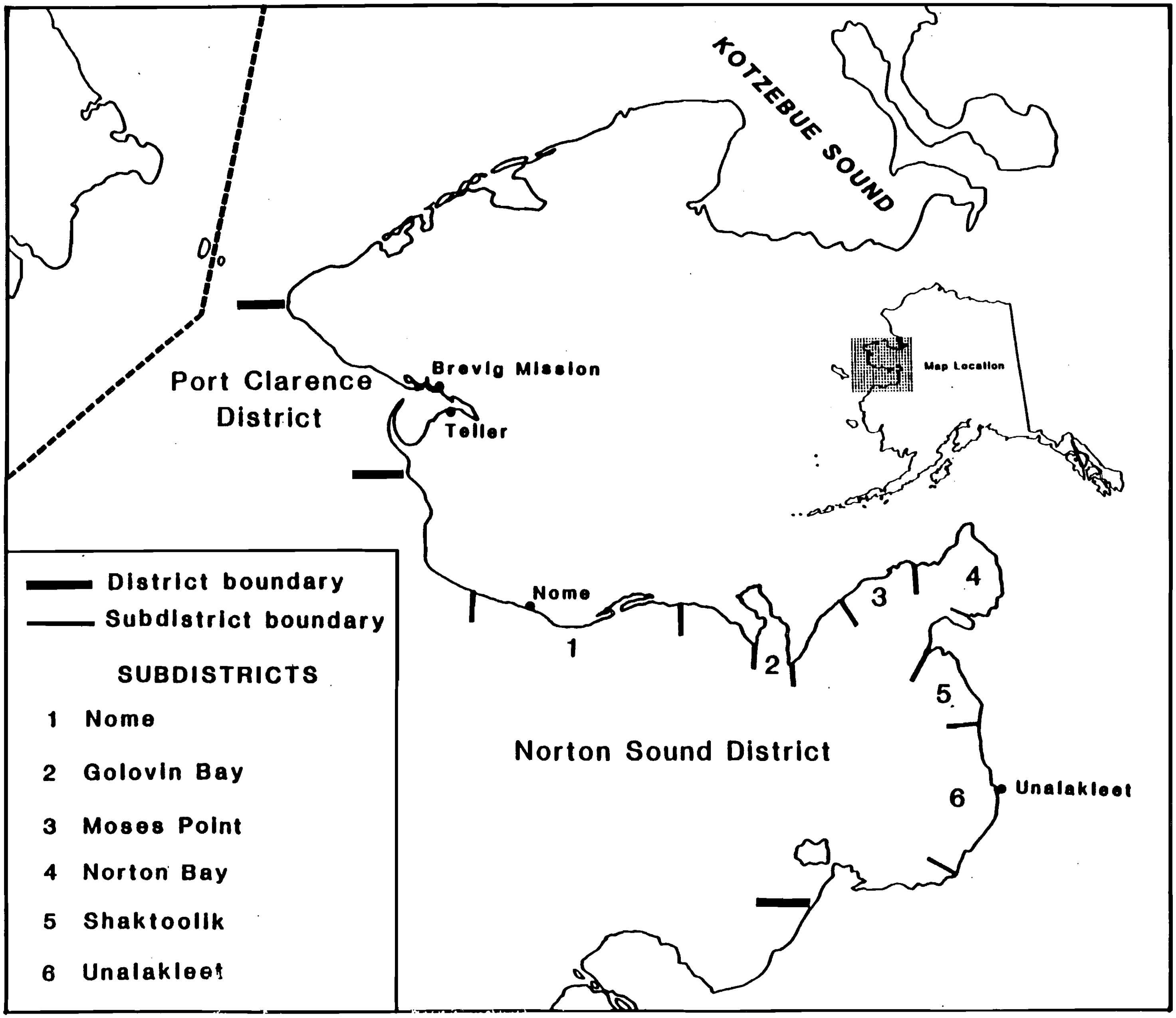



Figure 1. Norton Sound/Bering Strait commercial salmon fishing subdistricts.

(1) Plan development and amendment; (2) Review of private nonprofit (PNP) hatchery permit applications and recommendations to the commissioner; and (3) Review and comment on proposed permit suspensions or revocations by the commissioner.

A regular exchange of information, discussion of objectives, and active cooperation between regional associations/organizations (i.e., NSEDC, Bering Sea Fishermen's Association [BSFA], Kawerak, Inc.), U.S. agencies (i.e., Bureau of Land Management and Fish and Wildlife Service), and various divisions of ADF&G is possible with this planning effort. Comprehensive salmon planning in Alaska progresses in stages.

The actual plans that have been thus far developed and approved have consisted of two phases: Phase I sets the goals, objectives, and strategies for the area; and Phase II identifies potential projects and establishes criteria for evaluating the enhancement and rehabilitation potentials of the salmon resource. However, the intent of the Norton Sound/Bering Strait RPT is to generate a regional comprehensive salmon plan that considers both the long-term goals and objectives and the short-term strategies and projects (i.e., Action Plan) over a period of 15 years in one document.

**Village Informational Meetings**

In order to invite public participation to the comprehensive salmon planning process, ADF&G and NSEDC staff as well as members of the Norton Sound/Bering Strait RPT traveled to each the 15 communities in the region from January to March 1995 to provide information on salmon restoration/enhancement techniques and, in turn, receive information on the most promising salmon-producing systems near those communities for applying those techniques. The information obtained during those meetings was used for both the short- and long-range planning incorporated into this document.

**Acknowledgments**

The Norton Sound/Bering Strait Regional Planning Team respectfully acknowledges its members for contributions to programs of the Department of Fish and Game, Norton Sound Economic Development Corporation, residents of the regional communities, and the people of the State of Alaska through their collective efforts in drafting the regional comprehensive salmon plan:

> Co-chairman Eugene Asicksik, NSEDC, Shaktoolik; Co-chairman Pete Velsko, ADF&G, CFMD Division, Nome; Gerald Soonagrook, Sr., NSEDC, Gambell; Norman Menadelook, NSEDC, Teller; Dan Aukon, NSEDC, Elim; Virginia Washington, NSEDC, St. Michael; Elizabeth Andrews, ADF&G, Subsistence Division, Fairbanks; Charles Lean, ADF&G, CFMD Division, Nome; Fred DeCicco, ADF&G, Sport Fish Division, Fairbanks; Tim Smith (ex-officio) Nome Fishermen's Association, Nome; Joe Webb (ex-officio), BLM, Fairbanks; Art Nelson (ex-officio), Kawerak, Inc., Nome.

The Norton Sound/Bering Strait RPT extends its acknowledgment and appreciation to Kevin Duffy, Salmon Planning and Development Manager, ADF&G, CFMD Division; Steve McGee, PNP Program Manager, ADF&G, CFMD Division; Tom Kron, AYK Regional Supervisor, ADF&G, CFMD Division; John Zuck, Technical Advisor, NSEDC; Jude Henzler, Executive Director, BSFA; and Sid Morgan, Planner, ADF&G, CFMD Division for their coordination of the planning efforts and assistance in preparing the initial and final drafts. The NSRPT respectfully acknowledges Bob Wolfe (ADF&G, Subsistence Division) for denoting the social and cultural effects of fisheries enhancement and restoration in the region.

## GUIDING PRINCIPLES AND PLANNING ASSUMPTIONS

### Principles

The mission of the comprehensive salmon plan is to promote, through sound biological practices, activities to increase salmon production in the Norton Sound/Bering Strait region for the maximal social and economic benefits of the users consistent with the public interest. In accordance with this mission the Norton Sound Regional Planning Team will recommend rehabilitation and enhancement activities in the region that will be consistent with the protection of the existing wild salmon stocks and the habitats upon which they depend. Artificial propagation shall not be used as a substitute for effective fishery regulation, stock conservation, and habitat management or protection. The priorities for implementing restoration and enhancement projects shall be in this order: (1) restoring habitat and wild stocks, (2) enhancing habitat, and (3) enhancing wild stocks.

Careful planning is necessary before undertaking restoration or enhancement projects that might impact wild stocks. Projects shall be evaluated by the RPT in accordance with a regional comprehensive salmon plan. Careful assessment and inventory of wild stocks and their health, habitat, and life history must be an integral part of restoration and enhancement planning. Alaska fish genetics and fish disease policies will be applied to all salmon restoration or enhancement projects. When appropriate, the regional planning team will solicit an evaluation of the ecological and genetic risks and socioeconomic impacts and will identify alternative actions, including but not restricted to fishery management actions. The RPT shall establish production levels for restored stocks consistent with natural or enhanced habitat capacity.

### Assumptions

For the purposes of this plan, it is assumed that the following conditions will exist. If some of these conditions change or are proved false, then added difficulty will be encountered in implementing this plan.

1. The Norton Sound/Bering Strait Regional Planning Team will take a conservative approach to the project planning process to ensure perpetuation of natural stock production;

2. Enhancement and rehabilitation projects will be designed to restore or supplement wild stock production and harvest opportunities with minimal impacts on wild stocks and the priority for wild stock management;

3. Benefits to all user groups will be considered and equity within the constraints of Alaska statutes and regulations will be a primary consideration as part of the long-term planning process;

4. To the extent possible, the highest possible quality of harvested fish will be promoted;

5. The flexibility to adapt to changes in the fishery will be incorporated into the updating process of the comprehensive salmon plan;

6. Domestic and international markets and/or user groups will absorb the increased production of salmon;

7. This comprehensive salmon plan will use the best data available;

8. It will be biologically feasible to bring about a sustained increase in harvest rates of salmon beyond the past 15-year average, if appropriate technology and management practices are utilized;

9. The technology exists or will be developed to meet production objectives (e.g., promising techniques for identifying the contributions of enhanced stocks are otolith marking and genetic stock identification);

10. Research programs will be implemented to obtain information needed for optimizing salmon production, using the strategies of habitat and fishery restoration/protection, management, enhancement, and rehabilitation;

11. Marine and freshwater habitats will be safeguarded to remain favorable for salmon survival;

12. Accessibility to project sites will be an important consideration in the planning process;

13. Cost-effectiveness will also be an important consideration in the planning process;

14. Political support will continue and sufficient funding will be provided to achieve the goals within the time frame indicated, although, unfortunately, in some cases this assumption will need to be revisited and updated.

15. State funding for marketing of Alaska salmon and involvement of fishermen in these efforts will continue;

16. The goals and objectives of this plan will be periodically reviewed and revised as needs, knowledge, and resources change; and

17. Funding of the ADF&G's management and development programs for the Norton Sound/Bering Strait region will be maintained.

## GOALS, OBJECTIVES, STRATEGIES, AND PROJECTS

The primary goal of participants in Norton Sound/Bering Strait salmon fisheries (commercial, subsistence, sport) is to protect wild stocks while increasing and stabilizing production and harvests. Associated with this goal is the recognized need to increase our knowledge of local salmon resources and improve management so that we can generally improve related biologic, habitat, and socioeconomic conditions throughout the region.

Four integrally related tools are needed to accomplish the following goals: (1) increasing production/harvest of salmon, (2) collecting/evaluating data/research, (3) improving management precision, and (4) maintaining budgets for ADF&G. Three primary considerations for pursuit of this plan follow: (1) salmon resources need to be maintained in the strongest possible condition through protection of wild stocks and habitat, (2) most effective rehabilitation/ enhancement strategies can only be realized through a complete stock assessment and evaluation of limiting factors, and (3) harvest of salmon to the greatest extent possible is beneficial to all participants (i.e., common property fishermen), the region, and the state.

### Goals

Harvest Goals:

The target goals for total sport, commercial, and subsistence salmon harvests, to be achieved by the year 2010, are based upon obtainable increases to the recent 15-year annual average commercial harvests for the years 1981-1995 (Tables 1 & 2). Historical annual commercial harvest data for all species of salmon are provided in Figures 2-7; while annual harvest averages of 30-, 25-, 20-, 15-, 10-, and 5-year increments are shown in Appendix A. Commercial harvest data for the 1981 to 1995 period were used as a foundation, because salmon runs were generally stronger during this period than for any other comparable period since statehood and therefore best reflect current and anticipated conditions of relevant salmon stocks.

Between 1981 and 1995 the average annual commercial harvest of chinook salmon for the Norton Sound/Bering Strait region was 7,865 fish (i.e., 15-year average). Although, the target goal of 20,000 chinook salmon recognizes that none of the projects outlined in this plan directly address chinook stocks, a moderate increase in chinook production may arise from projects focused on sockeyes and cohos as well as the improved management of chinook escapements.

Average annual sockeye salmon commercial harvests for the past 15 years (i.e., 1980-1994) have only been about 250 fish, although an atypical harvest of 1,252 sockeye occurred in 1988; the most recent harvest was 128 fish. A target for stable annual harvests of 10,000 sockeye salmon is based upon the potential increase in production from increase in sockeye runs to Salmon and Glacial Lakes as well as improved management (e.g., weirs to monitor escapements) of those systems.

Table 1. Regional commercial salmon catches by species in Norton Sound, 1961-1995.

| Year | Chinook | Sockeye | Coho | Pink | Chum | Total |
|---|---|---|---|---|---|---|
| 1961 | 5,300 | 35 | 13,807 | 34,327 | 48,332 | 101,801 |
| 1962 | 7,286 | 18 | 9,156 | 33,187 | 182,784 | 232,431 |
| 1963 | 6,613 | 71 | 16,765 | 55,625 | 154,789 | 233,863 |
| 1964 | 2,018 | 126 | 98 | 13,567 | 148,862 | 164,671 |
| 1965 | 1,449 | 30 | 2,030 | 220 | 36,795 | 40,524 |
| 1966 | 1,553 | 14 | 5,755 | 12,778 | 80,245 | 100,345 |
| 1967 | 1,804 | no data | 2,379 | 28,879 | 41,756 | 74,818 |
| 1968 | 1,045 | no data | 6,885 | 71,179 | 45,300 | 124,499 |
| 1969 | 2,392 | no data | 6,836 | 86,949 | 82,795 | 178,972 |
| 1970 | 1,853 | no data | 4,423 | 64,908 | 107,034 | 178,218 |
| 1971 | 2,593 | no data | 3,127 | 4,895 | 131,362 | 141,977 |
| 1972 | 2,938 | no data | 454 | 45,182 | 100,920 | 149,494 |
| 1973 | 1,918 | no data | 9,282 | 46,499 | 119,098 | 176,797 |
| 1974 | 2,951 | no data | 2,092 | 148,519 | 162,267 | 315,829 |
| 1975 | 2,393 | 2 | 4,593 | 32,388 | 212,485 | 251,861 |
| 1976 | 2,243 | 11 | 6,934 | 87,916 | 95,956 | 193,060 |
| 1977 | 4,500 | 5 | 3,690 | 48,675 | 200,455 | 257,325 |
| 1978 | 9,819 | 12 | 7,335 | 325,503 | 189,279 | 531,948 |
| 1979 | 10,706 | 57 | 31,438 | 167,411 | 140,789 | 350,344 |
| 1980 | 6,311 | 39 | 29,841 | 227,352 | 180,792 | 444,335 |
| 1981 | 7,929 | 56 | 31,562 | 232,479 | 169,708 | 441,734 |
| 1982 | 5,892 | 10 | 91,690 | 230,281 | 183,335 | 511,208 |
| 1983 | 10,308 | 27 | 49,735 | 76,913 | 319,437 | 456,420 |
| 1984 | 8,455 | 6 | 67,875 | 119,381 | 146,442 | 342,159 |
| 1985 | 19,491 | 166 | 21,968 | 3,647 | 134,928 | 180,200 |
| 1986 | 6,395 | 233 | 35,600 | 41,260 | 146,912 | 230,400 |
| 1987 | 7,080 | 207 | 24,279 | 2,260 | 102,457 | 136,283 |
| 1988 | 4,096 | 1,252 | 37,214 | 74,644 | 107,966 | 225,172 |
| 1989 | 5,707 | 265 | 44,091 | 123 | 42,625 | 92,811 |
| 1990 | 8,896 | 428 | 56,710 | 501 | 65,123 | 131,658 |
| 1991 | 6,068 | 203 | 63,647 | -- | 86,871 | 156,789 |
| 1992 | 4,541 | 296 | 105,418 | 6,469 | 84,090 | 200,814 |
| 1993 | 8,972 | 279 | 43,283 | 157,574 | 53,562 | 263,670 |
| 1994 | 5,285 | 80 | 102,140 | 982,389 | 18,290 | 1,108,184 |
| 1995 | 8,860 | 128 | 47,862 | 81,644 | 42,898 | 181,392 |
| **10-yr avg[1]** | **6,590** | **337** | **56,024** | **134,686** | **75,079** | **272,713** |
| **15-yr avg[1]** | **7,865** | **242** | **54,872** | **133,971** | **113,643** | **310,593** |
| **20-yr avg[1]** | **7,578** | **188** | **45,116** | **143,321** | **125,596** | **320,795** |

[1] reflects most recent 10-, 15-, and 20- year commercial harvest averages: 1986-1995, 1981-1995, and 1976-1995, respectively.

Table 2. Norton Sound/Bering Strait commercial salmon harvests by subdistrict, 15-year average harvests (1981-1995) and 15-year target goals (1996-2010).

| Year | Area | Chinook | Sockeye | Coho | Pink | Chum | Total |
|---|---|---|---|---|---|---|---|
| 1981 | Nome | 4 | -- | 508 | 3,202 | 18,666 | 22,380 |
| | Golovin Bay | 23 | 5 | 13 | 49,755 | 58,323 | 108,119 |
| | Moses Point | 198 | -- | 5 | 26,417 | 29,325 | 55,945 |
| | Norton Bay | 63 | -- | -- | 177 | 3,111 | 3,351 |
| | Shaktoolik | 1,484 | 4 | 1,191 | 29,695 | 21,097 | 53,471 |
| | Unalakleet | 6,157 | 47 | 29,845 | 123,233 | 39,186 | 198,468 |
| | **Total** | **7,929** | **56** | **31,562** | **232,479** | **169,708** | **441,734** |
| 1982 | Nome | 20 | -- | 1,183 | 18,512 | 13,447 | 33,162 |
| | Golovin Bay | 78 | 5 | 4,281 | 39,510 | 51,970 | 95,844 |
| | Moses Point | 253 | -- | 318 | 9,849 | 40,030 | 50,450 |
| | Norton Bay | 96 | -- | 2,332 | 2,535 | 7,128 | 12,091 |
| | Shaktoolik | 1,677 | 3 | 22,233 | 17,019 | 26,240 | 67,172 |
| | Unalakleet | 3,768 | 2 | 61,343 | 142,856 | 44,520 | 252,489 |
| | **Total** | **5,892** | **10** | **91,690** | **230,281** | **183,335** | **511,208** |
| 1983 | Nome | 23 | -- | 261 | 308 | 11,691 | 12,283 |
| | Golovin Bay | 52 | 10 | 295 | 17,414 | 48,283 | 66,054 |
| | Moses Point | 254 | -- | -- | 17,027 | 65,776 | 83,057 |
| | Norton Bay | 215 | -- | 204 | 3,935 | 17,157 | 21,511 |
| | Shaktoolik | 2,742 | 4 | 12,877 | 12,031 | 67,310 | 94,964 |
| | Unalakleet | 7,022 | 13 | 36,098 | 26,198 | 109,220 | 178,551 |
| | **Total** | **10,308** | **27** | **49,735** | **76,913** | **319,437** | **456,420** |
| 1984 | Nome | 7 | -- | 820 | -- | 3,744 | 4,571 |
| | Golovin Bay | 31 | -- | 2,462 | 88,588 | 54,153 | 145,234 |
| | Moses Point | -- | -- | 5,959 | 28,035 | 9,477 | 43,471 |
| | Norton Bay | -- | -- | -- | 1,162 | 3,442 | 4,604 |
| | Shaktoolik | 1,613 | -- | 10,730 | 1,596 | 32,309 | 46,248 |
| | Unalakleet | 6,804 | 6 | 47,904 | -- | 43,317 | 98,031 |
| | **Total** | **8,455** | **6** | **67,875** | **119,381** | **146,442** | **342,159** |
| 1985 | Nome | 21 | -- | 356 | -- | 6,219 | 6,596 |
| | Golovin Bay | 193 | 113 | 1,196 | 3,019 | 55,781 | 60,302 |
| | Moses Point | 816 | 32 | 1,803 | 559 | 24,466 | 27,676 |
| | Norton Bay | 528 | -- | 384 | 68 | 9,948 | 10,928 |
| | Shaktoolik | 5,312 | -- | 2,808 | -- | 13,403 | 21,523 |
| | Unalakleet | 12,621 | 21 | 15,421 | 1 | 25,111 | 53,175 |
| | **Total** | **19,491** | **166** | **21,968** | **3,647** | **134,928** | **180,200** |
| 1986 | Nome | 6 | -- | 50 | -- | 8,160 | 8,216 |
| | Golovin Bay | 81 | 8 | 958 | 25,425 | 69,725 | 96,197 |
| | Moses Point | 600 | 41 | 5,874 | 15,795 | 20,668 | 42,978 |
| | Norton Bay | 139 | 2 | 1,512 | 40 | 1,994 | 3,687 |
| | Shaktoolik | 1,075 | 29 | 6,626 | -- | 16,126 | 23,856 |
| | Unalakleet | 4,494 | 153 | 20,580 | -- | 30,239 | 55,466 |
| | **Total** | **6,395** | **233** | **35,600** | **41,260** | **146,912** | **230,400** |

--Continued--

Table 2. Continued

| Year | Area | Chinook | Sockeye | Coho | Pink | Chum | Total |
|---|---|---|---|---|---|---|---|
| 1987 | Nome | 3 | -- | 577 | -- | 5,646 | 6,226 |
| | Golovin Bay | 166 | 51 | 2,203 | 1,579 | 44,334 | 48,333 |
| | Moses Point | 907 | 15 | 64 | 568 | 17,278 | 18,832 |
| | Norton Bay | 544 | -- | 145 | 16 | 3,586 | 4,291 |
| | Shaktoolik | 2,214 | -- | 6,193 | -- | 14,088 | 22,495 |
| | Unalakleet | 3,246 | 141 | 15,097 | 97 | 17,525 | 36,106 |
| | **Total** | **7,080** | **207** | **24,279** | **2,260** | **102,457** | **136,283** |
| 1988 | Nome | 2 | -- | 54 | 182 | 1,628 | 1,866 |
| | Golovin Bay | 108 | 921 | 2,149 | 31,599 | 33,348 | 68,125 |
| | Moses Point | 663 | 93 | 3,974 | 13,703 | 18,585 | 37,018 |
| | Norton Bay | 434 | 2 | 709 | 1,749 | 7,521 | 10,415 |
| | Shaktoolik | 671 | 79 | 6,096 | 3,681 | 21,521 | 32,048 |
| | Unalakleet | 2,218 | 157 | 24,232 | 23,730 | 25,363 | 75,700 |
| | **Total** | **4,096** | **1,252** | **37,214** | **74,644** | **107,966** | **225,172** |
| 1989 | Nome | 2 | -- | -- | 123 | 492 | 617 |
| | Golovin Bay | -- | -- | -- | -- | -- | -- |
| | Moses Point | 62 | -- | -- | -- | 1,667 | 1,729 |
| | Norton Bay | -- | -- | -- | -- | -- | -- |
| | Shaktoolik | 1,241 | 43 | 8,066 | -- | 19,641 | 28,991 |
| | Unalakleet | 4,402 | 222 | 36,025 | -- | 20,825 | 61,474 |
| | **Total** | **5,707** | **265** | **44,091** | **123** | **42,625** | **92,811** |
| 1990 | Nome | -- | -- | -- | -- | -- | -- |
| | Golovin Bay | 52 | 21 | -- | -- | 15,993 | 16,066 |
| | Moses Point | 202 | -- | -- | 501 | 3,723 | 4,426 |
| | Norton Bay | -- | -- | -- | -- | -- | -- |
| | Shaktoolik | 2,644 | 49 | 4,695 | -- | 21,748 | 29,136 |
| | Unalakleet | 5,998 | 358 | 52,015 | -- | 23,659 | 82,030 |
| | **Total** | **8,896** | **428** | **56,710** | **501** | **65,123** | **131,658** |
| 1991 | Nome | -- | -- | -- | -- | -- | -- |
| | Golovin Bay | 49 | 1 | -- | -- | 14,839 | 14,889 |
| | Moses Point | 161 | -- | -- | -- | 804 | 965 |
| | Norton Bay | -- | -- | -- | -- | -- | -- |
| | Shaktoolik | 1,324 | 55 | 11,614 | -- | 31,619 | 44,612 |
| | Unalakleet | 4,534 | 147 | 52,033 | -- | 39,609 | 96,323 |
| | **Total** | **6,068** | **203** | **63,647** | **--** | **86,871** | **156,789** |
| 1992 | Nome | 1 | 2 | 693 | 185 | 881 | 1,762 |
| | Golovin Bay | 6 | 9 | 2,085 | -- | 1,002 | 3,102 |
| | Moses Point | -- | -- | 3,531 | -- | 6 | 3,537 |
| | Norton Bay | 27 | -- | -- | -- | 1,787 | 1,814 |
| | Shaktoolik | 1,098 | 56 | 14,660 | -- | 27,867 | 43,681 |
| | Unalakleet | 3,409 | 229 | 84,449 | 6,284 | 52,547 | 146,918 |
| | **Total** | **4,541** | **296** | **105,418** | **6,469** | **84,090** | **200,814** |

--Continued--

Table 2. Continued

| Year | Area | Chinook | Sockeye | Coho | Pink | Chum | Total |
|---|---|---|---|---|---|---|---|
| 1993 | Nome | -- | -- | 611 | -- | 132 | 743 |
| | Golovin Bay | 1 | 4 | 2 | 8,480 | 2,803 | 11,290 |
| | Moses Point | 3 | 4 | 4,065 | -- | 167 | 4,239 |
| | Norton Bay | 267 | -- | -- | 290 | 1,378 | 1,935 |
| | Shaktoolik | 2,757 | 20 | 12,315 | 106,743 | 20,926 | 142,761 |
| | Unalakleet | 5,944 | 251 | 26,290 | 42,061 | 28,156 | 102,702 |
| | **Total** | **8,972** | **279** | **43,283** | **157,574** | **53,562** | **263,670** |
| 1994 | Nome | -- | 1 | 287 | -- | 66 | 352 |
| | Golovin Bay | -- | -- | 3,424 | -- | 111 | 3,535 |
| | Moses Point | -- | -- | 5,345 | -- | 414 | 5,759 |
| | Norton Bay | -- | -- | -- | -- | -- | -- |
| | Shaktoolik | 885 | 8 | 22,065 | 502,231 | 5,411 | 530,600 |
| | Unalakleet | 4,400 | 71 | 71,019 | 480,158 | 12,288 | 567,936 |
| | **Total** | **5,285** | **80** | **102,140** | **982,389** | **18,290** | **1,108,184** |
| 1995 | Nome | -- | 1 | 369 | -- | 122 | 492 |
| | Golovin Bay | -- | -- | 1,616 | 4,296 | 1,987 | 7,899 |
| | Moses Point | 4 | 44 | 3,742 | 2,962 | 1,171 | 7,923 |
| | Norton Bay | -- | -- | -- | -- | -- | -- |
| | Shaktoolik | 1,239 | 5 | 10,855 | 37,377 | 14,775 | 64,251 |
| | Unalakleet | 7,617 | 78 | 31,280 | 37,009 | 24,843 | 100,827 |
| | **Total** | **8,860** | **128** | **47,862** | **81,644** | **42,898** | **181,392** |

**15-year Annual Average Harvest Total and 15-year Target Goal**

| | Chinook | Sockeye | Coho | Pink | Chum | Total |
|---|---|---|---|---|---|---|
| **Average Harvest** | **7,865** | **242** | **54,872** | **133,971** | **113,643** | **310,593** |
| **Target Goal** | **20,000** | **10,000** | **90,000** | **1,250,000**[1] | **200,000** | **1,570,000** |

[1] Represents the average of odd- and even-year target goals for pink salmon of 500,000 and 2,000,000, respectively.

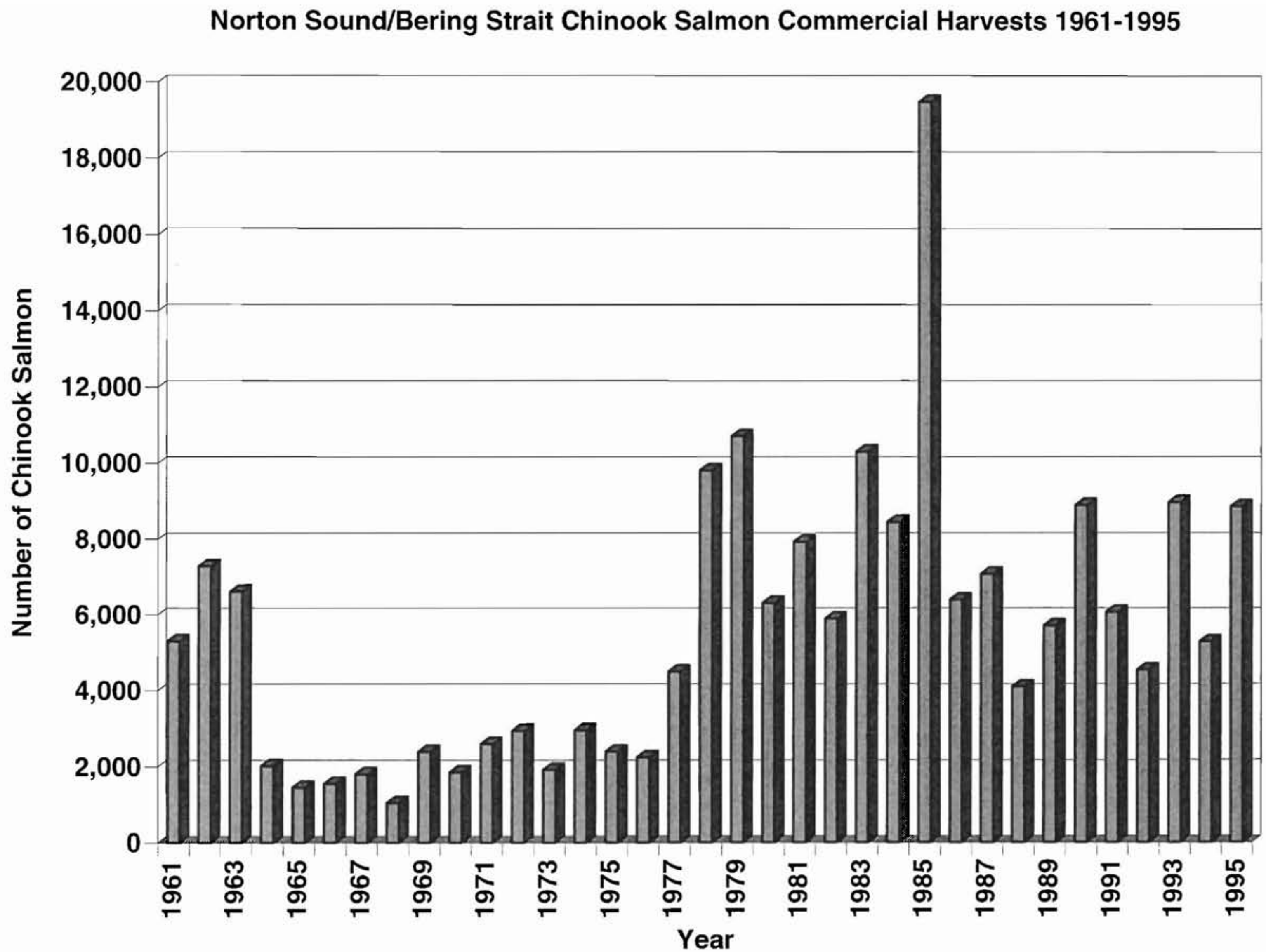



Figure 2. Annual chinook salmon commercial harvests for Norton Sound/Bering Strait region, 1961-1995.

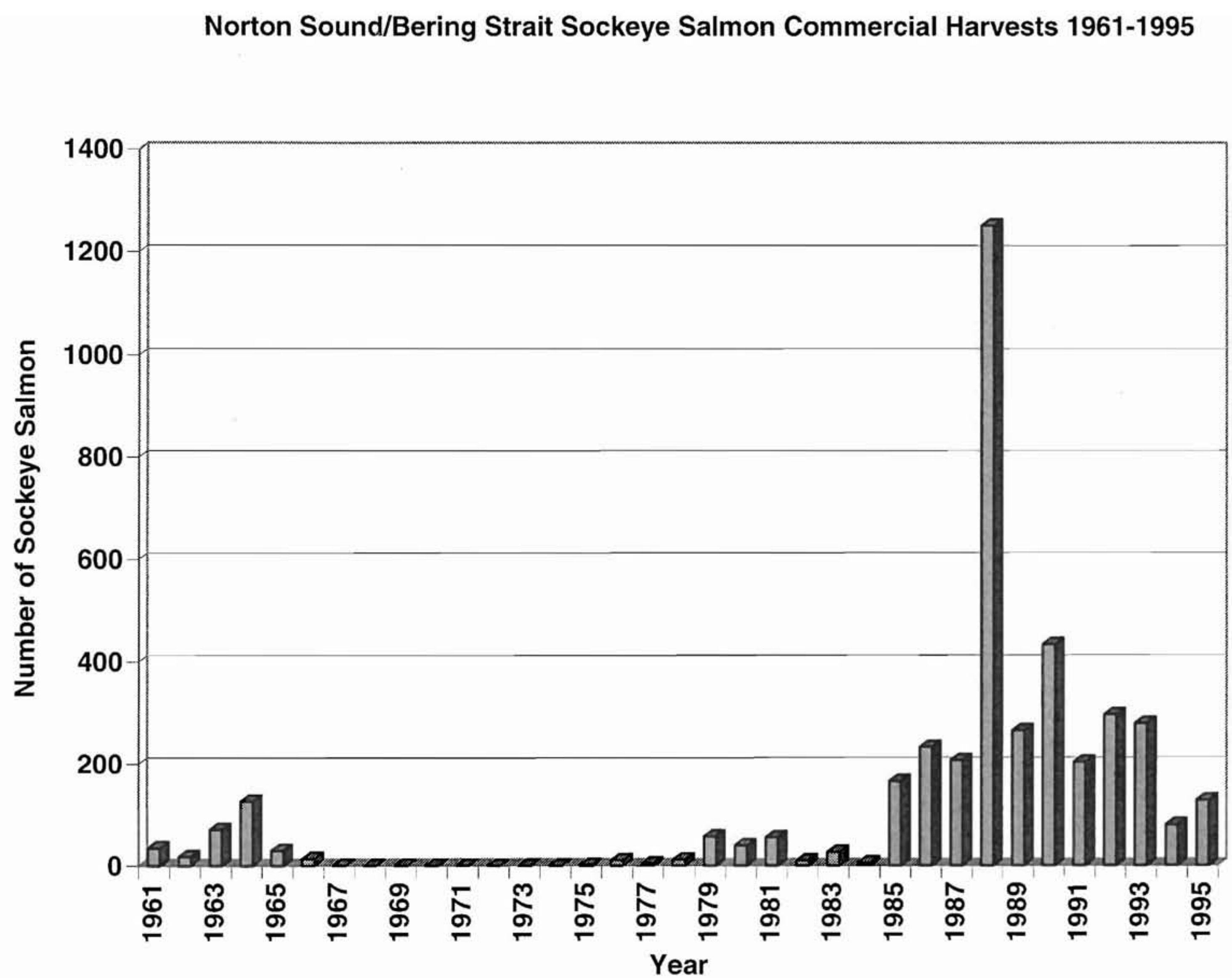



Figure 3. Annual sockeye salmon commercial harvests for Norton Sound/Bering Strait region, 1961-1995.

