CHAKACHAMNA HYDROELECTRIC PROJECT
INTERIM FEASIBILITY ASSESSMENT REPORT

VOLUME II

APPENDIX TO SECTION 6.0

BECHTEL CIVIL & MINERALS INC.

ENGINEERS – CONSTRUCTORS

BECHTEL

MARCH 1983

ALASKA POWER AUTHORITY

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ANCHORAGE, ALASKA

CHAKACHAMNA HYDROELECTRIC PROJECT
INTERIM FEASIBILITY ASSESSMENT REPORT, MARCH 1983

VOLUME II

TABLE OF CONTENTS

VOLUME II

LIST OF TABLES

Section			Page

VOLUME II

LIST OF TABLES

Table No.	Title
6-46	Estimated escapement of chum salmon, 1982
6-47	Estimated escapement of coho salmon, 1982
6-48	Percent species composition of fish collected for all fyke net combined - 1982
6-49	Percentage species composition of fish collected in fyke net 6, Chakachatna River - 1982
6-50	Monthly catch per effort values for all lifestages of major species collected by fyke nets - 1982
6-51	Percentage of total fyke net catch per effort represented by sub-adults of all species - 1982
6-52	Species composition by location fyke nets - 1982
6-53	Percentage of species - specific catch per effort (c/f) represented by each lifestage for major species collected by fyke net 6 - 1982
6-54	Mean (X) and standard error (SE) for catch per effort - values for all lifestages of major species collected by fyke net - 1982
6-55	Results of mark and recapture of Dolly Varden (DV) and rainbow trout (RT) on the McArthur-Ckakachatna system. Fish tagged at fyke net stations - 1982
6-56	Catch per effort: minnow trap samples, August 1982
6-57	Catch per effort: minnow trap samples, September 1982
6-58	Catch per effort: minnow trap samples, October 1982
6-59	Dolly Varden parr catch per effort using minnow traps - 1982
6-60	Dolly Varden juveniles catch per effort using minnow traps - 1982
6-61	Dolly Varden juvenile and parr catch per effort using minnow traps - 1982

VOLUME II

LIST OF FIGURES

Figure No.	Title
6-1	Approximate Boundary of Chakachamna Lake Study Area
6-2	Locations of Hydrologic Study Areas, Representative Locations and Channel Configuration Reach Boundaries
6-3	Stream and Floodplain Transect on Chakachatna River Showing Approximate Range of Natural Stages
6-4	Stream and Floodplain Transect on Upper McArthur River Showing Approximate Range of Natural Stages
6-5	Stream and Floodplain Transect on McArthur River Showing Approximate Range of Natural Stages
6-6	Hydraulic Geometry of Chakachatna River Showing Approximate Range of Natural Flow
6-7	Hydraulic Geometry of Upper McArthur River Showing Approximate Range of Natural Flow
6-8	Hydraulic Geometry of McArthur River Showing Approximate Range of Natural Flow
6-9	Chakachamna Lake Bottom Profile Offshore from Shamrock Glacier Rapids
6-10	Chilligan River and Chakachamna Lake Bottom Profiles
6-11	Electroshocking and Seine Sampling Locations
6-12	Location of Fixed Net Sets
6-13	Habitat Utilization of Chakachatna River
6-14	Sockeye Salmon Spawning Area - Chilligan River and Kenibuna Outflow
6-15	Potential Sockeye Spawning Areas - Chakachamna Lake
6-16	Chum and Sockeye Spawning Areas - Chakachatna River Canyon and Straight Creek
6-17	Chakachatna River Mainstem Sockeye, Chum and Pink Salmon Spawning Areas

CHAKACHAMNA HYDROELECTRIC PROJECT
INTERIM FEASIBILITY ASSESSMENT REPORT

VOLUME II

APPENDIX TO SECTION 6.0
ENVIRONMENTAL APPENDIXES A1 - A5

BECHTEL CIVIL & MINERALS INC.

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6.0 ENVIRONMENTAL STUDIES

As described previously, one component of the Chakachamma Project Interim Feasiblity Assessment is an environmental evaluation of the natural and human resources. To accomplish the evaluation, the environmental studies were divided into four disciplines: environmental hydrology, acquatic biology, terrestrial biology, and human resources. The objectives of this study are to:

- obtain sufficient information on the environment of the study area to identify constraints that may be placed on the project, potentially affecting its feasibility; and

- obtain information to assist in the preparation of the environmental exhibits for a FERC license application.

To meet these objectives a two phase program was designed. Phase I consisted of reconnaissance-level surveys conducted during the fall of 1981. Phase II studies conducted during 1982 concentrated on the fishery resource to provide a better understanding of it and data that would allow a more appropriate design of 1983 Phase III studies if such are to be performed.

During 1981, there were two reconnaissance efforts. The first, conducted in August by the task leaders of the biological and hydrological disciplines, was undertaken to document the presence of sockeye salmon in the major project waters and to survey the site in preparation for the fall reconnaissance. The second investigation was carried out in mid-September and involved two weeks of field data collections. The objectives of this effort were to obtain sufficient information and understanding of the study area and its resources to allow for the design of more detailed 1982 studies, and to assess, in a preliminary manner, the conceptual designs of the project alternatives. Concurrently with the 1981 field studies were ongoing reviews of the literature and discussions with key agency and Native Corporation personnel.

Specific objectives and preliminary results of the 1981 environmental investigations by each discipline are presented in Sections 6.2 through 6.5. Sections 6.6 through 6.9 describe the 1982 field program, its objectives and results.

Identification of some of the anticipated environmental effects associated with each project alternative is presented in Section 7, while descriptions of conceptual work plans for 1983 programs will be set forth in a separate study plan yet to be prepared.

6.1 Environmental Study Area

The study area is located on the west side of Cook Inlet approximately 60 miles west of Anchorage (Figure 6.1). This region supports a wide variety of biological and visual resources, and is bordered by the Alaska Mountain Range on the west and Upper Cook Inlet on the east. Administration of the lands and waters of the area come under the jurisdiction of the U.S. Fish and Wildlife Service, the National Park Service, the Alaska Department of Fish and Game, the Alaska Department of Natural Resources, and two native corporations (Cook Inlet Region and Tyonek Native). Although management of the area is complex due to the multitude of organizations responsible for the area, specific sites within the study area have specific management objectives. While the Trading Bay State Game Refuge is maintained to protect waterfowl and provide sport hunting, the Lake Clark National Park's principal objective is to maintain the ecosystem in as nearly pristine a condition as possible. Research in both areas involves documenting pristine conditions and processes, and determining the stability of the ecosystems. In contrast to refuge and park objectives, the native corporations manage their lands for high yield timber harvesting and maintenance of subsistence resources.

Between the mountains and the tidal flats in Trading Bay, the land is flat and drainage is poor. Throughout these lower elevations of the project area, the absence of relief has contributed to the formation of a continuous array of marshes, bogs, and ponds. Two major rivers transport the water from the mountains to the inlet, collect runoff from adjacent marshes and bogs, and provide both migration and spawning habitat for numerous species of resident and anadromous fish. The first of these major rivers, the McArthur, has its origin at McArthur Glacier, yet receives the majority of its water from Blockade Glacier. The second major waterway is the Chakachatna River. Originating at the outlet of Chakachamna Lake, the river flows east about 15 miles through a canyon containing almost continuous rapids and few pools. Once on the low flatlands, the Chakachatna floodplain gets substantially larger until it reaches its divergence from Noaukta Slough, after which it becomes much narrower. The Noaukta Slough carries a large proportion of the flow from the divergence as it fans out into a two mile wide tangle of interlaced channels before it joins the McArthur River. Downstream from this confluence, the McArthur flows several miles to the Chakachatna River confluence, after which it passes through marshes and tidal flats before reaching Trading Bay.

Chakachamna Lake and its tributaries, the Nagishlamina River, the Chilligan River, and Kenibuna Lake are located in the higher elevations of the study area above the Chakachatna River. As with the rest of the project area, these high elevation lands and waters support a variety of fish and wildlife. Chakachamna Lake is approximately 350 feet deep with mountains rising 3000 to 4000 feet above its steep, rocky shoreline. At the mouths of the major tributaries are large deltas, composed mainly of sand and glacial-fluvial deposits.