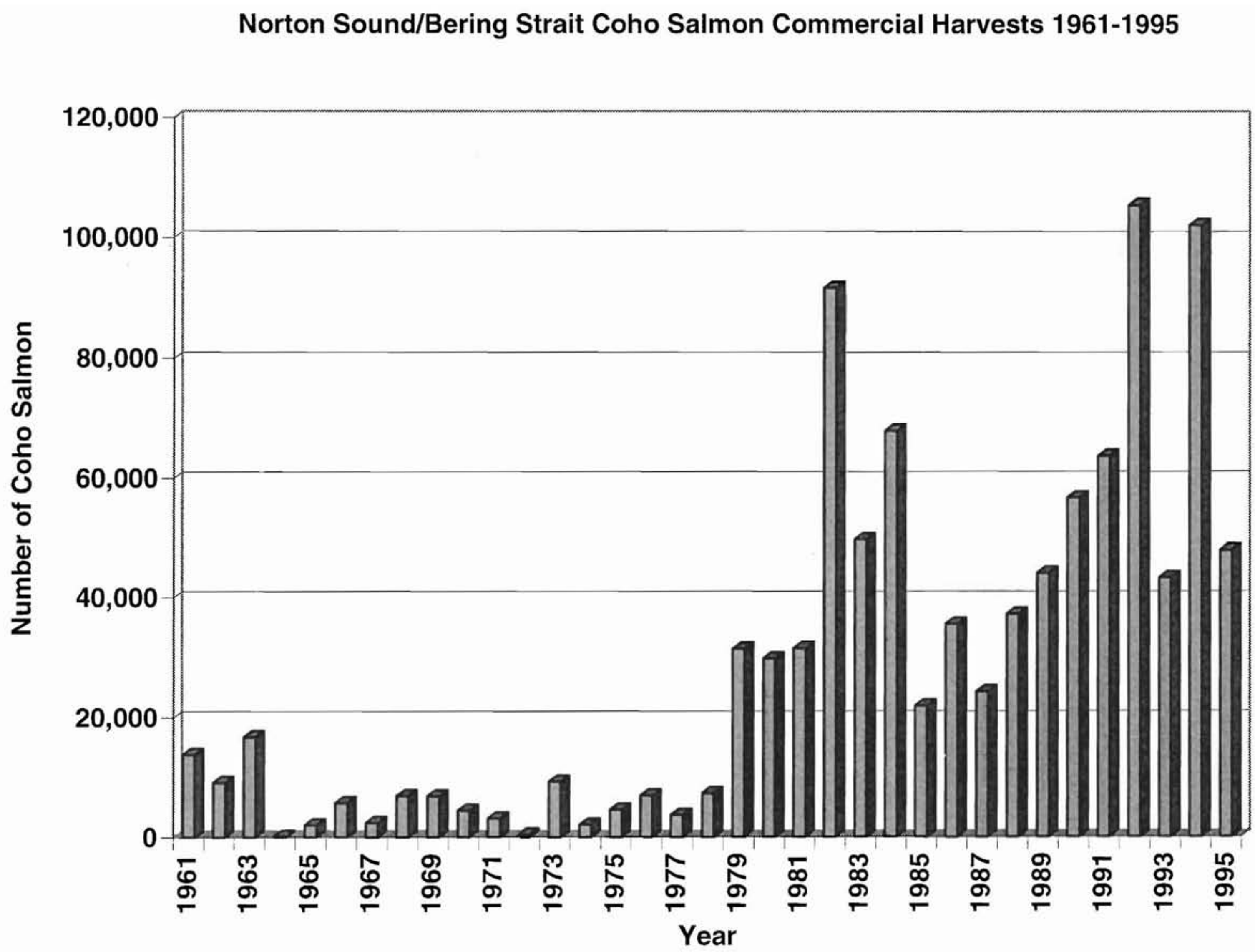



Figure 4. Annual coho salmon commercial harvests for Norton Sound/Bering Strait region, 1961-1995.

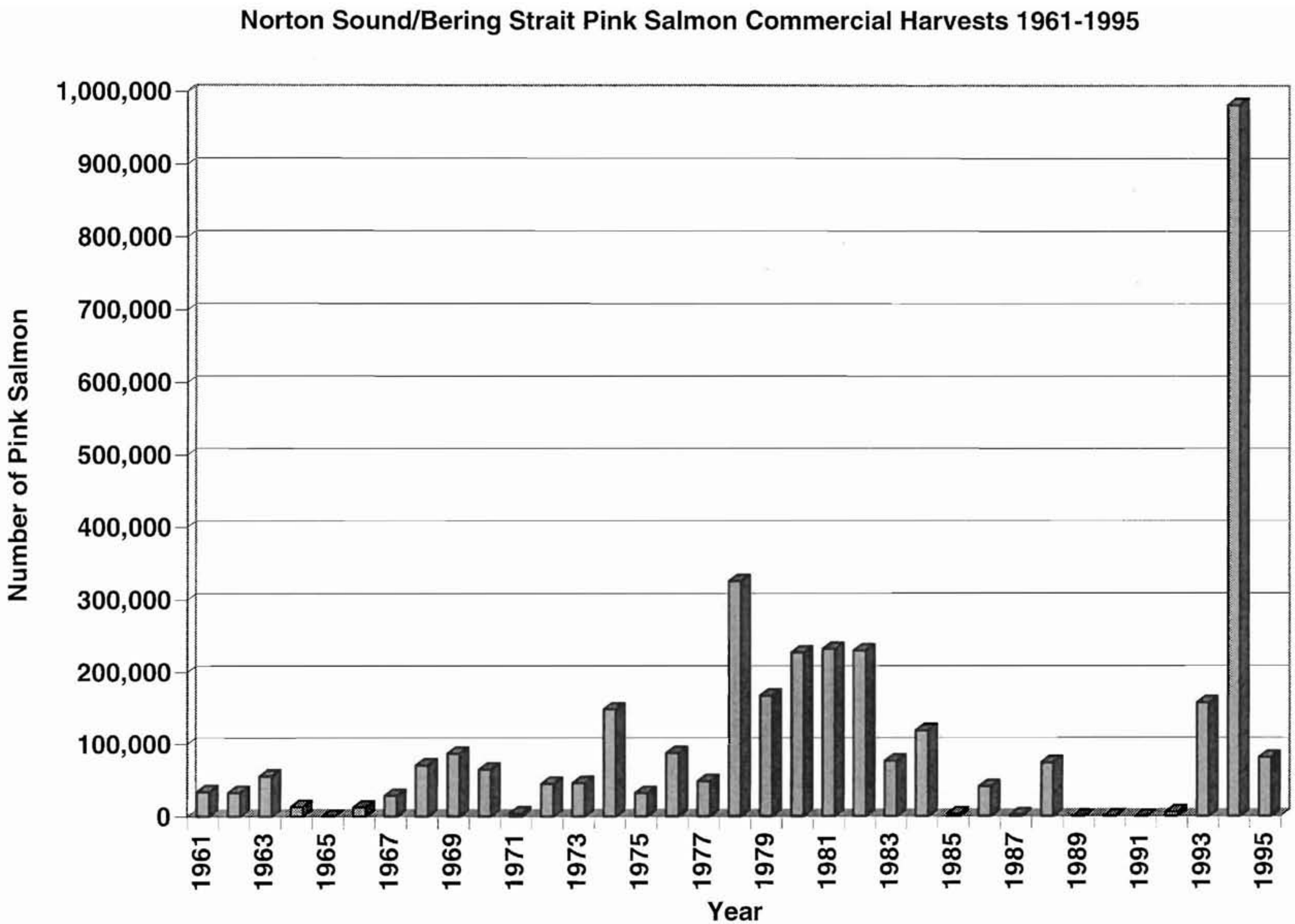



Figure 5. Annual pink salmon commercial harvests for Norton Sound/Bering Strait region, 1961-1995.

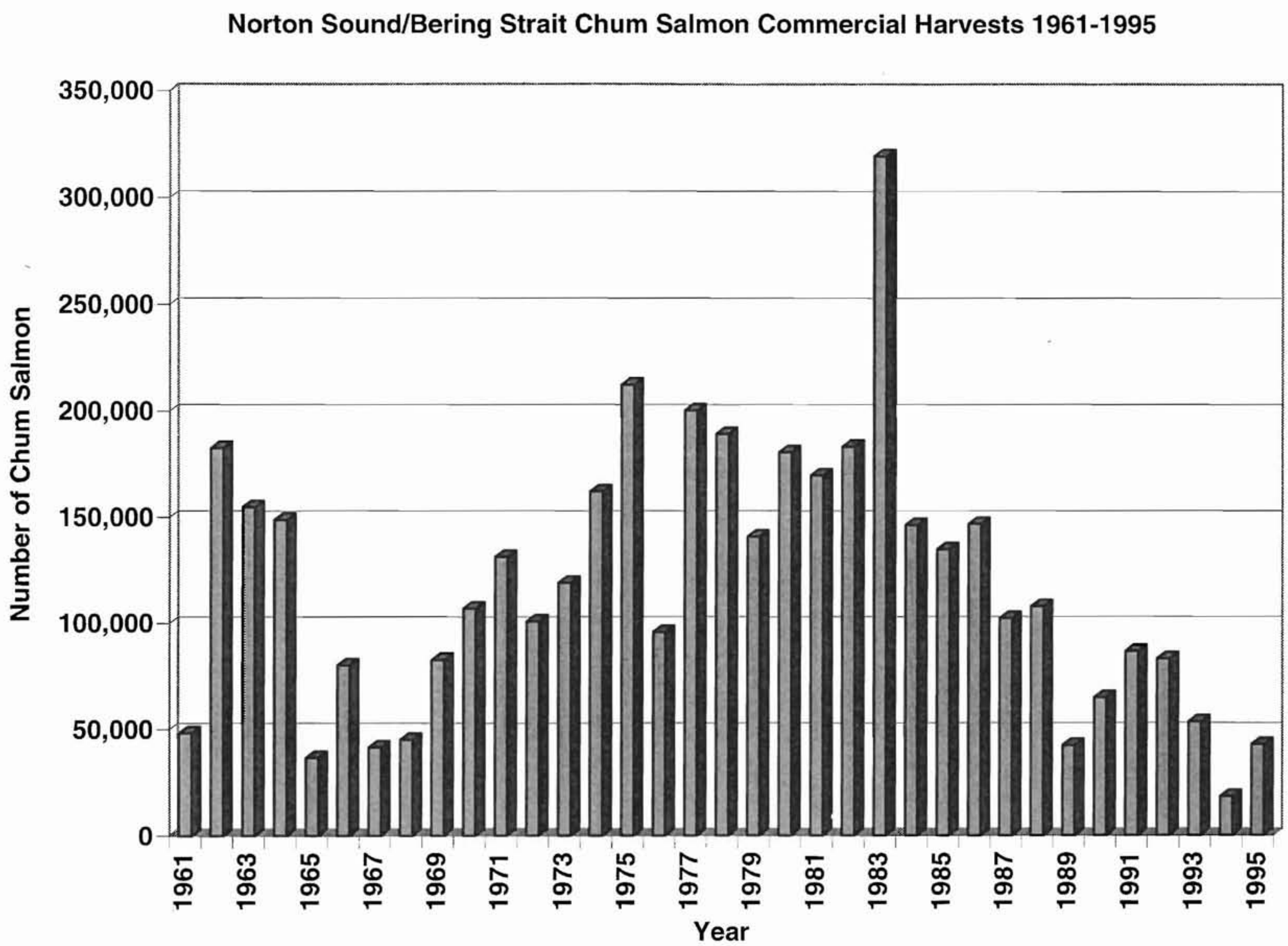



Figure 6. Annual chum salmon commercial harvests for Norton Sound/Bering Strait region, 1961-1995.

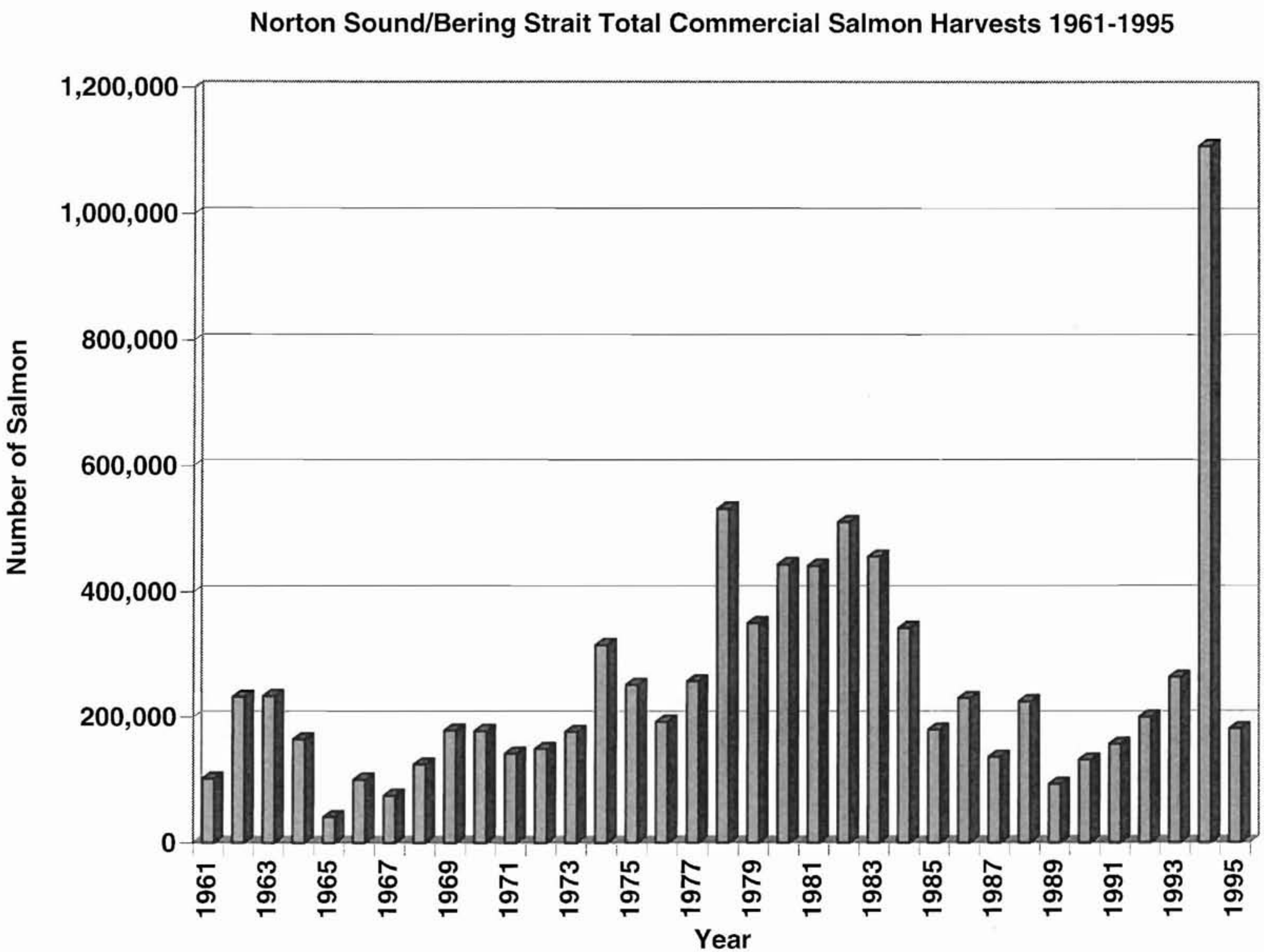



Figure 7. Annual total commercial harvest of salmon (all species) for Norton Sound/Bering Strait region, 1961-1995.

The average annual coho salmon commercial harvest for 1981-1995 period was about 56,000 fish. By virtue of extending fishing and processing activities further into the fall and through conducting a number of stream restoration and enhancement projects (e.g., rearing ponds) on watersheds supporting coho salmon, an annual target harvest goal of 90,000 fish can be achieved.

Pink Salmon commercial harvests have averaged about 134,000 annually from 1981 to 1995, with fairly wide fluctuations; for example, a record-high harvest of 982,000 occurred in 1994. Because the emphasis of this plan is not directed toward large-scale hatchery production of pink salmon, their production is not targeted to increase by millions of fish; however, by virtue of a number of enhancement or restoration projects, better management for escapements, and perhaps targeted fisheries and improved processing opportunities, this plan projects an annual target harvest goal of 500,000 pink salmon for odd years and 2,000,000 for even years.

The average annual commercial harvest of chum salmon for the past 15 years (1981-1995) was about 114,000 fish. With management efforts now pointed toward increasing the harvests of chum salmon through use of instream and recirculating incubators, a major increase in chum salmon harvests are targeted. An annual harvest goal of 200,000 chum salmon is also based upon consideration of increased production arising from rehabilitation and/or enhancement projects, better management of escapements, and enforcement of fishery regulations.

In summary, target harvest goals by species to be pursued over the next 15 years include increases over the most recent 15-year commercial harvest averages (*see* Table 1) of about 4,000% for sockeyes; 150% for chinook; 64% for cohos; 270% (odd year) and 1,400% (even year) for pinks, plus some annual stability; and a 76% increase for chums. Attainment of these goals will rely upon success in conducting a suite of baseline studies, maintenance of ADF&G and NSEDC budgets for the Norton Sound/Bering Strait region, establishment of recirculating or instream incubation units throughout the region, restoration of systems severely damaged through mining activities, establishment of a central incubation facility, and implementation of specific projects to promote fish passage/rearing and increased production.

Research, Management, and Planning Goals:

Although fisheries management goals are aimed at maintaining and improving salmon runs by achieving proper escapement for each stock and full utilization of fish surplus to escapement needs, the precision of management policies is sometimes limited by insufficient knowledge of run size, stock composition, timing, optimal escapement rates and levels, and behavioral characteristics of both juveniles and adults, which represent essential information needed for optimal production of both wild and supplementally produced fish. There are many necessary and associated research studies (e.g., hydroacoustic, scale analysis, smolt outmigration, limnology, etc.) not directly expressed in production or harvest numbers that may directly or indirectly result in more fish. Such studies will contribute to a stronger fisherman/manager/ resource relationship that, in turn, will contribute to increased production and harvests. The following goals will be pursued: (1) Protect wild stocks and increase their production; (2)

improve accuracy of salmon forecasts; (3) improve accuracy of escapement enumeration and refine estimates of optimal escapement levels for all species; (4) assess spatial and temporal distribution and migration paths of salmon in the region as well as age, size at return, and location of return; (5) assess stock composition of the harvest; (6) inventory and catalog spawning and rearing habitat in conjunction with habitat protection, stream clearance and improvement activities, carrying capacity and productivity assessments, limnological investigations, and stocking assessments; and (7) periodically review and reevaluate needs of subsistence, sport, and commercial users in the regional fisheries.

**Objectives**

Establishing objectives is a process whereby long-term goals are broken down into attainable short-term increments (for example, 5-year increments within a 15-year plan or the initiation of a project within a specified time period). In this sense, objectives are benchmarks taken at specified intervals of a plan to determine whether or not it is adequately proceeding toward meeting its goals. The following objectives and/or projects (1) set the stage for accomplishment of the harvest goals outlined above, (2) can be realized in the short term, and (3) are based upon a set of strategies discussed later in this plan.

Stream Clearance and/or Modification of Barriers:

The clearance of periodic blockages (e.g., debris-choked culvert, instream debris, etc.) of portions of streams can facilitate the passage of salmon into spawning and rearing areas that otherwise would lose production potential for some species of salmon.. Many of these blockages occur on an intermittent basis and are of a size that removal could be accomplished by department or other designated personnel. Authority to remove these stream blockages requires approval by Habitat Division on a case-by-case basis. It is an objective of this plan to aggressively pursue these types of projects in the near term.

**Glacier Creek Culvert.** A culvert survey was completed there in 1992, and remedial recommendations to provide upstream access to salmon were transmitted to the Alaska Department of Transportation and Public Facilities (ADOT&PF) in 1993. Potential material sites were surveyed in 1993 to evaluate potential fish and wildlife habitat enhancement potential. Pink, chum, and coho salmon spawning have been documented in this system. It is an objective of this plan to have this project initiated in 1996.

**Rocky Mountain Creek Culvert Correction.** The existing culvert located about 22 miles out the Nome-Taylor Highway is perched approximately four feet at the culvert outlet. Division of Habitat staff have prepared a corrective plan for ADOT&PF to place a series of large rip rap groins downstream of the culvert outlet. Bed-load deposition within each of the groin pools will eventually reestablish a normal stream gradient and provide access to spawning and rearing habitat above the culvert. Targeted species include coho and chum salmon. It is an objective of this plan to have this project initiated in 1996.

Rearing Ponds:

**Anvil Creek Coho Rehabilitation.** Two separate gold mining operations (under lease from Alaska Gold, Inc.) are located immediately north and west of the Nome-Beltz High School have created seven ponds totaling over 20 surface acres. Three of the ponds are presently connected to Anvil Creek and support documented populations of juvenile coho salmon. The ponds were surveyed in 1993 to establish relational elevations and facilitate preparation of a plan for connecting all of the ponds with Anvil Creek. Additional remedial activities may include riparian revegetation with willow cuttings and potential coho salmon fry releases. Development staff of CFMD Division has the lead for coordination with Alaska Gold, Inc. and Nome-Beltz High School, and Habitat Division staff are providing technical support and developing the proposed reclamation plan. It is an objective of this plan to have this project initiated in 1996.

**Little Creek Coho Rehabilitation.** Located southwest of the Nome-Beltz High School immediately west of the Nome Prison facility, Little Creek is a tributary to Anvil Creek. The stream supports a small population of coho salmon. The upper headwaters of this stream tap a large settling pond located on the north side of the Nome-Teller Highway. The settling pond previously was used by Alaska Gold, Inc. for its mining operations located west and north of the high school. A bathymetric survey of the remnant settling pond was conducted there in 1994, and the depth ranges from three to twenty-four feet; the pond also has seven small islands. Remedial activities include channel enhancements at the pond outlet to improve connectivity to Little Creek, shoreline grading to reduce bank slope and increase quantity of littoral habitat, and willow plantings. The pond is a potential site for releasing coho salmon fry. It is an objective of this plan to have this project initiated in 1996.

**Center Creek Off-Channel Excavations.** An ongoing mining operation (i.e., Alaska Gold, Inc.) will divert the upper headwaters of this creek into Little Creek and excavate several large off-channel pits that are expected to fill with ground and surface water upon completion of mining. The current assessment focuses on the potential for interconnecting these lake features to Center Creek and/or Little Creek to provide summer rearing and overwintering habitat for juvenile coho salmon that have been documented in the system. It is an objective of this plan to have this project initiated in 1996.

**Hastings Creek Off-Channel Excavations.** A gravel mining operation (i.e., Vezey/Martinson Dredge) initiated in 1993 will remove approximately 25,000 cubic yards of material. Total estimated gravel reserves could eventually affect up to 15 acres of Hastings Creek and its floodplain and tidal estuary. The site was evaluated and surveyed in 1993. A conceptual plan was developed in conjunction with the contractor and includes provisions for developing up to 20-foot-deep off-channel evacuations. Upon depletion of the gravel reserves, each off-channel excavation will be interconnected with a final downstream connection to the tidal estuary. The reclaimed site is intended to provide rearing habitat for coho salmon as well as estuarine habitat for emigrating pink salmon. It is an objective of this plan to have this project initiated in 1996.

**Dry Creek Rearing Ponds.** Fisheries evaluation and site inspection were completed in 1993. Several options were identified for construction of rearing ponds within or adjacent to the active stream channel in conjunction with gold dredging operations. Juvenile coho salmon have been documented in this system. It is an objective of this plan to have this project initiated in 1996.

**Nome-Taylor Road Rearing Ponds.** A evaluation of material sites with fisheries enhancement potential between mile posts 26 and 28 along the Nome River were identified through a survey in 1992. Several potential sites for development of fish rearing ponds were identified. One spring was also identified; it could potentially be utilized to establish a chum salmon spawning channel. Further evaluation of flow rates and temperature regime is required. Preliminary site plans are under development. The targeted species to be benefitted would be coho and chum salmon. It is an objective of this plan to have this project initiated in 1996.

**Sinuk River Rearing Pond.** Historic shallow surfaced-scrapes of gravel along the west bank of the Sinuk River resulted in extensive riparian disturbance and shifts in the river channels. The site was evaluated and surveyed in 1988-1989. Conceptual plans have been developed to stabilize the existing river channel and create a deep backwater pond. Target species include coho salmon. It is an objective of this plan to have this project initiated in 1996.

**Solomon River Rearing Pond.** Potential material sites at mile post 37 of the Nome-Council Road were evaluated by Division of Habitat staff at the request of the contractor Martinson Dredge. A site development plan is being prepared to create an interconnected off-channel rearing pond within the Solomon River floodplain. It is an objective of this plan to have this project initiated in 1996.

**Pilgrim River Off-Channel Rearing Pond.** A preliminary site evaluation and survey of an existing material site was conducted by Division of Habitat staff to evaluate the potential for establishing an 8- to 10-acre off-channel rearing pond. Baseline assessment has been completed; however, further work has been placed on hold pending resolution of adjacent private landowner's (Native allotment) concerns regarding access restrictions and potential hydraulic river bank alterations. It is an objective of this plan to resolve the landowner concerns during the 1996 season.

Project Timetable:

As limnological and habitat assessment studies progress, a timetable will need to be established for obtaining funding and implementing various rehabilitation, restoration, research, and enhancement projects. While such a detailed timetable cannot be presented in this plan, it is an objective of the Norton Sound/Bering Strait RPT to keep abreast of funding opportunities and study results so that appropriate projects can be implemented according to the 15-year goals. The conduct of limnological studies, establishment of instream and/or recirculating incubators, and completion of specific rehabilitation or enhancement projects will require substantial funding. The RPT cannot, by itself, act as a funding source; however, avenues to acquire funds are available to local governments, seafood processors, regional and local Native corporations, NSEDC, and state and federal agencies. It is an objective of this plan to have a cooperative agreement in place between NSEDC and ADF&G by July 1996.

**Strategies and Projects**

General statements of priorities to guide specific actions of agencies or associations working toward research, management, or production goals and objectives for salmon are strategies. The specific tactics and actions employed to address these strategies are projects. As such, strategies and projects represent the heart of the plan--the means of resolving the production, harvest, development, and research needs of the region's users of the salmon resource. In the context of the Norton Sound/Bering Strait comprehensive salmon plan, strategies and projects are provided for each of the following categories: (1) production/harvest, (2) management, and (3) research/data collection and evaluation.

<u>Production/Harvest Strategies:</u>

These strategies are designed to replenish depressed natural stocks of fish and increase their numbers beyond levels attainable without intervention or to historic high averages. These strategies are also designed, if desired, to supplement production and increase harvests throughout the region. General strategies that may be addressed during the course of the planning process include (1) escapement monitoring (i.e., fish weirs, counting towers, and aerial surveys), (2) establishment of recirculating incubators where suitable systems occur, (3) installation of instream incubation boxes, (4) stream clearance/restoration, (5) rearing pond construction, (6) lake fertilization, (7) spawning channel construction, (8) water flow control, (9) egg or fry plants, (10) lake or stream stocking, and (10) monitoring of fishing grounds.

<u>Management Strategies:</u>

These strategies are designed to preserve and enhance wild stocks and achieve proper escapements into the major spawning systems. One of the distinguishing characteristics of these strategies is they are directed at the user, rather than the resource, implemented by the Alaska Department of Fish and Game, and governed by regulations set down by the Alaska Board of Fisheries. These strategies should increase management precision and accuracy and enhance reasonable enforcement activities. General strategies that may be addressed during the planning process include (1) coordinating emergency closures and openings, (2) imposing prudent fishing periods, (3) monitoring escapement, (4) monitoring harvests (5) implementing test fisheries, (6) reanalyzing escapement goals, (7) establishing bag limits and licensing procedures, (8) imposing gear specifications, (9) opening and closing fishing areas, and (10) increasing education and enforcement of fishing and habitat protection laws.

Improved fishery management data can directly result in more precise management of fisheries. Aerial surveys often result in an underestimation of the escapement; i.e., more fish could be in the system than such surveys indicate, resulting in unnecessary restrictions to fishing opportunity. More direct assessment methods, such as counting towers, weirs, or sonar, would provide better escapement data and allow improved or informed fisheries decisions. Continued collection of subsistence harvest data is also important in determining the effectiveness of meeting management goals.

Research and Evaluation Strategies:

These strategies will produce fish, but only through the use of projects they support. They are effective tools for resource management; however their value for increasing production are more indirect than the other categories of strategies. By necessity, these strategies are applied for long periods of time and therefore require a dedication of funding, staff, and consistency of approach in order to get useful results. General strategies that may be addressed during the course of the planning period follow: (1) field surveys, (2) computer modeling, (3) data gathering and analyzing, (4) qualitative sampling, (5) fish enumerating, and (6) tagging and genetic stock composition studies.

Monitoring and Evaluating Strategies:

The Norton Sound/Bering Strait RPT supports existing state policies and processes that relate to the monitoring and evaluating of rehabilitation and enhancement projects. The size, nature, and potential impacts of a project will determine the degree of monitoring required. Low-cost, low-risk projects often need only cursory monitoring, while high-cost, high risk projects or projects involving new technologies may need more intensive monitoring. If many similar projects are implemented, only a representative sample needs to be monitored. Projects that may significantly impact wild stocks or alter allocations among user groups will have a comprehensive evaluation and monitoring plan approved by the department.

The monitoring plan developed for a project may include specific reporting and terminating dates and identify specific data needs. Monitoring actions may include the following: (1) implementation of approved monitoring plan, (2) evaluation of results, (3) preparation and distribution of periodic evaluation and performance reports, as described in the monitoring plan, and (4) storage of reports for future reference. The information realized from monitoring activities will be used to help in the formulation of project plans as well as revisions to the comprehensive salmon plan. Cooperative funding among interested parties will also be emphasized for monitoring and evaluating activities.

## 15-YEAR ACTION PLAN

### Ongoing Projects

The following projects have been identified as fitting the strategies outlined in the preceding chapter and have become the initial actions necessary to accomplish the goals of this plan. Please note that the restoration projects the RPT expects to be initiated during the 1996 field season are listed under the objectives section beginning on page 20.

Instream Incubation Boxes for Chum Salmon Restoration:

Little is known regarding historical numbers of chum salmon in the Nome area, but returns to other systems within the region suggest their abundance may have been much higher. The Kwiniuk and Fish Rivers, for example, have had annual escapement estimates of 2,500 (i.e., based on counting tower assessments) and 17,000 (i.e., based on aerial surveys) fish, respectively, since the mid-1970s. In contrast, according to aerial surveys escapement estimates of the Nome, Solomon, and Snake Rivers have averaged only 1,500 and 3,100 chum salmon, respectively, during the same period. These differences are probably related to the widespread habitat degradation of rivers in the Nome area and subsequent exploitation of those stocks. This project will focus on identifying and developing incubation sites for chum salmon.

Potential Incubation Box Site Locations:

A cooperative agreement (No. 95-065) between the Bering Sea Fishermen's Association and the Commercial Fisheries Management and Development Division of ADF&G was signed in March 1995. This agreement allowed ADF&G personnel to conduct late-winter aerial surveys to locate potential instream incubation sites throughout the region. Location of these sites is difficult because of the remoteness and inaccessibility of the region as well as the rigorous site-specific requirements. Aerial surveys are a practical and accurate method of locating potential sites that minimally must remain ice free during the winter.

Beginning on March 17, 1995, five aerial surveys were conducted; flying time totalled 12 hours. Part of the surveys were flown near the villages of White Mountain, Golovin, Elim, and Koyuk, and potential ice-free instream incubation sites were located in the following systems: (1) Mukluktulik River (Koyuk); Aggie Creek (White Mountain); and Walla Walla, Clear, Quiktalik, and Miniatulik Creeks (Elim). Aerial surveys were also conducted to the west of Nome, including the Snake, Penny, Sinuk, and Feather Rivers. Aside form the incubation sites already in operation on Boulder Creek (i.e., tributary to Snake River), the only other system with apparent potential is a spring located on the Sinuk River, approximately three miles north of the Sinuk River Bridge.

Limnology Investigations:

Over a two-year period, it will be necessary to acquire data and knowledge relative to the productive potential of Salmon and Glacial Lakes. Limnology sampling would entail taking a suite of physical measurements (for light penetration, salinity, temperature, oxygen concentration, and water depth), water samples (for analysis of nutrient concentrations and phytoplankton abundance), zooplankton samples (to determine food availability for salmon fry), and fry samples (to determine growth patterns and diet. Limnology sampling on each lake must be conducted an average five times per year (May through October) for two years to assess seasonal and annual fluctuations. Further accumulation of biological and limnological data on shallow lakes will provide necessary information to assess and model carrying capacities of such lakes. Limnological studies of physical, chemical, and biological attributes of regional lakes will assess their respective potential feasibility for fertilization or application of other enhancement or rehabilitation techniques for increased production of sockeye and, perhaps, coho salmon.

The fisheries aspects of the investigations have been initiated to determine the nature and extent of juvenile sockeye fry utilization of the two lakes. This is accomplished by enumerating emigrating sockeye fry in the lakes using fyke nets or mark-recapture techniques to determine abundance and timing of the migration. Adult fish returning to these systems will also be enumerated. Additionally, smolt enumeration and sampling will determine the production of smolts from each system and establish an index for abundance, size, and age data sufficiently accurate to be used in forecasting as well as monitoring conditions of the rearing environments.

These types of limnological and biological studies have been initiated at Salmon and Glacial Lakes as a result of a cooperative agreement between Bering Sea Fishermen's Association, U.S. Bureau of Land Management, and ADF&G (i.e., No. 1422L953-A5-0013) as well as a cooperative agreement between ADF&G and NSEDC (i.e., COOP 96-003). Comprehensive limnology work has not previously occurred in the region because of its remoteness, commensurate high costs of transportation, and other difficult logistical constraints. These studies are necessary, however, not only to provide a foundation for future restoration and enhancement work, but to provide a basic understanding of sockeye production in western Alaska. Anecdotal evidence suggests that sockeye populations in these lakes were historically far more abundant than at present. Preliminary data suggest potential for annual returns of 200,000 or more adults. Sockeye salmon are highly valued for subsistence and commercial harvests; however, there has been no commercial fishing on these stocks since 1967, and subsistence harvests are believed to have been only about 1,000 fish annually. These projects will attempt to rebuild these populations to levels limited by the carrying capacity of the freshwater environment. Initial work will focus on identifying these limits and methods to fully utilize available habitat.

Nome Recirculating Incubation Project:

Efforts to rehabilitate salmon stocks in the Nome area will require developing reliable incubation sites to ensure increased survival of eggs to emergent fry. Stream-side incubators function well in this capacity, but they can fail when subject to extreme winter conditions (e.g., extended freezing temperatures under low-flow conditions), dissolution of gases in the water supply, and wash-out from flood events. A controlled recirculating incubation facility will eliminate or reduce the potential for such losses and provide consistently greater contributions of fry to the early rearing environment. Each recirculating incubation facility can be fully utilized by incubating eggs to the eyed stage for seeding streams late fall after the hydrologic conditions have stabilized. These incubators could also produce emergent fry for releases into natal streams in the spring.

The Nome Public Schools provided a room at the school for the purpose of experimenting with developing recirculating incubator technology. A cooperative agreement (No. 95-089) between Bering Sea Fishermen's Association, Nome Public Schools, and ADF&G was signed in June 1995. In addition to the room at the school, the agreement provided for an upgrade of the electrical power to accommodate two recirculating incubators, the components for construction of a second incubator, and the operation and maintenance of the incubators. This work was completed in November 1995. Additionally, a cooperative agreement between ADF&G and BSFA (No. 96-024) has resulted in the purchase and installation of a telephone alarm system to detect system failure.

Weir/Counting Towers:

Typically, a 15-foot-high scaffolding tower is erected on the bank of the river to serve as an observation platform, and a 50-foot by 8-foot flash panel is placed on the river bottom directly in front of the tower. A weir to direct the fish over the flash panel is built from the midstream end of the flash panel to the opposite bank. The weir is made of livestock fencing and thaw-field pipes. An array of four 120-volt lights are mounted on a post below the tower to illuminate the flash panel during periods of low light and darkness. Daily counts are radioed in to the Nome office of ADF&G each morning; the daily and cumulative counts are tracked throughout the season. The objectives of tower projects are to (1) obtain daily and seasonal information concerning timing and magnitude of chum, pink, chinook, and coho escapement into the river and (2) establish a base for possible egg takes to facilitate rehabilitation of the system's salmon stocks.

**Eldorado River Counting Tower.** The counting tower project on the Eldorado River is a cooperative project funded and operated by the Sitnasuak Native Corporation. The Nome Eskimo Community, Kawerak Incorporated, U.S. Bureau of Land Management (BLM) and ADF&G were contributors to this project. ADF&G analyzes and expands the tower count data to incorporate into their annual reports. 1995 was the first year a salmon counting tower had been operated on the Eldorado River; the project was initiated to obtain timely and accurate escapement information required for active management of salmon stocks during the fishing season. Historically, this drainage produces the most chum salmon of the various other systems in the Nome subdistrict. The counting tower camp is located on Sitnasuak Native Corporation land above the highest upstream connecting channel to the Flambeau River and is approximately 45 minutes by boat from the Safety Sound highway bridge.

**Snake River Counting Tower.** The counting tower project on the Snake River is a cooperative project funded and operated by the Kawerak Corporation; ADF&G analyzes and expands the tower count data to incorporate into their annual reports. 1995 was the first year a salmon counting tower has been operated on the Snake River. The project was initiated to obtain timely and accurate escapement information required for active management of salmon stocks during the fishing season. A net pen was placed in deep water area just downstream from the weir, and the crew collected chum salmon by beach seine and held them in the net pen for ripening. When the fish were ripe, and egg take was conducted using standard fish culture methods and the fertilized eggs were transported to an instream incubator on Boulder Creek.

**Potential Restoration or Enhancement Projects**

As of the date of publication, the following projects have been identified as contributing to the goals of this plan.

<u>Construction of Instream Incubation Boxes:</u>

In 1991 ADF&G introduced the use of instream incubation technology as a relatively low-cost method of rebuilding depressed salmon stocks in the Norton Sound region. In nature, the normal survival for fertilized salmon eggs to fry typically is from 5% to 10%, while the survival rate for fertilized salmon eggs to fry in an instream incubator may be as high as 80%. These incubators protect salmon eggs by providing them with near-optimal conditions as they develop through the winter, dramatically increasing their chances for survival. Since 1991 incubators have been placed in the Nome, Snake, and Solomon River drainages. Investigations to locate suitable incubation sites have continued. The objective of this project is to construct three additional fiberglass incubators, each having a capacity of 100,000 eggs. Additional units will be placed in the Nome and Snake Rivers, and a third will be placed in the Sinuk River.

<u>Boulder Creek Rehabilitation</u>:

Boulder Creek is a spring fed, ice-free tributary of the Snake River located approximately 10 miles north of the river mouth. The creek, which is approximately 4.6 miles in length, has been heavily mined. Mineral exploration is still active around the Boulder Creek area. ADF&G, since 1991 has operated and maintained instream incubators located approximately 1.5 miles upstream of the confluence of the Snake River in an effort to rebuild seriously depressed chum salmon stocks. The incubation site sits on Alaska Gold Company lands, and access to the creek site requires permission from the Sitnasuak Native Corporation. The Boulder Creek incubation site has been successful in incubating chum salmon; i.e., about 200,000 fry released since 1992. Adult returns can be expected to begin occurring in 1996. Recent mineral exploration activities and subsequent use of the access road adjacent to Boulder Creek has altered the creek bed and road. This has caused some concern that these activities may have adversely impacted the successful outmigration of juvenile chum salmon from the incubation boxes. Remedial corrective action to realign portions of Boulder Creek is considered a high priority.

Banner Creek Material Site Coho Salmon Rehabilitation:

A series of gravel ponds totaling approximately 20 acres, located at mile 13 on Beam Road and connected via culvert and small creek to the Nome River, has the potential for creating a large area habitat suitable for rearing juvenile coho salmon. Continuous upwelling water flow during the winter at the upper end of pond has the potential for creating a small chum salmon spawning area within the upwellings. Riparian vegetation is sparse, and additional plantings of willows and other woody debris will be necessary downstream of the culvert.

Kawerak, Inc. Proposed Counting Tower Sites:

**North River Counting Tower.** A counting tower located between the bridge and the system's confluence with the Unalakleet River would enable better escapement data for chinook, chum, pink, and coho salmon. The North River is an important salmon-producing tributary of the Unalakleet River, and that system is the most commercially valuable salmon producer in Norton Sound. It also provides extensive subsistence and sport fishing opportunity for residents of Unalakleet. Harvests of these species of salmon have been hampered in recent years by chum salmon conservation efforts. The monitoring information that will be made possible by the tower will provide the department with valuable in-season escapement data for use in the management of the fisheries, while assuring that escapements are being met and subsistence harvests adequately provided. There is historic data from this system that will act as a baseline to compare newly gathered data.

**Pilgrim River Counting Tower.** A tower located immediately upstream from the hot springs would enable monitoring of returns of chum, pink, and coho salmon into the Pilgrim River, which is an important salmon-producing system that provides subsistence opportunities for the residents of Teller, Brevig Mission, and Nome. In recent years, the subsistence use by Nome residents has increased because of fishing restriction in northern Norton Sound. The operation of the counting tower will provide department managers with more accurate escapement data and provide a better understanding the system's needs and enable recommendations of restoration or enhancement strategies to improve salmon production in the Pilgrim River system. This project might also be done in conjunction with the Salmon Lake project (i.e., limnological and biological investigations).

Mukluktulik River Chum Salmon Restoration:

This river system is located approximately one mile south of the village of Koyuk. The river, which is part of the Koyuk River drainage, is approximately 12 miles long and runs in a northwesterly direction from Koyuk Inlet. The Mukluktulik River currently supports a very weak chum salmon population. Local residents indicated the system had been heavily overfished during the 1950s and had not yet rebuilt itself. Recently, beavers have established themselves on the river and constructed several dams that may be impeding the ability of returning salmon to reach some of the spawning areas. Historically, the river supported a local subsistence fishery. The goal of this project is to restore and/or increase chum salmon production in the

Mukluktulik River; the objective of the evaluation phase of the project will be to determine the current productivity, inventory habitat, and design a restoration program. Although the primary focus will be on chum salmon, coho salmon will also be addressed. Because of its close proximity to the village of Koyuk, the use of a recirculating salmon incubation system could prove effective in rebuilding chum salmon stocks there. Other restoration techniques that may be suitable include beaver dam removal and "eyed" egg plants.

Quiktalik Creek Chum Salmon Restoration:

Efforts to rehabilitate regional salmon stocks using instream incubators require locating and developing reliable sites to insure increased survival of eggs to emerging fry. Investigations conducted in 1991 indicated that Quiktalik Creek, located about two miles west of Elim, had the biological and physical characteristics necessary for successful implementation of a salmon restoration project there. The system currently supports a run of chum salmon. The objective of this project is to evaluate the system for potential placement of an instream incubator.

Evaluation of Otolith Patterns to Identify Incubation Reared Fish:

Use of instream incubators is a proven method of increasing juvenile salmon survival rates; however, quantitative adult returns have been difficult to obtain because the remoteness of incubation sites makes it impossible to use conventional tagging methods. This project will evaluate the success of instream incubation boxes by examining the patterns of growth on the otoliths, which are the ear bones of fish. The otolith starts to form prior to the eyed-egg stage, and its growth is continuous throughout the life of the fish. Otolith patterns formed early in life are preserved in the otolith of older fish and can be detected by grinding down the overlying material and examining the patterns with a microscope. Temperature is an important factor controlling the rate of otolith growth and type of patterns laid down. Incubation boxes are placed in areas of spring-fed water, where the ambient water temperatures during winter remain fairly constant at two to three degrees Celsius. By contrast, natural spawning that occurs in adjacent areas are near zero degrees during most of the winter. The examination of both natural spawning fish and incubation-box-reared fish may reveal two different growth patterns in the otoliths; therefore, a relatively simple method of distinguishing natural from enhanced fish may be available.

Eldorado River Chum Salmon Restoration:

The Eldorado River is located approximately 10 miles east of Nome. The primary user group is subsistence fishers. In recent years, the chum salmon population has been in decline. The ADF&G escapement goal of 5,250 fish has frequently not been met, and the stock is considered depressed and is a conservation concern. The placement of instream incubation boxes in this system do not appear favorable because aerial and ground surveys have failed to locate suitable sites. Other restoration options may include the use of a water recirculating incubator located at the Nome-Beltz High School and maintained by ADF&G to incubate salmon eggs, where fry would be transported by helicopter for release back into the Eldorado River in the spring. A pilot project (50,000 eggs) could be implemented in 1996. If successful, production could be increased if additional incubation units were available.

Sinuk River Chum Salmon Restoration:

The Sinuk River is located approximately 25 miles northwest of Nome. Pink, chum, coho, sockeye, and chinook salmon are present in the system. Subsistence fishermen are the primary user group of pink and chum salmon, while sport fishermen target the coho, sockeye, and chinook salmon. Chum salmon escapement of 4,500 has not been met regularly; ADF&G considers the run depressed and a candidate for restoration. Aerial and ground surveys have located a spring area about three miles upstream from the Blodgett Memorial Highway on the east side of the Sinuk River. This project will evaluate the site (physical, chemical, biological), installation of an instream incubator, and a small-scale (<50,000) chum salmon egg take.

Moonlight Springs Centralized Incubation Facility Feasibility Study:

Efforts to rehabilitate salmon stocks in the Norton Sound area requires locating and developing reliable incubation sites to ensure increased survival of eggs to emergent fry. Instream incubators function well in this capacity, but locating suitable sites on all streams in need of salmon restoration has proved difficult and is probably not possible because these incubators are subject to adverse environmental conditions; e.g., extreme freezing temperatures, dissolution of gasses in the water supply, low flows, and flooding. A controlled incubation facility, located in a centralized area and capable of simultaneously incubating several stocks of fish, may be the only practical and economic method (at least for the short term) for rebuilding depressed salmon populations in the region. This facility may be fully utilized by incubating eggs to the "eyed" stage for seeding streams in late fall and producing emergent fry for direct release into natal streams in the spring. All Nome area rivers accessible by road could see restoration projects implemented immediately after initial feasibility studies have been completed. Outlying, more remote area streams could benefit from either "eyed" egg or fry plants. The primary objective of this project is to determine if Moonlight Spring, located about three miles west of Nome, meets all the parameters for successful placement of a central incubation facility.

Iron Creek Replacement of Road Culvert:

Iron Creek is located approximately 4 miles east of Elim and has spawning populations of pink and chum salmon. An existing culvert is positioned so that normal fish access to spawning areas has been greatly reduced. Repositioning this culvert lower in the stream bed would enable more pink and chum salmon to utilize available spawning habitat. Additional site engineering work by DOT and ADF&G staff will be necessary to design specific remedial solutions.

Kuiak River Salmon Habitat Investigation:

The Kuiak River is located about 14 miles southwest of St. Michael; it flows northward before entering Norton Sound. Pink, chum, and coho salmon are present in the system. This project proposal would determine if a vertical lava formation about 10 miles upstream from the mouth is impeding fish access to potential spawning and rearing areas in the upper reaches of the system. A survey of the river would be conducted to inventory habitat and determine if such a barrier prevents fish access. This study would also determine the best strategy (e.g., fish pass) for increasing salmon production in the system.

<u>Limnological/Fisheries Assessment of Imuruk Basin:</u>

Sockeye salmon and other Pacific salmon sometimes rear in brackish water before migrating to the ocean as smolts before reaching one year of age. These brackish lagoons and basins can be highly productive habitats, providing ample sources of food for rearing juvenile salmon. Imuruk Basin, located north of Nome and approximately 17 miles long and about 20 feet deep, is such a potential rearing site for juvenile sockeye salmon. The proposed limnological/fisheries study would investigate the following: (1) physical parameters (e.g., light penetration, temperatures, dissolved oxygen content); (2) water quality, including salinity, pH, alkalinity, nutrients, algal biomass; and (3) zooplankton community (e.g., species, body size, age), including stomach content analysis of juvenile salmon. This proposed project will provide information to enable determining the extent that Imuruk Basin is used by rearing salmon. The project will also provide information regarding the production of age-0 sockeye salmon smolts in the Nome area, which will be useful when considering potential enhancement projects.

**Potential Systems for Restoration or Enhancement in Norton Sound/Bering Strait Region**

The following rivers, streams, and/or lakes throughout the region (Figure 8, Table 3) have been identified as systems where production of salmon may be increased through implementation of various enhancement or rehabilitation techniques, thereby benefitting regional fishermen with increased harvests. The Norton Sound/Bering Strait Regional Planning Team has selected habitat restoration/improvement, recirculating and/or instream incubation techniques as the most practical and cost-effective strategies to investigate in the region; however, before any of the techniques can be actualized in the form of projects, it is necessary to learn as much as possible about the physical, chemical, and biological characteristics of selected systems and/or determine feasibility of proposed projects.

Systems selected for investigation were based on information received from fishermen, regional planning team members, ADF&G staff, and public comments received during the village information meetings. The criteria used to determine systems that would initially be investigated included (1) importance to community (2) size of system, (3) proximity to communities, (4) potential for increased salmon production based on historical escapement and harvest information, and (5) status of land surrounding the system.

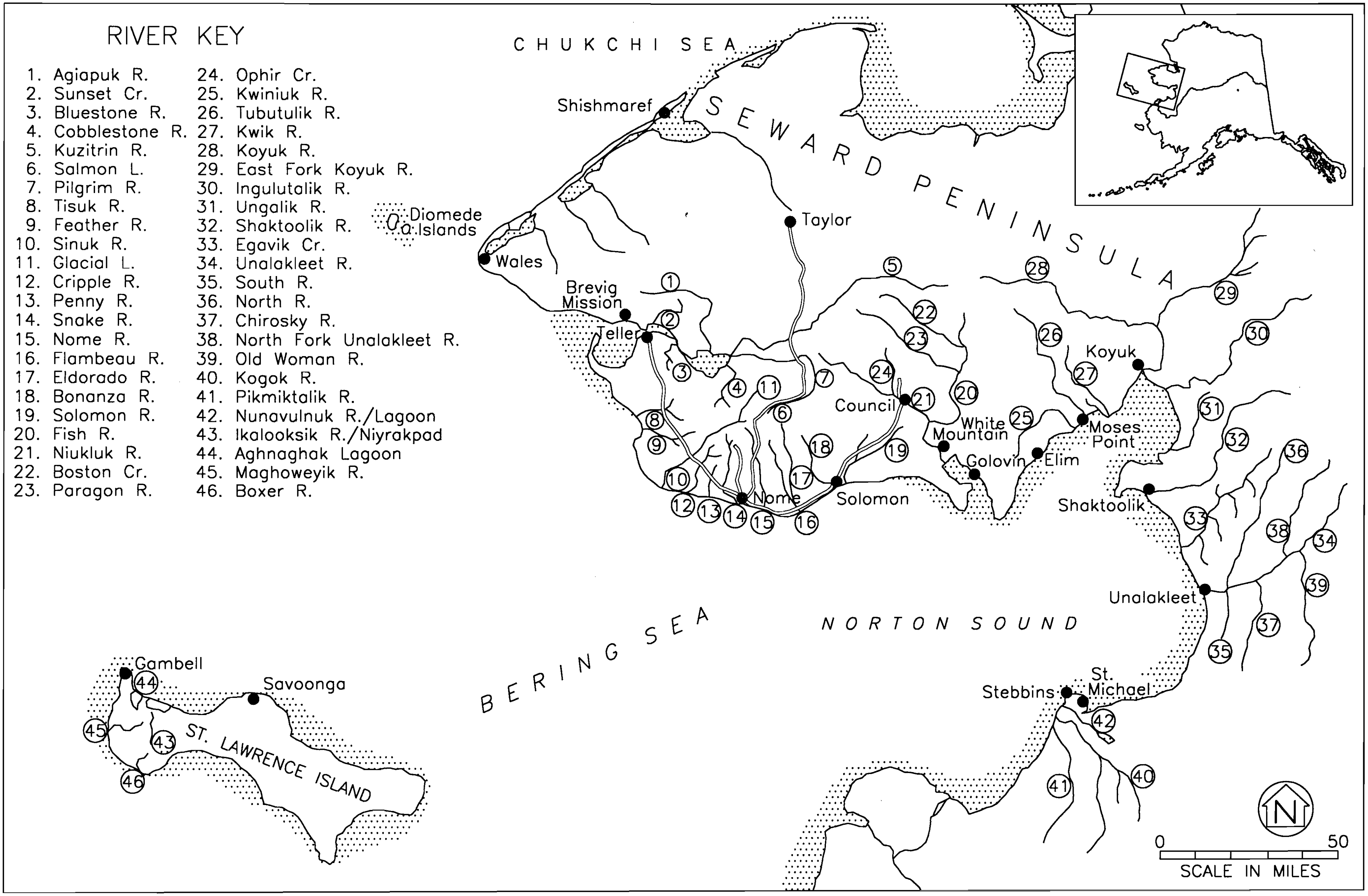



Figure 8. Key River Systems in the Norton Sound/Bering Sea Region.

Table 3. List of Norton Sound salmon systems as well as species distribution, status, and human use of salmon.

| District System | Species | Escap. Goal | Current Fisheries | Conser. Concern | Escap. Proj. | Type Proj. | Priority | Remarks |
|---|---|---|---|---|---|---|---|---|
| **Port Clarence** | | | | | | | | |
| Agiapuk R. | Pink | | sb | | | | | |
| | Chum | | sb | | | | | |
| | Coho | | sb | | | | | |
| Sunset Cr. | Pink | | sb | | | | | |
| Bluestone R. | Pink | | sb | | | | | |
| | Chum | | sb | | | | | |
| Cobblestone R. | Chum | | | | | | | |
| Kuzitrin R. | Pink | | sb | | | | | |
| | Chum | | sb | | | | | |
| | Coho | | sb | | | | | |
| | Red | | | | | | | |
| | King | | | | | | | kings colonizing |
| Salmon Lake | Red | | sb | | B,D | 1 | | existing proj. |
| Pilgrim R. | Pink | | sb | | | | | |
| | Chum | | sb | | | | | |
| | Coho | | sp | | | | | |
| | King | | sb | | | | | kings colonizing |

**Key: Type of Project**

1 = Evaluation studies
2 = Instream incubation
3 = Recirculating incubator
4 = "eyed" egg plants
5 = Direct fry release
6 = Barrier removal
7 = Habitat restoration

**Escapement Project**

A = ADF&G tower\weir
B = Cooperative tower\weir
C = ADF&G test net
D = Aerial survey index

**Current Fisheries**

sb = Subsistence
sp = Sportfish
cm = Commercial

**Priority**[1]

I = Inadequate escape.
II = Good escape. inadequate subs.
III = Good escape. & subs. inadequate sport or commercial
IV = No action neccessary

**Table 3.** **List of Norton Sound salmon systems as well as species distribution, status, and human use of salmon.**

| District System | Species | Escap Goal | Current Fisheries | Conser. Concern | Escap. Proj. | Type Proj. | Priority | Remarks |
|---|---|---|---|---|---|---|---|---|
| **Norton Sound** | | | | | | | | |
| Tisuk R. | Chum | | sb | | | | | |
| | Pink | | sb | | | | | |
| | Red | | sb | | | | | |
| Feather R. | Pink | | sb | | | | | |
| | Chum | | sb | | | | | |
| | Coho | | sb | | | | | |
| Sinuk R. | Pink | | sb | | D | | II | |
| | Chum | 4,500 | sb | yes | D | 1,2 | I | #1&2 scheduled 1996 |
| | Coho | | sb | | D | | | |
| | King | | sb,sp | | D | | III | kings colonizing |
| Glacial Lake | Red | | | yes | D | 1 | I | |
| Cripple R. | Pink | | sp | | | | II | heavy demand |
| | Chum | | | yes | | | I | " " |
| | Coho | | sp | | | | I | " " |
| **Subdistrict 1** | | | | | | | | |
| Penny R. | Pink | | sp | | | | II | " " |
| | Chum | | | yes | | | I | " " |
| | Coho | | | yes | | | I | " " |
| Snake R. | Pink | | sp | | B,D | | II | " " |
| | Chum | 1,000 | | yes | B,D | 2,7 | I | #2 exist. proj. |
| | Coho | | sp | yes | B,D | 1,3 | I | #1&3 scheduled 1996 |

**Table 3. List of Norton Sound salmon systems as well as species distribution, status, and human use of salmon.**

| District System | Species | Escap. Goal | Current Fisheries | Conser. Concern | Escap. proj. | Type Proj. | Priority | Remarks |
|---|---|---|---|---|---|---|---|---|
| Nome R. | Pink | | sp | | A,D | | III | heavy demand |
| | Chum | 2,000 | sb | yes | A,D | 2 | I | #2 exist. proj. |
| | Coho | | sb,sp | | A,D | 7 | II | #7 scheduled 1996 |
| | Red | | sb,sp | | A | | II | heavy demand |
| | King | | sb,sp | | A | | II | " " |
| **Subdistrict 2** | | | | | | | | |
| Flambeau R. | Pink | | sb | yes | D | | I | |
| | Chum | 3,250 | sb | yes | D | | I | |
| | Coho | | sb | | D | | IV | |
| Eldorado R. | Pink | | sb | yes | B,D | | I | |
| | Chum | 5,250 | sb | yes | B,D | 1,3 | I | #1&3 scheduled 1996 |
| | Coho | | sb | | B,D | | IV | |
| Bonanza R. | Pink | | sb | | | | III | |
| | Chum | 1,500 | | yes | | | I | |
| | Coho | | | | | | IV | |
| Solomon R. | Pink | | sb | yes | D | | I | |
| | Chum | 550 | | yes | D | 1&2 | I | #1&2 exist. proj. |
| | Coho | | | yes | D | | I | |
| **Subdistrict 3** | | | | | | | | |
| Fish R. | Pink | | sb,cm | | D | | IV | |
| | Chum | 17,500 | sb,cm | | D | | III | |
| | Coho | | sb,sp | | D | | IV | |
| | King | | sb,sp | | D | | III | kings colonizing |

Table 3. List of Norton Sound salmon systems as well as species distribution, status, and human use of salmon.

| District System | Species | Escap. Goal | Current Fisheries | Conser. Concern | Escap. Proj. | Type Proj. | Priority | Remarks |
|---|---|---|---|---|---|---|---|---|
| Niukluk R. | Pink | | sb, cm | | A,D | | IV | |
| | Chum | 8,000 | sb,cm | | A,D | | III | |
| | Coho | | sb,sp | | A,D | | IV | |
| | King | | sb,sp | | A,D | | III | kings colonizing |
| Boston Cr. | Pink | | sb | | D | | IV | |
| | Chum | 2,500 | sb | | D | | III | escap. general. met |
| | Coho | | sb | | D | | III | |
| | King | | sb | | D | | III | escap. declining |
| Paragon R. | Pink | | | | | | | |
| | Chum | | | | | | III | |
| | Coho | | | | | | | |
| | King | | | | | | III | very small run |
| Ophir Cr. | Pink | | | | | | | |
| | Chum | | | | | | III | |
| | Coho | | sp | | D | | II | stocks declining |
| **Subdistrict 4** | | | | | | | | |
| Iron Cr. | Chum | | | | | 6 | I | #6 scheduled 1996 |
| Kwiniuk R. | Pink | | | | A | | | |
| | Chum | 19,500 | sb,cm | yes | A | | II | escap. gener. unmet |
| | Coho | | sb,cm | | D | | | |
| | King | | | | A | | III | very small run |
| Tubutulik R. | Pink | | | | D | | | |
| | Chum | 12,000 | sb,cm | yes | D | | II | escap. gener. unmet |
| | Coho | | sb,cm | | D | | II | escap. general. met |

Table 3. List of Norton Sound salmon systems as well as species distribution, status, and human use of salmon.

| District System | Species | Escap. Goal | Current Fisheries | Conser. Concern | Escap. Proj. | Type Proj. | Priority | Remarks |
|---|---|---|---|---|---|---|---|---|
| Kwik R. | Chum | | | | | | III | small fall run |
| Mukluktulik R. | Chum | | | | | 1 | I | #1 scheduled 1996 |
| Koyuk R. | Pink | | sb | | | | | |
| | Chum | | sb | | | | | |
| | Coho | | sb | | | | | |
| | King | | sb | | | | | |
| E. Fork Koyuk R. | Pink | | sb | | | | | |
| | Chum | | sb | | | | | |
| | Coho | | sb | | | | | |
| Ingulutalik R. | Pink | | sb | | D | | | occasional survey |
| | Chum | 8,500 | sb | | D | | | " " |
| | Coho | | sb | | D | | | " " |
| | King | | sb | | D | | | " " |
| Ungalik R. | Pink | | sb | | D | | | |
| | Chum | 2,500 | sb | | D | | | |
| | Coho | | sb | | D | | | |
| | King | | sb | | D | | | |
| **Subdistrict 5** | | | | | | | | |
| Shaktoolik R. | Pink | | sb,cm | | D | | | tower proj. 1996 |
| | Chum | 11,000 | sb,cm | | D | | | " " |
| | Coho | | sb,cm | | D | | | " " |
| | King | | sb,cm | | D | | | " " |

Table 3. **List of Norton Sound salmon systems as well as species distribution, status, and human use of salmon.**

| District System | Species | Escap. Goal | Current Fisheries | Conser. Concern | Escap. Proj. | Type Proj. | Priority | Remarks |
|---|---|---|---|---|---|---|---|---|
| Egavik Cr. | Pink | | sb,cm | | D | | | |
| | Chum | | sb,cm | | D | | | |
| | Coho | | sb,cm | | D | | | |
| | King | | sb,cm | | D | | | |
| Unalakleet R. | Pink | | sb,sp,cm | | | | | |
| | Chum | | sb,sp,cm | | | | | |
| | Coho | | sb,sp,cm | | | | | |
| | Red | | sb,sp,cm | | | | | |
| North R. | Pink | | sb,sp | | D | | | tower proj. 1996 |
| | Chum | | sb,sp | | D | | | " " |
| | Coho | | sb,sp | | D | | | " " |
| | King | | sb,sp | | D | | | " " |
| South R. | Pink | | | | | | | |
| | Chum | | | | | | | |
| | Coho | | | | | | | |
| | King | | | | | | | |
| Chirosky R. | Pink | | | | | | | |
| | Chum | | | | | | | |
| | Coho | | | | | | | |
| N. Fork Unk. R. | Pink | | | | | | | |
| | Chum | | | | | | | |
| | Coho | | | | | | | |
| Old Woman R. | Pink | | | | D | | | |

**Table 3. List of Norton Sound salmon systems as well as species distribution, status, and human use of salmon.**

| District System | Species | Escap. Goal | Current Fisheries | Conser. Concern | Escap. Proj. | Type Proj. | Priority | Remarks |
|---|---|---|---|---|---|---|---|---|
| Old Woman | Chum | 1,000 | | | D | | | |
| | Coho | | | | D | | | |
| | King | | | | D | | | |
| **S. Norton Sound** | | | | | | | | |
| Kogok R. | Pink | | sb | | D | | | |
| | Chum | | sb | | D | | | |
| | Coho | | sb | | D | | | |
| | King | | sb | | D | | | very small run |
| Pikmiktalik R. | Pink | | sb | | D | | | |
| | Chum | | sb | | D | | | |
| | Coho | | sb | | D | | | |
| | King | | sb | | | | | very small run |
| Nunavulnuk R. | Pink | | sb | | | | | very small run |
| | Chum | | sb | | | | | " " |
| | Red | | sb | | | | | " " |
| **St. Lawrance Is.** | | | | | | | | |
| Niyrakpad Lagoon | Pink | | sb | | | | | limited data |
| | Chum | | sb | | | | | " " |
| | Red | | sb | | | | | " " |
| | King | | sb | | | | | " " |
| Ikalooksik R. | Pink | | sb | | | | | " " |
| | Chum | | sb | | | | | " " |
| | Coho | | sb | | | | | " " |

**Table 3. List of Norton Sound salmon systems as well as species distribution, status, and human use of salmon.**

| District System | Species | Escap. Goal | Current Fisheries | Conser. Concern | Escap Proj. | Type Proj. | Priority | Remarks |
|---|---|---|---|---|---|---|---|---|
| Ikalooksik R. | King | | sb | | | | | limited data |
| Aghnaghak Lagoon | Pink | | sb | | | | | " " |
| | Chum | | sb | | | | | " " |
| | Coho | | sb | | | | | " " |
| | Red | | sb | | | | | " " |
| | King | | sb | | | | | " " |
| Moghoweyik R. | Pink | | sb | | | | | " " |
| | Chum | | sb | | | | | " " |
| | King | | sb | | | | | " " |
| Boxer R. | Pink | | sb | | | | | " " |

[1] The No. I priority requires closure of all fisheries in the system; it is the highest priority for implementing rehabilitation and enhancement strategies.

The No. II priority indicates a sufficient escapement of salmon; however, the number of fish is inadequate to support subsistence harvests in that system.

The No. III priority indicates adequate escapement and stocks to support subsistence harvests; however, other consumptive uses of those stocks in that system will not be met.

The No. IV priority indicates salmon stock is adequate to meet escapement and all other uses in that system.

Port Clarence District:

**Agiapuk River**. The watershed system for the Agiapuk River consists of the main river and two major tributaries, the American River and Igloo Creek with several smaller tributaries such as Boulder, Arctic, and Flat Creeks. The mouth is located approximately 21 miles east-southeast of Teller and about 25 miles from Brevig Mission. The river originates in the Black Mountains and flows approximately 60 miles southeast to the Imuruk Basin. The American River is approximately 35 miles in length, entering the Agiapuk about 18 miles from its mouth. Igloo Creek flows approximately 28 miles to the American River, one mile north of its junction with the Agiapuk. Pink, chum, and coho salmon are present and are targeted by subsistence fishermen. Residents of Teller have indicated that chinook salmon are also present in the Agiapuk River. Escapement goals have not yet been determined for this river; however, it appears to be in relatively good shape and is considered an important salmon system to local residents, who have indicated there are ice-free areas on the Agiapuk and American Rivers as well as Igloo Creek during the winter. It is a primary system for subsistence chum salmon in that area. The fish run from July through September, and the fall chums are fat when they enter Port Clarence Bay.

**Sunset Creek.** The headwaters of this system lie southwest of Eva Mountain. Sunset Creek flows approximately six miles before entering Grantley Harbor, four miles northeast of Teller. Escapement goals for Sunset Creek have not been established. Pinks are the only known salmon to spawn in Sunset Creek. They are utilized by the subsistence fishermen who camp at the creek's mouth.

**Bluestone River**. The headwaters of Bluestone River are at the junction of Gold Run and Right Fork; the river flows northeast approximately 13 miles to Tuksuk Channel, 12 miles southeast of Teller. Pink and chum salmon are present in the Bluestone River, but the numbers are few. Subsistence fishermen are the primary user group of these salmon stocks, and the system is important because of its proximity to Teller.

**Cobblestone River**. Cobblestone River headwaters are located in the Kigluaik Mountains. This river flows northeast approximately 20 miles to Imuruk Basin, about 28 miles southeast of Teller. Chum and pink salmon are the only known salmon species to inhabit this system. No escapement goals have been established for this river, and no data are available concerning what user groups, if any, target this system.

**Kuzitrin River**. Kuzitrin Lake is the headwaters of the Kuzitrin River, a body of water approximately three miles long and located within the Bering Land Bridge National Preserve. The Kuzitrin River flows west approximately 95 miles to Imuruk Basin, passing through the Kuzitrin Flats. Pink, chum, coho, chinook, and sockeye salmon are also present in this system. The Noxapaga River is a major tributary that supports populations of pink and chum salmon. Belt Creek, a small tributary, also has spawning populations of chum and coho salmon. Subsistence fishermen are the primary user group that targets pink, chum, and coho salmon.

**Salmon Lake**. Salmon Lake (Eskimo name "Nahwazuk" meaning salmon) is approximately 35 miles north of Nome. Salmon Lake is four miles long; it is the headwaters of the Pilgrim River. Salmon Lake is accessible via Nome-Taylor Highway, and it is considered one of the most northerly lakes in Alaska supporting a sockeye salmon population. Historically, the sockeye population was much higher; it supported a small commercial fishery that has not been conducted since 1967. The population appears to be slowly increasing; escapements into the system average between 3,000 and 5,000 adults annually. ADF&G began limnology studies in 1994 to determine potential productivity levels, in hopes of increasing the sockeye numbers back to more historic levels. Residents of Brevig Mission and Teller indicate sockeye salmon are their most desired subsistence species.