6.2 Environmental Hydrology

6.2.1 Background

The overall objectives of the 1981 environmental hydrology studies for the Chakachamna Hydroelectric Project were to:

- o assess the impacts of flow regulation on the physical characteristics of the Chakachatna and McArthur River systems and

- o provide input to the biological and socioeconomic impact analysis investigations.

Studies conducted during FY 82 addressed both of these objectives at a reconnaissance level.

6.2.1.1 Data Base

There have been few, if any, environmental hydrology studies conducted in the project area in relation to the development of hydropower. Hydrologic studies have been conducted in the past on the Chakachatna River to evaluate its hydropower potential. The first studies were reported in 1950 and more detailed studies were made in the 1960's. Section 4.0 of this report summarizes the current level of knowledge of the flows available for hydropower generation.

Mr. Robert D. Lamke, Chief of the Hydrology Section of the Water Resources Division of the U.S. Geological Survey, provided flow data and standard hydrologic analyses for use in this investigation. Hydrologic data for engineering purposes are presented in Section 4.0 of this report. Some of these analyzed data were used in the environmental hydrology evaluations.

6.2.1.2 Study Area

The study area was described in the previous section. The major areas studied during the environmental hydrology reconnaissance investigation included:

- Three areas near the mouths of the major tributaries to Chakachamna Lake; Shamrock Glacier Rapids (A, Fig. 6.2), Chilligan River (B, Fig. 6.2), and Nagishlamina River (C, Fig. 6.2).

- Four areas along the Chakachatna River (D through G, Fig. 6.2).

- Two areas along Middle River (F and H, Fig. 6.2).

- Eight areas along the McArthur River (I through P, Fig. 6.2).

- Two areas of Noaukta Slough Channels at their confluence with McArthur River (O and P, Fig. 6.2).

Other areas along the streams that may be impacted by the project were also investigated, but in less detail.

6.2.2 Study Objectives and Methodology

The specific objectives of the FY 82 environmental hydrology reconnaissance study were to:

- collect sufficient quantitative and qualitative data to make a preliminary assessment of the physical impacts related to each of the project alternatives, and

- provide input to preliminary assessments of biological and socioeconomic impacts related to each of the project alternatives

These objectives were realized through a combination of field data collection and office evaluations, as described in the following sections:

6.2.2.1 Hydrology

Field Data Collection. Hydrologic field data that were collected during the two week field reconnaissance in mid-September included:

- o discharge measurements,
- o lake water level survey, and
- o wetland/river level surveys.

Discharge measurements were taken at study locations D, F, G, H, I, K, L, and M (Figure 6.2) using procedures similar to those of the U.S. Geological Survey; however, for expediency during this brief reconnaissance, only about 10 measuring stations were used in each channel. A Marsh-McBirney flow meter was used to measure velocity at a depth equal to 60 percent of the full depth.

A survey was conducted at Chakachamna Lake to establish the lake surface elevation at the time of the survey. Vertical angle measurements were taken from Bench Mark MORE (on the south side about mid-way along the lake) to the lake water level. A Topcon DMS-1 electronic distance measurement system was used to measure distances.

Standard differential leveling techniques were used to measure the difference between the water level in a wetland and the water level in a channel of the Noaukta Slough a short distance downstream from study area E (Figure 6.2). An approximate method using a hand level was used in study area H (Figure 6.2) to evaluate the water level difference between a wetland and Middle River.

Office Evaluations. Office evaluations were conducted to develop approximate hydrologic data at eight locations in the study area numbered locations, (Figure 6.2). Developed data include:

- natural mean monthly flows,
- mean annual flows for natural flow conditions,
- natural flood flows at selected locations
- natural low flow conditions at selected locations.

In addition, interim assessments of instream flow requirements for maintaining fisheries habitat were calculated on a monthly basis at the outlet of Chakachamna Lake. All office evaluations were selected to provide reasonable estimates of flow conditions for the purpose of making preliminary impact assessments.

Natural mean monthly flows were estimated from the relations shown in Table 6.1 with the following assumptions:

- mean monthly flows per square mile based on calculated Chakachamna Lake inflows (from Section 4.0) are representative of those from mountainous areas,
- mean monthly flows per square mile based on the 4 year average of mean monthly flows of the Chuitna River (Station 15294450) are representative of those from non-mountainous areas, and
- proportions of flow in downstream channels at each divergence is the same as the proportion of flow in those channels at the time of the reconnaissance measurement.

Mean annual flows were determined from the calculated mean monthly flows using a weighted average method; the weighting was based on the number of days in each month. For example, mean January flow would be multiplied by 31/365 to obtain the January portion of the mean annual flow.

The natural flood flows were calculated based on a regional flood frequency analysis (Lamke 1979). The drainage area, percentage of lakes and percentage of forest cover, were obtained for each location from 1,250,000 scale topographic maps; Lamke's (1979) isocline maps were used to obtain mean annual precipitation and minimum January temperature. A weighted average for these parameters was used for locations 4, 5, and 8 based on the percentage of flow carried by each channel downstream from divergences measured during the reconnaissance.

The natural low flow conditions at those locations lying along the Chakachatna River were estimated on the basis of the unit discharge per square mile from the Chakachatna River gaging station records under low flow conditions. The low flow analyses of the gage records were provided by the U.S. Geological Survey.

Mitigative water releases to support fisheries were calculated using different methods for the McArthur and Chakachatna River powerhouse alternatives. The results of these analyses are presented in Section 7. For the alternatives with the powerhouse on the McArthur River, fisheries habitat down the entire length of the Chakachatna River were considered.

The Montana Method (Tennant 1975) was used to estimate the instream flow requirements for this preliminary assessment. The use of this method required several major assumptions which included the following:

- the method is valid for a complex stream system like the Chakachatna River,
- the seasonal flow regimes postulated in the model are appropriate for south-central Alaska, and
- the method is appropriate for the complex of anadromous and resident salmonids found in the Chakachatna River.

The instream flow requirements calculated by this method are based on a percentage of the mean annual flow. The percentage is based on observations that the wetted perimeter of a stream (potential usable habitat) typically increases rapidly with increasing discharge up to a flow equal to 30 percent of the mean annual flow. For higher discharges, the wetted perimeter increases less rapidly. Tennant (1975) refers to minimum instantaneous flows of 30 percent of the mean annual flow as "good" flow. The method also calls for two different seasonal flow regimes, a low flow period from October through March and a higher flow period from April through September. "Fair" to "good" flows can be obtained if 10 and 30 percent of the mean annual flow is maintained during the low flow and higher flow periods, respectively. In the FY 82 studies, these percentages were used to estimate what instream flow needs to be maintained for the fishery resource. The natural flow during the low flow period was periodically less than the recommended flow; flows equal to the natural flows were assumed to be released in these situations.

The required flow for the fishery resource is different for the alternatives with the powerhouse on the Chakachatna River. For these alternatives, the dewatered section of the Chakachatna River is in the canyon; this section of river apparently provides primarily migratory habitat and relatively small amounts of spawning and rearing habitats. Thus, it was assumed that maintenance of the migratory habitat is sufficient to mitigate the major impacts of dewatering this section of stream.

It was assumed that a 30 cfs flow release would be adequate to maintain a sufficient migratory pathway between the powerhouse and the lake, possibly requiring some channelization.

6.2.2.2 Hydraulics

Field Data Collection. Hydraulic data that were collected during the field reconnaissance included:

- o stream and floodplain transects,
- o stream gradients, and
- o lake bottom profiles.

The stream and floodplain transect data were collected using one or a combination of the following methods:

- o transit and electronic distance measuring equipment to get horizontal and vertical angles and distances to locations along the transect,
- o discharge measurement data to represent the transect below water level, and
- o a Raytheon DE-719B depth recorder mounted to a boat to represent the transect below water level in streams too deep or swift to wade.

Some transects consist only of the portion of the transect below water level.

Stream gradients were surveyed using a transit and electronic distance measuring equipment. Water surface profiles typically were surveyed, as were bed profiles at the lake tributary study areas.

Lake bottom profiles were surveyed using a Raytheon DE 719B depth recorder. Horizontal control was provided in an approximate manner by relating to terrain features and by monitoring boat speed.

Office Evaluation. Hydraulic evaluations were conducted in the office to estimate the following:

- o hydraulic geometry (width, depth, and velocity as a function of discharge) and
- o flooding and backwater characteristics.