**Pilgrim River**. The Pilgrim River (the Eskimo name is "Kruzgamepa") begins at the outlet of Salmon Lake southeast of the Kigluaik Mountains and flows northeast and then west approximately 55 miles to Kuzitrin River before entering Imuruk Basin. The basin is connected to Grantley Harbor by Tuksuk Channel, a six-mile-long tidal canal with strong currents that reverse periodically. Brevig Mission and Teller are located on Port Clarence near the entrance to Grantley Harbor, 14 miles from the Bering Sea. Pink, chum, coho, chinook, and sockeye salmon are all present in the river. Escapement goals have not been established. Pink, chum, and sockeye salmon are primarily harvested for subsistence use by residents of the villages of Teller and Brevig Mission. Coho and chinook salmon are targeted by sport fishermen, many of which are from the Nome area. Residents of Teller have indicated that there are areas on the Pilgrim River that remain ice free and open during winter.

<u>Norton Sound District:</u>

**Tisuk River**. The Tisuk River is located approximately 40 miles northwest of Nome. The river system is accessible via the Blodgett Memorial Highway. It is approximately 22 miles in length and flows west into Wooley Lagoon before reaching the Bering Sea. Chum salmon migrate into Wooley Lagoon on their way to the Tisuk River. This system supports small chum and pink salmon runs that are targeted mainly by subsistence fishermen. ADF&G has not yet established escapement goals for this system.

**Feather River**. The Feather River is located approximately 38 miles northwest of Nome. The river is accessible from the Blodgett Memorial Highway. This system is approximately 17 miles in length, flowing west into Wooley Lagoon before reaching the Bering Sea. The river has runs of chum, coho, and pink salmon. ADF&G has not yet established escapement goals for this system.

**Sinuk River**. The Sinuk River is located approximately 25 miles northwest of Nome; it is accessible via the Blodgett Memorial Highway and by a trail along the beach. The Sinuk River is about 48 miles long, drains Glacial Lake, and empties into Norton Sound. An Eskimo village and mission were once sited at the mouth of this system. The Sinuk River has runs of pink, chum, chinook, coho, and sockeye salmon. Subsistence fishermen are the primary user group of pinks and chums, while sport fishermen target the coho, chinook, and sockeye salmon.

Five-year average escapements for pink, coho and sockeye stocks appear adequate, while the chum escapement of 4,500 has not been met regularly. Chum salmon stocks in the Sinuk River are depressed.

**Glacial Lake.** Glacial Lake is located approximately 25 miles northwest of Nome; it drains into the Sinuk River. It is also one of the most northerly lakes in Alaska supporting a sockeye salmon population. Glacial Lake is approximately 3.7 miles in length, has a mean and maximum depth of 20 feet and 72 feet, respectively, and a surface area of 986 acres. Historically, sockeye were more abundant than at present; preliminary data suggests there is an opportunity to enhance this stock. Limnology studies that are currently underway to determine the lake's productivity should be completed by late 1996. There appears to be a potential for increasing the sockeye salmon population of Glacial Lake.

**Cripple River.** Cripple River is located approximately 12 miles northwest of Nome and is accessible from the Blodgett Memorial Highway and a trail along the beach. The Cripple River is approximately 25 miles in length and empties into Norton Sound. Pink, chum, and coho salmon are present in this system. Several tributaries of the Cripple River provide rearing habitat for juvenile coho salmon. Sport fishermen are the primary user group of these fish. Up until the early 1980s, a small seasonal subsistence fishing camp existed at the mouth of the Cripple and Penny Rivers. A tourist mining camp has been established at the mouth of the Cripple River, displacing both subsistence camps. The five-year-average escapement goals for pink salmon are being met, while escapements for chum and coho salmon are considered inadequate.

<u>Subdistrict 1 (Nome)</u>:

**Penny River.** The Penny River is located approximately 10 miles west of Nome; it is accessible via the Blodgett Memorial Highway and a trial along the beach. The river is approximately 13 miles in length and supports pink, chum, and coho salmon runs. Sport fishermen are the primary user group. Escapement for pink salmon is adequate, while chum and coho stocks are depressed; escapements for these species are generally inadequate.

**Snake River.** The Snake River, named in 1898 because of its serpentine-like course by the persons who discovered gold in the area, is formed by junction of Goldbottom Creek and North Fork Snake River. The river flows southwest 15 miles, then southeast five miles to Norton Sound near the west end of the City of Nome. The Glacial Creek Road follows the river. The Snake River drainage was the site of the first major gold discovery in Nome during the late nineteenth century. The area was heavily impacted from mining activities, which played a significant role in damaging salmon spawning and rearing habitat as well as impacting the returns of the different species of salmon. The Snake River's many tributaries are still actively mined today. In 1995, Kawerak Native Corporation, in cooperation with ADF&G began operating a salmon counting tower on the Snake River in an effort to better assess salmon escapements. Escapement for pink salmon are generally considered adequate, while chum and coho salmon escapements are not. The aerial survey escapement goal for chum salmon (i.e., 1,000 adults) has rarely been met. The primary user group of this system is subsistence fishermen, who target pink, chum, and coho salmon. Sport fishermen predominately target coho salmon from this system. ADF&G has targeted the Snake River for chum and coho salmon restoration in recent years. Small ice-free (i.e., winter) tributaries offer opportunities to increase chum salmon populations using instream incubation boxes. Several abandoned mining pits constructed by mining companies offer potential for development into rearing habitat for juvenile coho salmon.

**Nome River.** The Nome River is located approximately three miles east of Nome; it is about 40 miles long and flows in a southerly direction following the Nome-Taylor Highway nearly its entire length before draining into Norton Sound. Prior mining activity on the Nome River and its tributaries as well as road construction have adversely impacted salmon populations over the years. Pink, chum, and coho salmon are the predominant species, with occasional recordings of sockeye and chinook salmon. Since 1993, ADF&G staff have operated a salmon counting Tower on the Nome River in an effort to better assess escapements. Chum salmon stocks are depressed, with escapement goals of 2,000 adults occasionally being met. Fort Davis, a seasonal subsistence camp, has been the focus of subsistence salmon harvests for this watershed for years. Recently, all forms of harvest has been severely curtailed in an attempt to attain adequate escapements. ADF&G has targeted the Nome River for chum salmon restoration.

**Flambeau River.** The Flambeau River is located approximately 10 miles east of Nome and about 15 miles southwest of Solomon; it flows in a southeasterly direction approximately 23 miles before entering Safety Sound. The Flambeau River supports a pink, chum, and coho salmon populations, and previously it had been a major producer of chum salmon harvested in the Subdistrict 1 commercial fishery. Today, the primary users of salmon in Subdistrict 1 are subsistence fishermen. Seasonal subsistence fishing camps are located along Safety Sound. The chum salmon escapement goal of 3,250 adults is not often met, and the stock should be considered depressed.

**Eldorado River.** The Eldorado River is located approximately 10 miles east of Nome and about 15 miles southwest of Solomon. The river flows southeast approximately 30 miles and enters the Flambeau River about 4 miles north of Safety Sound. Pink, chum, chinook, and coho salmon are present in the Eldorado River. The primary user group are subsistence fishermen who predominately target the chum and coho salmon stocks. Seasonal subsistence fishing camps are located along Safety Sound. Escapement goals have not been determined for pink or coho salmon, but escapements are considered adequate for both. The chum salmon escapement goal of 5,250 is not frequently met, and stocks are depressed.

**Bonanza River.** The Bonanza River flows southeast approximately 25 miles before entering Bonanza Channel, an extension of Safety Sound. Pink, chum, sockeye, and coho salmon are present in the system. Escapement goals have not been established for coho, sockeye, and pink salmon, but are generally considered adequate. The escapement goal of 1,500 chum salmon is not being met, and stocks are considered depressed.

**Solomon River**. Solomon River flows west-southwest approximately 22 miles before entering Norton Sound. The main stem of the Solomon River parallels the Nome-Council Highway for about 10 miles. The village of Solomon (i.e., established as a mining camp in 1900 and Dixon Railroad terminus) is located on the west bank of the river, about one mile from Norton Sound. Early mining activity was substantial; at least 13 dredges operated on the Solomon River and its' tributaries. Considerable damage was done to some sections of the river as a result of these activities. Additionally, road construction has resulted redirection of portions of the river that may require stream channelization work for a complete recovery. Major tributaries that support spawning or rearing areas include the East Fork, Big Hurrah, and Shovel Creek. Pink salmon are currently the primary species targeted by subsistence fishermen. Escapement goals for coho salmon have not been established. Chum salmon stocks are severely depressed; the escapement goal of 550 has rarely being met. ADF&G development staff have begun chum salmon restoration work on this system.

Subdistrict 2 (Golovin Bay):

**Fish River**. The Fish River is an important salmon system located in the White Mountain/ Golovin area. It begins in the Bendeleben Mountains and flows approximately 47 miles south to Golovin Lagoon. There are several tributaries (e.g., Fox, Niukluk, Klokerblok, Etchepuk, Pargon, Rathlatulik Rivers and Boston Creek) that form the Fish River system. The Niukluk River and Boston Creek are the two most important salmon tributaries. The village of White Mountain is located about 15 miles from the mouth. Historically, the Fish River was once the largest single chum and pink salmon producer in Norton Sound, and for a time it supported a commercial fishery for chum salmon. In recent years, however, diminished escapements and the subsistence-use priority have severely curtailed the Subdistrict 2 commercial fishery there. Many local residents have subsistence fishing camps along the river. Escapement goals for chum salmon (i.e., 17,500) are generally met and considered adequate, although the runs are somewhat limited. Because the subsistence fishery has highest priority, there is only a limited commercial fishery for chum salmon. Because of the recent trend of declining chum returns to system, the department has conservation concerns there. Coho salmon have contributed to a popular and significant sport fishery there, and small numbers of chinook salmon are also present in this system.

**Niukluk River**. The Niukluk River is a major tributary of the Fish River. The river's headwaters begin about 5 miles northwest of Mount Bendeleben; the river flows southwest approximately eight miles, then southeast 52 miles, passing the village of Council, before entering the Fish River. During the Gold Rush days of the early 1900s, Council had a human population of about 10,000. Pink, chum, and coho salmon are present in this system, along with an occasional chinook salmon. In 1995, ADF&G established a salmon counting tower approximately 10 miles downstream of Council. Subsistence fishermen from the villages of White Mountain and Golovin are the primary harvesters of salmon. The escapement goal for chum salmon at 8,000 fish has normally been met.

**Boston Creek.** Boston Creek, a tributary of the Fish River, has its headwaters in the Bendeleben Mountains. It flows approximately 38 miles southeast to the Fish River. Pink, chum, coho, and chinook salmon are present in this system. The chum salmon escapement goal (i.e., 2,500) has generally been met. The primary user group is subsistence fishermen. Boston Creek is also home to the bulk of the chinook salmon returning to the Fish River system, although chinook escapements have recently shown a decline.

**Paragon River.** The Paragon River is a tributary of the Fish River. The headwaters are in the Bendeleben Mountains with the river flowing in a southeasterly direction approximately 32 miles before entering the Fish River. Populations of pink, chum, coho and king salmon are present.

**Ophir Creek.** Ophir Creek flows approximately 19 miles southwest before entering the Niukluk River and is located about 2 miles northwest of Council. Pink, chum and coho salmon have been reported to inhabit Ophir Creek. Because the Ophir Creek coho stock is heavily impacted by Council residents, local harvests have begun to decline..

Subdistrict 3 (Moses Point):

**Kwiniuk River.** The Kwiniuk River flows northeast approximately 43 miles and then south eight miles to its mouth at Moses Point on Norton Bay. Moses Point is about 10 miles northeast of Elim. Pink, chum, coho, and chinook salmon are present in the Kwiniuk system. Escapements of pink and coho salmon are generally considered adequate, while chum goals have recently not been met. Escapement goals for chinook salmon have not been determined because of the small size of that stock. There is some commercial fishing for coho salmon. The Kwiniuk River is considered depressed. Fisheries managers frequently require commercial and subsistence fishing closures to meet escapement needs.

**Tubutulik River.** The Tubutulik River flows southeast approximately 25 miles to Kwiniuk Inlet at the northwest end of Norton Bay, approximately 15 miles northeast of Elim and 25 miles southwest of Koyuk. A large Eskimo village was once located at the mouth of the Tubutulik River. Today a seasonal camp at Caches is situated on the barrier spit near the river to take advantage of the returning salmon. Escapements of pink and coho salmon are generally considered adequate, while chum salmon escapement goals have not been met. Fisheries managers frequently require commercial and subsistence closures to meet escapement needs. There is some commercial fishing for coho salmon.

**Kwik River.** The Kwik River flows southeast approximately 20 miles before entering Norton Bay. This system is approximately 20 miles northeast of Elim and 15 miles southwest of Koyuk. The Kwik River is home to one of the few runs of fall chum salmon in Norton Sound. These chums spawn in a spring-fed lake about 10 miles from the mouth of the river. A large Eskimo village was once located at the mouth of the Kwik River.

Subdistrict 4 (Norton Bay):

**Koyuk River**. The Koyuk River flows southeast approximately 115 miles where it enters Koyuk Inlet, about 30 miles northwest of Christmas Mountain-Nulato Hills area. The village of Koyuk is located on the west bank of the river, about three miles upriver from Norton Bay. Pink, chum, coho, and chinook salmon are present in the system. The primary salmon producing tributary is the East Fork.

**East Fork Koyuk River**. The East Fork Koyuk River flows southwest approximately 33 miles to the Koyuk River and is located 8 miles southeast of Haycock and about 20 miles northeast of Koyuk. This river once (i.e., 1910-1930) supplied Dime Landing's dog food needs with chum salmon. Pink, chum, and coho salmon are present in the system; they are targeted primarily by subsistence fishermen from the village of Koyuk.

**Ingulutalik River**. The term Inglutalik River means "like a house;" it was named after an adjacent hump-like landmark that in profile looks like a house." The Ingulutalik River heads at Traverse Peak and flows southwest approximately 80 miles to Norton Sound Bay. The mouth is located 10 miles southeast of Koyuk. This river historically supported fish camps. Pink, chum, coho, and chinook salmon are present in the system and targeted primarily by subsistence fishermen. Escapements goals for all salmon species have not been established.

**Ungalik River**. The Ungalik River heads on Traverse Peak and flows southwest 90 miles to Norton Bay at Ungalik. This river has a long history of subsistence use by Athabascans and Inupiaqs. In the early 1900s, active mining sites were located approximately one mile and 10 miles from the mouth. A dredge, which had been operated about 15 miles up this river, was recently shut down. Pink, chum, coho, and chinook salmon are present in the river. In the 1970s and 1980s, Norton Bay fishermen conducted their commercial fishing effort at the mouth of this system; however, since 1988, salmon species have been harvested primarily by subsistence users. The last commercial harvest occurred in 1993. The escapement goal for chum salmon is considered adequate by ADF&G; the escapement goals for pink, coho, and chinook salmon have not yet been established. During a village informational meeting in January 1995, residents of Koyuk indicated concerns over increased beaver activity in some rivers and the interception by trawling fleets in the North Pacific as possible reasons for the decline in salmon in Norton Bay drainages. Koyuk residents have also expressed interest in the use of instream incubation boxes as a means to increase local salmon populations.

Subdistrict 5 (Shaktoolik):

**Shaktoolik River**. The Shaktoolik River flows southwest approximately 95 miles to Shaktoolik Bay; its mouth is located about 22 miles southwest of Christmas Mountain. It is a shallow, fast running river that has a long history of subsistence use. Historically, there was an Inupiaq village located approximately five miles up the river near Rabbit Vail. In the 1930s a few cabins were built along the banks by prospectors and reindeer herders. Currently, fish camps are located from the mouth to 10 miles upriver. Pink, chum, coho, and chinook salmon are present in the river, and Shaktoolik is the only community that targets these resources. ADF&G managers consider escapements for all species to be adequate. Pink salmon are harvested primarily by subsistence users, while chum, coho, and chinook salmon contribute to a significant commercial fishery. There is a small amount of sport use in the upper stretches of the system. The fish mill between Shaktoolik and Unalakleet Rivers, and fishermen in the two communities are able to harvest fish bound for either river. During village informational meetings, residents of Shaktoolik expressed concern for habitat degradation due to some human activities (i.e tree cutting along riverbanks), predation from bears and trout, jet-boat use, and beaver emigration as problems contributing to declines in the number of returning salmon. Local residents have expressed an interest in chum salmon restoration and beaver and predator control.

Subdistrict 6 (Unalakleet):

**Egavik Creek.** Egavik Creek flows southwest approximately 29 miles to Norton Sound; its mouth is located 38 miles southwest of Christmas Mountain and 25 miles southeast of Shaktoolik. During the 1930s a reindeer plant was located at the outlet of the creek, and some its structures are still in use today. Pink, chum, coho, and chinook salmon are present in the creek, although escapement numbers for each species have not yet been established. Only a few chinook salmon return each year, and pink salmon are harvested primarily by subsistence users. Salmon stocks from this river also contribute harvests in the vicinity of the Shaktoolik and Unalakleet Rivers.

**Unalakleet River.** The headwaters of the Unalakleet River are in the Kaltag Mountains. The river flows to approximately 90 miles to its outlet at Norton Sound, just south of Unalakleet. The Unalakleet river drainage system has a long history of subsistence use by upriver Athabascans and coastal Inupiaqs and Yupiks; currently, subsistence fishing is an important activity that occurs at the mouth of the river. All five species of salmon occur in the river, and ADF&G managers consider escapements of pink, chum, coho, and chinook salmon to be adequate. Pink salmon are harvested primarily by subsistence users, while chum, coho, and chinook salmon primarily contribute to the commercial fisheries. Red salmon are occasionally harvested in those fisheries. There is one sport fishing lodge located on the river, and several outfitters utilizing the river are based in Unalakleet. Local residents also maintain cabins on the lower portion of the river. There are several major tributaries of the Unalakleet River, including the South and North Rivers, Chirosky Fork, North Fork Unalakleet River, and Old Woman River.

**South and North Rivers.** The South (i.e., 40 miles long) and North (i.e., 50 miles long) River enter the system from the south and northeast, respectively, about five miles from the outlet of the Unalakleet River. The South River is primarily a chum salmon system, and fish congregate about a mile from its outlet where a spring is located. The lower section of the South River is more like a slough with a muddy bottom and gentle current. ADF&G managers have not yet established escapements for pink, chum, coho, and chinook salmon because the system supports very few salmon overall. North River escapements for pink, chum, coho and king salmon are considered adequate by the department; however, chum salmon numbers are relatively low.

**Chirosky Fork.** The Chirosky Fork flows approximately 50 miles northeast into the Unalakleet River about 15 miles from its outlet. Escapement for pink, chum, and coho salmon have not yet been established by ADF&G managers, and chinook salmon are present, although in very small numbers.

**North Fork Unalakleet River.** The North Fork Unalakleet River is approximately 30 miles long; it enters the Unalakleet River about 25 miles from its outlet. Escapement for pink, chum, coho, and chinook salmon has not yet been established, and numbers of fish are relatively low.

**Old Woman River.** The Old Woman River is 48 miles long, entering the Unalakleet River from the north, about 37 miles from its outlet. Historically, Athabascans inhabited the area. There is one cabin, which is used as a shelter on the Iditarod Trail route, built along the river. ADF&G managers consider escapements for pink, chum, coho, and chinook salmon to be adequate. Local residents attending a village informational meeting stressed the department should focus efforts toward salmon restoration as opposed to enhancement. There was also concern about the possible decline of the coho salmon run.

<u>Southern Norton Sound</u>:

**Kogok River.** The Kogok River flows northwest approximately 35 miles to Norton Sound, and its outlet is about 22 miles southwest of St. Michael. Pink, chum, coho, and chinook salmon are present in this system. The villages of St. Michael and Stebbins primarily target these fish for subsistence use. Beaver dams have prevented salmon access to much of the river, and now salmon inhabit only the lower 10 miles of the system below Nunakogok Fork. There is one permanent subsistence camp on the lower river. Salmon species stock status is unknown, and escapement goals have therefore not been determined by the department.

**Pikmiktalik River.** The Pikmiktalik River flows north approximately 45 miles to Norton Sound; it is located about 22 miles southwest of St. Michael. Pink, chum, coho, and chinook salmon are present in the system, and residents of St. Michael and Stebbins primarily target these fish for subsistence use. There are roughly 10 permanent fish camps on the lower river owned primarily by families from Stebbins and St. Michael, although one cabin is owned by a family from Kotlik. Salmon species stock status is unknown and therefore department staff have not established escapement goals for this system.

**Nunavulnuk River.** The Nunavulnuk (descriptive Eskimo name meaning *river which widens to form a lake*) River flows northwest approximately 30 miles to Big St. Michael Canal, about 11 miles southeast of St. Michael. The *ADF&G Anadromous Water Catalog* indicates the presence of both pink and chum salmon in the system, although the numbers appear to be very low. A 1.5-mile-long lake is located approximately eight miles from the mouth of the river. Local residents indicate there is a small population of red salmon there and that the salmon spawn above the lake in areas that remain ice free in winter. Sheefish are also present in this river and lake. There is an abandoned village and fish camp at the outlet of the lake; there is also a smaller abandoned fish camp at the confluence of the river and canal.

St. Lawrence Island:

**Ikalooksik River/Niyrakpad Lagoon.** The headwaters of the Ikalooksik River, located on the north side of St. Lawrence Island, is on the north slope of Poovookpuk Mountains; this river flows north 10 miles into Niyrakpak Lagoon, which is about 16 miles southeast of Gambell. There are four active fish camps around the lagoon. Pink, chum, coho, sockeye, and chinook salmon are present in the system, and subsistence fishing is the traditional use for these fish.

**Aghnaghak Lagoon.** Aghnaghak (pronounced "Akhnakhak") Lagoon, which refers to two Eskimo women who lost their lives there, is located on the north side of St. Lawrence Island. The lagoon extends northwest five miles from the mouth of Kangik River, 10 miles southeast of Gambell. In addition to the Kangik River, the Aghnuk River also flows north about 10 miles into the lagoon. Residents of Savoonga report that pink, chum, coho, sockeye, and chinook salmon are found in this system. Subsistence fishing has been the traditional use of the resource.

**Moghoweyik River**. The Moghoweyik River flows northwest approximately 12 miles to the Bering Sea, 22 miles south of Gambell. Residents of Savoonga report that pink, chum, chinook and Dolly Varden are present. Subsistence fishing has been the traditional use of the resource.

**Boxer River**. Located on the south side of St. Lawrence Island, the Boxer River flows south approximately seven miles to Boxer Bay, named in 1926 for the vessel *USMS Boxer* which took shelter there during a storm. Residents of Savoonga report that pink salmon are present in the system and that subsistence fishing is the traditional use for these fish.

## CONTINUED IMPLEMENTATION OF THE PLAN

### The Regional Planning Team's Role

Alaska statutes specify three functions of the Regional Planning Team: (1) development of a comprehensive salmon plan, including provisions for both public and private nonprofit hatchery systems (AS 16.10.375); (2) review of private nonprofit hatchery permit applications (AS 16.10.400 [a]); and (3) review of the proposed suspension or revocation of a permit (AS 16.10.430). The remainder of this chapter provides further elaboration on the responsibilities identified above and also a description of the annual updating process.

### Ongoing Planning

Alaska Statute 16.10.375 provides the Norton Sound/Bering Strait RPT with the responsibility for development of a comprehensive salmon plan. Plan development is a constantly evolving process, as opposed to one that is fixed or static. This nature of the planning process gives the RPT a continuing role in salmon rehabilitation and enhancement planning, because it is responsible for relating actual events to the plan and making the plan responsive to new knowledge, ideas, and changing conditions. Opportunities have thus far been presented within a 15-year time-frame. Numerous unknowns surround many of these opportunities, and some will never become actual projects. As projects in the 15-year action plan become implemented or are determined to be infeasible or undesirable, they may be replaced with new projects for the following planning period. The comprehensive plan will be revised as necessary. A procedure for periodic updating of the action plan will allow for revision of certain sections. At times new information and events will require the reevaluation of goals, objectives, area and site-specific strategies/projects, or assumptions used for planning.

### Evaluation Criteria for RPT Review of Proposed Projects

Alaska Statute 16.10.400(a) provides that a project proposal must be at least evaluated in the context of its compatibility with the comprehensive salmon plan by the RPT, as well as criteria established by current regulations and statutes (*see* Appendix B). AS 16.10.400(g) identifies conditions that must be satisfied if permits are to be issued by the Commissioner before the regional comprehensive salmon plan is complete. Part (f) of the same law requires that the commissioner shall classify a stream as suitable for enhancement purposes prior to a permit being issued.

There are numerous anadromous systems in the Norton Sound/Bering Strait region, and the process of evaluating each one to determine whether or not it would be suitable for enhancement is very complicated, time consuming, and expensive. To accomplish a full inventory and classification of all the anadromous streams in this region is beyond the financial and temporal limits of the plan in the short term. Criteria are provided in Appendix B that are consistent with the language and mandate provided in AS 16.10.400(a), (f), (g). In reviewing and making recommendations to the Commissioner on restoration and enhancement project proposals, the

RPT will also consider that criteria in their review. When evaluating project proposals, the Norton Sound/Bering Strait RPT will also consider the following criteria:

1. No detrimental impacts to production or management of existing fisheries or stocks;

2. Overall equity of benefits to wide ranges of user groups; and

3. Cost-effectiveness, scientific credibility, and practicality.

**Updating Process**

The comprehensive salmon plan is designed to be a working document that provides a framework for increasing salmon production for the Norton Sound/Bering Strait region; therefore, it will be updated periodically and a report on regional comprehensive salmon planning progress submitted to the commissioner of ADF&G. To maintain these updates, the RPT will meet at least once a year to discuss (1) reports on current projects; (2) new projects under consideration; and (3) new opportunities that may be investigated as potential future projects. A statement of progress toward achievement of the goals and objectives in the plan and a project status report will be incorporated into the periodic report. Over time, this report will reflect achievement of the goals and objectives of the plan.

# REGIONAL PROFILE

## Physical Environment

> The Bering Strait area is still commonly visualized as a narrow path or trail over which people hustled, in one direction, on their way to take up positions in which they would presently be discovered. . . . In fact, the Bering Land Bridge was an enormous continental area extending nearly 900 miles from its southern extremity, now the eastern Aleutians, to its northern margin in the Arctic Ocean. It was an area that could accommodate many permanent residents, human and animal, and it endured for a longer time than that documented for the entire period of human occupancy in America (Laughlin 1967).

The Norton Sound/Bering Strait region is essentially the southwestern three-fourths of the Seward Peninsula and the coastal drainages as far south as St. Michael. The area is about 26,000 square miles that is bounded on the east by the Nulato Hills, on the south and southwest by Norton Sound, and on the northwest by the Chukchi Sea. It encompasses nearly all types of land features including mountains, highlands, plateaus, coastal plains, and interior basins and valleys. The extensive coastline is characterized by low barrier spits and islands and lagoons. Port Clarence and Golovin Bay provide good anchorage on an otherwise exposed coast. The principal rivers that drain the regions are from north to south the Agiapuk, Kuzitrin, Sinuk, Niukluk, Fish, Koyuk, Kwiniuk, Unealik, Shaktoolik, and the Shaktoolik. The continental divide extends in an east-west direction, dividing the Seward Peninsula into drainages flowing to either the Chukchi Sea or the Bering Sea. Coastal uplands are topped by small mountain ranges; Mount Osborn in the Kigluaik Mountains (also known as the Sawtooths) rises to 4,720 feet. Though not high by Alaska standards, the York, Kigluaik, Bendeleben, and Darby mountains consist of rocks that have withstood erosion before the Pleistocene glacial period. Offshore, the Bering Sea varies from 100 to 200 feet deep, and the major island groups include the Diomedes, King, Sledge, Fairway Rock, Punuk, and the largest one, St. Lawrence (Selkregg 1976).

## Climate

The region's climate reflects a combination of maritime and continental factors. Sea ice usually covers the Bering Sea from late autumn through early spring, and wind-induced ice movement causes ice ridge and hummock formation and convergence of ice floes. In the Bering Sea a discontinuous changing mass of irregular fields, floes, and cakes of ice are intersected by numerous breaks and leads. When the Bering Sea is ice free, usually from late June until November, ocean waters moderate temperatures, humidity increases and clouds frequent the coastline. Once the sea freezes over, however, more extreme continental influences take over, including lower temperatures and clear skies. At Unalakleet, for example, January average temperatures range from minus 5°F to minus 12°F; July average temperatures range from 42°F to 61°F, and extreme temperatures range from minus 50°F to 87°F. Interior portions of the region typically endure more temperature fluctuations and have fewer cloudy days in the summer. Measured seasonally, summer had the most precipitation with more than 33% of the annual total of 10 inches. Winter snowfall reaches 60 inches annually. Winds average 10 to 15 knots year-round, and calm periods occur 5% to 15% of the time at most locations. These persistent strong winds cause an increase in the wind chill, which becomes an important factor in surviving the region's winter environment--in extremes severely limiting wintertime activities. At Wales, for example, the wind chill factor can reach minus 100°F, which causes instant freezing of exposed flesh (Selkregg 1976).

**Vegetation**

Permafrost, which is any earth material that has remained below 32°F from one winter through the next, underlies the region. In the lowlands where water saturates the ground, typified by a multitude of lakes and ponds, wet tundra with its mat-forming grasses and sedges is predominate. Midway up hillsides between coastal wetlands and drier mountainous areas, moist tundra form small hills or tussocks. In higher elevations, low-growing alpine tundra covers the well drained ridges and mountain slopes. Grasses that have adapted to saltwater intrusion thrive in the sandy dunes in the northwestern portion of the region. The white spruce forest of Alaska's interior reaches its northern limit in the Koyuk river valley. Between the tundra and the woodlands grow mixed thickets of willow, alder, and birch.

Moist and wet tundra, the major vegetation types within the region, are particularly common in foothill and lowland areas, respectively. Tundra usually completely covers the ground and is productive during the growing season. The tundra varies from an almost continuous and uniformly developed cotton grass tussock growth to stands devoid of tussocks or often interspersed with small lakes. Tussocks form as the grass clumps grow and die back each year. The soil is commonly saturated, and mosses and lichens grow in the moist channels between tussocks. Plants associated with cotton grasses include shrubs such as dwarf birch, willows, and Labrador tea; herbs like mountain avens, bistort, and saxifrages; and lichens and mosses. Alpine tundra communities occur in mountainous areas and along well-drained ridges. The soil is usually coarse, stony, and dry. Plants with a low growth form are typical of this exposed habitat. Important plants include mountain avens, willows, and heather. Lichens and true mosses are common. Grasses, sedges, and a few herbs are also evident. Associated species include cotton grass, lousewort, and buttercup in the wetter sites and purple mountain saxifrage in drier habitats.

The Upland spruce-hardwood forest is usually found on well-drained soils in valley bottoms and on southerly slopes, rarely occurring more than 300 feet above the valley floor. Most forests of this type in the region are composed primarily of paper birch with scattered stands of white spruce, aspen, balsam poplar, and black spruce and are primarily found in the foothills near Elim and as far west as Council. These forests also occupy most river valleys and southwesterly slopes of the Nulato Hills. The bottomland spruce-poplar forest is common on well-drained soils on river terraces, riverbanks, and recently abandoned stream channels. This system is generally found below 1,000 feet and grows best on south-facing slopes, and it is found in the lower reaches of the Koyuk River. Typical understory vegetation includes young trees, willows, roses, berries, ferns, bluejoint, fireweed, and various mosses (Selkregg 1976).

**Fish and Wildlife Resources**

Marine and Freshwater Fish:

The oceanography of the Bering Sea is dominated by northward-flowing current and characterized as having moderate standing crops of zooplankton. Small populations of both tanner and red king crabs and several species of shrimp are found in Norton Sound. Bottom fish distribution is determined by temperature and salinity. Yellowfin sole occupies shallow warm waters, while the Bering flounder inhabits deep cold waters. Generally, bottom fish in this region are sparsely distributed and smaller than those in areas further south. Predominant bottom fish in Norton Sound are members of the flatfish family, including rock and yellowfin sole, tomcod, saffron cod, and several species of sculpins. In Norton Sound, smelt and herring are also common. Anadromous fish include all five species of Pacific salmon (Table 3); however, pink, chum, and coho salmon are significantly more abundant than sockeye and chinook salmon. The chinook salmon run to the Unalakleet River is comparatively strong, and spawning populations of sockeye salmon occur at Glacial and Salmon Lakes. Arctic char, inconnu, several species of whitefish, northern pike, burbot, lake trout, and grayling are also common freshwater species in the region. For a list of other species indigenous to the region, please see Table 4 (Selkregg 1976).

Marine Mammals:

The Bering Sea abounds with marine mammals. Walrus, seals, whales, and polar bears occur regularly in the region, although polar bears do not venture too far beyond the northwestern part of the region (e.g., Wales). Fay (1974) categorized polar bear, walrus, seals, and beluga and bowhead whales as maintaining regular contact with sea ice; he categorized killer, gray, humpback, fin, and minke whales and the harbor porpoise as having some contact with ice. Bearded seals are most abundant in the region during their spring and fall migrations. Ringed seals are the most numerous in the region when landfast ice is present. Spotted seals are the most common in the region during the open-water season, frequenting bays and rivers. They winter on the edge of the ice in the Bering Sea. Beluga whales winter in the south Bering Sea, Bowhead whales are confined to the edge of the ice pack, gray whales migrate northward after the ice has retreated, and humpback whales prefer ice-free waters.