The hydraulic geometry as defined above was calculated by means of the Manning equation. Input data to the equation included channel geometry and energy gradients that were obtained from the stream and floodplain transects and water surface profiles that were measured in the field. Manning roughness coefficients were estimated by back-calculating values from discharges measured or estimated in the field, and checked their reasonableness with respect to previous experience.

Flooding was estimated at selected transect locations by establishing the stage (water level) corresponding to the calculated flood discharge from the hydraulic geometry data. Areal extent of flooding between transects is qualitative and based on aerial photographs and field observations. Backwater characteristics in tributaries were described qualitatively based on a review of flood levels and surveyed stream gradients.

6.2.2.3 Channel Configuration and Process

Field Data Collection. Data collected during the field reconnaissance pertaining to channel configuration and process include:

- observations of channel configuration,
- observations of lateral migration activity,
- observations of sediment transport characteristics.
- stream substrate
- potential fish overwintering area location surveys, and
- fish spawning channel location surveys.

The latter two data types were collected during fall 1981 in preparation for fish overwintering studies planned for early 1982.

The observations of channel configuration, lateral migration activity and sediment transport characteristics were qualitative and were based on the experience of the environmental hydrologist. Stream substrate was described qualitatively and documented in some cases with photographs. The surveys conducted to establish the location of selected potential fish overwintering areas and identified fish spawning channels used a combination of transit, electronic distance measuring devices, tape, and magnetic compass.

Office Evaluations. Channel configuration, lateral migration activity and sediment transport characteristics were qualitatively evaluated for natural stream flows. The data used to evaluate these characteristics included the hydraulic characteristics discussed previously, aerial photographs, and field observation. These preliminary evaluations were qualitative and the results descriptive.

6.2.3 Results and Discussion

The results of this reconnaissance level investigation are preliminary. Certain assumptions have been made to enable a comparison of alternatives; these assumptions will be checked during the more detailed investigations planned for 1982.

The results of the field reconnaissance and office evaluations for the current natural conditions are presented and discussed below.

6.2.3.1 Hydrology

The locations, date, and results of discharge measurements during the fall reconnaissance are summarized in Table 6.2. Estimates of mean monthly and mean annual flows at eight representative locations in the study area are presented in Table 6.3. A comparison of measured values with mean monthly values indicates that the flow at the time of the survey generally was less than the mean for September. The flow generally was decreasing throughout the two week reconnaissance. The discharge measurements indicate that approximately 90 percent of the Chakachatna River flow goes through Noaukta Slough. The remaining 10 percent flows to the Chakachatna and Middle River divergence where approximately 84 percent of this flow remains in the Chakachatna River and 16 percent flows down Middle River. This flow distribution was assumed to remain constant through the year for the purposes of comparison in this preliminary investigation.

Calculated flood discharges at eight representative locations are summarized in Table 6.4. Also shown are results of a flood frequency analysis of the Chakachatna River gage data. It is apparent that the regional flood frequency analysis yields larger flood magnitudes than the gage values, especially at greater recurrence intervals. This may be in part due to the lack of inclusion of the lake parameter in the equation for parameter D, representing the standard deviation of the floods. Calculated values at locations 1 through 5 and 8 are affected by this discrepancy. Locations 6 and 7 are likely to be better represented by the calculated values since there are no significant lakes in their basins; these locations are most significant in the evaluation of the alternatives. Thus the discrepancy at the other sites was not resolved for this preliminary investigation.

The results of the low flow investigation are summarized in Table 6.5. Low flows were not calculated downstream from the Chakachatna River-Noautka Slough divergence due to lack of confidence in predicting the flow distribution at low flows. Low flows on the McArthur River should not be reduced by the project and thus were not calculated. When surveyed, the lake water surface elevation was 1142 feet above sea level.

Surveys to establish the water level in selected wetlands in relation to the river water level indicated that the wetland levels were greater than the river levels in both cases. A wetland on the northwest side of Noaukta Slough downstream from its divergence from Chakachatna River was found on 22 September to be 1.7 ft. above the water level in the closest channel of the Slough. This difference is not surprising since (1) the wetland is on the upslope side of the river and (2) the river was dropping rapidly from its higher summer stage. The survey was not sufficient to establish whether or not the Chakachatna River supplies water to the wetland.

A similar, but more approximate, survey was conducted on the Middle River near its mouth. Wetlands are present on both sides of the river at a level about 6 ft. above the Middle River water level on 26 September at about 1100 hours. Wetlands were also present on the sloping bank of the river to nearly the river level at the time of the survey. High water evidence was present at about 4 to 5 feet above the surveyed river level. This reach of Middle River is within the range of tidal influence, but the amount of influence was not evaluated during this reconnaissance study. Although the data are not conclusive, it would appear that the wetlands may be flooded periodically by a combined river flow and high tide.

The wetlands are likely to be slow-draining and may get most of their water from snowmelt and rainfall. Data from this reconnaissance study are insufficient to establish with any certainty the water budget of these wetlands.

4.2.3.2 Hydraulics

Plots of stream and floodplain transects in study areas D, L, and P (Figure 6.2) are presented on Figures 6.3, 6.4, and 6.5, respectively. Stages corresponding to the highest and lowest mean monthly flow values are plotted on the figures to show the typical annual range in stages. The hydraulic geometry for the same three transects is shown on Figures 6.6, 6.7, and 6.8. Mean monthly flows are denoted on these figures. The flows increase due to snowmelt in May, followed by a large increase in June and July as the mountain snowpack continues to melt and the glaciers begin to melt. In late summer, the flows taper off gradually toward the winter low flows. As the discharges change, so does the hydraulic geometry.

The seasonal flow patterns of the Chakachatna River vary over a wide range. (Figure 6.3). Winter flows would likely be only a foot or two deep in the main channel with very little or no flow in the left channel. Summer flows would inundate the bar separating the two channels and a portion of the Straight Creek floodplain as well.

The flow in the Upper McArthur River probably varies over a much narrower range. (Figure 6 4). Winter flows would be about a half foot deep and summer flows may be 2 to 3 feet more than that. Downstream, the McArthur River will increase in both depth and range of depth (Figure 6.5). Winter depths may be a foot or more; summer flows in the main channel may be as much as 8 feet in maximum depth with water flowing in high water channels.

Flood stages were estimated for the 10 year recurrence interval flood at the three transects discussed above and were plotted on Figures 6.3, 6.4, and 6 5. The Chakachatna would likely flood the lower floodplain of Straight Creek but will probably not flood any vegetated areas. The floods on the McArthur remained in the unvegetated portion of the floodplain at these transects; it is likely that much of the McArthur River would have similar flooding characteristics.

It was apparent at some confluences that backwater conditions have been experienced in one or both of the joining channels. The backwater profile could be traced by high water marks along the banks of McArthur River upstream of its confluence with the Lower Blockade Glacier Channel. Similar conditions likely occur at most confluences where the two joining channels have dissimilar flow regimes.

Typical examples of Chakachamna Lake bottom profiles are shown in Figures 6.9 and 6.10. Also shown on Figure 6.10 is a river survey leading into the bottom profiles. The profile show that the bottom gradually gets deeper in the offshore direction until a depth of approximately 20 feet is reached, at which time the depth increase very rapidly.

6.2.3.4 Channel Configuration and Process

The channel configurations of the Chakachatna, McArthur, and Middle Rivers and Noaukta Slough were assessed during the field and office investigations and are identified on Figure 6.2. The indicated boundaries of the reaches are approximate. Four stream configurations were selected to represent the streams in the study area:

(1) Mountainous (Mt) - characterized by numerous, almost continuous rapids; they are usually single channeled and are often controlled in shape and location by external forces such as glacial moraines, rock outcrops, and tributary deltas.

(2) Braided (B) - characterized by numerous channels, often having different water levels; short rapids, often located at the divergence of two channels; and wide, usually unvegetated floodplains: channels tend to shift their location and configuration frequently in response to the deposition of sediment transported in from upstream.

(3) Split (S) - characterized by one to three relatively stable channels, often having different water levels, all of which carry water for much of the year.

(4) Meandering (M) - characterized by a single channel whose thalweg (deepest part) shifts from one side to the other along the length of the stream; large sand or gravel bars are typically exposed on alternating sides of the stream at low flows.

Stream reaches in the study area with mountainous configurations include the upper reaches of the Chakachatna River in Chakachatna Canyon which has almost continuous rapids and maintains mostly a single channel. The ice cored moraine of Barrier Glacier controls the upper reach; old morainal and colluvial deposits form the control of the lower reach. The McArthur River also has two mountainous configuration reaches. The upper reach is well into the headwaters of the river; control is provided by cobbles and boulders whose source is the surrounding and upvalley mountains. The lower reach is formed by the terminal moraine of Blockade Glacier. The mountainous reaches on the McArthur River are primarily single channel reaches.

Braided configuration reaches in the study area include the Chakachatna River upstream of Straight Creek, Noaukta Slough, and the Upper McArthur River. The Chakachatna River reach is very typical of a braided configuration; numerous channels flow at different water levels, the number of channels being a function of the discharge entering the reach. The Noaukta Slough configuration appears to be due more to lack of channel capacity than to excessive deposition of sediments. However, dune bedforms extended across most of the channel width in many locations indicate that heavy bedloads are transported at and above some threshhold discharge. The braided reach on the Upper McArthur River is a result of sediment deposition. It contains numerous small channels flowing at different water levels.

There are two split configuration reaches in the study area. They are located upstream and downstream of the Chakachatna River braided reach. The upper reach appears to be steeper, contains more rapids, and is likely to be less stable than the lower reach. Both reaches are nearby a braided configuration, but they appear to be much more stable than the typical braided reach.

Meandering configurations are typical of the lower reaches of the Chakachatna River and most of the McArthur and Middle Rivers. The lower Chakachatna and Middle River reaches are very similar in appearance; both are primarily single channel with few exposed bars, even at relatively low flows. Dune bedforms were numerous and closely spaced over the full length of these reaches. The McArthur River has two channels downstream of Blockade Glacier. The north channel receives inflow from the glacier via two main channels. The north and south channels both flow mainly in a single channel meandering configuration before joining near their confluence with Noaukta Slough. The channels appear to be the most active of all channels in the study area in terms of lateral migration, from which many logs have been introduced into the floodplain. Very large sand and gravel bars are evident at low flow conditions. Large dunes in the channel provided evidence of a significant bedload transport above some threshhold discharge.

Sedimentation characteristics in the study area include:

- o sediment transport characteristics and

- o bed and bank material types.

Sediment transport was discussed briefly above in terms of bedforms providing evidence of bedload movement. The Chakachatna River downstream of the canyon and upstream of the Noaukta Slough divergence contained some gravel dunes as the most evident bedform; these dunes are often found at the head of a channel where it splits from another channel. All channels downstream from the Noaukta Slough divergence and all of the McArthur River downstream of Blockade Glacier had dunes formed mainly of sand sized particles.

Suspended load contains concentrations of fine "glacial flour". Sand sized particles will likely be carried in suspension by discharges greater than those at the time of the reconnaissance.

Bed and bank materials are typically gravels, cobbles, and some boulders in the Chakachatna River from the lake to the Noaukta Slough divergence and in the Upper McArthur River down to Blockade Glacier. There are some sandy sections in the braided reach of the Upper McArthur River as well. The size distribution of the bed and banks then decreases rapidly in the downstream direction to become very fine sands and silts near the mouths of the rivers.

The ice characteristics in the study area were not investigated during 1981.

6.2.4 Conclusions

The 1981 field reconnaissance and subsequent office evaluations provided valuable information regarding the characteristics of the two river systems that could be impacted by the proposed Chakachamna Hydroelectric Project.

The 1981 field reconnaissance provided the following types of information:

- instantaneous discharges at various locations throughout the study area giving information on flow distribution, hydraulic roughness, and channel bottom configuration,

- lake water level for comparison with historic water levels,

- wetland water levels relative to adjacent streams for evaluating wetland water sources,

- stream and floodplain transects for evaluating local water levels for a variety of discharges,

- stream water surface gradients for estimating energy gradients for hydraulic calculations,

- lake bottom profiles for evaluating the lake tributary stream gradients following draw down of the lake level,

- observations of channel configuration and processes for evaluation of the changes that could occur to the various configurations under a regulated flow condition, and

- observations of bed and bank materials for evaluating the sedimentation characteristics of the stream systems.

Although these reconnaissance level field data were not always rigorously collected nor extensive in areal coverage, they provide a valuable starting point for making preliminary impact evaluations and for planning more detailed field and office investigations.

The office evaluations of the field data provided the following information:

- o Hydrologic data developed for eight representative locations through the study area typical of glacial rivers with low flow in late winter, large glacier melt flows in July and August, and annual peaks due to fall rains; the data include:

  - mean annual flows,
  - mean monthly flows,
  - flood flows with various recurrence intervals, and
  - 7 and 30 day low flows with various recurrence intervals.

- o Hydraulic geometry calculated at three representative transects illustrating that the range of width, depth, and velocity for the natural flow regime is typical of streams of this size; the annual range of stages appears to increase in the downstream direction.

- o Floods on the McArthur River are likely to remain in the unvegetated floodplain for all but the most infrequent events, although most floods will likely result in substantial bank erosion; floods on the Chakachatna also will likely remain mostly in the unvegetated portion of the floodplain.

- o Backwater conditions at stream confluences are a likely condition.

- o Chakachamna Lake bathymetry indicates that a distinct break in bottom gradient occurs at a depth of approximately 20 ft at the deltas of major tributary streams; at shallower depths, the gradient is gradual and at deeper depths, the gradient is steep.

- o Chakachatna River contains reaches with the following configurations:

  - mountainous in Chakachatna Canyon,
  - braided downstream of canyon and in Noaukta Slough,
  - split in the lower part of the canyon and between the bridge and Noaukta Slough, and
  - meandering in downstream reaches.

- o McArthur River contains reaches with the following configurations:

  - mountainous in the headwaters and at the Blockade Glacier moraine,
  - braided on the Upper McArthur between the two mountainous reaches,
  - meandering through the entire lower McArthur River.

- o Sedimentation characteristics of both rivers appear to be typical of glacial systems with very fine suspended sediment sizes and substantial bed load transport.
- o Ice characteristics are assumed to include development of a full ice cover and have minimal aufeis development.

The above results were based on field data, office evaluations, professional experience, and several important assumptions. The assumptions must be checked during the 1982 investigations.

6.3 Aquatic Biology

6.3.1 Background

To perform a reconnaissance level evaluation of the Chakachamna Hydroelectric Project study area resources, it was necessary first to review the literature, particularly reports of previous studies. A variety of regulatory agencies were contacted including the U.S. Fish and Wildlife Service (USFWS) and the Alaska Department of Fish and Game (ADF&G). The ADF&G, Division of Sport Fish, has conducted a number of surveys in portions of the Chakachamna Lake - Chakachatna River and McArthur River systems over the past 30 years. These surveys have included aerial observations, gill netting, electroshocking, and ground observations.

In general, these reconnaissance level surveys were primarily aimed at detecting spawning runs of salmon. However, these efforts were often hampered by turbid glacial waters. As a result, some salmon species were often unobserved.

Overall, these studies showed that all five of the North American Pacific salmon species were present in the general vicinity of the project area (Table 6.6). However, the presence of these species was not documented at more than a few locations nor had the habitat utilization been documented.

6.3.1.1 Study Area

The study area has been generally described in previous sections. Refer to Section 6.0 and 6.1 for more detail.

The Chakachamna - Chakachatna and Chilligan River System and the McArthur River System are large complex water-bodies. The riverine systems contain braided reaches, islands, inactive floodplains, sloughs, riffles, white-water areas, side channels, tributary streams, inputs of groundwater flow, and boulder strewn areas of high gradient. The main stems of these rivers contain glacially turbid waters, although there are also clear water sloughs and tributaries present in each system.

Habitat diversity is further enhanced through substrate and water quality variability. Substrates typically range from silt and fine mud to large boulders and bedrock. Water temperatures during the fall season can vary by more than 10°C, ranging from 0.25°C glacial runoff to 11°C shallow pools. Water depths also vary, with some areas of the Noaukta Slough being less than 0.5 ft. deep, while some areas in Chakachamna Lake are more than 300 ft. deep.

6.3.2 Study Objectives and Methodologies

Two reconnaissance level surveys were conducted on Chakachamna Lake, and the Chakachatna, Chilligan and McArthur Rivers during the fall of 1981. The investigations included many of the tributary streams as well. The first reconnaissance, that was conducted on 17-18 August 1981, consisted of aerial observations of the project area. The objectives of this reconnaissance were to assess:

- o the extent of the system,
- o which areas should be sampled in view of their potential to be impacted by the proposed project,
- o what types of sampling gear might be used; and
- o the potential logistical problems caused by the site location and topography.