Terrestrial Mammals: Wintering caribou of the Western Arctic Herd occasionally range into the eastern and southern part of the region, although most range suitable for caribou is also used by domestic reindeer. Grizzly bears occur throughout region, except St. Lawrence Island; their greatest abundance is where salmon and berries are plentiful. They are concentrated along stream valleys in high brush and timber, and in winter they occupy the American, Kuzitrin, Koyuk, and other river drainages. Muskoxen were transplanted in 1970 from Nunivak Island

Table 4. Life cycles of salmon species in the Norton Sound/Bering Strait drainages.

| Lifestage | Activity | Chinook | Coho | Sockeye | Pink | Chum |
|---|---|---|---|---|---|---|
| Egg | Incubation location | clean gravel riffle | small streams; clean gravel | streams near lakes; springs | clean gravel, intertidal,lower stream | intertidal lower stream |
| Alevin | Hatching (remain in gravel) | midwinter | late winter | mid/late winter | midwinter | midwinter |
| | Emergence (swim-up) | April-May | May-June | April-May | April-May to estuary | April-May to estuary |
| Fry | Rearing location | stream, river edges | lakes, streams, ponds, sloughs | mostly lakes; some sloughs | nearshore, marine | nearshore, marine |
| | Time in fresh water | 1 year | 1-2 years | 1-2 years | short-term | short-term |
| | Food | aquatic insects | aquatic insects | plankton | plankton | plankton |
| Smolt | Migration | May-June | June-July | May-June | May-June (as fry) | May-June (as fry) |
| | Size | 3-4 inches | 4 (+) inches | 3 (+) inches | 1.5 inches | 1.5-2.0 inches |
| | Age | 1 year | 2 years | 1 or 2 years | 1-3 weeks | 1-6 weeks |
| Ocean rearing & development | Food | fish/other | fish/other | large plankton | fish/other | fish/other |
| | Growth | rapid | rapid | rapid | rapid | rapid |
| | Time in ocean | 1-5 years | 1 year | 3 years | 1 year | 2-4 years |
| Homing Migration | Timing | June-July | August-October | June-September | July-August | July-August |
| | Size | 15-70+ lb | 10-15+ lb | 6-15 lb | 4-6 lb | 10-20 lb |
| Spawning | Timing | July-August | September-October | June-August | July-August | July August |
| | Location | streams, rivers | streams | streams near lakes, lake upwelling, sloughs | intertidal; lower stream | intertidal; lower streams, sloughs |

Table 5. List of common and scientific names of finfish species of the Norton Sound region.

| | |
|---|---|
| Arctic char | Salvelinus alpinus |
| Arctic cod | Boreogadus saida |
| Arctic flounder | Lipsetta glacialis |
| Arctic grayling | Thymallus arcticus |
| Alaska plaice | Pleuronectes quadrituberculatus |
| Burbot | Lota lota |
| Bering cisco | Coregonus laurettae |
| Bering poacher | Ocella dodecaedria |
| Bering wolffish | Anarhicas orientalis |
| Blackfish | Dallia pectoralis |
| Boreal smelt (rainbow-toothed) | Osmerus mordax |
| Broad whitefish | Coregonus nasus |
| Capelin | Mallotus villosus |
| Dolly Varden | Salvelinus malma |
| Pond smelt | Hypomisus olidus |
| Humpback whitefish | Coregonus pidschian |
| Inconnu (sheefish) | Stenodus leucichthys |
| Least cisco | Coregonus sardinella |
| Longhead dab | Liranda proboscidea |
| Ringtail snailfish | Liparis rutteri |
| Northern pike | Esox lucius |
| Longnose sucker | Catostomus catostomus |
| Pricklebacks | Stichaeidae |
| Pacific herring | Clupea harengus pallasi |
| Rock flounder | Lepidosetta bilineata |
| Rock greenling (terpug) | Hexagrammus lagocephalus |
| Round whitefish | Prosopium cylindraceum |
| Sculpins | Cottidae |
| Pink salmon | Oncorhynchus gorbuscha |
| Chum salmon | Oncorhynchus keta |
| Coho salmon | Oncorhynchus kisutch |
| Sockeye salmon | Oncorhynchus nerka |
| Chinook salmon | Oncorhynchus tshawytscha |
| Saffron cod | Eleginus gracilis |
| Starry flounder | Platichthys stellatus |
| Sandlance | Amrodytes hexapterus |
| Sturgeon poacher | Agonus acipenserinus |
| Threespine stickleback | Gasterocteus aculeatus |
| Ninespine stickleback | Pungitius pungitius |
| Tubenose poacher | Pallasina barbata aix |
| Whitespotted greenling | Hexagrammus stelleri |
| Yellowfin sole | Limanda aspera |

to the Feather River near Nome. These animals moved from the original site and now make use of two widely separated ranges--one covering a large portion of the tip of the Seward Peninsula and the other on the north side of Norton Bay. These animals range widely and occur at scattered locations. Other common species in the subregion include shrew, tundra and snowshoe hare, brown lemming, Alaska vole, wolf, marten, red fox, black bear, Arctic ground squirrel, short-tailed weasel, and wolverine. Beaver, muskrat, mink, and river otters are commonly found in the freshwater habitats of the region, and beavers have been steadily expanding their territory west (Rennick 1987).

Birds:

Gyrfalcons and peregrine falcons, rough-legged hawks, golden eagles, snowy and short-eared owls are found throughout the region. Boreal owls, hawk owls, and goshawks are found in forest habitats. Sharp-tailed and spruce grouse occur in forested areas, while willow and rock ptarmigan and more than 30 songbird species occur throughout the region (Selkregg 1976). Wetland habitats (i.e., wet or moist tundra, lagoons, and coastal ponds) are important to many species of nesting and migrating waterfowl and shorebirds, and they are abundantly present throughout the region. Norton Sound is used extensively for resting and feeding by waterfowl and shorebirds migrating to and from the Arctic, and swans, Canada geese, numerous ducks, sandhill cranes, loons, and shorebirds nest in the protected waters of the region. Large numbers of birds inhabit the region, including black-footed albatross, the slender-billed shearwater, northern fulmar, fork-tailed storm-petrel, phalaropes, and jaegers. St. Lawrence Island supports six major colonies of such species as auklets, murres, puffins, guillemots, gulls, and cormorants, and Murie (1936) recorded 20 species of seabirds there. A colony on Little Diomede Island supports more than 100,000 birds of 22 species--16 of which nest there. King, Sledge Egg, and Besboro Islands and Bluff, Rocky Point, Cape Darby, and Cape Denbigh also support major seabird colonies; the one at King Island may contain more than one million birds.

**Human Environment**

History:

The Seward Peninsula is a modern-day remnant of Beringia (i.e., Bering Land Bridge) that off and on has linked North America with Asia. Most scientists agree that the prehistoric people who populated the Americas crossed over that bridge (Rennick 1987). Chronologically, the various peoples/cultures that settled the Norton Sound region were as follows: American Paleo-Arctic tradition (8000 to 6000 B.C.), Northern Archaic culture (3000 B.C.), Arctic Small-Tool tradition (1000 B.C.), Ipiutak tradition (500 A.D.), Northern Maritime tradition (800 A.D.), Inupiat Eskimos (1200 A.D.), and Euro-Americans (1700 A.D.)

There is some evidence that the Russians first sailed through the Bering Strait and explored northwest Alaska and Arctic coasts in the 1640s, although it was Vitus Bering who was given credit for the European discovery of St. Lawrence Island and the Diomedes in the early 1700s, although European goods had been earlier introduced into the region through Siberia by way of the people of the Diomedes, King Island and Cape Prince of Wales. (Selkregg 1976). At the time of European discovery, settlement patterns in the region were coastal and riverine, and communities were located and grew in size in direct relationship to the availability of food and shelter. Most communities were occupied all winter, but only periodically in the summer. Permanent communities were distinguished from seasonal fishing, sealing, or berrying camps by the presence of community houses (i.e, kazgis).

As in all early Alaska Eskimo societies, the region's people depended on the biotic resources of the environment for their survival. Because the people of the Norton Sound/Bering Strait region were able to survive extreme environmental conditions, they developed a flexible culture that could adjust to almost any environment that was compatible with their technology, and according to Birket-Smith (1971) it was the sea rather than the land that conditioned the life of Eskimos--that their food, clothing, implements, and to a great extent their fuel came from the sea. The hunters of the Bering Strait were experts on weather and ice in the region; those who were knowledgeable about sea currents and wind literally jumped aboard ice cakes for trips to either the mainland or islands (Selkregg 1976).

For several hundred years after the initial contact by Euro-Americans during the mid-seventeenth century, the economic opportunities provided by marine mammal and terrestrial furbearer resources of the region caused an introduction of international commerce, resulting in subsequent changes in trading patterns in the area and an increased need for salmon harvests by local residents (Thomas 1982). The establishment of missions, discovery of gold at Cape Nome in 1898 and subsequent mining operations, and military build-up during World War II were all watershed events causing dramatically progressive changes in the region in terms of communication, medical facilities, transportation, population increases, housing, and availability of goods and services. Residents of outlying areas sometimes abandoned established smaller villages (e.g., King Island) to move to communities offering better employment opportunities and a larger variety of goods and services.

**Community Profiles**

Fifteen communities make up the population centers in the region (Table 5, Figure 9). In 1990 the U.S. Census Bureau accounted for approximately 7,800 residents in the region. The largest community in the region is Nome (population = 3,618), followed by Unalakleet (population = 730). With the exception of Nome, the region's population is predominately Eskimo, although many residents also have Athabaskan, Russian, and European forbearers.

<u>Islands-Bering Strait Subregion:</u>

**Gambell.** Gambell is located on the northwest cape of St. Lawrence Island, 200 miles southwest of Nome. The community is 36 miles from the Chukotsk Peninsula, Siberia. St. Lawrence Island has been inhabited intermittently for as long as 10,000 years. There was little contact with the outside world until European traders began to frequent the area. In the 18th and 19th centuries, over 4,000 people inhabited the island in 35 villages. Famine decimated the population in the 1880s. In 1891, President Theodore Roosevelt established the island as a

Table 6. U.S. Census Bureau and Alaska Department of Labor population counts for communities in the Norton Sound/Bering Strait Region, 1990 and 1993, respectively.

| SUBREGION | COMMUNITY | 1990 U.S. CENSUS | 1993 ESTIMATE |
|---|---|---|---|
| **Islands-Bering Strait** | | | |
| | Gambell | 525 | 562 |
| | Savoonga | 519 | 556 |
| | Wales | 161 | 147 |
| | Diomede | 178 | 168 |
| **Northwest Norton Sound** | | | |
| | Brevig Mission | 198 | 243 |
| | Teller | 232 | 264 |
| | Nome | 3,500 | 3,618 |
| **Northeast Norton Sound** | | | |
| | White Mountain | 180 | 180 |
| | Golovin | 127 | 152 |
| | Elim | 264 | 278 |
| **Eastern Norton Sound** | | | |
| | Koyuk | 231 | 281 |
| | Shaktoolik | 178 | 195 |
| | Unalakleet | 714 | 730 |
| **Southern Norton Sound** | | | |
| | St. Michael | 295 | 298 |
| | Stebbins | 400 | 453 |
| **Balance of Nome Census Area** | | 90 | 63 |
| **Total** | | **7,792** | **8,188** |

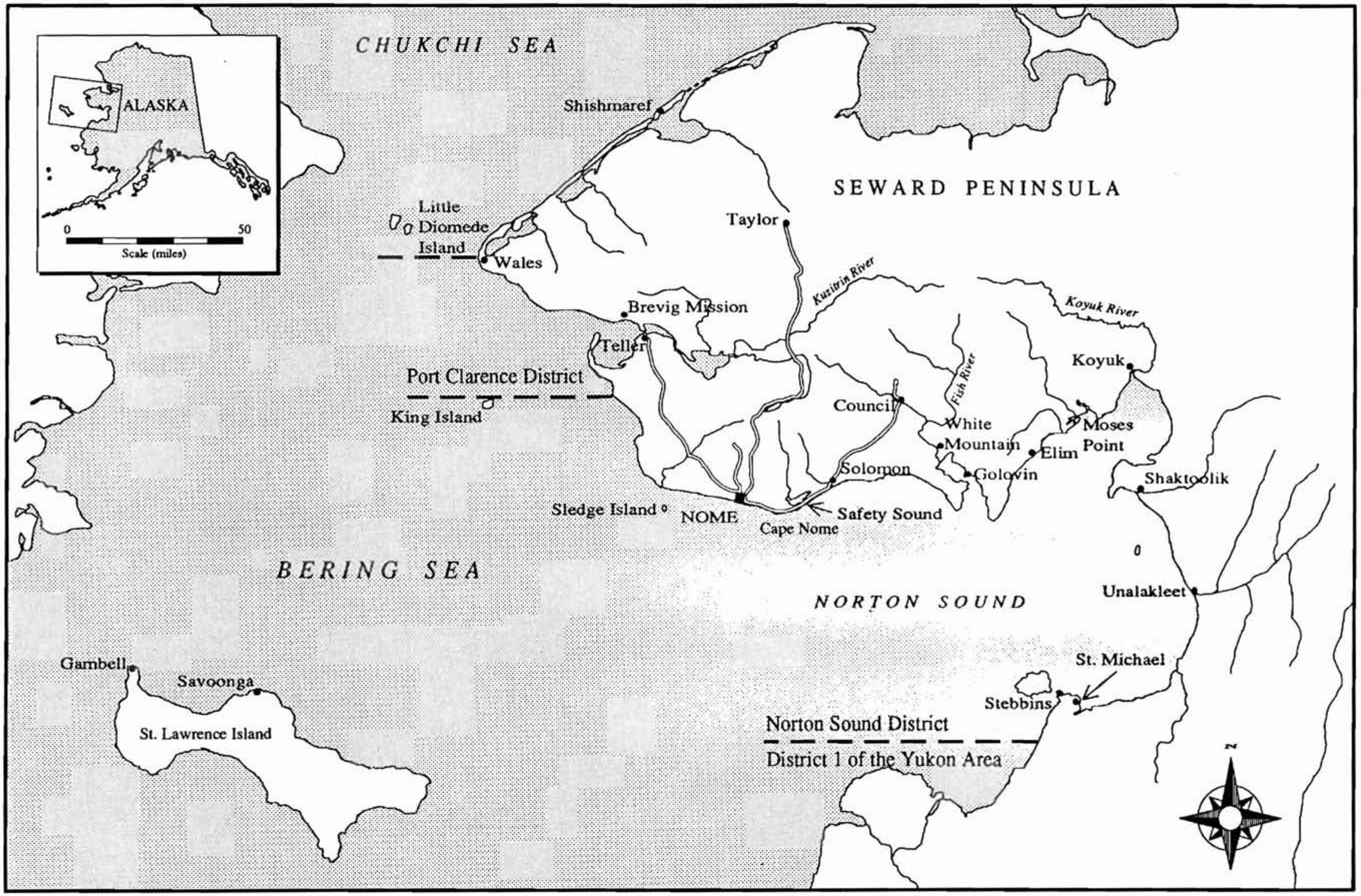



Fig. 9. Natural features and named places on southern Seward Peninsula and in northern Norton Sound, including the Norton Sound and Port Clarence Districts.

reindeer reserve. Residents of St. Lawrence Island are nearly all bilingual. During the 1930s, several residents of Gambell moved to Savoonga to establish a permanent settlement there.

The isolation of Gambell has helped Yupik Eskimo to maintain their traditional culture, their language, and their subsistence way of life, which is based on marine mammals. Walrus hide boots are still in use during hunts. In 1990 the population was listed as 525, although later estimates by the Department of Labor indicated an increase to 562 (Table 6). The city government of Gambell was incorporated in 1963. Native residents of Gambell are shareholders in the Gambell Native Corporation. The organization was incorporated in accordance with the terms of the Alaska Native Claims Settlement Act (ANCSA) of 1971. Gambell's city government functions under the authority of a mayor elected from the seven-member city council. For nonmunicipal programs and services, Gambell's Native population is also represented by a seven-member Indian Reorganization Act (IRA) council.

The economy of Gambell is largely based upon subsistence harvests from the sea: seal, walrus, fish, and beluga whale. Foxes are trapped as secondary sources of cash income. Some reindeer roam free on the island, but most harvesting of them occurs nearer Savoonga. Ivory carving and sale of archaeological artifacts are popular sources of income. Limited tourism by bird-watchers is provided by the abundant number of seabird colonies. The median family income in 1990 was $17,188. Employment occurs in the following areas: 3% services; 3% reindeer herding; 3% health care; 5% ivory carving and other crafts; 5% local store, shop, restaurant, bed and breakfast; 11% other; 16% construction; 16% local, state, or federal government (including schools); and 30% did not respond to questionnaire (NSEDC 1992).

Gambell's isolated location on an island with no seaport results in heavy dependence upon air transportation. Regularly scheduled and charter flights from Nome are available. Major airport improvements were completed in 1995. Lighterage services bring freight from Nome and Shishmaref. Gambell has a cool, moist maritime climate with some continental characteristics in the winter, when much of the Bering Sea freezes. Winds and fog are common, and precipitation occurs 300 days per year. Average summer temperatures range from 34°F to 48°F, while average winter temperatures range from minus 2°F to 10°F. Extreme winds with relatively mild temperatures are typical for St. Lawrence Island.

**Savoonga.** The community is located on the northern coast of St. Lawrence Island, 38 miles from Gambell on Northwest Cape and 164 miles west of Nome. The community is situated on a bluff above the Bering Sea, and the land to the south is hilly. Atuk Mountain rises to a height of 2,207 feet only eight miles to the south. St. Lawrence Island has been inhabited for several thousand years, and the island had a population of about 4,000 by the 19th century. Natives had little contact with the rest of the world until European traders began to frequent the area. A tragic famine occurred on the island in 1880, reducing the population to 500. In 1900 a herd of reindeer were moved to the island, but by 1917 the herd had grown large enough to warrant establishing the community of Savoonga, where grazing lands were better.

Savoonga is a traditional Eskimo village with a subsistence way of life. In 1990 the U.S. Census Bureau counted 519 residents in Savoonga; in 1993 the Alaska Department of Labor population estimate was 556 (Table 6). St. Lawrence Island is unique because Native residents elected to take control of their traditional lands under ANCSA, rather than accept the optional cash settlement that resulted in obtaining surface rights only. The island is jointly owned by the communities of Savoonga and Gambell. Native residents of Savoonga are shareholders in the Savoonga Native Corporation, which was incorporated within the terms of ANCSA. The city government functions under the authority of a mayor elected from the seven-member city council. For nonmunicipal programs and services, the local Native population is represented by an eight-member IRA council.

The economy of Savoonga is largely based upon subsistence hunting and fishing as well as some cash income. Residents hunt walrus and whales in the spring and fall. During the summer they fish, hut birds, gather eggs, and harvest various seafoods, greens, blackberries, salmonberries, and cranberries. Seal, fish, and crab are harvested throughout the winter. The median family income in 1990 was $12,411. Employment occurs in the following areas: 2% construction; 11% local, state, or federal government (including schools); 3% local store; shop, restaurant; bed and breakfast; 3% other services; 19% other; and 46% did not respond to the questionnaire (NSEDC 1992).

Savoonga's isolated location on an island with no seaport and iced-in conditions during the winter causes dependence on air transportation. Regular air service is available from Nome and Unalakleet. Because there is no docking facility, supplies must be lightered from Kotzebue to Shismaref and off-loaded on the beach. Savoonga has a subarctic maritime climate with some continental influences during the winter. Summer temperatures range from 40°F to 51°F, and winter temperatures range from minus 7°F to 11°F. Temperatures below minus 20°F are unusual. Average precipitation is 16 inches annually, with 80 inches of snowfall.

**King Island.** Located in the Bering Sea forty miles west of Cape Douglas off the Seward Peninsula, King Island is primarily precipitous rock that is 700 feet high and one mile long. King Island was historically occupied by Eskimos who called themselves "Aseuluk." Captain Cook named the island for a member of his crew, Lieutenant James King, in 1778, although the Eskimo name was "Ukiwuk." Historically, the village of King Island was occupied during the winter by about 200 people who lived in walrus skin swellings tied to the face of the cliffs; these people were famous for hunting and ivory carving abilities. The community members subsisted on walrus, seal, birds, berries, and plants common to the island. Every summer the entire population would travel to the mainland by kayak and umiak for a few months. When Nome was founded near the turn of the century, the King Islanders camped near the town each summer to sell their ivory carvings. In 1937 there were 190 residents, 45 houses, a Catholic church, and a school in the village. Beginning in the 1950s fewer and fewer residents returned to the island each fall. According to the U.S. Census count, in 1960 only 49 residents occupied the village of King Island, and after 1970 no one continued to live year round there. Instead, the community had effectively reestablished itself in Nome, although some people use the traditional village as a summer fish camp. The King Island Village Corporation has approximately 200 shareholders and owns several businesses.

**Wales.** Wales is located on Cape Prince of Wales, at the western tip of the Seward Peninsula, 111 miles northwest of Nome. A burial mound of the Birnirk culture (500 A.D. to 900A.D.) was discovered near Wales and is now a national landmark. In 1827 local Natives were visited by the Russian Navy, and in 1894 a reindeer station was organized. Wales has been a major whaling center, and prior to the influenza epidemic of 1918, it was the region's largest and most prosperous village with more than 500 residents. Wales has a strong traditional Eskimo whaling culture. Ancient songs, dances, and customs are still practiced. In the summer, Little Diomede residents travel between the two villages in traditional skin boats. In 1990 the U.S. Census Bureau accounted for 161 residents of Wales; in 1993 the Alaska Department of Labor population estimate was 147 (Table ).

Native residents of Wales are shareholders in the Wales Native Corporation. The city government functions under the authority of a mayor elected from a six-member council. The Native population is also represented by a five-member IRA council. The economy of Wales is based on subsistence hunting and fishing, trapping, Native arts and crafts, and mining. A private reindeer herd is managed out of Wales, and local residents are employed during the harvest. In 1990 the median family income in Wales was $19,063 (Walters 1994). Employment occurs in the following areas: 4% other services, 4% health care, 4% ivory carving and other arts and crafts, 9% construction, 13% local, state, or federal government (including schools), 26% other, and 39% did not respond to questionnaire (NSEDC 1992).

Wales is accessed by air and sea only; there is a gravel airstrip, and ice on the Bering Strait is frequently used by planes in the winter. Scheduled and charter flights are available. A cargo ship delivers goods from Nome, which are lightered one half mile to shore. Skin boats are still a popular method of sea travel, and snowmobiles are used during the winter.

Wales has a maritime climate when the Bering Strait is ice-free, usually June through November. The freezing of the strait and of the Bering and Chukchi Seas causes an abrupt change to a cold continental climate. Average summer temperatures range from 40°F to 50°F; winter temperatures range from minus 10°F to 6°F. Winter is cold and windy with an average of 35 inches of snowfall; annual precipitation recorded in Wales is 10 inches. Frequent fog and snow blizzards limit access to the community.

**Diomede.** Diomede is located on the west coast of Little Diomede Island in the Bering Straits, 135 and 80 miles northwest of Nome and Teller, respectively. The international boundary between the U.S. and Russia lies between Big and Little Diomede Islands, which are only 2.5 miles apart. Early Eskimos on both islands were an advanced culture that practiced elaborate whale-hunting ceremonies. They traded with both continents. When the "Iron Curtain" was formed following World War II, Big Diomede became a Soviet military base, and all Native residents were moved to mainland Russia. Diomede currently is a traditional Ingalikmiut Eskimo village with a subsistence way of life that is dependent on sea mammals, cod, crab, and birds. Villagers depend almost entirely upon a subsistence economy for their livelihood. Seasonal mining, construction and commercial fishing have recently been on the decline. The 1990 and 1993 population estimates for Diomede were 178 and 168, respectively (Table 6).

Native residents of Diomede are shareholders in the Inalik Native Corporation. The city government functions under the authority of a mayor elected from a seven-member council; the Native population is also represented by a five-member IRA council. The median family income in 1990 was $16,250. Employment occurs in the following areas: 4% construction; 4% health care; 8% other; 8% local store, shop, restaurant, or bed and breakfast; 16% local, state, or federal government (including schools); 32% ivory carving or other arts and crafts; and 28% did not respond to the questionnaire (NSEDC 1992).

Because of the isolation and environmental conditions, accessibility is restricted to airplanes in the winter and boats in the summer. Because there is no airstrip, planes must land on an ice strip in winter, and few float-plane pilots attempt to land on the rough often foggy open sea during the summer, although regular flights are scheduled from Nome, weather permitting. There is also no dock. Skin boats are still a common method of travelling to Wales, 28 miles across open water. Summer temperatures range from 40°F to 50°F; winter temperatures range from minus 10°F to 6°F. Annual precipitation is 10 inches, and the average annual snowfall is 35 inches.

<u>Northwestern Norton Sound Subregion:</u>

**Brevig Mission.** Brevig Mission is located at the mouth of Shelman Creek on the north shore of Port Clarence on the Seward Peninsula. It is five miles northwest of Teller and 65 miles northwest of Nome. It was originally the Teller reindeer station that was established in 1892 by the U.S. government. As herding declined, the Norwegian Lutheran mission became dominant, and the settlement was known as Teller Mission. The Kauwerak Eskimos in this area lived in migratory communities, pursing a life of hunting, trapping, and fishing; these people also engaged in fur trading ventures with the residents of Siberia, Diomede, and King Island. Reindeer was the economic base of the community until 1974. While Brevig Mission was originally a non-Native settlement, the population is now predominantly Eskimo who generally pursue a hunting and fishing subsistence way of life. The U.S. Census Bureau population count in 1990 was 198, while the Alaska Department of Labor population estimate in 1993 was 243 (Table 6).

The primary employment is with the city and school district. Year-round jobs are scarce, unemployment is high, and seasonal jobs in mining are becoming limited because of a depressed minerals markets. Arts and crafts provide some cash income. The median family income in 1990 was $18,333. Employment occurs in the following areas: 3% construction; 3% health care; 3% local store, shop, restaurant, bed and breakfast; 3% fishing; 3% airlines; 21% other; 16% ivory carving, art, or crafts; 18% local, state or federal government (including schools), and 30% did not respond to the questionnaire (NSEDC 1992). Brevig Mission has a maritime climate with continental influences when the Bering Sea freezes. Summer temperatures average

44°F to 57°F; winter temperatures average minus 9°F to 8°F. Annual precipitation is 11.5 inches, with an average annual snowfall of 50 inches. The community is very exposed to northerly winds.

**Teller.** Teller is located on the Seward Peninsula, on a spit between Port Clarence and Grantley Harbor. It is 72 miles northwest of Nome. The permanent settlement was established in 1900, following the Bluestone Placer discovery 15 miles away. During the boom years, Teller had a population of 5,000 and was a major regional trading center. In 1926, bad weather caused the "Norge"--a Norwegian dirigible on the first transpolar flight from Europe to North America--to land at Teller, rather than at Nome. Teller has evolved into traditional Eskimo village with a subsistence way of life. The local economy is based on subsistence food harvests supplemented by part-time wage earnings. In 1990 the U.S. Census Bureau counted 232 people in Teller, while the 1993 Department of Labor population estimate is 264 (Table 6). There is a herd of over 1,000 reindeer in the area, and the annual round-up provides meat and cash; over one third of the households produce crafts or art work for sale. The median family income in 1990 was $16,750. Employment occurs in the following areas: 2% local store, shop, restaurant, or bed and breakfast; 2% ivory carving or other crafts; 2% fishing; 2% reindeer work; 4% health care; 20% other; 11% construction; 20% local, state, or federal government (including schools); and 33% did not respond to the questionnaire (NSEDC 1992).

Teller has a road link to Nome from May to September, and it is easily accessible by sea and air. There is a gravel runway and regularly scheduled flights from Nome; however, there is no dock and goods are lightered from Nome and off-loaded on the beach. Port Clarence is a natural harbor and is considered a deep-water port. The climate is maritime when the Bering Sea is ice-free, usually from early June to mid-November. The freezing of the sea and Port Clarence causes a change to a more continental climate with less precipitation and colder temperatures. Annual precipitation is 11.5 inches, with an average of 50 inches of snowfall. Average summer temperatures range from 44°F to 57°F; winter temperatures range from minus 9°F to 8°F.

**Nome.** The largest community in the region (1990 U.S. Census Bureau population of 3,618; Table 6) is located about 500 miles north of Anchorage near Cape Nome on the Seward Peninsula; it is 96 miles west of Elim and 148 miles from Unalakleet. Historically, Malemiut, Kauweramiut, and Unalikmiut Eskimos have occupied the Seward Peninsula with a well developed culture adapted to the environment; however, the discovery of gold at nearby Council in 1897 and on the sandy beaches of Norton Sound in 1900 brought thousands of prospectors to Nome, creating a boom town. The gradual depletion of gold, a major influenza epidemic in 1918, the Great Depression, and World War II each affected the area's population. The population of Nome is about 50% Alaska Native, primarily Eskimo. Former residents of King Island, which is only used seasonally, now reside in Nome.

Nome is a first-class city, and is governed by a six-member city council and a mayor, both elected by the people. The Sitnasuak Native Corporation was incorporated into ANCSA by the Native residents of Nome; there is also an IRA council and the Nome Eskimo Community with a seven-member council that governs nonmunicipal programs and services. Nome is the center of the Bering Strait/Seward Peninsula region, and government service provide much of its employment. While the Department of Labor estimated the 1993 Nome population at 3,618 (Table 6), the City of Nome estimated its population in 1992 to be 4,559 (Linda Conley, personal communication). The median family income in 1990 was $49,491 (U.S. Census Bureau 1990). Employment occurs in the following areas: 1% fishing; 1% ivory carving or other crafts; 1% reindeer herding; 3% mining; 4% construction; 6% health care; 6% local store, shop, restaurant or bed and breakfast; 22% other; 22% local, state, or federal government (including schools); and 37% did not respond to the questionnaire (NSEDC 1992).

Regularly scheduled jet flights are available, as well as charter and helicopter services. A port and berthing facility accommodates vessels up to 14 feet of draft. Lighterage services distribute cargo to other communities in the area. Local roads lead to Teller, Council, and the Kougarok River. Winter temperatures range from minus 3°F to 11°F, while summer temperatures typically range from 44°F to 65°F. The average annual precipitation is 18 inches.

**Solomon.** This community is located thirty miles east of Nome on the Seward Peninsula and was originally settled by Eskimos of the Fish River Tribe. It became a mining camp at the height of the Nome gold rush. Only one family lives there year round, and it is a subsistence-use area for Nome residents. Solomon residents depend almost entirely upon subsistence hunting and fishing for their livelihood, although there are a limited number of seasonal jobs in Nome and some mining still occurs in the area. Solomon is located on the Nome/Council road. There are two airstrips in the area, but neither is well maintained, although charter and regularly scheduled flights are available in Nome. Snowmachines and dog sleds are important forms of transportation during the winter. The local climate is both continental and maritime; summers are short, wet, and mild while winters are cold and windy; temperatures range between minus 30°F and 56°F.

<u>Northeastern Norton Sound Subregion:</u>

**White Mountain.** White Mountain is located on the west bank of the Fish River near the head of Golovin Lagoon on the Seward Peninsula. It is 15 miles northwest of Golovin, 33 miles east of Solomon, and 80 miles east of Nome. Historically, White Mountain is the site of an Eskimo fish camp, where fish from the Fish and Niukluk Rivers supported the Native populations. The community grew after the influx of prospectors during the gold rush of 1900. The first structure was a warehouse built by a miner to store supplies for his claim in the Council District. Later, a government orphanage was built there, and in 1926 it was converted to an industrial school. The local economy is based both on wages and subsistence activities, with residents spending much of the summer at fish camps.

Native residents of White Mountain are shareholders in the White Mountain Native Corporation. the city government function under the authority of a mayor elected from the five-member city council. The Native population is represented by a five-member IRA council. The population count in 1990 was 180 (Table 6), and the median family income was determined to be $15,000

(U.S. Census Bureau). Employment occurs in the following areas: 3% fishing; 5% construction; 8% health care; 3% local store, shop, restaurant or bed and breakfast; 21% other; 23% local, state, or federal government (including schools); and 34% did not respond to the questionnaire (NSEDC 1992).

Access to White Mountain is by air and sea; there are no roads. Scheduled flights are available daily from Nome. Major improvements have recently been made to the airport, and the Fish River is used as a landing site for float planes during ice-free seasons. There is no dock, and supplies are lightered from Nome and off-loaded on the beach; cargo also arrives annually from Seattle. White Mountain has a transitional climate with less extreme seasonal and daily temperatures. Continental influences prevail in the winter. Average summer temperatures range from 41°F to 61°F, while winter temperatures range from minus 7°F to 15°F. Annual precipitation is 15 inches; and average of 58 inches of snow fall during the winter..

**Golovin.** Golovin is located on a point of land between Golovin Bay and Golovin Lagoon on the Seward Peninsula; it is 70 miles east of Nome and 42 miles east of Solomon. The Eskimo village of "Chinik," which is located at the site of Golovin, was initially settled by Kauweramiut Eskimos who later mixed with the Unaligmiuts. Golovin became a supply point for the Council gold fields, and in 1887 the Mission Covenant of Sweden established a church and school there. Reindeer herding was an integral part of the mission during the early 1900s.

The Golovin economy is based on subsistence activities, reindeer herding, fish processing, and commercial fishing. Salmon fisheries and reindeer herding offer further potential for cash income to augment subsistence food harvests. Native residents of Golovin are shareholders in the Golovin Native Corporation. The city government functions under the authority of a mayor elected form a seven-member city council. For nonmunicipal programs and services, Native residents of Golovin are represented by a seven-member combined IRA and traditional council. In 1990 the population was 127, and the median family income was $17,500 (U.S. Census Bureau). The Department of Labor estimated the 1990 population to be 152 (Table 6). Sources of employment occur in the following areas: 12% fishing; 18% construction; 24% other; 12% local, state, or federal government (including schools); and 35% did not respond to the questionnaire (NSEDC 1992).

Because there are no roads connecting the city with other areas, access to Golovin is limited to air and sea. both scheduled and chartered flights are available from Nome. The runway has recently been lengthened; however there is no dock, and supplies are lightered from Nome and off-loaded on the beach. A cargo ship brings supplies once each summer. Marine climatic influences prevail during the summer when the sea is free of ice. Summer temperatures range from 40°F to 60°F; winter temperatures range from minus 2°F to 19°F. The average precipitation is 10 inches; an average of 38 inches of snow falls annually.

**Elim.** Elim is located on the northwest shore of Norton Bay, approximately 65 miles east of Solomon and 96 miles east of Nome on the Seward Peninsula. This community originally was established as an a Malimiut Eskimo village of Nuviakchak. In 1911 the surrounding area was established as a federal reindeer reserve; however, reservation status was eliminated with ANCSA. The Covenant Mission church and school was opened there in 1914.

The Elim economy is based on subsistence harvests and cash employment. Residents of Elim are shareholders in the Elim Native Corporation. The city has a mayor/council form of government, and the mayor is elected from the seven-member council. Elim's Native population is represented by a seven-member IRA council. In 1990 the U.S. Census Bureau counted 264 residents and listed the median family income at $17,083. The 1993 population estimate for Elim was 278 (Department of Labor). Sources of employment occur in the following areas: 2% other services; 3% ivory carving and other arts or crafts; 7% local store, shop, restaurant, or bed and breakfast; 8% construction; 13% other; 18% local, state, or federal government (including schools); and 50% did not respond to the questionnaire (NSEDC 1992). Unemployment is high, and seasonal part-time employment in nearby Nome has declined recently because of a depressed gold market.

Elim is accessible by air and sea; regularly scheduled flights are available from Nome, and airport improvements in 1989 have made the facility one of the best and most modern in the region. There is no docking facilities available, so supplies must be lightered to shore. A cargo ship also provides freight service annually. Elim has a subarctic climate, with maritime influences when Norton Sound is free of ice. Summers are cool and moist; winters are cold and dry. Summer temperatures range form from 46°F to 62°F, while winter temperatures range form minus 8°F to 8°F. Average annual precipitation is 19 inches, including about 80 inches of snow.

<u>Western Norton Sound Subregion:</u>

**Koyuk.** Koyuk is located at the mouth of the Koyuk River at the northeastern end of Norton Bay on the Seward Peninsula. It is 132 miles east of Nome and 75 miles north of Unalakleet. The site of Iyatayet to the south of Koyuk has traces of early humans that are from 6,000 to 8,000 years old. Prior to 1900, the villagers were nomadic, ranging within 20 miles of the present site. Two gold mining boom towns emerged in the Koyuk region in 1914: Dime Landing and Haycock. In addition to gold, coal was mined one mile upriver to supply steam ships and to export to Nome. The first school was established in 1915 in the church; the U.S. government build a school there in 1928. Koyuk is a traditional Unalit and Malemiut Eskimo village that speaks a dialect of Inupik Eskimo.