The second reconnaissance, conducted from 15-28 September 1981, involved the collection of data from the areas identified during the initial reconnaissance. This effort employed both field sampling and visual observations. The objectives of this reconnaissance were to:

- o identify the major species present during the fall;
- o identify critical habitats and life functions taking place in the system at the time of the study;
- o provide an insight to the species composition and habitat use occurring at different times of the year;
- o evaluate those species and habitats potentially vulnerable to impacts that might occur during the construction and operation of one of the proposed alternative hydroelectric facilities; and
- o evaluate the nature and extent of studies that would be necessary to assess the minimum amount of water

necessary to maintain a viable salmon fishery. Due to the reconnaissance level nature of the 1981 effort, it was decided that only the fish populations (no invertebrates) in these systems would be investigated.

6.3.2.1 August 1981 Reconnaissance

The first reconnaissance primarily relied upon visual observations, including both aerial overflights and ground-level reconnaissance. During aerial overflights, the location of spawning salmonids were observed and recorded. At selected sites, ground surveys were conducted. At these locations, carcasses were observed and identified and photographs were taken to document observations of habitat parameters. The results of this reconnaissance were used in planning the 1981 fall survey.

6.3.2.2 September 1981 Reconnaissance

Since the September reconnaissance included the sampling of a variety of habitats at various depths and under varying flow conditions, a number of different fish collecting techniques were used. Table 6.7 lists the fish collection methodologies used in each water body, while specific gear types are identified in Table 6.8. Visual observations of all major water bodies were recorded from a helicopter at altitudes between 10 and 200 ft.

Electroshocking, using backpack electroshockers, was utilized in areas where water depths of four feet or less were encountered and conductivities were less than 2000 micromhos/cm. The electroshocker immobilizes fish enabling them to be collected. Pulsed direct current

(DC) was utilized to reduce the physical damage to fish while it allowed taking advantage of galvanotaxis (the attraction of fish to the positive electrode), thus making them easier to catch with a dipnet. The relatively small range of the backpack shocker confined its use to shore- line areas and shallow open water areas. It was generally operated by one member of the field team while one or both of the other members deployed dipnets or seines. This technique was particularly effective in collecting juvenile fish that were sheltered among rocks and snags and could not be sampled with other equipment. It was also useful in fast flowing areas when used in conjunction with a seine or stationary drift net since fish could be collected from swift moving waters that would otherwise be inaccessible. Areas sampled by electroshocking, seine netting or both are shown in Figure 6.11.

A hand seine (Table 6.8) was utilized both individually and in conjunction with the electroshocker. When used in conjunction with the electroshocker, the hand seine was deployed downstream, usually in swift currents. In slower moving water the seine was moved upstream (with the ends of the seine extended) toward one member of the field team who kicked or shuffled the substrate. This gear was effective on both small and large fish in confined channel reaches and along shorelines.

The stationary drift net used in this study was an otter trawl with a fine mesh liner. It was deployed in streams with high velocity currents. The streamlined shape of this net allowed it to be deployed in areas where the water currents were too swift to deploy a seine.

The beach seine was similar to the hand seine described above but of much greater length (Table 6.8). This net was only used in Chakachamna Lake. One end of the net was secured to the shore while the other end was carried out from shore by boat. As the boat moved in an arc back to shore, the bottom of the net was kept on the lake bottom, thereby surrounding a volume of water. This technique was effective, but only in those areas where the current was relatively small or nonexistent and where the shore area was shallow enough to deploy the net properly.

Experimental, 75 foot long gill nets (Table 6.8), consisting of 5 panels of 0.75, 1, 1.5, 2, and 2.5 inch bar mesh were utilized in Chakachamna Lake. These nets were deployed perpendicular to the shore, and at the surface and bottom (Figure 6.12). The small mesh panel (0.75") was always kept on the shoreward side, where juvenile fish concentrate their activity. The nets were marked with floats and checked after 1 to 3 hours. All fish collected were measured and weighed and live fish were released. Those nets that did not catch large numbers of fish were left in place overnight.

The gill nets facilitated the collection of fish in deeper areas of the lake. By leaving the nets set overnight a more time-integrated sampling of the fish populations was possible.

Fyke nets (Table 6.8) are trap nets that are set with long leads of heavy twined mesh. Fish that encounter the leads are guided towards a series of mesh funnels that guide the fish into a trap from which they can be removed. The leads and net are held in place and oriented by steel poles driven into the bottom. The nets can be used where water is shallow enough (generally 4 feet) to allow the leads to extend from the stream bottom to the water surface, and where water currents are at a minimum.

Advantages of the fyke net include both the large areas fished and the fact that they do relatively little damage to trapped fish. These nets were set in the deep water sections of the rivers that could not be adequately sampled by other gear (Table 6.7). In the Noaukta Slough, Middle River, and Chakachatna River the wings of the nets essentially directed all fish moving upstream into the funnels. In the McArthur River one main-channel section was completely blocked by the nets.

Hoop nets were set without leads in Chakachamna Lake at each of the gillnetting sites (Table 6.8). This was done to diversify the fishing techniques utilized so that species or individuals not vulnerable to the gill nets might also be collected. This gear was relatively ineffective.

Minnow traps, made of galvanized mesh were set near the hoop nets. These traps had much smaller mesh than either the gill nets or hoop nets and were utilized to again diversify the gear and enable the collection of smaller fish such as juvenile salmonids. These were generally set among rocks or other such cover that usually provides habitat for juvenile fish.

The variety of collecting gear used prevented biasing of our collections through gear selectivity. In this manner, fish of many different life stages and in different habitats were successfully collected thus providing a more complete picture of the fish populations present at each site.

In the field, fish were measured to the nearest millimeter for total length and usually weighed to the nearest ounce. Where possible, the sex of the fish was noted and whether the fish, in the case of salmonids, was a parr, smolt, juvenile or adult. Scales were taken from selected specimens. All captured adult salmon and other live fish were released at the point of collection.

Juveniles were identified in the field and released whenever possible. Several specimens whose species identification could not be confirmed in the field were preserved in a 10 percent formalin solution for laboratory identification.

Physical data collected in the field included water temperatures measured with a YSI Model 57 temperature-oxygen meter or a Taylor mercury thermometer, and water velocities measured with a Marsh-McBirney Model 201 electromagnetic flow meter or a General Oceanics Model 2035B remotereading flow meter.

Fish specimens were identified in the laboratory using keys prepared by Hart (1975), McConnel and Snyder (1972), Morrow (1980) Scoott and Crossman (1973), Smoker (1955), Troutman (1973) and Wydoski and Whitney (1979). Habitat requirements of salmon and trout were characterized by Bailey (1969), Balon (1980), Blackett (1968), Foester (1968), Martin and Oliver (1980), Merrell (1970), Morrow (1980), Nikolskii (1961), and Scott and Crossman (1973).

6.3.3 Results and Discussion

Although a large amount of data were gathered during the August and September 1981 reconnaissance efforts, these data represent only the biological events occurring within the short period of time encompassed by these investigations. Data that were collected included:

- o Species occurrence;
- o Habitat utilization;
- o Critical life functions taking place; and
- o Relative success of the collection gear.

The following sections summarize the results of these data.

6.3.3.1 Species Occurrence

Species occurrence is perhaps one of the most significant results of this reconnaissance. All five species of salmon occurring in Alaskan waters were found to spawn in both drainages (Table 6.9). It is unclear at this time which species usually is most abundant, but spawning sockeye salmon were most abundant during the investigation. Lake trout appeared to occur only in Chakachamna Lake, while Dolly Varden were ubiquitous throughout both drainages. Rainbow trout appeared only in the lower portions of both drainages. Round and pygmy whitefish were found in most areas of both drainages, although pygmy whitefish were not found in Chakachamna Lake or drainages above it. Slimy sculpin were found throughout both systems and in tributary streams. Sticklebacks, however, were only found in backwater areas and among vegetation, usually in the lower reaches of the rivers. Only a single grayling was observed in a side channel in the upper Nagishlamina River and none were collected or observed at any other location. It is clear, with few exceptions, that most of the species found, occurred throughout both drainages.