The Koyuk economy is based on subsistence and augmented by limited part-time, seasonal employment. Unemployment is high. Native residents of Koyuk are shareholders in the Koyuk Native Corporation, which is incorporated into ANCSA. The city government functions under the authority of a mayor elected from a seven-member city council. For nonmunicipal programs and services, the Native population is further represented by a five-member IRA council. In 1990 the U.S. Census Bureau counted 231 residents and listed the median family income at $18,750. The 1993 population estimate for Koyuk was 281 (Department of Labor). Sources of employment occur in the following areas: 3% health care; 3% local store, shop, restaurant, or bed and breakfast; 5% other services; 5% fishing; 19% construction; 22% local, state, or federal government (including schools); 20% other; and 22% did not respond to the questionnaire (NSEDC 1992).

There are no roads connecting Koyuk with other villages. Access is limited to air and sea; there is a 2,000-foot gravel runway that has been recently improved. Regular flight service from Nome and Unalakleet is available. Supplies arrive from Nome and are lightered to shore. Koyuk has a subarctic climate, with maritime influences when Norton Sound is free of ice. Summers are cool and moist; winters are cold and dry. Summer temperatures range form from 46°F to 62°F, while winter temperatures range form minus 8°F to 8°F. Average annual precipitation is 19 inches, including about 40 inches of snowfall.

**Shaktoolik.** Shaktoolik is located on the east shore of Norton Sound, 12 miles southeast of Cape Denbigh; it is 125 miles east of Nome and 33 miles north of Unalakleet. The village was originally located at the mouth of the Shaktoolik River; thereafter it was moved four times before becoming established in its present location. Shaktoolik was the first and southernmost Malemiut settlement on Norton Sound; it has been occupied since 1839. Reindeer herds were managed in the area in the early 1900s. Residents of Shaktoolik are shareholders in the Shaktoolik Native Corporation. The city government functions under the authority of a mayor elected from a seven-member city council. For nonmunicipal programs and services, the local Native population is represented by a seven-member IRA council.

The economy is based on subsistence food harvest and part-time, seasonal employment. Commercial fishing is on the increase, providing a major source of income. Development of a new fish processing facility is a village priority. Reindeer herding also provides additional income. In 1990 the U.S. Census Bureau counted 178 residents and listed the median family income at $22,500. The 1993 population estimate for Koyuk was 195 (Department of Labor). Sources of employment occur in the following areas: 3% local store, shop, restaurant, or bed and breakfast; 3% other services; 5% other; 11% bank; 11% construction; 17% local, state, or federal government (including schools); 17% fishing; and 33% did not respond to the questionnaire (NSEDC 1992).

Shaktoolik is primarily accessible by air and sea. An airstrip accommodates regular service from Nome; it has recently undergone major improvements. Cargo is barged from Nome and lightered to shore. Shaktoolik has a subarctic climate, with maritime influences when Norton Sound is free of ice. Summers are cool and moist; winters are cold and dry. Summer temperatures range form from 47°F to 62°F, while winter temperatures range form minus 4°F to 11°F. Average annual precipitation is 14 inches, including about 43 inches of snowfall.

**Unalakleet.** Unalakleet is located on Norton Sound at the mouth of the Unalakleet River in the Nulato Hills. It is 148 miles southeast of Nome and 400 miles from Anchorage. Archaeologists have dated house remnants along the beach ridge from 200 B.C. to 300 A.D. (Walters 1994). Unalakleet is the terminus for the Kaltag Portage, an important winter travel route connecting to routes along the Yukon River. It was an important trade center. Indians on the upper river had a trading monopoly on the Indian-Eskimo trade along the Kaltag Portage. The Russian

American Company built a post there in the 1830s. In 1901 the Army Signal Corps built over 605 miles of telegraph line from St. Michael to Unalakleet and over the Portage to Kaltag and Fort Gibbon. The community has a history of diverse cultural and trading activity. Along with a traditional Eskimo subsistence way of life, the local economy is the most active one in Norton Sound.

Native residents of Unalakleet are shareholders in the Unalakleet Native Corporation, and for nonmunicipal programs and services, they are represented by a five-member IRA council. The city government functions under the authority of a mayor elected from a seven-member city council. Both commercial fishing and subsistence activities are major components of Unalakleet's economy. A herd of musk ox is maintained nearby, and the underwool (qiviute) is hand-knit by locals as a cottage industry. In 1990 the U.S. Census Bureau counted 714 residents and listed the median family income at $40,347. The 1993 population estimate for Unalakleet was 730 (Department of Labor). Sources of employment occur in the following areas: 2% ivory carving or other arts and crafts; 8% local store, shop, restaurant, or bed and breakfast; 21% other; 10% construction; 30% local, state, or federal government (including schools); 9% fishing; and 20% did not respond to the questionnaire (NSEDC 1992).

There are regularly scheduled flights from Anchorage to Unalakleet. It has a 6,200-foot gravel runway, and major improvements were completed in 1994. Cargo is lightered from Nome. Overland travel is primarily by snowmachine in the winter; all-terrain vehicles are also used. Unalakleet has a subarctic climate, with maritime influences when Norton Sound is free of ice. Summers are cool and moist; winters are cold and dry. Summer temperatures range form from 47°F to 62°F, while winter temperatures range form minus 4°F to 11°F. Average annual precipitation is 14 inches, including about 41 inches of snowfall.

<u>Southern Norton Sound Subregion:</u>

**Saint Michael.** The village of St. Michael is located on the east coast of Saint Michael Island in Norton Sound; it is 48 miles southwest of Unalakleet and 125 miles southeast of Nome. Fort St. Michael, located near the Eskimo village of Tachik, was built by the Russian-American Company in 1833. It was the northernmost Russian settlement in Alaska. During the gold rush of 1897, it was a trading post for Eskimos; however, the existing Native trade monopoly was difficult for the Russians to break into. Centralization of people from surrounding villages intensified after the measles epidemic of 1900; the influenza epidemic of 1918 decimated many of the smaller outlying villages. St. Michael is largely an Eskimo community with strong historical Russian influences.

Native residents of St. Michael are shareholders in the St. Michael Native Corporation; for nonmunicipal programs and services, they are represented by a seven-member IRA council. The city government functions under the authority of a mayor elected from a seven-member city council. The Saint Michael economy is based on subsistence food harvests supplemented by part-time wage-earning. The U.S. Census Bureau counted 295 residents and listed the median family income at $24,028. The 1993 population estimate for Unalakleet was 298 (Department of Labor). Sources of employment occur in the following areas: 1% fishing; 2% construction; 2% health care; 4% local store, shop, restaurant, or bed and breakfast; 5% other services; 21% other 23% local, state, or federal government (including schools); and 41% did not respond to the questionnaire (NSEDC 1992).

St. Michael is accessible by air and sea only. Regular and charter flights are available from Nome and Unalakleet. It is near the Yukon River delta and has a good natural harbor, but no dock. Lighterage service is provided on a frequent basis from Nome, and the community receives at least one annual shipment of cargo by freighter or barge.

St. Michael has a subarctic climate, with maritime influences when Norton Sound is free of ice. Summers are cool and moist; winters are cold and dry. Summer temperatures range form from 40°F to 60°F, while winter temperatures range form minus 4°F to 16°F. Average annual precipitation is only 12 inches, including about 38 inches of snowfall.

**Stebbins.** Stebbins is located on the northwest coast of St. Michael Island, just north of the Yukon/Kuskokwim River delta in Norton Sound. It is eight miles northwest of St. Michael, 53 miles southwest of Unalakleet, and 120 miles southeast of Nome. The Eskimo name for the village is Tapraq. The Stebbins economy is based on subsistence that is supplemented by part-time wage earnings. City government and the school system provide the only full-time employment. Although reindeer herding was important in the past, there is only an unmaintained herd on Stuart Island remaining. The commercial herring fishery has become increasingly important as a source of cash, including commercial salmon fishing activities on the lower Yukon.

Native residents of Stebbins are shareholders in the Stebbins Native Corporation. For nonmunicipal programs and services, Native residents are represented by a five-member IRA council. The city government functions under the authority of a mayor elected from a seven-member city council. The Saint Michael economy is based on subsistence food harvests supplemented by part-time wage-earning.

The U.S. Census Bureau counted 400 residents and listed the median family income at $23,250. The 1993 population estimate for Unalakleet was 453 (Department of Labor). Sources of employment occur in the following areas: 1% fishing; 2% construction; 2% health care; 4% ivory carving or other arts and crafts; 6% fishing; 6% construction; 20% other; 25% local, state, or federal government (including schools); and 37% did not respond to the questionnaire (NSEDC 1992).

Stebbins is accessible by air and sea only. Regular and charter flights are available from Nome. There is an unattended 2,300-foot turf runway. The community receives at least one annual shipment of freight by cargo ship. There is no dock, an lighterage of goods to shore is provided out of Nome. Stebbins has a subarctic climate, with maritime influences when Norton Sound is free of ice. Summers are cool and moist; winters are cold and dry. Summer temperatures range form from 40°F to 60°F, while winter temperatures range form minus 4°F to 16°F.

Other Social and Cultural Effects of Fishery Enhancement in Rural Communities:

All the economic benefits and costs of a fishery enhancement or restoration projects are not reflected in market prices for salmon and harvesting and processing costs. Particularly in Alaska Native societies, fishing is part of traditional cultures and economic systems that hold other important intrinsic values to society. For the Inupiat, Yupik, and Athabaskin of northwest Alaska, harvesting wild resources expresses and reinforces special relationships among the Inupiat and Yupik people and the land, relationships with roots stretching back many centuries in the arctic.

The Native societies of northwest Alaska insist that without traditional fishing and hunting activities, they would disappear as culturally-distinct peoples (Berger 1985). Without traditional harvesting activities, Alaska Native villages would likely disappear or become transformed into minority enclaves wholly dependent on welfare and other transfer payments from the dominant Euro-American government (Feit 1983). Such dependencies would be associated with increased rates of social pathologies such as chronic substance abuse, domestic violence, suicides, homicides, accidents, and destructive anomie (Minnis 1963, Parker 1964, Reasons 1972). History supports these social effects. The historic relationships between politically dominant Euro-American societies and Native American societies have lead to such outcomes for many indigenous tribes in the continental United States (Bahr et al. 1972, Pearce 1965, Washburn 1975). The Inupiat and Yupik have sought to halt these historic processes in northwest Alaska through economic, political, and social means, including culturally appropriate fishery enhancement projects.

Fishery enhancement in northwest Alaska is a form of economic development that reinforces traditional cultures and economic systems of Inupiat and Yupik societies (Feit 1983, Usher 1978, Wolfe 1984). Enhanced fish stocks are harvested as part of the traditional seasonal pattern of fishing and hunting activities of these people (Schroeder et al. 1987b:50-106). The fishing activities build upon traditional meanings and relationships among people and the land. The capital income earned from the commercial sale of enhanced salmon is reinvested by local fishers into traditional subsistence activities through the purchase of equipment, tools, and other small-scale capital (Wolfe 1984). Consequently, this form of economic development has many nonmonetary benefits to the Inupiat and Yupik.

It benefits the traditional subsistence sector of the local economy by providing income to subsistence work groups for capitalization in the means of subsistence production. It benefits the functioning of Inupiat extended family groups by providing meaningful, productive work roles, particularly to adult men who fish. Its benefits the continued transmission of traditional cultural knowledge, skills, and beliefs between older and younger generations, which promotes continuity and social order. It benefits the continued existence of Inupiat and Yupik societies in northwest Alaska communities by providing one of the means for its social reproduction and self-determination. To the Inupiat and Yupik people, these types of values appear to be among the more important goals from economic development. Yet, these types of benefits are not normally reflected in market prices and production costs.

Land Status and Use:

The majority of the land in the region is undeveloped, and it is managed by federal and state governments as well as Native regional and village corporations, the largest private landholders in the region. These corporations were formed pursuant to the Alaska Native Claims Settlement Act (ANCSA) of 1971, whereby land selections were made in the whereabouts of the region's communities. Bering Strait, the Regional Native Corporation controls the subsurface rights to all village and regional corporation lands, and Kawerak, Inc. is the nonprofit arm of that corporation. Sitnasuak is the local Nome Native corporation. These corporations have expressed their willingness to work with salmon rehabilitation and enhancement projects on their lands, subject to a case-by-case review. A representative of Kawerak, Inc. is a member of the Norton Sound/Bering Strait Regional Planning Team. The Bureau of Land Management (BLM), whose representative also serves on the RPT, manages several million acres of land in the region, and the National Park Service (NPS) manages the Bering Land Bridge National Preserve, of which a portion of occurs in the region. There are also a number of patented mining claims established throughout the region.

**Federal Policy.** Proposed fishery rehabilitation, restoration, and enhancement activities in the Norton Sound/Bering Strait region could potentially occur on lands managed by the U.S. Bureau of Land Management, in as much as some anadromous systems fall within in their jurisdictional boundaries. The BLM has developed a national anadromous fish habitat management plan (Veterick et al. 1988), that proposes to increase anadromous fish numbers on public lands by 20%. This anadromous fish plan outlines a program of inventory, habitat improvement, monitoring, research, and cooperative management plans to achieve that purpose.

The northern district office has developed an aquatic habitat management plan (Webb 1988) for BLM lands in the Norton Sound region under authority of the Sikes Act (Title II, Public Law 93-452). This plan was developed with the cooperation of ADF&G. One of the major objectives of the Sikes Act was the development of comprehensive plans in cooperation with state agencies to develop, maintain, and coordinate programs for the conservation and rehabilitation of fish and game. The Sikes Act establishes formal coordination and cooperation with the state, and it ensures that state population goals and BLM habitat goals are coordinated (Webb 1988).

Other laws, regulation, and policy memoranda pertaining to management of fish and riparian habitat on BLM-administered lands are as follows: (1) National Environmental Policy Act, (2) Federal Land Policy and Management Act, (3) Alaska Native Claims Settlement Act, (4) Clean Water Act, (5) Mining Law, (6) Coastal Zone Management Act, (7) Master Memorandum of Understanding between ADF&G and BLM, (8) Alaska Water Quality Standards, (9) Alaska Anadromous Fish Act-Title 16, (10) BLM Riparian Area Management Policy, and (11) Executive Orders 11988 (floodplain management) and 11990 (wetland protection).

# CURRENT SALMON PRODUCTION/MANAGEMENT STATUS

## Commercial Fisheries

Introduction:

Although subsistence salmon fishing has been an integral part of life for Norton Sound/Bering Strait residents for centuries, commercial salmon fishing (i.e, for export from region) in the Norton Sound/Bering Strait region initially began in the Unalakleet and Shaktoolik subdistricts in 1961. The majority of early commercial interests were centered on chinook and coho salmon that were flown to Anchorage for additional processing. In 1961 one U.S. freezer ship also purchased and processed pink and chum salmon. In 1962 two floating cannery ships operated in the region, and commercial fishing was extended to the Norton Bay, Moses Point, and Golovin Bay subdistricts. Since 1963, when the canning operations reached their peak, markets have been sporadic and fishermen from the region have been unable to attract buyers for their fish. A joint venture between Koyuk-Elim-Golovin (KEG) Fisheries and NPL Alaska, Inc. operated from 1984 through the middle of the 1988 season; in this joint venture a permit was issued by the governor to allow two Japanese freezer ships to buy directly from domestic fishermen in the internal waters of Golovin and Norton Bays. Currently the most consistent markets for sale of salmon are at Shaktoolik and Unalakleet where fish are iced before being flown directly to Anchorage for processing (Lean et al. 1993).

Access to commercial salmon fishing within state waters is limited to persons holding a permit issued by the Commercial Fisheries Entry Commission (CFEC). Beginning in 1975, CFEC has been issuing commercial drift net permits to qualified persons. Eligibility was initially determined by a complex system based on points awarded by criteria such as residency and past participation in the fishery. According to information provided by CFEC staff (Elaine Dinneford, Research Analyst, personal communication), in 1994 there were 201 gillnet permits issued (Table 6). Although the region encompasses the Port Clarence District (i.e., Cape Douglas north to Cape Prince of Wales, including Salmon Lake and Pilgrim River drainages), because of the relatively small runs of salmon and existence of an important subsistence fishery, commercial salmon fishing has been prohibited since 1967.

The commercial salmon fishing season generally is opened by emergency order sometime between the second week and end of June, depending on run timing of various salmon species within each of the six subdistricts: (1) Nome, from Penny River to Topkok Head (2) Golovin, from Rocky Point to Cape Darby (3) Moses Point, from Elim Point to Kwik River (4) Norton Bay, from Kuiuktulik River to Island Point (5) Shaktoolik, from Cape Denbigh to Junction Creek, and (6) Unalakleet from Junction Creek to Black Point. Each of these subdistricts contain at least one major salmon spawning system. Subdistrict boundaries were established around major salmon producing streams to minimize interception of stocks bound for other areas (Lean et al. 1993). The season is closed by regulation on August 31 in Subdistricts 1, 2, and 3 and on September 7 in Subdistricts 4, 5, and 6. Two 48-hour fishing periods usually occur each week in all subdistricts but Nome and Moses Point, where two 24-hour fishing periods per week occur. Commercial fishing gear is limited to set gillnets having a maximum aggregate

Table 7. Estimated value[1] of Norton Sound commercial salmon fishery to fishermen, 1975-1994.

| Year | Ex-vessel value | Total permits issued | Total permits fished |
|---|---|---|---|
| 1975 | $413,255 | 250 | 182 |
| 1976 | 285,283 | 310 | 141 |
| 1977 | 528,610 | 210 | 167 |
| 1978 | 814,221 | 199 | 177 |
| 1979 | 876,547 | 200 | 173 |
| 1980 | 583,388 | 201 | 157 |
| 1981 | 758,471 | 200 | 167 |
| 1982 | 988,588 | 203 | 162 |
| 1983 | 1,038,967 | 203 | 169 |
| 1984 | 721,055 | 204 | 141 |
| 1985 | 822,056 | 205 | 155 |
| 1986 | 539,576 | 203 | 163 |
| 1987 | 504,631 | 202 | 164 |
| 1988 | 754,751 | 202 | 151 |
| 1989 | 335,928 | 202 | 110 |
| 1990 | 497,623 | 201 | 127 |
| 1991 | 425,430 | 181 | 126 |
| 1992 | 448,395 | 201 | 110 |
| 1993 | 322,117 | 200 | 128 |
| 1994 | 864,882 | 201 | 119 |
| 1995 | 357,313 | 199 | 104 |
| **15-year average (1981-1995)** | **$625,319** | **201** | **140** |

[1] data provided by Commercial Fisheries Entry Commission.

length of 100 fathoms (600 feet) per fisherman. There are no mesh size or depth restriction during scheduled periods. Most fishermen do not tend their nets continuously once they are set, and fish quality can suffer in direct proportion to the time they spend in the nets (Lean et al. 1993). Commercial salmon fishing in the Port Clarence District has been prohibited since 1967. Because of the relatively small runs of salmon into this area and the existence of an important subsistence fishery, commercial salmon fishing has not been reopened.

Management:

The most important way of conserving and protecting wild stocks of salmon is through good fisheries management practices and strategies, which are designed to achieve a proper balance between (1) providing sufficient numbers of salmon to fully utilize habitat and spawn (i.e., escapement) and (2) utilizing the surplus of fish (i.e., harvest). It is only in this manner that healthy populations of salmon can be maintained in each system. In order to effectively manage salmon, it is necessary to understand their behavior and life cycle. Until migrating salmon reach their spawning grounds, various stocks and species may be traveling together, thereby increasing the risk of overharvesting weak stocks. The genetic composition of a spawning stock of salmon may be altered if the early or late portion of a run is overharvested. Freshwater habitat often controls the size of a particular stock of salmon. If surplus fish are not harvested and too many fish access their spawning habitat, fishermen do not receive the benefit, both spawning and rearing habitat can be damaged, and the subsequent run may be adversely affected. If too many salmon are harvested in the fisheries, then the habitat will not be filled to capacity and subsequent runs will be adversely affected.

The Division of Commercial Fisheries Management and Development Division (CFMD) of ADF&G manages the commercial and subsistence fisheries in this region on the basis of comparative commercial catch data, escapements, and weather conditions. Salmon management has changed significantly during recent years because of limited market conditions and marginal returns of many salmon stocks to the area. The eastern subdistricts (Norton Bay, Shaktoolik, and Unalakleet) have fairly healthy salmon stocks. Commercial fishing is managed for all species using comparative commercial fishing statistics and the Unalakleet River test net project. Both Golovin Bay and Moses Point subdistricts have recently suffered poor chum salmon returns. The Nome subdistrict is managed intensively for subsistence uses (Bue and Lean 1994).

A single factor or combination of factors may result in the issuing of emergency orders affecting seasons, fishing periods, mesh size, and areas (Lean et al. 1993). Aerial surveys monitor escapements in the majority of the regions salmon systems, while a counting tower on the Kwiniuk River has been operated annually since 1965. Other counting towers, notably on the Nome, Niukluk, and Unalakleet Rivers, have been periodically used to determine escapements. Commercial fishing usually begins for chinook salmon in mid-June, for chum salmon toward the end of June, and for coho salmon during the third week in July. Pink salmon are only abundant during even years, and efficient and profitable means of marketing and processing them are being investigated by local fishermen organizations. There has been few commercial salmon harvests in Subdistricts 1 and 4 because of depressed stocks in Subdistrict 1 and healthy stocks but not markets in Subdistrict 4. Commercial fisheries in Subdistricts 2 and 3 target chum salmon, and those harvests have dropped dramatically since the mid-1980s (Table 6). These poor returns have caused restrictive management actions to allow for escapement and subsistence needs. The southern subdistricts 4 and 5 are sustained fisheries that target chinook, chum, and coho salmon. The chinook and coho harvests have remained fairly stable (Table 6), while chum harvests have also been declining since the mid-1980s (Lean et al. 1993).

### Subsistence Fisheries

There are approximately 8,000 people in the region, the majority of whom are Eskimos, residing in 15 small communities scattered along the coast and river systems. Nearly all of these local people are dependent to varying degrees on the fish and game resources for their livelihood. Subsistence fishermen operate gillnets or seines in the main rivers and, to a lesser extent, in the coastal marine waters to harvest salmon (Figure 10). Beach seines are used near spawning grounds to harvest schooling salmon. The major portion of salmon taken during the summer months is air dried or smoke for later consumption (Magdanz and Utermohle 1994).

Subsistence use of resources involves more than just the actual utilization of fish, game, and plants. The harvest, distribution, and consumption of resources are an integral part of a society, because these actions have ties to the economic, the social, and the ideological aspects of a complex cultural system (Veltre and Veltre 1982). Wolfe and Ellanna (1983) characterized a subsistence-based socioeconomic system as follows: (1) a mixed economy with mutually supportive market and subsistence sectors; (2) a domestic mode of production where extended kinship-based production units control capital, land, and labor; (3) a stable and complex seasonal round of production activities within the community; (4) substantial noncommercial sharing, distribution, and exchange networks; (5) traditional systems of land use and occupancy, and (6) complex systems of belief, knowledge, and values associated with resource uses passed on between generations as the cultural and oral traditions and custom of a social group. The analysis of resource utilization is sometimes difficult because of (1) the complex socioeconomic and ethnic makeup of the community and (2) subsistence activities are interrelated to a number of variables, including commercial fishing and processing (Veltre and Veltre 1982). Although the communities of the Norton Sound/Bering Strait region vary in their reliance on subsistence harvest and distribution of fish, it is an integral part of the way of life of most residents as well as a contributing facet of their economies. For example, the distribution of fish according to established sharing patterns throughout entire communities in the early 1800s (Lantis 1970) remains prevalent among Eskimo communities (Spaulding 1955, Berreman 1954). Sharing was also uniformly reported to be based on need and was not equally distributed throughout the community households (Langdon and Worl 1981). Salmon, halibut, cod, Dolly Varden char, shellfish (primarily red king crab), and marine invertebrates constitute the principal fisheries-related subsistence foods (Veltre and Veltre 1983).

### Sport Fisheries

The Division of Sport Fish is responsible for management of the region's recreational fisheries resources. It is dedicated to the conservation of self perpetuating populations of salmon (among

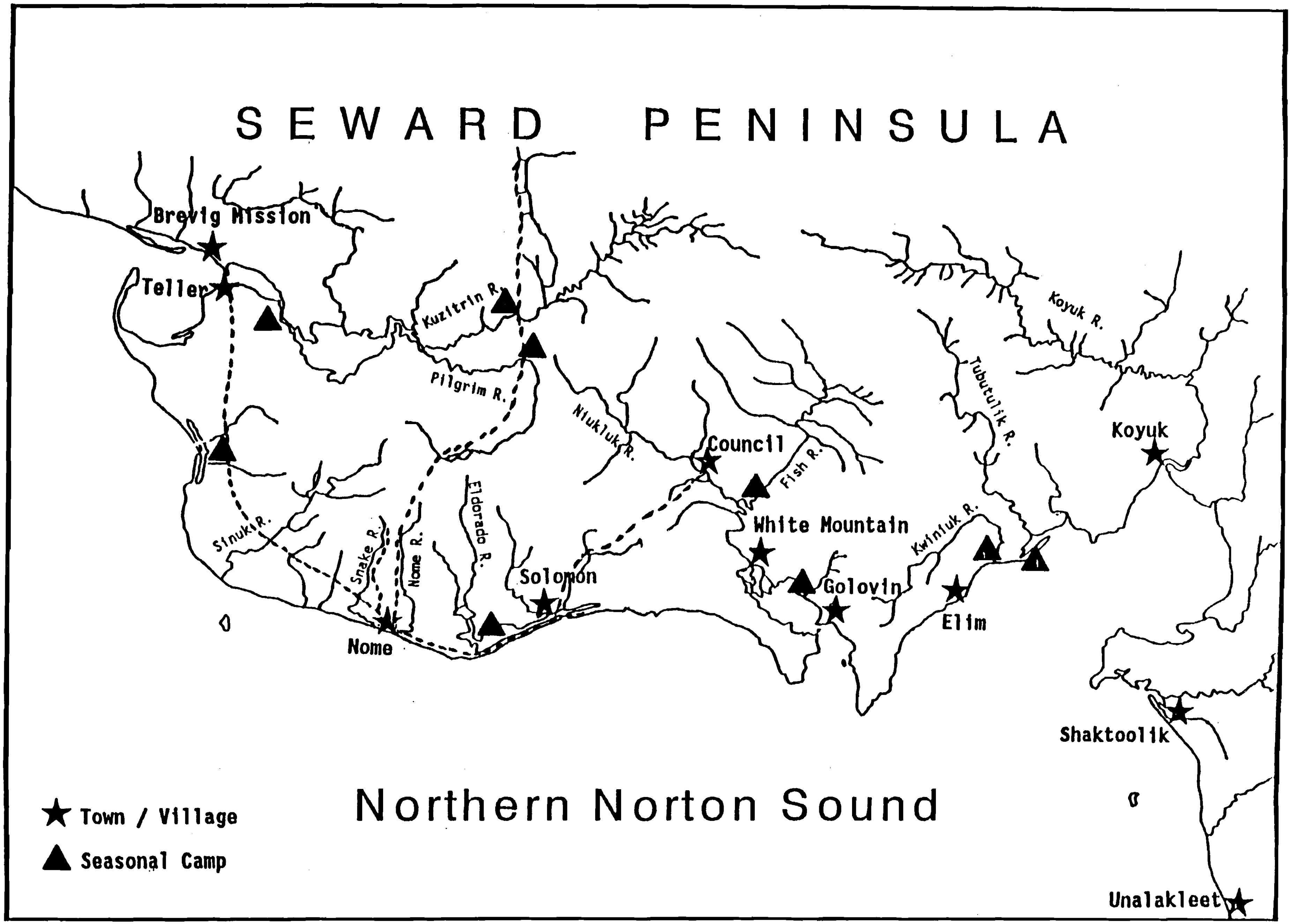



Figure 10. Northern Norton Sound subsistence fishing sites.

other species), the management of sport salmon fisheries in salt and fresh water, and the hatchery production and release of salmon for sport fishing purposes. The goals of the division are to (1) conserve wild populations, (2) provide a diverse mix of sport fishing opportunities, and (3) optimize the social and economic benefits of Alaska's recreational fisheries. In order to accomplish these goals they must implement several fundamental determinations: (1) size of wild populations, (2) whether the number of fish in a population is sufficient, and (3) what level of harvest the population can sustain. Since recreational salmon fisheries typically occur in rivers, after commercial and subsistence harvests have been made, escapement data are essential in order to manage these fisheries. They also need to determine the fishing effort and the actual harvest as well as impacts on the environment. In order to enhance fishing opportunities, the division develops and implements stocking plans that establish location, species, and numbers of fish reared and released from four public hatcheries as well other facilities producing fish intended to benefit sport fisheries. Stocking generally occurs near population centers to offer additional fishing opportunities or to divert effort away from sensitive wild stocks. To date, no stocking by the Sport Fish Division has occurred in the Norton Sound area.

Meeting public demand for recreational fishing opportunities while maintaining and protecting the fisheries resources has become increasingly difficult in most developed areas of the state, although it has not yet become a significant problem in the Norton Sound region, where rapid population expansion and industrial development have not taken place, with the exception of Nome. Although Norton Sound sport fisheries are relatively uncrowded, international treaties, Native land allotments, national land legislation, federal takeover of subsistence management on federal lands with the state, state and federal land conveyances, habitat degradation, and problems of access have complicated the management today's sport fisheries. Moreover, recreational salmon fishing has become a significant factor in the overall management of salmon fisheries; and in some regions user conflicts between sport, commercial, and subsistence interests have developed. In the Seward Peninsula/Norton Sound area (i.e., Division of Sport Fish data sub-area) in 1993, the total sport sea-run salmon harvest was about 13,700 (i.e., 600 chinook; 5,500 coho; 18 sockeye; 7,100 pink; and 500 chum salmon) (Howe *et al.*1995).

Primary sport salmon fishing streams in eastern Norton Sound include several that drain the Nulato Hills, which separate Norton Sound from the Yukon and Koyukuk River valleys, such as the Unalakleet, Shaktoolik, Inglutalik, and Ungalik rivers. The Unalakleet River is the largest and most heavily utilized of these, and supports populations of chinook, chum, coho, and pink salmon. Several salmon sport fishing steams are located along the southern half of the Seward Peninsula from Koyuk to Teller. Most receive little sport fishing effort except those with road access from Nome such as the Niukluk, Fish, Solomon, Nome, Snake, Pilgrim and Sinuk rivers. Most of these streams contain populations of coho, chinook, pink, and chum salmon. Glacial Lake in the Sinuk River drainage and Salmon Lake, which is located about 90 miles northeast of Nome in the headwaters of the Pilgrim River, both contain small (remnant) populations of sockeye salmon. Salmon lake is accessible by road from Nome, and during the gold rush period it was an important fishing area for gold miners, who nearly eliminated the large runs of sockeye salmon that were common to the system (Arvey 1993).

# SUPPLEMENTAL PRODUCTION METHODS

## Definitions

The techniques used in the supplemental production of salmon will fall into one of two categories: (1) Enhancement--the application to a stock already at natural capacity of procedures designed to increase the numbers of harvestable fish to a level beyond that which could naturally be produced. This may be accomplished by using production systems (e.g., hatchery) or by increasing the natural productive habitat through physical or chemical modifications. (2) Rehabilitation--the application to a depressed stock or endangered habitat of fish propagation, habitat restoration, or management techniques to return those stocks to a previously recorded level of production.

A risk assessment study is necessary to determine if significant biological, social, and economic impacts will result from implementation of enhancement or rehabilitation projects. In this context three primary issues are normally addressed: (1) planning procedures governing enhancement and rehabilitation efforts, (2) fishery management implications, (3) and genetic, disease, fish stocking, and lake fertilization policies and guidelines (Appendix C). Genetic impacts to wild, indigenous fish stocks may occur during the transporting of fish from one location to another to release them and when hatchery fish are created to enhance existing wild stocks. Two potential genetic hazards to wild fish populations are associated with producing hatchery stocks and then transporting them to other locations for release: (1) effects of gene flow between fish stocks and (2) maintenance of adequate genetic diversity within and between fish populations (Davis and Burkett 1989).

The state of Alaska has a genetics policy that governs rehabilitation, enhancement, and development of salmon populations (Davis et al. 1985). This policy was written to provide guidelines for such activities while protecting the integrity and diversity of wild stocks, the mainstay of the commercial fishing economy. Projects addressed in this plan will be evaluated for conformance to the genetic policy. Before approval, the commissioner will determine that a proposed project can be conducted in a manner to ensure the health and diversity of the stocks and species in the affected area.

The long-range goal of established fish disease policies is to prevent dissemination of infectious finfish and shellfish diseases within or outside the borders of Alaska without introducing impractical constraints for aquaculture and necessary stock-renewal programs (Meyers et al. 1987). Lake fertilization policies guide the efficient use of nutrient enrichment to effectively increase productivity of natural systems.

## Hatcheries

Generally, hatchery facilities are used as a production base (Figure 11) for salmon rehabilitation and enhancement programs because they are approximately eight times more efficient in converting eggs to juvenile fish than the natural environment (McMullen et al. 1983). The efficiency of such production shortens the time involved in rehabilitating depleted stocks. Because of sizable initial capital investments, hatcheries may appear to be an expensive means of supplementing salmon production. Also, the longer a hatchery holds fish, the more money it invests in each one; however, this factor is mitigated by improved survivals of fish because of their fuller development prior to release. Short-term rearing, for example, can double marine survivals and substantially increase hatchery feasibility. Criteria for regional planning team review of proposed enhancement/rehabilitation projects are provided in Appendix B.

**In-Stream Incubation Units**

The application of this technique (Figure 12) involves use of a large container containing fertilized eggs and substrate in alternating layers that is placed in or alongside a stream. A plumbing system forces water up through the substrate. Such units control the water flow, substrate type, sedimentation, and predation to provide green-egg-to-fry survival rates as high as 90%. In-stream incubators are a low-cost enhancement technique that are ideally suited for small operations at remote sites. After artificial spawning of the brood stock and placing of eggs in the unit, minimal care is required. When they are used for enhancement of indigenous stocks, these units can eliminate the genetic and pathology concerns associated with transport of eggs or fry. To effectively apply this technique, the following prerequisites are needed: (1) high-quality water source, (2) adequate head (i.e., height differential to provide sufficient flow) without installing excessive length of piping, (3) suitable stream bottom, and (4) protected area for incubation units. These units can be used to bolster fry production independently or in combination with lake fertilization and fish pass projects.