The fish in this area may be classified into two primary groups, forage fish and commercial and sport fish. Forage fish in the project area include threespine stickleback, ninespine stickleback, slimy sculpin, pygmy whitefish, and round whitefish (Morrow 1980, Scott and Crossmen 1973, Balon 1980). Although the round whitefish is probably not used as a subsistence species in these drainages it is eaten by lake trout and other species of fish. Sport and commercial fishes include pink, chum, sockeye, coho and chinook salmon, Dolly Varden, lake trout, rainbow trout, and grayling (Morrow 1980, Scott and Crossman 1973).

6.3.3.2 Habitats Utilized For Various Life Functions

A wide variety of habitats were sampled during the course of the reconnaissance studies using a diverse assemblage of sampling gear. As stated, one objective of the 1981 program was to gather a wide variety of data from a large area during a relatively short period of time, thus more attention was given to collecting qualitative rather than quantitative data, and to characterize general habitat use. Habitat utilization will be reported and discussed by waterbody or river stretch, as appropriate.

Chakachamna Lake Tributaries

The results of studies at each site sampled or observed in the Chakachamna Lake/ Chakachatna River drainage is summarized in Figure 6.13. This figure identifies habitat utilization and potential habitat utilization for salmon and trout species.

The rivers flowing into Kenibuna Lake were investigated by means of low level overflights, since the waters in the Neacola, Another and Igitna Rivers were sufficiently clear to observe fish and generally characterize the substrate. The Neacola River, at the date of the overflight, was relatively shallow with an apparent sand/ silt substrate. Large amounts of emergent vegetation were present, and although the substrate appeared to be unsuitable for salmon spawning, several adult Dolly Varden were seen from the air. It is possible that round whitefish were also present and that sockeye salmon juveniles may utilize this river.

The Another River was also overflown at relatively low altitudes in September 1981, and was found to contain a substrate composed of gravel, cobble, rubble, and boulders including some areas suitable for salmonid spawning. Although the water was clear with riffles, no sockeye salmon were observed, however, one adult Dolly Varden was observed. The stream could potentially provide habitat for adults and juveniles of stream dwelling species, such as Arctic grayling, round whitefish and slimy sculpin.

When the Igitna River was overflown, the water was somewhat clouded by glacial silt. However, it was obvious that there was a great deal of gravel substrate and large numbers of sockeye salmon were observed and redds (spawning nests) were identified.

The areas of the stream that were utilized most intensively were the side-channels and relatively shallow areas of the main channel within a few miles of Kenibuna Lake. Some of the side channels appeared clearer than the main channel possibly due to the influence of flows from clearwater tributaries or groundwater. Such streams are preferred by sockeye (Foerster, 1968). Within the stream sections utilized by sockeye salmon, there appeared to be about 3-10 fish (including both live and dead) for each 10 feet of stream length. Sockeye carcasses were abundant and while not counted, there were probably more than 1000 fish in this general area.

Although Kenibuna Lake was too turbid for proper observation, a Dolly Varden was seen at the mouth of the Igitna River. During overflights conducted by ADF&G in 1952 (undated) sockeye salmon were seen at the west end of the lake (Table 6.6). In addition to serving as a migratory pathway for spawning sockeye salmon, the lake probably also serves as nursery habitat for juvenile sockeye salmon. The lake may also provide habitat for lake trout and kokanee since these species were collected from Chakachamna Lake. The potential also exists for salmon or lake trout to spawn along the northeast shoreline of Kenibuna Lake since a gravel-cobble substrate is present.

The Chilligan River, which discharges into the northwest end of Chakachamna Lake was overflown during both August and September 1981. Although the river waters were cloudy, large numbers of sockeye salmon were observed during both investigations. Gravel and cobble substrates were common in many parts of the river. Sockeye salmon were present in large numbers but appeared to be more abundant in side channels of the river, particularly in those with clearer water. (Figure 6.14.) More than one thousand fish were observed during each survey. During the August overflight, some unidentified grey fish were seen in the lower part of the river. Positive identification could not be made due to the depth and turbidity of the water. Dolly Varden may also use the Chilligan River for spawning and were observed near the banks, in shallow water. The combination of substrate, water temperature, and current found in this river meet the habitat criteria for Dolly Varden described by Blackett (1968) and Leggett (in Balon 1980).

The Nagishlamina River, which discharges into the northeast end of Chakachamna Lake was overflown in August and September. Ground observations were conducted during August and nets were used at the mouth of the river during September. The ground reconnaissance in August revealed both adult and juvenile Dolly Varden as well as one Arctic grayling in the upper reaches of the river. Dolly Varden were also observed in the areas closer to the lake (Figure 6.13). A variety of sub- strates, with large stretches of gravel and cobble that appeared suitable for spawning by a number of salmonid species were also found. The upper reaches of the river were shallower and less cloudy than areas closer to Chakachamna Lake.

A sand delta occurs at the mouth of the Nagishlamina River. This area was fished with nets during the

September reconnaissance. Dolly Varden, lake trout juveniles and adults, and juvenile and ripe adult sockeye salmon were captured. In addition, one ripe kokanee male was collected. During the last day of the September 1981 reconnaissance several large gray fish were observed in the river. These may have been kokanee or possibly Dolly Varden.

Chakachamna Lake.

Chakachamna Lake is large and deep. On the average, the lake is over 300 ft. deep, with relatively steep slopes and very narrow shallow areas (U.S. Geological Survey bathymetric charts 1960). Slopes of 1:2.5 or even 1:1.1 are not uncommon in some portions of the lake and gentler slopes of 1:5 are only found at the river deltas. The water in the lake is cloudy due to glacial silts. The shoreline varies from sand deltas to gravel beaches to boulder slopes. Because the perimeter of the lake is very large, a fairly extensive shallow water habitat exists despite the narrowness of the shallow water zone found along the shoreline.

During the September investigation, five species were collected in the lake including, ripe sockeye salmon migrating along the shore of the lake, lake trout, Dolly Varden, round whitefish, and slimy sculpin (Figure 6.13).

Substrates suitable for sockeye salmon and lake trout spawning were found in several areas of Chakachamna Lake. It appeared that the sockeye were spawning along one area of gravel beach on the north shore of the lake (Figure 6.15). The substrate in this area was suitable and a large number of sockeye were milling about in the area. Although visibility prohibited observing redds, a female was observed excavating a redd. It is unclear to what extent this area is used for spawning, but the beach area was apparently utilized as nursery habitat by juvenile sockeye salmon, lake trout, and round whitefish (Figure 6.13). Adult lake trout, round whitefish, Dolly Varden and slimy sculpins were also found in this area. The round whitefish in this area were feeding on insect larvae, and the lake trout were feeding on juvenile sockeye salmon and round whitefish.

Adult lake trout were found in all areas sampled, although they were most abundant in rocky areas, particularly those sites with large boulders. Many of the adults examined during the September 1981 investigation were sexually mature spawners. This may have influenced their distribution, since the rocky shallow water areas are used for spawning. The lake trout in these areas were also found to be actively feeding. The stomach contents of one large lake trout contained 22 sockeye salmon parr.

Dolly Varden did not appear to be as abundant as lake trout, but were found at most collection sites. Anadromous, sexually mature Dolly Varden were identified near the lake outlet, while juvenile Dolly Varden were present in many of the shallow water areas.

Several of the small streams entering the lake were surveyed and were found to contain fish. One large stream at the southern end of the lake that was fed by glacial runoff (B in figure 6.15) contained suitable substrate for salmonid spawning, however, the water temperature was too cold. (0.25°C, compared to the 7.5° - 9°C found in the lake).

Although the deeper open water areas of the lake were not sampled during this reconnaissance, information from the literature (Scott and Crossman 1973) and past studies (Russells 1979) indicated that these areas would normally be utilized by lake trout and juvenile sockeye salmon. Since the juvenile sockeye are planktivorous (Scott and Crossman 1973), they would be expected to make extensive use of the open lake waters. Due to cooler temperatures in Chakachamna Lake, lake trout would be expected to make greater use of the upper strata all year long.

Upper Chakachatna River

Waters from Chakachamna Lake discharge from an outlet at the eastern end of the lake (Figure 6.15) into the Chakachatna River. This reach of river was characterized by a steep gradient, boulders, standing waves, and white-water. The water remains at a relatively high gradient to the base of the canyon about 14 miles east of the lake (Figure 6.13 and 6.16).

Due to the relatively swift currents and lack of cover in the upper portions of the Chakachatna River canyon, this area apparently is used primarily as a migratory pathway by the salmon and Dolly Varden that spawn in and above Chakachamna Lake. It is also apparent that this section is used by outmigrants, including sockeye smolt and Dolly Varden.

During August and September, sockeye salmon and chum salmon were observed spawning in sloughs and side channels in the lower canyon where the velocity of flow was slower than in the main channels. Juvenile Dolly Varden and salmon were also found to utilize the side channels throughout the lower canyon. However, they were also found in the main channel in areas where boulders provide cover and reduced velocities.

Along the main channel of the river (Figure 6.13) Dolly Varden, pygmy whitefish and round whitefish were found in most areas. Dolly Varden appeared to be most abundant. Rainbow trout were commonly found in major channels below Straight Creek.

Substantial numbers of sockeye, chum, and pink salmon were found to spawn in side channels and sloughs along the Chakachatna River considerably downstream of the canyon. The largest numbers of spawning fish were found near the confluence of Straight Creek and downstream from the Chakachatna bridge. Those areas containing spawning redds generally were side channels with suitable substrate that contained ground water flows or clearwater tributaries (Figure 6.17). Pink salmon were found in the vicinity of the Chakachatna River bridge during the August survey, however, at the beginning of the September survey, only one desiccated pink salmon carcass remained. The extent of pink salmon spawning and the presence of other spawning locations within the river are presently unknown. During the August reconnaissance, Chinook salmon were not observed spawning in the main channel of the river although some chinook were observed in the vicinity of the confluence of side channels with the main channel. Coho salmon were observed migrating up the Chakachatna, but the location of their spawning areas are presently unknown. Some coho probably spawn in Straight

Creek or its tributary, while others may spawn in the Nagishlamina River. It was unclear whether any coho spawn in side channels of the Chakachatna River. Overall, the largest numbers of spawning salmon were found in the Chakachatna near the bridge and in the Straight Creek tributary.

During the September 1981 reconnaissance, the river stage had dropped from that observed in August. During both reconnaissance trips, there were many side channels and backwater areas present, particularly below Straight Creek. Typical bank habitats varied from cobble-gravel to sand-silt. Juvenile fish were found in most areas containing a cobble-gravel substrate, while larger fish were generally found further from the banks in areas of swifter current. Migrating salmon were found to utilize the backwaters for milling or "resting areas" during their upstream migrations.

Straight Creek

Straight Creek, a major tributary of the Chakachatna River, contains substrates that vary from sand-silt to cobble-rubble, including many areas of gravel-cobble substrates suitable for salmonid spawning. The waters are cloudy with glacial silt and visibility is very limited.

Water velocities in the creek vary. Velocities in the center of the main channel have been measured at 6 ft/sec during high flows. Side channels at the same time had velocities of between 0.6 and 1.2 ft/sec.

Collections from the side channels and backwater areas of the creek show that these areas are used extensively by juvenile salmonids, of which Dolly Varden, chinook salmon parr and pygmy whitefish are the most common. Both chinook and coho salmon have been observed migrating up Straight Creek. A, D, F, and G recognizes Straight Creek as a Chinook spawning stream. However, it is unknown whether they spawn in the clearwater tributaries to the creek or whether some spawn in the creek itself. Chum and sockeye have also been observed migrating up Straight Creek near its mouth. Both species are also believed to spawn just outside the creek mouth, in side channels of the Chakachatna River.

Spawning sockeye, chum, pink and chinook salmon were observed in the clearwater tributary to Straight Creek (labelled A in Figure 6.17) during the August reconnaissance. Migrating coho salmon, as well as spawning chums and sockeyes were observed during the September study.

The tributary is relatively narrow compared to Straight Creek, with a main channel width of about 30 ft. The substrate is largely gravel with some sand and cobble. The banks are heavily overgrown with trees and other vegetation. There are also cutbanks throughout the area; roots, snags, and sweepers also provide significant cover in this stream. The stream contains side channels and backwaters as well as a variety of pool and riffle habitats.

Juvenile salmonids were abundant in this stream, particularly chinook, coho, and Dolly Varden parr. The shallow areas around snags and tree roots appeared to be favored areas due to the lower water velocity and cover. Larger Dolly Varden and rainbow trout were found in deep, swifter moving water, and were found to be consuming both Dolly Varden and chinook salmon parr, as well as pygmy whitefish. Although neither rainbow trout spawning areas nor juveniles were found in this stream, substrate and other habitat factors necessary for spawning were present (Morrow 1980, Scott and Crossman 1973).

Lower Chakachatna River.

The lower Chakachatna River divides up into three principal outflows. These are the Middle River, the Chakachatna River and the Noaukta Slough.

This lower portion of the Chakachatna River was characterized by relatively shallow depths and slower moving water than stretches further upstream. The substrate for this section of river was primarily sand-silt mud. There were relatively few rocks present. Much of the bank area was tree lined until close to the confluence with the McArthur River.

Sampling in the upstream portion of this stretch showed that Dolly Varden were abundant, comprising 80 percent of the catch. About half of the catch of Dolly Varden were fish 10 inches or less in length. Coho salmon juveniles and rainbow trout adults were also common. The area apparently serves as both nursery and adult habitat for these species.

The Middle River flows directly into Cook Inlet. Different stretches of the Middle River were characterized by different habitat types. The upper sections of the Middle River, downstream from the division with the Chakachatna, were characterized by relatively swifter currents, mixed substrates, tree-lined banks, and a highly variable channel. The substrates varied from sand-gravel, sand-silt, and gravel-cobble. Cut banks were present as well as tree roots along the banks.

While the upper reaches of the Middle River were characterized by an abundance of juvenile and adult Dolly Varden, the area also served as a nursery area for coho salmon and apparently some sockeye salmon. Parr of all three species were found in areas of low velocity and cover. The river is also used by sockeye salmon during out-migrations and by sockeye, coho and chum salmon for spawning migrations. Sockeye and chum salmon were observed in August, and coho were collected during September. Rainbow trout adults were also common in the upper river. However, both pygmy and round whitefish were common throughout the area. Several small, unnamed tributaries enter the Middle River. Some of the tributaries are slow moving and represent flow from old beaver dams. Both ninespine and threespine sticklebacks were found in these areas.

In the lower stretches of the Middle River the channel became wider and slower flowing, and riparian vegetation became increasingly more marsh like as the river approached Cook Inlet. The substrate is a fine sand-silt mud (Figure 6-18) with relatively few outcroppings of rock and little bank cover. Very few fish were observed or collected in this area; the most common being sticklebacks. Only one juvenile Dolly Varden and one sockeye smolt were collected in this section. There was no evidence that this stretch was used as a nursery area. This section was also part of the migratory route of sockeye, coho and chum salmon. However, no evidence was collected during this survey that indicated that chinook salmon, pink salmon, or anadromous Dolly Varden use the Middle River as part of their migratory route.

Although intertidal spawning by both pink and chum salmon has been reported in Alaska (Bailey 1964, Bailey 1969, Merrell 1970), it was not observed in the Middle River, and since the lower Middle River does not contain suitable cobble or gravel substrates (Bailey 1969, Merrell 1970, Nikolskii 1961, Morrow 1980), neither species would be expected to spawn there.

The Noaukta Slough is an area of diverse and meandering channels, islands, pools, and substrates. The slough, as observed during the two 1981 reconnaissance trips, was considerably more complex than depicted on existing maps. The slough included a large number of islands and flooded wooded areas.

Substrates within Noaukta Slough varied extensively with large areas of the slough characterized by soft substrates dominated by sand-silt muds, while other areas were dominated by cobble-gravel substrates. Areas in the upstream portions of the slough contained greater amounts of hard substrate than areas further downstream. Riffles were more common and velocities slightly higher in this upstream reach.

Sampling in the upstream portion of Noaukta Slough (Figure 6-17) showed that Dolly Varden were abundant, comprising 80 percent of the catch. More than half of the catch of Dolly Varden were fish 10 in. or less in length. Coho salmon juveniles and rainbow trout adults were also common. The area also apparently serves as both nursery and adult habitat for these species.

Both pygmy and round whitefishes were also present in the Slough. While the pygmy whitefish was more common than the round whitefish and was often found in areas that provided cover, round whitefish were often found in deeper, faster moving water. Since adult, migrating coho salmon were collected in the upper part of the slough near the Chakachatna River, it was apparent that the slough is part of their migratory pathway.