**Lake Stocking**

When spawning area is limiting salmon production, the natural rearing area of lakes can be maximized through stocking; lakes serving as rearing habitat for juvenile salmon (including chinook, coho, and sockeye) that are underutilized because low escapements can be maximized through lake stocking; i.e., release into the aquatic environment of artificially propagated fish at any life stage. Before a stocking project is implemented, specific criteria and procedures need to be considered, including but not limited to (1) prestocking studies as required by ADF&G stocking policy, including limnological and fisheries investigations to determine suitability of lakes for stocking and the rearing/stocking capacity and ensure optimal fry growth and survival; (2) basic tenets of genetic and pathology policies and guidelines need to be followed to preserve genetic/disease integrity of both wild and hatchery stocks; and (3) salmon returning to a stocked lake must be available for harvest and have minimal impact to returning wild salmon.

**Stream Stocking**

When streams have areas of underutilized habitat that can serve as natural rearing areas, a variety of stream-stocking techniques may be helpful in rehabilitating declining populations of wild stocks: (1) after artificial spawning, green eggs are planted; (2) after artificial spawning and partial incubating, eyed eggs are planted; (3) after artificial spawning and incubating, unfed fry are released; (4) after artificial spawning, incubating, and partial rearing, fed fry are released; and (5) after artificial spawning, incubating, and rearing, smolts are released into the stream.

Applying fish hatchery technology allows for the increased production of fish. This is accomplished in a controlled or protective environment which allows for substantial increases in the number of fish that can be produced. Various types of incubation technology can increase spawner efficiency from 6 to 9 times what would occur in nature.

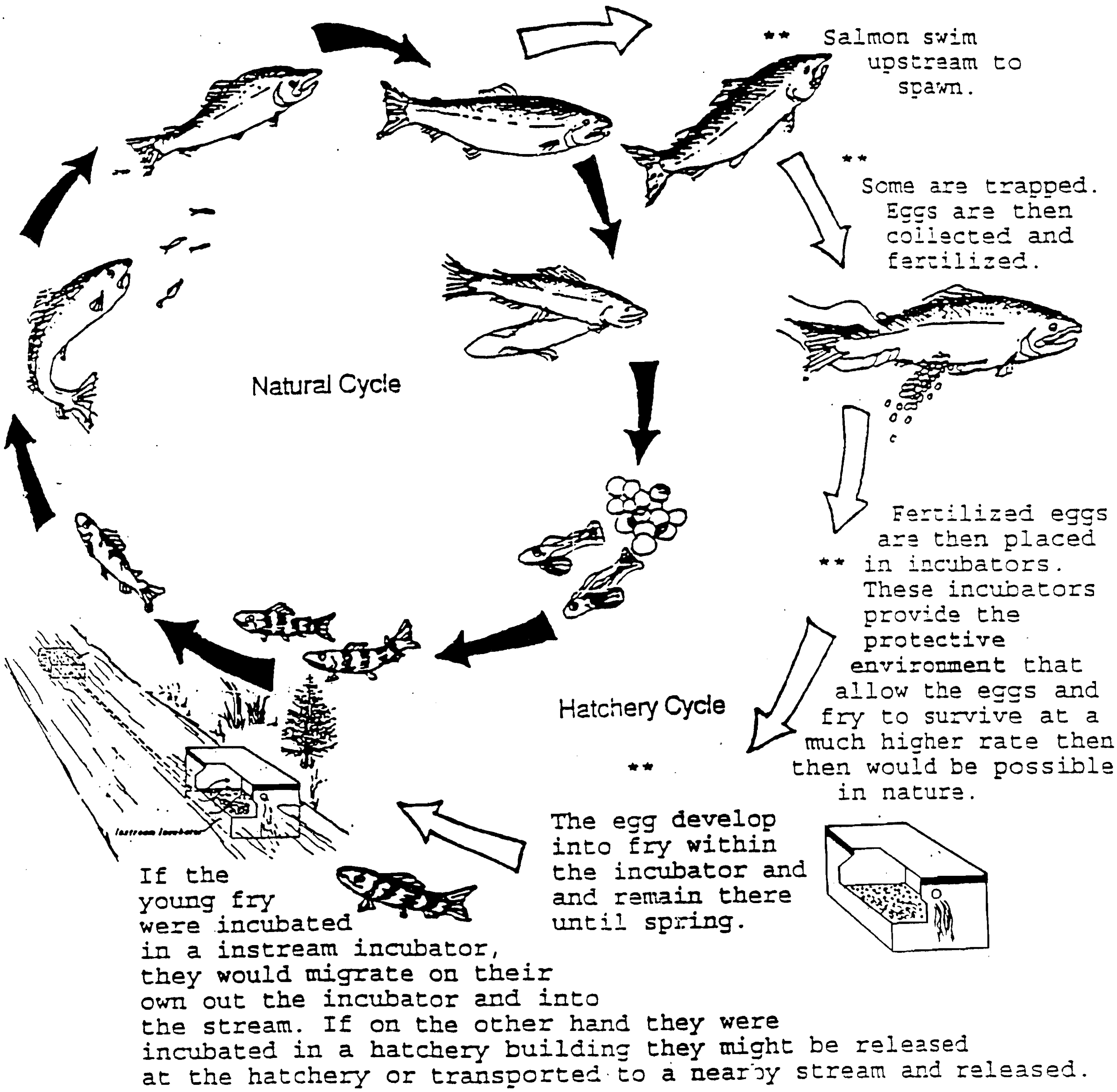
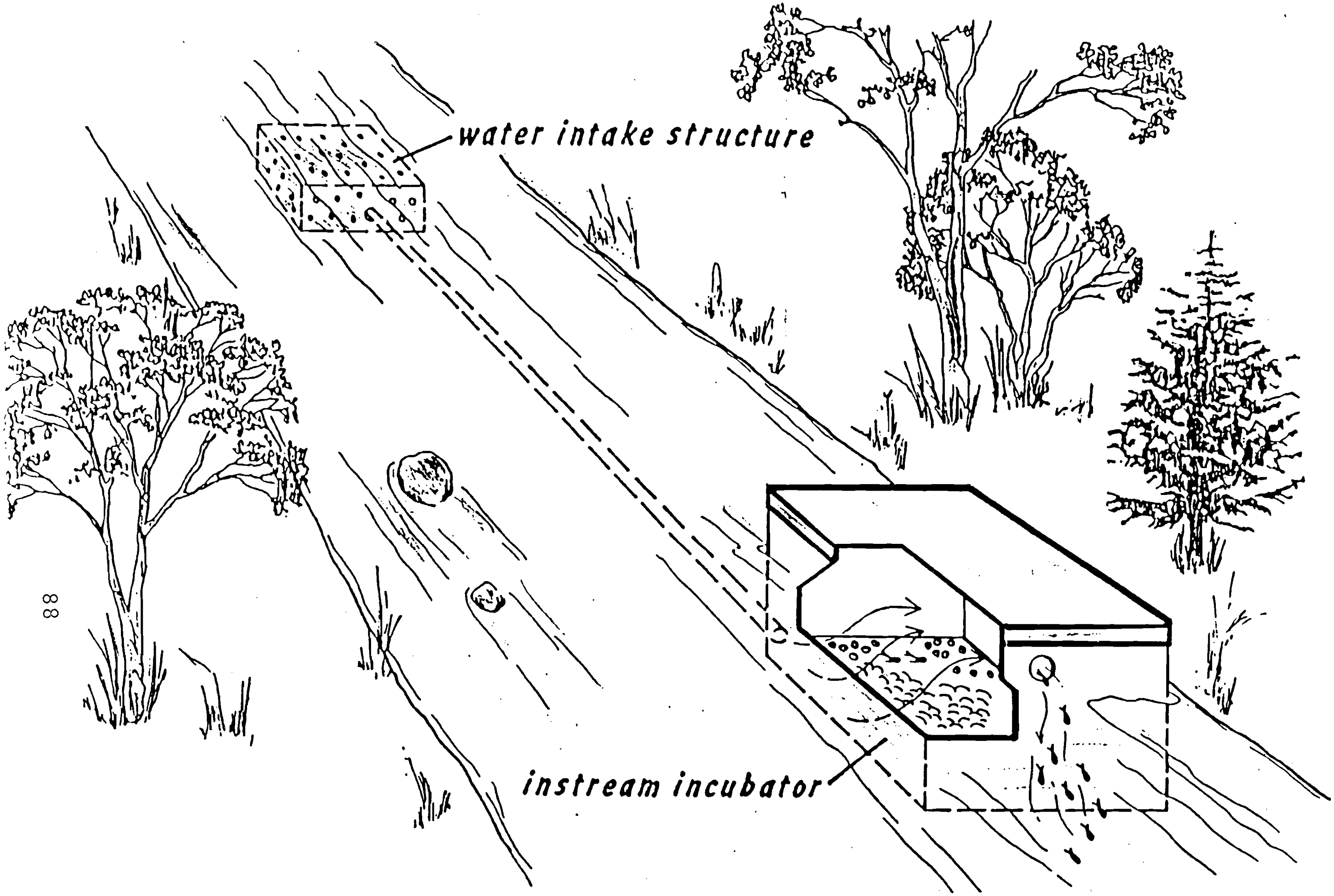



Figure 11. Fish enhancement technology.




The INSTREAM INCUBATOR (streamside incubator or hatch box) is an incubator designed to incubate salmon eggs and alevins (small fish) under conditions similar to those in natural spawning beds. The incubators are usually positioned in the stream or on the stream bank. Water is directed downstream through a pipeline which supplies the eggs with a continuous flow of oxygen-enriched water. Once fertilized eggs have been placed in the incubator, little maintenance is required. The eggs develop through the winter in a protective environment. In spring the young fry migrate out of the incubator to begin their long migration out to sea before returning as adults.

Figure 12. Instream Incubator.

## Lake Fertilization

Addition of nutrients to lakes that serve as nurseries for rearing salmon, particularly sockeyes, increases the quantity of phytoplankton and, in turn, the quantity of zooplankton, which is the major source of food for rearing fish (particularly sockeye juveniles). There are many lakes within Alaska and Canada that have been treated with nutrient additions and have greatly benefitted wild and introduced sockeye salmon stocks; however, there have been some lakes whose stocks have not benefitted; therefore, it is necessary to know as much as possible about the physical, chemical, and biological characteristics of candidate lakes.

The ADF&G lake fertilization guidelines mandate observation of selection criteria and evaluation requirements prior to implementing lake fertilization projects. There are essentially seven criteria for selecting lakes: (1) food supply must limit salmon growth and/or numbers by limiting nutrient supply; (2) for added nutrients to be available to phytoplankton, mean depth of lake should be greater than depth of euphotic zone (lake depth should be at least 10 m), epilimnion should be less than twice the depth of euphotic zone, flushing rate of epilimnion should be low enough so turnover time is at least one year, shoreline should be steep and have little periphytic and macrophytic vegetation, and light penetration and temperatures should not limit production; (3) nutrient enhancement is compatible with preexisting water usage; (4) ability to evaluate, monitor, and manage adult salmon returns to all fisheries; (5) initial salmon populations of 300-400 fry /lake-surface-hectare or the potential to stocking to that density; (6) spawning or rearing areas should be sufficient for increased numbers of returning adults or of a size that would not limit salmon production; and (7) predators and /or competitor populations should be of a size that would not limit salmon production. Basically, these criteria favor lakes larger than 300 acres that are steep-sided and deep (> 10 m), have a low density of predators/competitors, and have a water residence time of one year (Koenings et al. 1979).

From the varying responses of lakes to nutrient enrichment in Alaska, it is evident that extrapolation of results from one treated lake to another of similar size and morphometry cannot and should not be done. Thus the efficacy of nutrient enrichment is lake specific and dependent on biological factors, such as food-web processes of fish densities, predators/competitors, and other abiotic factors (e.g., cool rearing temperatures and turbidity). After a thorough and systematic fisheries and limnological pre-assessment study has been conducted, only lakes that offer the most potential, relative to existing productivity and selection criteria, should be enhanced. The goal of lake fertilization projects is to increase growth and survival of juvenile sockeye through increasing primary productivity without significantly changing the plankton community or the lakes oligotrophic condition.

Studies have shown significant correlations between the availability of food to juvenile salmon, their size at outmigration as smolts, and their survival in marine waters. Because of inherent variability within and between lake systems, before an enrichment project is initiated, both limnological and fisheries investigations are done at least two years prior to actual fertilization. Such evaluations of the physical, biological, and chemical status of a lake is required to determine if fertilization is feasible, based on lake-specific information and to use such information as a gauge to measure the success of a nutrient enrichment project. Without an evaluation program, scientific and monetary benefits from lake fertilization projects cannot be clearly identified, nor will maximal production be realized. After two years of studies, a pre-fertilization report is prepared and distributed for review and discussion before projects are implemented. During the fertilization phase, monitoring at all trophic levels is conducted; after fertilization monitoring is continued for another two years (at a reduced level) to assess the return of the lake to a nonfertilized state. All the time-phase monitoring and assessments are done to relate the overall physical, chemical, and biological conditions of the lake to growth and production of juvenile salmon and to the subsequent contributions of adults to the common property fisheries.

**Limnological Investigations**

Prior to lake fertilization or stocking, a set of studies should be conducted to assess the potential feasibility and performance of any enhancement or rehabilitation effort. Limnology field sampling entails water samples collected from two depths, temperature profile from surface to bottom, dissolved oxygen profile from surface to bottom, light penetration measurements, and two replicate zooplankton tows. Additional, if a morphometric map is unavailable, mapping of the lake (transect depth soundings) will be necessary. Field sampling by trained personnel should take from 1.o to 1.5 hours/station for data/sample collection. Water samples will need to be preserved and filtered prior to their shipment to a limnology laboratory for analysis.

Limnology field sampling occurs in two stages (years) as follows: (1) feasibility surveys and (2) pre-enhancement surveys. During the feasibility stage each lake/station is sampled four times/year (1 spring, 2 summer, 1 fall). Generally, lakes will have one station; however, for those lakes greater than 1 mile long (e.g., Bear and Sapsuk Lakes), two stations should be used. Based on the lake's enhancement potential determined during the feasibility stage, the second year of sampling is intensified. During this pre-enhancement stage each lake/station is sampled at a minimum of six times/year.

**Fish Habitat Restoration and Improvement**

<u>Spawning Channel:</u>

Artificial spawning channels are designed to increase and enhance natural spawning habitat through control of such factors as water flow, substrate, sedimentation, and predation, thereby increasing egg-to-fry survival rates. While the average egg-to-fry survival rate in a natural stream may be as little as 10% or 15%, the introduction of spawning channels may increase those rates by as much as 80%. Implementation of this technique requires a controllable water source, proper terrain, and sufficient brood stock.

Stream Clearance/Improvement:

Despite its simplicity and cost-effectiveness, this technique has some accompanying risks. Complete removal of physical barriers (e.g., beaver dams, rocks, logs, driftwood, or other debris) may result in an increase in water velocity, downstream scouring, and elimination of pooling areas; therefore, selective removal of a portion of a barrier sufficient to allow the passage of fish upstream without substantially altering the flow of water or downstream conditions is required. When evaluating potential stream clearance projects, assessments should be made of spawning or rearing habitat that will be made available, the portion of the barrier to be removed, availability of sufficient spawning populations, and the relative costs (e.g., time and equipment) involved.

Required applications vary from system to system; in some instances the rearranging of rocks or logs by hand to provide resting pools and shorten jumps over falls may be all that is needed. One of the aftereffects of storms in the area is that beach gravel deposits and other debris frequently block the mouths of streams, effectively denying access to upstream spawning/and or rearing habitat. The partial removal of these obstructions can be an effective means of providing that access. Providing access to blocked side channels, lakes, or sloughs can also in some instances provided additional rearing area for sockeye and coho.

Fish passage Improvements:

The construction of a fish pass (fish ladder, steep pass, fishway) is a permanent form of habitat modification to enable fish access to spawning and rearing habitat beyond impassable barriers such as high-velocity rapids or waterfalls. This technique can be applied either as a (1) construction made of concrete, steel, or aluminum to bypass a barrier or (2) as an alteration of the barrier itself through explosives to provide a series of ascending/resting pools. The success of either of these applications will depend on an adequate preconstruction or preblasting evaluation, including estimates of high- and low-water flows and number and species of fish using the system to ensure sufficient utilization and absence of conflicts with any unique fish stocks above a barrier. Generally, experience in the application of this technique over a broad range of barriered systems indicate that a well-placed fish pass can result in a significant increase in production.

Other Restoration and Improvement Techniques:

In addition to spawning channels, stream clearance projects and fish passes discussed in the foregoing sections, there are a number of other techniques that can be used to restore or improve fish habitat. Techniques such as stream bank stabilization or structures to maintain stream riffles and pools have been used in other areas of Alaska to improve salmon spawning and rearing habitat. Habitat structures such as boulders and large woody debris can be utilized in certain situations to improve rearing areas, thereby increasing production. Water level or water flow direction can be adjusted with the use of various structures to improve fish production. It is also possible to connect ponds to existing systems to expand available rearing areas and improve production. As with the other techniques discussed here, habitat manipulation projects must be carefully evaluated by the Norton Sound/Bering Strait Regional Planning Team prior to their installation. Before implementing these projects, sites should be monitored and evaluated for a one-year period. Seasonal visits will be most critical during low-water flow and during extremely cold periods. The most important parameters to evaluate include water temperature, volume, velocity, and dissolved oxygen content. A map of the existing and proposed habitats should be drawn, and engineering plans may need to be developed. Finally, when the project has been completed, it must be monitored and maintained on a regular basis to assure that it is operating as designed.

**Fish Tag/Recovery and Stock Separation Studies**

Information concerning salmon biology, valuable migration characteristics, and level of contribution to various fisheries can be obtained from well designed tagging studies. Information from this type of work is very helpful in fishery management decision making process to assure that both hatchery and wild stock harvest levels and escapement can be maintained in balance and to allow for continued healthy perpetuation of the salmon runs. Additional information concerning movements and residence time of Alaska Peninsula salmon in coastal waters would be very helpful. In certain instances, tagging studies are required in association with large-scale productions of salmon that exceed the natural production capabilities of wild stocks; for example, a large-scale release directly from a hatchery. These types of mark/recovery studies (e.g., thermal marking of otoliths, coded wire tagging, or genetic marking) allow managers to identify hatchery fish in the common property harvest to the extent that it is possible to assure that the wild stocks are not overharvested. Additionally, stock separation studies (for example, age-structure, run timing, scale analysis, genetics, etc.) in systems throughout the region will further increase our understanding of the resources potential.

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## LIST OF TERMS

ADF&G - Alaska Department of Fish and Game

alevins - newly hatched fish on which the yolk-sac is still apparent.

allocation - to apportion, through regulation, salmon harvest to various user groups (i.e., subsistence, sport, or commercial fishermen).

anadromous - fish such as salmon that are born in fresh water, migrate and feed at sea, and return to fresh water to spawn.

aquaculture - culture or husbandry of salmon (or other aquatic fauna/flora).

aquatic plant - any species of plant, excluding the rushes, sedges, and true grasses growing in a marine aquatic or intertidal habitat.

barter - the exchange or trade of fish or game, or their parts, taken for subsistence uses for (1) other fish or game or their parts or (2) other food or for nonedible items other than money, if the exchange is of a limited and noncommercial nature.

BSFA - Bering Sea Fishermen's Association

benthic - bottom-dwelling fish such as halibut and rockfish.

biomass - the combined weight of a group of organisms; for example, a school of herring.

brood stock - salmon contributing eggs and milt for supplemental culture purposes.

CFMD Division - Commercial Fisheries Management and Development Division

coded wire tag - magnetically detectable pin-head-sized tag implanted in the nose of a young fish for identification as an adult.

commercial fishing - the taking, fishing for, or possession of fish, shellfish, or other fishery resources with the intent of disposing of them for profit, or by sale, barter, trade, or in commercial channels.

commissioner - principal executive officer of the Alaska Department of Fish and Game.

commissioner approval - formal acceptance by the commissioner of a comprehensive salmon production plan or other RPT product or recommendation.

comprehensive salmon production plan - a statutorily-mandated, strategic plan, spanning a specified number of years (10- to 20-year range), for perpetuation and increase of salmon resources on a regional basis.

criteria - accepted measures or rules for evaluation of programs, project proposals, and operations.

depressed stock - a stock (of fish) that is currently producing at levels far below its historical levels.

enhancement - strategies/procedures designed to supplement the harvest of naturally produced stock (e.g., salmon) beyond what could be naturally produced in its natural habitat. This can be accomplished by artificial or semi-artificial production systems or by an increase in the amount of productive habitat in the natural environment through physical or chemical changes.

epilimnion - layer of water overlying the thermocline of a lake and subject to action of the wind.

escapement - salmon that pass through the fisheries to return upstream to a spawning ground or used as brood stock in a hatchery.

euphotic zone - constituting the upper layers of a body of water into which sufficient light penetrates to permit growth of green plants.

ex-vessel value - price paid to the commercial fishermen for their catch.

eyed egg - stage in which the eyes of the embryo become visible.

fecundity - number of eggs per adult female salmon (or other fish).

fingerling - stage of salmon life between fry and smolt.

fishery - a specific administrative area in which a specific fishery resource is taken with a specific type of gear.

fish pass - fish ladder to enable salmon to get past a barrier (e.g., waterfall) to reach spawning grounds.

fish stock - a species, subspecies, geographic grouping, or other category of fish manageable as a unit.

fish wheel - a fixed, rotating device for catching fish that has no more than four baskets on a single axle and is driven by river current or other means.

five-year action plan - section of a comprehensive salmon production plan that recommends projects for implementation within the next five years.

fry - stage of salmon life from emergence from gravel until it doubles its emergence weight.

gillnet - a net primarily designed to catch fish by entanglement in the mesh and consisting of a single sheet of webbing hung between cork line and lead line and fished from the surface of the water: (a) a set gillnet is one that has been intentionally set, staked, anchored, or otherwise fixed and (b) a drift gillnet is one that has not been intentionally staked, anchored, or otherwise fixed.

goals - broad statements of what a regional planning team, with input from the user groups, hopes to see accomplished within a specified period of time.

green egg - stage of salmon egg development from ovulation until the eye becomes visible, at which time it becomes an eyed egg.

habitat - the place or type of site where a plant or animal naturally or normally lives and grows.

hatchery - facility in which people collect, fertilize, incubate, and rear fish.

incidental catch - harvest of a salmon species other than the desired species for which the fishery is managed. Fish of another species and/or stock caught during harvest of specific species and/or stock.

instream incubator - device located in or adjacent to a stream that collects water from the stream and is used to incubate and hatch salmon eggs.

limnology - the scientific study of physical, chemical, meteorological, and biological conditions in fresh waters.

littoral zone - pertaining to the shore and, in fresh waters, confined to those zones in which rooted vegetation occurs.

macrophytic vegetation - plant life on a body of water large enough to be viewed by the naked eye.

mixed stock fishery - harvest of salmon at a location and time during which several stocks are intermingled. Harvest of more than one stock at a given location and/or period.

natural production - salmon that spawn, hatch, and rear without human intervention (i.e., in a natural stream environment).

NSEDC - Norton Sound Economic Development Corporation

NSRPT - Norton Sound\Bering Strait Regional Planning Team.

otolith - calcified ear bones of fish that offer future environmental marking promise. Manipulation of water temperature can produce distinctive otolith banding patterns in juvenile salmon, and these patterns can be used to identify specific groups of hatchery fish or differentiate between other hatchery and wild fish stocks.

pelagic - pertaining to the open ocean as opposed to waters close to shore.

periphytic vegetation - relating to small plant organisms that live attached to underwater surfaces or substrate; e.g., algae, diatoms.

personal use fishing - the taking, fishing for, or possessing of finfish, shellfish, or other fishery resources by Alaska residents for personal use and not for sale or barter with gill or dip net, seine, fish wheel, long line, or other means defined by the Board of Fisheries.

pot - box-like or conical trap covered with mesh for catching fish or shellfish.

plan development - composing, drafting, revising, and finalizing a comprehensive salmon production plan document.

PNP - private nonprofit: level and/or operational status of a private-sector organization without profit motives.

present condition - average catch for the last five years.

private nonprofit hatchery permit application - request presented by a private nonprofit corporation to the Department of Fish and Game for a permit to operate a private nonprofit hatchery.

private sector - that group active in salmon resource development that is not employed by government.

production - perpetuation or increase of the salmon resource through maintenance, rehabilitation/restoration, or enhancement programs and techniques.

project - unit of work having a beginning, middle, and end that functions according to defined performance criteria.

projected status - continuation of the present condition without additional supplemental production.

public sector - that group active in salmon resource development that is employed by government.

recruitment - upcoming or next generation of fish.

regional aquaculture association (RAA) - statutorily-based nonprofit corporation comprised of representatives of fisheries user groups organized for the purpose of producing salmon.

regional planning team (RPT) - statutorily mandated planning group, composed of ADF&G staff and regional aquaculture association representatives, designated to develop a comprehensive salmon plan.

rehabilitation/restoration - procedures applied to a depressed natural stock of fish (e.g., salmon) to increase or rebuild it to historical abundance using management, enhancement, habitat protection/restoration, or other applicable strategies.

review and comment process - collection of accepted procedures to solicit and generate examination and remarks.

revised plan - comprehensive salmon planning document resulting from incorporation of commissioner-approved material into a plan.

roe - eggs of a fish.

run - returning salmon stock(s) bound for spawning area; these stocks are often further described by their timing and numbers.

run strength - total run of salmon, including escapement plus harvest.

salmon:

Chinook (king) - <u>Oncorhynchus</u> <u>tshawytscha</u>
Chum (dog) - <u>Oncorhynchus</u> <u>keta</u>
Coho (silver) - <u>Oncorhynchus</u> <u>kisutch</u>
Pink (humpy or humpback) - <u>Oncorhynchus</u> <u>gorbuscha</u>
Sockeye (red) - <u>Oncorhynchus</u> <u>nerka</u>

salmon stock - population of salmon identified with a specific water system, or portion thereof. Salmon of a single species that are produced from a single geographic location and are of the same genetic origin.

seine (purse) - a floating net designed to surround fish that can be closed at the bottom by means of a free-running line through one or more rings attached to the lead line.

seine (beach) - a floating net designed to surround fish that is set from and hauled to the beach.

seine (hand purse) floating net designed to surround fish that can be closed at the bottom by pursing the lead line; pursing may only be done by hand power, and a free-running line through one or more rings attached to the lead line is not allowed.

smolt - salmon, trout, or char that have passed through the physiological process of becoming ready to migrate to salt water.

sonar - technology that uses sound waves in water to detect submerged objects such as schools of fish.

spawn - (verb) to produce or deposit eggs; (noun) a mass of spawned eggs.

spawning channel - engineered addition to natural salmon spawning habitat in which water flow, substrate, sedimentation, and predation are controlled to increase egg-to-fry survivals.

sport fishery - the taking of or attempting to take for personal use and not for sale or barter, any fresh water, marine, or anadromous fish by hook and line held in the hand, or by hook and line with the line attached to a pole or rod which is held in the hand or closely attended, or by other means defined by the Board of Fisheries.

stock - group of fish that can be distinguished by their distinct location and time of spawning.

stock restoration - *see* above definition for rehabilitation/restoration.

subsistence fishery - the taking of, fishing for, or possession of fish, shellfish, or other fisheries resources by a resident domiciled in a rural area of the state for subsistence uses with a gillnet, seine, fish wheel, longline, or other means defined by the Board of Fisheries.

subsistence use - resources - the noncommercial, customary and traditional uses of wild, renewable by a resident domiciled in a rural area of the state for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of nonedible by-products of fish and wildlife resources taken for personal or family consumption, and for the customary trade, barter, or sharing for personal or family consumption.

supplemental production - salmon produced by method other than natural spawning using enhancement and/or rehabilitation methods.

take - taking, pursuing, hunting, fishing, trapping, or in any manner disturbing, capturing, or killing or attempting to take, pursue, hunt, fish, trap, or in any manner capture or kill fish or game.

terminal fishery - area where a terminal fishery harvest could be conducted.

thermal band - several closely grouped and equidistantly spaced thermal rings that visually blend together at low magnification (< 100K).

thermal cycle - occurrence of one ambient and one treated water event at a pre-identified temperature differential and combination of hours; one thermal cycle produces one thermal ring. A band or separation cycle is a modified thermal cycle designed to separate thermal bands by 2.5 times the distance between the rings.

thermal mark (TM) - discrete complex of rings on otolith resulting from temperature manipulations that identifies a specific brood stock or group.

thermal marking - process where a visibly enhanced increment or ring is induced in the microstructure of the otolith through controlled and repeated temperature fluctuations of the incubation water; these fluctuations result in an ordered complex of rings.

thermal ring - a single dark ring on the otolith resulting from temperature decline within one cycle. Microscopic viewing at high magnification (> 100K) is required to resolve ring structure. A hatchmark is a dark ring or a tight complex of rings that are naturally induced in the otolith during hatching. Its visual structure is often similar to a thermal ring; therefore, marking the prehatch embryo is preferred.

thermocline - layer of water in a lake separating an upper warmer lighter oxygen-rich zone for a lower colder heavier oxygen-poor zone.

total run (run strength) - number of salmon returning in a year for a stock or area (escapement plus harvest number).

trawl - a bag-shaped net towed through the water to capture fish or shellfish: (a) a beam trawl is a trawl with a fixed net opening utilizing a wood or metal beam; (b) an otter trawl is a trawl with a net opening controlled by devices commonly called otter doors; and (c) a pelagic trawl is a trawl where the net, trawl doors, or other trawl-spreading devices do not operate in contact with the seabed, and which does not have attached to it any protective device, such a chafing gear, rollers, or bobbins, that would make it suitable for fishing in contact with the seabed.

troll - this gear group consists of a line or lines with lures or baited hooks that are drawn through the water from a vessel either by hand trolling, strip fishing, or other types of trolling and retrieved by hand power or hand-powered crank (i.e., hand troll) or drawn and retrieved by electrical, hydraulic, mechanical or other assisting devices or attachments (i.e., power troll).

uniform procedures - those practices that have been accepted by planning participants as appropriate for conducting or accomplishing a task.

user group - identification by method and/or reason for the harvest of salmon (commercial, sport, or subsistence).

vessel - a floating craft powered, towed, rowed, or otherwise propelled, which is used for delivering, landing, or taking fish within the jurisdiction of the state, but does not include aircraft.

weir - fence, dam, or other device by which the stream migrations of salmon (or other fish) may be stopped or funnelled through for enumeration or holding purposes.

wild stock - any stock of salmon that spawns naturally in a natural environment and is not subjected to human-made practices pertaining to egg deposition, incubation, or rearing. Stocks that have not been rehabilitated or enhanced.

zooplankton - free-swimming, drifting, or floating organisms, mostly microscopic in size, which are found primarily in open water and are an important source of food for small fish.

# APPENDIX A

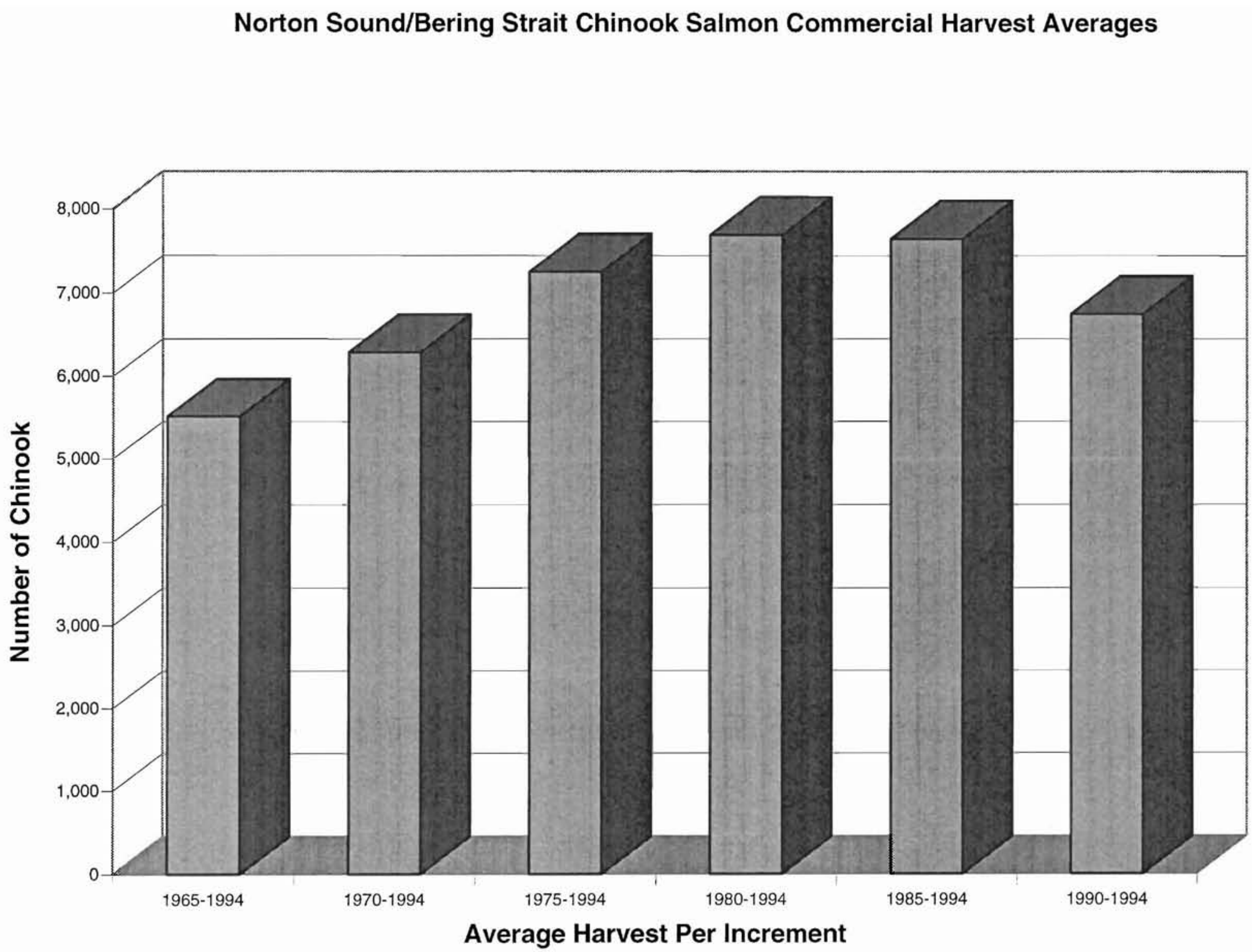


Figure 1. Commercial harvest averages for chinook salmon in Norton Sound/Bering Strait region, 1965-1994 (30 years), 1970-1994 (25 years), 1975-1994 (20 years), 1980-1994 (15 years), 1985-1994 (10 years), and 1990-1994 (5 years).

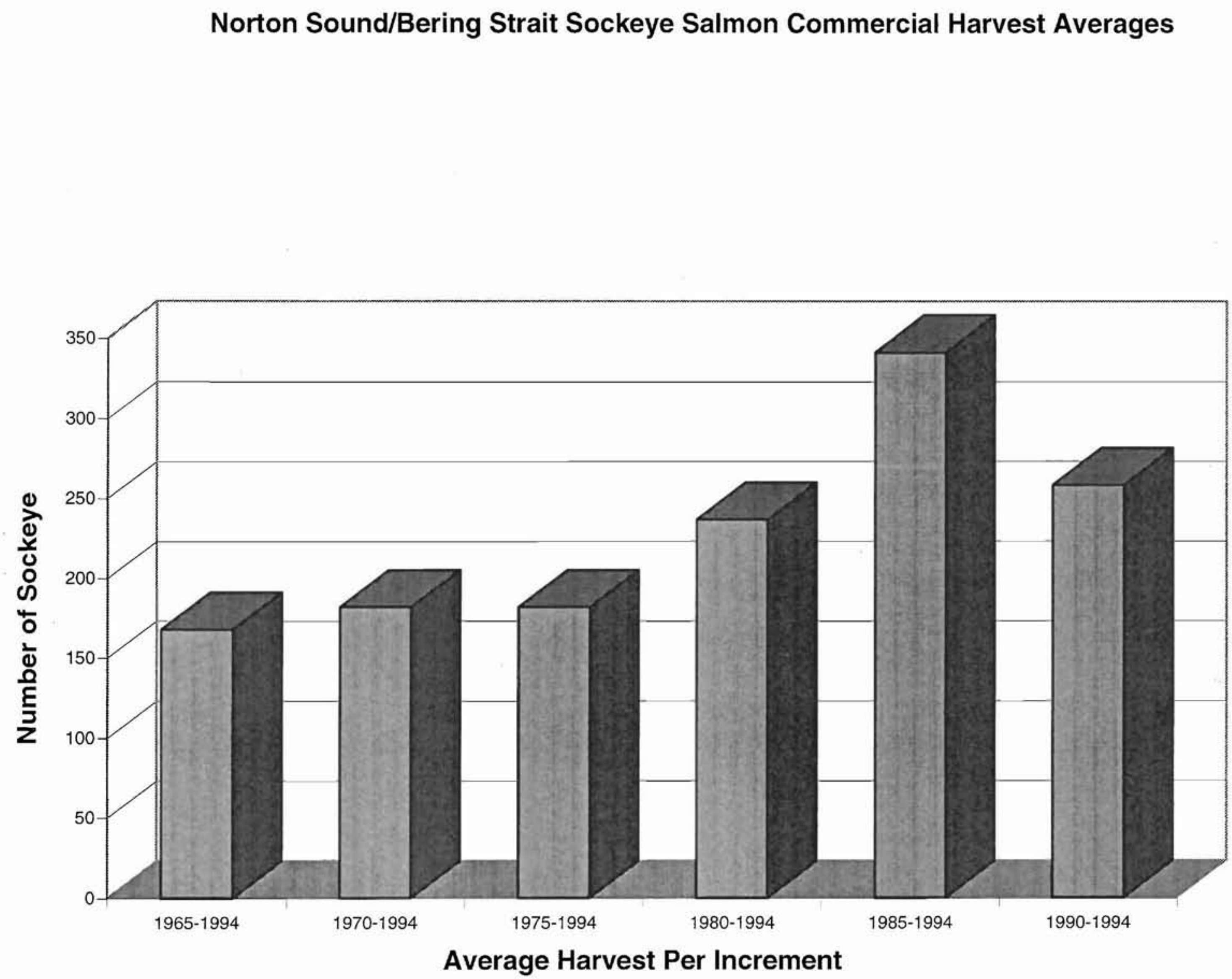


Figure 2. Commercial harvest averages for sockeye salmon in Norton Sound/Bering Strait region, 1965-1994 (30 years), 1970-1994 (25 years), 1975-1994 (20 years), 1980-1994 (15 years), 1985-1994 (10 years), and 1990-1994 (5 years).

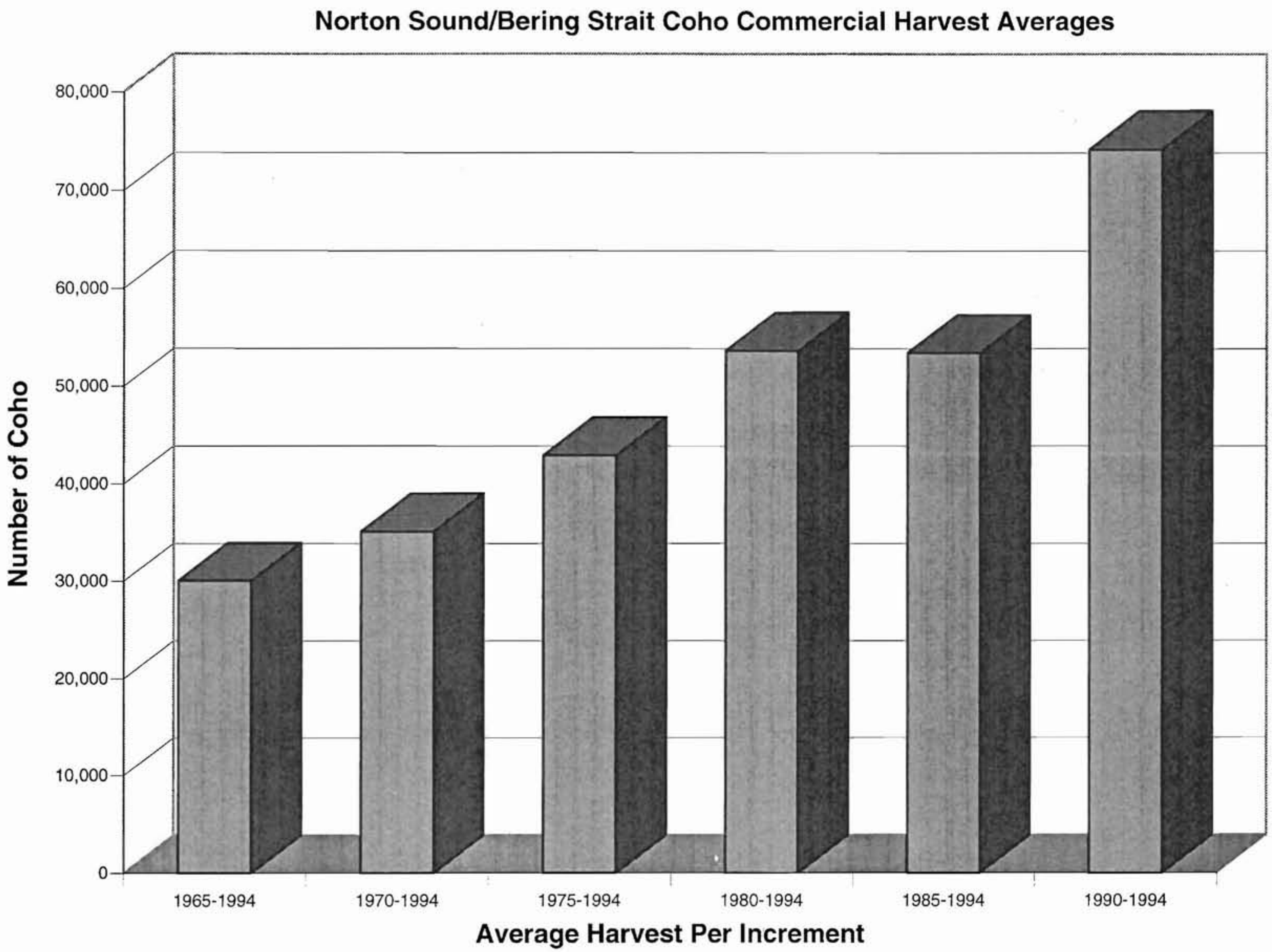


Figure 3. Commercial harvest averages for coho salmon in Norton Sound/Bering Strait region 1965-1994 (30 years), 1970-1994 (25 years), 1975-1994 (20 years), 1980-1994 (15 years), 1985-1994 (10 years), and 1990-1994(5 years).

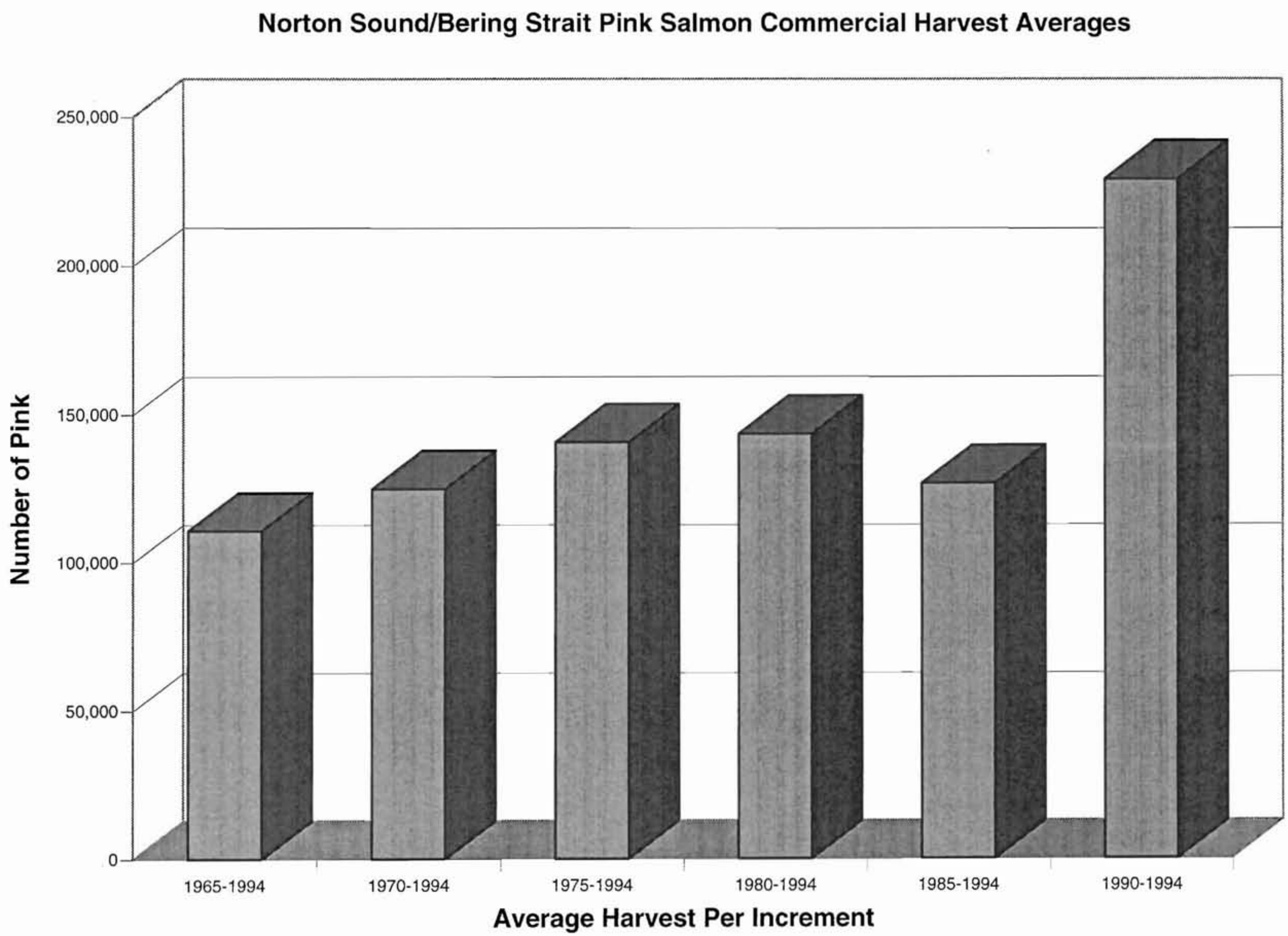


Figure 4. Commercial harvest averages for pink salmon in Norton Sound/Bering Strait region, 1964-1994 (30 years), 1970-1994 (25 years), 1975-1994 (20 years), 1980-1994 (15 years), 1985-1994 (10 years), and 1990-1994 (5 years).

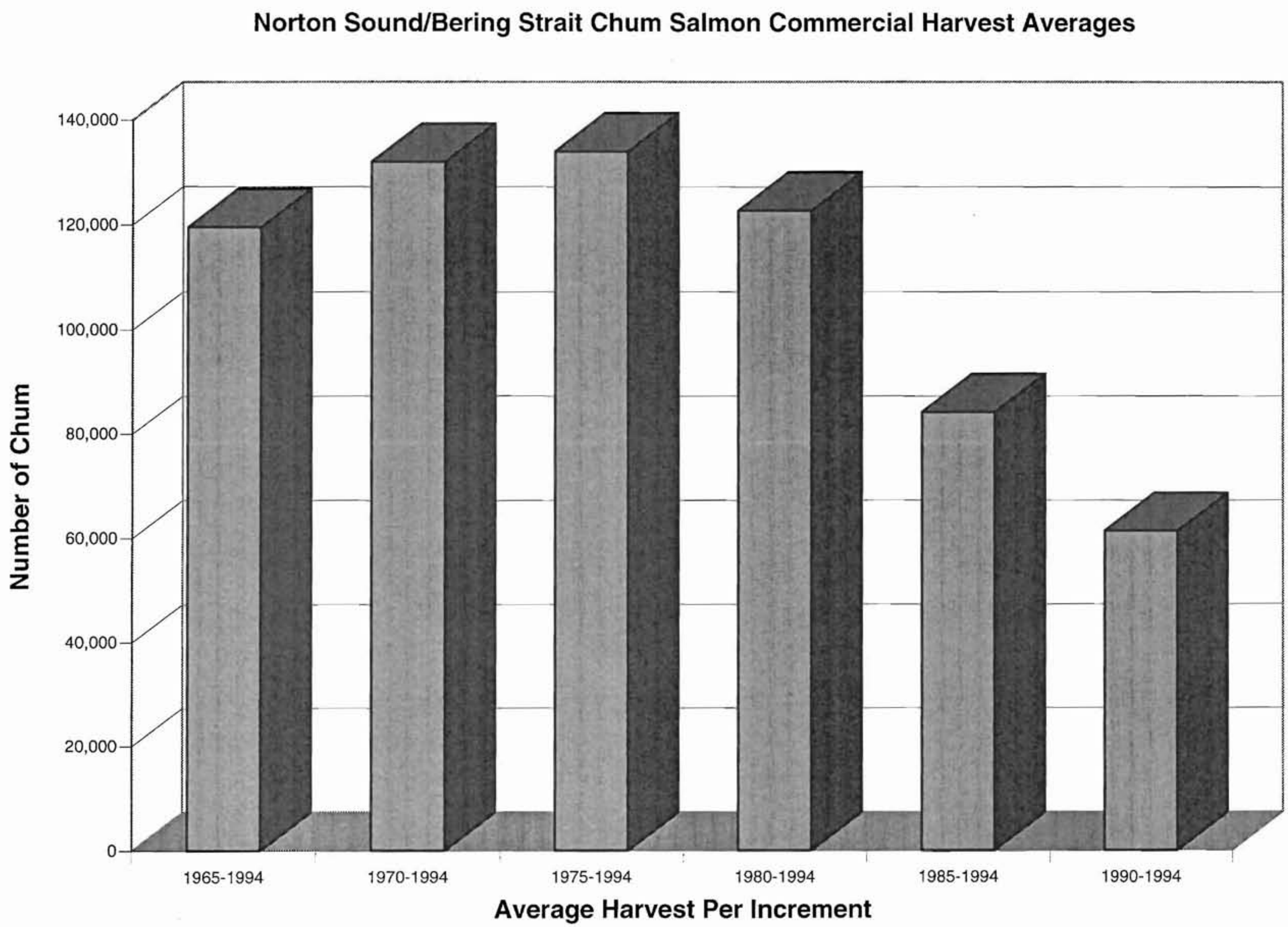


Figure 5. Commercial harvest averages for chum salmon in the Norton Sound/Bering Strait region, 1965-1994 (30 years), 1970-1994 (25 years), 1975-1994 (20 years), 1980-1994 (15 years), 1985-1994 (10 years), and 1990-1994 (5 years).

**Norton Sound/Bering Strait Total Salmon Commercial Harvest Averages (all species)**

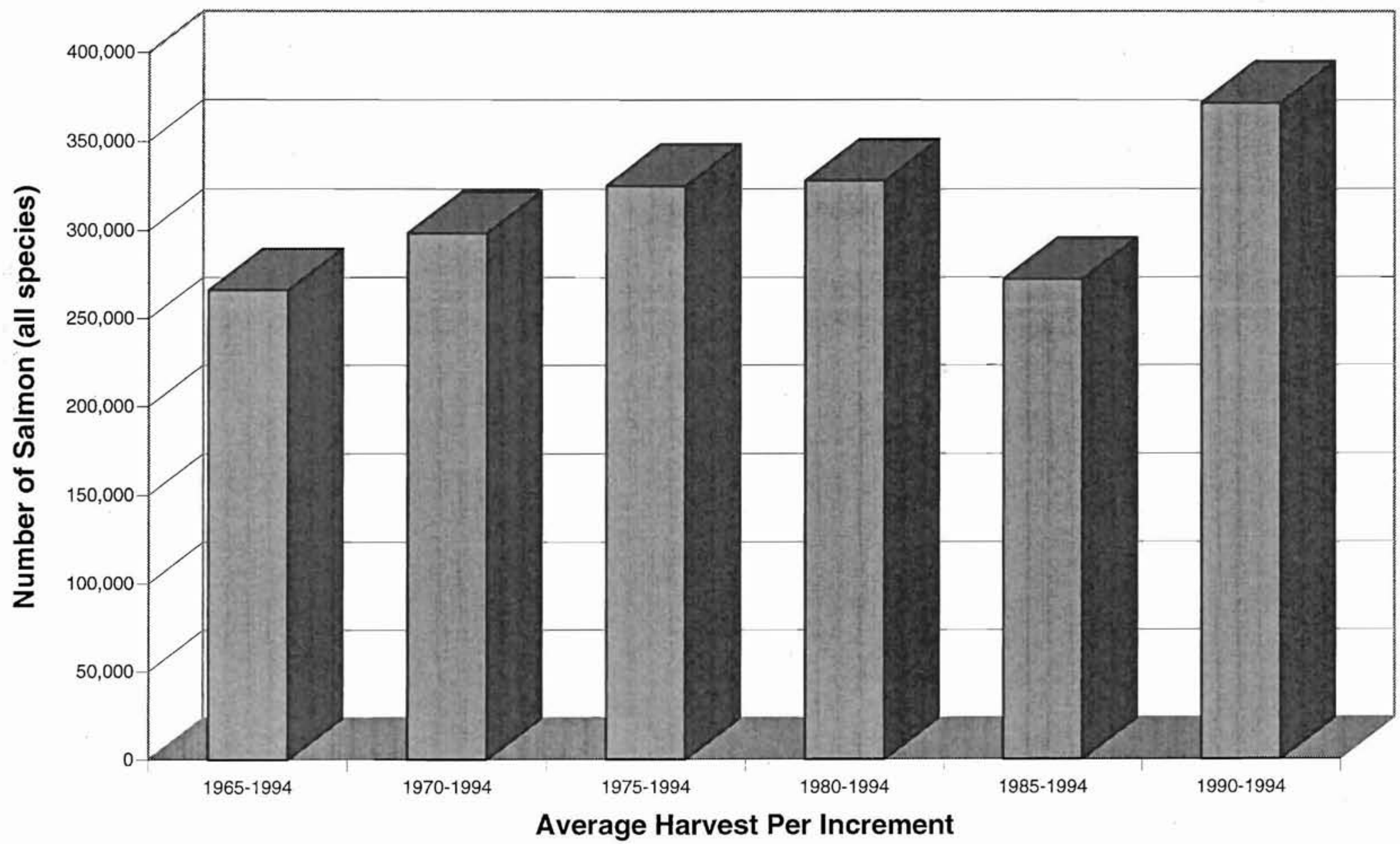


Figure 6. Commercial harvest averages for all species of salmon in Norton Sound/Bering Strait region, 1965-1994 (30 years), 1970-1994 (25 years), 1975-1994 (20 years), 1980-1994 (15 years), 1985-1994 (10 years), and 1990-1994 (5 years).

## APPENDIX B

REGIONAL PLANNING TEAM REVIEW CRITERIA FOR PROJECT PROPOSALS IN THE NORTON SOUND/BERING STRAIT REGION

1. Will it make a significant contribution to the common-property fisheries? (Authority: Section 1, Chapter 111, SLA 1974). The RPT will consider and make its recommendations on each species to be produced if there is a reasonable opportunity for common property harvest consistent with the average common property fishery exploitation rate for that species. For a site to be suitable for private nonprofit development, there must be capability to generate common property harvest.

Considerations pertinent to determining the potential common property benefits include:

Does the application contain significant omissions or error in assumptions? If so, the use of more accurate assumptions might indicate decreased benefits to common property fisheries. Pertinent assumptions might include those relating to (1) interception (harvest) rates in common property fisheries and (2) survivals of green eggs to adults.

If returns cannot provide at significant common property benefit in the traditional fisheries, is there an adequate terminal area where new fisheries could be created for the desired common property benefit without endangering the wild stock?

If the application provides insufficient information for adequate RPT evaluation, the team will request additional information. If they conclude that basic production and harvest assumptions are not realistic, they will recommend that changes in the proposed projects be incorporated by the applicant.

2. Does it allow for continued protection of wild stocks? (Authority: Section 1, chapter 111, SLA 1974) (AS 16.400(g) and AS 16.10.420/10). Any judgment as to the acceptability of impacts on natural stocks from an enhancement project should be make on only on the actual and potential size of the affected wild stocks, but also on the extent of benefits from enhancement and alternative enhancement opportunities in the area that may have less impact on natural stocks. Considerations include:

Can management or harvest strategies be developed to allow harvest of enhanced returns while protecting natural stocks?

Does the affected stock actually or potentially support a commercial, sport, and/or subsistence fishery?

Does the affected stock have unique characteristics or are there special circumstances (e.g., a unique early run of coho)?

3. Is the proposed project compatible with the Comprehensive Plan? (Authority: Section 1, chapter 111, SLA 1974) (AS 16.10.375, AS 16.10.400(g)). The goals and objectives of the

Comprehensive Plan that identifies ongoing and proposed projects that are compatible with management strategies for the wild stocks. Thus, the goals, objectives, and recommendations contained in the plan provide a basis for evaluating all projects. The proposed project should also be compatible with management concerns and guidelines set forth in the plan and with specific recommendations concerning strategies and projects.

The RPT, in its recommendation to the commissioner, will take all of these factors into consideration in determining the project's compatibility with the comprehensive plan.

4. Does it make the most appropriate use of the site's potential? (Authority: AS 16.10.400(g), AS 16.10.430(b)). A number of opportunities for further restoration and enhancement projects exist in the Norton Sound/Bering Strait region. If the plan goals and objectives, as well as substantial public benefits, are to be achieved, enhancement and restoration projects must be developed to their fullest potential with appropriate species using the best available technology.

In most instances, investigation will show one strategy to be far more effective than the others. Within a given strategy, it will be extremely important that the proposed project will develop the site appropriately and to its full potential.

Given technical feasibility, the RPT's determination of the appropriate development of a site will be based on such factors as the magnitude of its water supply, harvest potentials, manageability, and potentials to address user needs.

The applicant, in his application and presentation to the RPT, should demonstrate adequate plans for the site and the capabilities to carry them out. If the applicant does not show adequate planning and documentation, the RPT cannot judge the proposed project's ability to satisfy any criteria or determine whether the proposed project would result in public benefit as required under AS 16.10.400(g), AS 16.10.430(b).z, and the Guiding Principles and Planning Assumptions of the plan.

An applicant should document to the RPT an ability to develop the site properly and to its full potential. This documentation should include:

Plans for implementation and full development of long- and short-term production goals and objectives; and an adequate description of plans for incubation and/or rearing.

The RPT will formulate a recommendation based on its review of the application and forward it to the commissioner within 14 days of the date when the application is considered. The RPT's recommendation should not be construed as denoting the decision to be made by the Commissioner. The ADF&G staff as well as concerned members of the public may also provide reviews and recommendations to the Commissioner. The Commissioner may uphold or reject the recommendations of the RPT after reviewing all the merits and potential problems associated with the proposal.

Since the RPT need adequate review time prior to considering an application, it will generally require that applications and attendant materials be received by the RPT members at least two weeks before the meeting at which the application is to be considered. It may also request additional information during the initial review if the information in the application is inadequate. A representative from the corporation making the application will be expected to make a presentation of the proposal at the RPT meeting.

Alaska statutes specifically grant the RPT an opportunity to review a permit suspension or revocation. However, revocation by the Commissioner would occur only as a very last, unavoidable course of action. It is far more desirable to identify problems early and attempt to remedy them. Existing procedures provide for an annual evaluation of operating projects. The annual report and/or annual management plan supplies information on the project's performance., and RPT review of annual reports and/or annual management plans is a part of ongoing planning duties. This departmental and RPT review allows for monitoring or ongoing performance.

If the department has determined that a project's performance is inadequate and that a permit suspension or revocation is being considered, the Commissioner will notify the RPT, and the RPT will be provided with an opportunity to make a recommendation on the proposed action. In evaluating any PNP operation that is referred to the RPT by the Commissioner, the RPT will use the specific performance criteria in their review, evaluation, and recommendation to the Commissioner. The criteria are established in 5 AAC 40.860 of the 1986 edition of the "Alaska Statutes and Regulations for Private Nonprofit Hatcheries." The RPT, in this evaluation, will also consider any mitigating circumstances that were beyond the control of the project operators.

The reader is referred to the next section (i.e., Project Review Criteria and New Project Solicitation Form) for a detailed listing of criteria used during an initial review by the RPT of rehabilitation and enhancement projects.

Contribution to the fisheries of the Norton Sound/Bering Strait region will be the ultimate measure of project performance; however, it is not easy to define this criterion in measurable terms or to delineate what actions should be taken if the criterion is not met. Furthermore, the build-up of production at any project may be slow, so that the ultimate success or failure cannot be determined for many years. As experience with these restoration and rehabilitation projects is gained, the performance criteria should be reviewed and refined as needed. There is additional project review criteria for consideration in addition to those listed above.

## PROJECT REVIEW CRITERIA
## NORTON SOUND/BERING STRAIT REGION

FISHERY CONCERNS:

1. Is supplemental salmon production needed and desirable?

   a. What is the socioeconomic impact on local residents and fishermen?

   b. Do the public and user groups want a restoration or enhancement project in that location?

   c. Will the project fulfill a substantial portion of the region's 15-year target goals?

SITE LOCATIONS:

1. Can the restoration or enhancement project be implemented?

   a. Is the land available for use, and will the landowners consent to the project?

   b. What is the likelihood of the permit applications being approved or disapproved.

   c. Is the site area suitable and of sufficient size for the proposed project?

   d. Will the site require special biological and/or engineering studies and surveys (i.e., land, soil, water, and organisms)?

   e. Will the project be compatible with existing and future development in the area (i.e., potential habitat conflicts)?

2. Can the proposed project be operated and maintained?

   a. How accessible and logistically difficult will the project be to operate/maintain (i.e., access by road, air, or sea and distance from supply point)?

   b. Winter access and supply problems (i.e., bay ice conditions)?

3. Is the water supply adequate and suitable?

   a. Adequate flow year around for intended operations?

b. Are water quality and seasonal temperature regimes within acceptable parameters?

c. Are exclusive water rights available, and can water quality be maintained.

d. Will future land/habitat uses conflict with quality or quantity of the water supply?

4. Can brood fish be obtained and held?

a. Are local brood fish stocks available and in sufficient number at the right time?

b. Is brood fish disease history known and are disease problems anticipated?

c. Can brood fish be protected from the fishery and held in estuary or other holding area for ripening?

5. Can fry production be reared?

a. Is the estuary suitable for saltwater rearing pens (i.e., protected from seas, sufficient depth, salinities, temperature, fouling organisms, etc.)?

b. Can rearing be accomplished with land-based facilities (water and facility requirements)?

6. What is the capacity of the estuary and bay for additional salmon rearing?

a. Are food organisms abundant and available at time of release?

b. Will abundance of predatory and competitor species severely limit survival of hatchery fish?

c. Are estuarine and bay conditions suitable for good fry survival?

7. Can adult returns from projects be readily evaluated?

a. Will returning fish be mixed with other stocks?

b. What type and quantity of evaluation effort will be required to assess project success?

FEASIBILITY CONCERNS:

1. Are cost/benefit ratios and Net Present Value (NPV) acceptable and justifiable?

2. Are there specific or special economic impacts, benefits, and costs involved?

3. If implemented, will the restoration or enhancement project distract from other worthwhile or perhaps more feasible projects and facilities for the region?

## SPORT FISH PROJECT REVIEW CRITERIA

1. Fishery Status
   - Is it a depressed fishery?
   - Has the fish population been decimated or eliminated?

2. Habitat Assessment
   - Lakes should be five acres in size or large, at least eight feet deep.
   - Predator/competitor concerns must be identified.
   - Available spawning area should be identified/estimated.
   - Water quality characteristics.
     - D.O., Temp., Alkalinity, Conductivity
     - Morphodaphic Index-richer lakes are stocked prior to poorer lakes.

3. Access
   - Will it create new fisheries (has to have the potential)?
   - Accessible to the fishing public, anything you can hike to from the Kodiak road system within two hours would be a priority over fly-in.

4. Effect on Management
   - New sport fish projects should not complicate commercial fisheries management plans.

5. Lake Stocking Guidelines
   - ADF&G guidelines should be adhered to with any new projects.

6. Genetics Consideration
   - Donor stocks would have to be taken from as close to the area as possible.

## COMMERCIAL/SUBSISTENCE FISHERIES PROJECT REVIEW CRITERIA

Regarding supplemental production from an enhancement project (e.g., hatchery):

1. What are the potential effects on management plans with the implementation of the enhancement project?

2. What effects will the proposed production, by species, have on present management schemes?

3. What effects will the enhanced stocks (and their harvest) have on natural stocks in the area?

4. Can returns be harvested to provide "significant" common property benefits in traditional fisheries?

5. Is there an adequate terminal area where new fisheries could be created to affect the desired common property benefit?

6. Does the project as proposed allow for the continued protection of natural stocks?

   a. Can management or harvest strategies be developed to allow harvest or enhanced returns while protecting natural stocks?

   b. Is there a segregated area for harvest that will provide adequate cost recovery without impacting wild stocks?

   c. Does the affected wild stock actually or potentially support a commercial, sport, and/or subsistence fishery?

   d. Does the affected stock have unique characteristics or are there special circumstances (e.g., an unique early run of coho)?

   e. What is the degree of risk and the probable degree of loss to the natural stocks?

7. Does the enhancement proposal make the most appropriate use of the site's potential?

8. Does the proposed project pose any disruption to preexisting subsistence fisheries.

Ref./File#:________

Date:_____________

**NORTON SOUND/BERING STRAIT**
**REGIONAL PLANNING TEAM**
**FISHERIES REHABILITATION AND/OR ENHANCEMENT**
**NEW PROJECT SOLICITATION FORM**

This form is to be used by ADF&G and other government agency personnel and the public to identify opportunities that may be worthy to pursue to help rehabilitate and/or enhance the fisheries.

PROJECT DESCRIPTION:

1. WHAT: (Give a brief description of the project):

___________________________________________

___________________________________________

___________________________________________

___________________________________________

___________________________________________

___________________________________________

2. WHERE (be specific as to project location):

___________________________________________

___________________________________________

___________________________________________

___________________________________________

___________________________________________

_______________

3. BENEFITS TO USER GROUPS:

___________________________________________

___________________________________________

___________________________________________

___________________________________________

4. COST ESTIMATE OF PROJECT (IF KNOWN):

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

5. SUBMITTED BY:

Name:______________________________ Date:______________________________

Address:____________________________ Phone:_____________________________

___________________________________ Occupation:_________________________

6. SUBSISTENCE COMMENTS:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

7. COMMERCIAL FISHERIES MANAGEMENT COMMENTS:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

8. SPORT FISH MANAGEMENT COMMENTS:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

9. HABITAT PROTECTION COMMENTS:

10. COMMERCIAL FISHERIES DEVELOPMENT COMMENTS:

11. REMARKS:

Ref./File #:________
Date:____________

**POTENTIAL PROJECT VERIFICATION FORM**

NAME:______________________________ Date:______________________________

LATITUDE:__________________________ SURVEYED BY:______________________

LONGITUDE:____________________________________________________________

GEODETIC MAP NO:______________________________________________________

LOCATION:_____________________________________________________________

AERIAL SURVEY NOTES:__________________________________________________

______________________________________________________________________

______________________________________________________________________

TRAILS:_______________________________________________________________

______________________________________________________________________

PROJECT WILL PRIMARILY BENEFIT:_______________________________________

______________________________________________________________________

AVAILABLE ESCAPEMENT DATA:

| Year | Pink | Chum | Coho | Sockeye | King | Steelhead |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
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| | | | | | | |
| | | | | | | |

Other Species Present:________________________________________________

______________________________________________________________________

## ELEMENTS OF BENEFIT /COST ANALYSIS

Steps for undertaking the projects identified in this plan will incorporate variables such as the facilities and equipment, cost of operations, and the financing.

Feasibility of a Project

In determining the feasibility of a project, the team may consider the four following questions:

1. Are benefit/cost ratios and Net Present Value acceptable?
2. What special economic impacts, benefits, and costs are involved?
3. If a hatchery or other facility is constructed, will it detract from other more worthwhile projects in the region?
4. Will the cost for an annual hatchery or other facility operation and maintenance decrease funding available for other projects in the region?

Costing a Project

The cost of a project can generally be segregated into three major categories, depending upon the nature and the scope of the task. These are as follows:

Facility and Equipment:

- Site section, including studies of alternative areas.
- Site acquisition.
- Construction costs, including planning fees.
- Equipment acquisition.

Operations:

- Cost of labor, utilities, fish feed, personnel, and maintenance costs.
- Administrative.
- Project evaluation costs.

Financing:

- Available funding sources.

- Current interest rates.

Economic benefits to most groups directly affected by specific projects are easier to identify. However, the benefits of an enhanced fishery to sport and personal use fishermen are, again, very subjective and therefore difficult to assign a dollar value. The dollar impact to this group may not vary significantly from project to project and, when compared to the total economic benefit/cost ratio, will not have a significant effect on the overall analysis.

Economic Benefits to Commercial Fishermen and Processors

The economic benefits to these two groups can be expressed in dollar terms throughout the analysis of two major components; the anticipated increase product available for catch and the dollar value of the catch increase. Regardless of the nature of the project, however, the amount of product available depends on the annual adult salmon rate of return and the annual catch rate, expressed in terms of pounds of product.

Variables to Consider in Determining the Product Value

The value of the caught product includes a scrutiny of the following variables:

1. Type of product;

2. Anticipated market price, including the effect of world supply and demand on the market price; and

3. Cost of catching and processing the product.

In order to prepare a benefit/cost analysis for hatchery stock development, a form is available from ADF&G which provides in detail the variables required to determine the quantity of catchable product, value of the catch, impact multipliers, and cost information relating the development of fish hatcheries. For more information, contact your local ADF&G office.

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