It was also apparent that the Noaukta Slough was a major nursery area since juvenile fish were extremely abundant in the middle and lower parts of the slough. Coho salmon parr and Dolly varden parr were the most abundant. However, juvenile pygmy whitefish and sockeye salmon parr were also common. Juvenile salmonids were found where water velocities were low and cover was sufficient. The habitats utilized included tree roots, rocky bank areas, cut banks, shallow side channels with cover, snags, and sunken trees and bushes. Both sockeye salmon parr and smolt were present in these areas and occurred in a wide range of sizes. Although sockeye fry usually migrate to a lake and reside there for one to two years before going to sea (Foerster 1968), some juveniles from the Chakachatna and McArthur Rivers apparently migrate to Noaukta Slough and utilize it as a nursery area since a lake is not accessible.

Although no spawning was observed in the Slough and no redds found, there was a substantial amount of suitable substrate present. The presence of turbid water obscured observations, and only one adult sockeye salmon carcass was found in the slough. However, it could have washed down from known spawning areas upstream.

McArthur River

Figure 6-19 shows habitat utilization along the McArthur River as determined by observations and collections. The upper McArthur River originates at the McArthur Glacier. The area near the head waters of the McArthur River was characterized by boulders, rubble, cobble with intermixed gravel, and a fairly high gradient. There were many riffles present and water velocities reached over 4 ft/sec in the main channel. Water temperatures were measured at 0.25°C in this area. Although several samples were taken within that portion of the upper river stretching to approximately four miles below the glacier, no fish were found.

In the braided section approximately four miles downstream from the glacier, the habitat was characterized by a gravel-cobble substrate and a water temperature of 3°C. Small riffles and side channels of varying depth were located throughout this area. In addition, small clear water streams entered the river along both sides of the canyon. Fish were abundant in this section of the McArthur River. Dolly Varden adults, juveniles and parr were present in this area, however juveniles of other species were not found.

A number of species were found to use the lower part of this area for spawning. Chinook, coho, pink, sockeye and chum salmon were observed spawning in the side channels of this area. Chinook salmon were observed only during the August reconnaissance and coho only during September, but both species appeared to utilize very similar areas. Sockeye salmon were the most abundant spawning species observed in this area during the two investigations, and were found in a great variety of areas including Pond A (Figure 6.20). Coho spawners began to appear in large numbers at the end of the September reconnaissance. The peak abundance of coho spawners in the McArthur may not actually occur until later in the year (October-November).

At the conclusion of the September reconnaissance, large numbers of anadromous Dolly Varden were found in the side channels of this area. Spawning behavior exhibited by Dolly Varden in this part of the McArthur had not been observed in the earlier reconnaissance. Dolly Varden spawning likely occurs from late August to the end of November, with peak activity occurring in September and October (Morrow 1980).

Downstream from the braided section of river, juvenile salmonids representing a variety of species became more abundant. Juvenile fish found in this section of the river included Dolly Varden, coho salmon, sockeye salmon, and pygmy whitefish. Adult pygmy whitefish were also present in this area. The beaver ponds labeled A and B (Figure 6.20) were utilized by both sockeye salmon and Dolly Varden. Ninespine sticklebacks were also abundant in these ponds, but were especially abundant in pond C. The substrates comprising the lower braided reach to the mouth of the canyon were increasingly dominated by sand, and other fine materials. Juvenile fish were only found along the far banks of the river in areas with a hard substrate or cover provided by vegetation. The large open sand flat areas of the main channels appeared to be devoid of fish, with the exception of occasional migrants. These migrants included adult chinook, coho, chum, pink and sockeye salmon, as well as Dolly Varden.

The northern channel of the McArthur River was relatively shallow with a sand-silt substrate. Fish were generally found along the banks and in areas that provided cover. Fyke net catches in this area were smaller than at any of the other stations. The species composition was also different, with the adult fishes being dominated by pygmy whitefish and a few Dolly Varden. Juveniles in this area were also less numerous, with only juvenile coho salmon, pygmy whitefish and Dolly Varden present.

Downstream from this area, several side channels and islands were present (shown in detail in Figure 6.21, Area A). In and around these side channels and islands there was a variety of cover provided by flooded trees, snags, and cobble-rubble substrate. Fish found in these areas included coho and sockeye salmon juveniles, pygmy whitefish juveniles, and Dolly Varden parr. Adult rainbow trout, pygmy, and round whitefish were also found in these areas. Very few fish except adult round whitefish were found away from cover or the channel banks.

The southern channel of the McArthur River that originated from the Blockade Glacier was characterized by a boulder-rubble-cobble substrate. Although some of the areas in this stretch contained cobble-gravel substrate that might be suitable for salmonid spawning (Area C in Figure 6.21), water temperatures in the area were probably too low.

Further downstream, the substrate was more diverse, containing substantial quantities of sand with occasional boulders and patches of hard substrate. Water temperatures in this area (B, Figure 6.21) were approximately 3.5°C. Sampling in area B revealed that large numbers of juvenile fish were present in shallow areas that provided cover, low water velocity and eddies. Juveniles included sockeye salmon smolt and parr, chinook salmon parr, Dolly Varden, and pygmy whitefish. No coho salmon juveniles were collected in this area.

No adult salmon were found or observed in this part of the river during either reconnaissance. It is not known at present whether any spawning occurs in the southern channel.

In the vicinity of Cook Inlet, the McArthur River substrate was generally sand-silt/mud. This part of the river is not expected to provide significant juvenile nursery habitat nor spawning areas. It is, however, a migratory pathway for the anadromous salmonids.

The McArthur River also has a number of tributary streams that serve as both spawning and nursery areas. The streams identified by the letters D through H were found to contain spawning salmonids during one or both of the reconnaissance efforts (Figure 6.21). All of the streams had clear water, a variety of riffle and pool habitats, and substrate suitable for salmonid spawning. There was also a great deal of cover along the banks provided by rubble, cut banks, and overhanging trees. Stream D was found to contain spawning sockeye, chum, pink and chinook salmon during August 1981. Streams G and F were also found to contain chum and chinook salmon. Clearly stream G also served as a migratory pathway for streams E and F.

Although stream E was found to serve as nursery habitat for Dolly Varden, chinook salmon and coho salmon, this was the only upper McArthur tributary stream in which a juvenile fish was collected.

Stream H was overflown during September 1981 and was found to contain at least 1000 coho salmon. The stream contained large stretches of spawning substrate, and large numbers of fish were found at each bend in the stream. Local people in the Tyonek area also reported that chinook, pink, and chum salmon can be found in this stream as well as rainbow trout and Dolly Varden. The extent to which this stream may be utilized for spawning by species other than coho salmon is unknown.

Overall these tributary streams represent a major part of the spawning habitat in the McArthur River drainage and may be utilized more than the side channels of the main river.

6.3.3.3 Habitat Use

For the purpose of a preliminary assessment of habitat use, the study area was divided into the following 13 areas that represented areas of relatively similar habitat and/or geographic location (Figure 6 22).

A The lake tributary rivers apparently do not contain salmon spawning populations and do not appear to be widely utilized.

B The Chilligan and Igitna Rivers were the major sockeye salmon spawning areas found.

C Chakachamna Lake and Kenibuna Lake represent the major juvenile sockeye rearing lakes and nursery areas.

D The area from the outlet of Chakachamna Lake to the base of the canyon along the Chakachatna River is primarily a migratory route with some use by sockeye and chum salmon spawners (canyon slough spawning area), and by Dolly Varden as a nursery area.

E The Chakachatna River from the Canyon to the split with the Noaukta Slough. This area includes some moderately important sockeye and chum spawning areas. There may be some minor spawning by chinook in channels of this area. This is a major migratory route for sockeye, chinook, chum, pink and coho salmon. There may be minor use of this area as nursery habitat by sockeye and coho salmon, as well as Dolly Varden.

F Straight Creek and its clearwater tributary. This is a major chinook spawning area as well as a spawning area for sockeye, chum, coho, and pink salmon. Dolly Varden and rainbow trout adults utilize this area as well. These streams serve as a nursery area for chinook, coho, and Dolly Varden. These streams are also part of the migratory routes of all five salmon species.

G The lower Chakachatna River and Middle Rivers. These areas are part of the migratory pathways for the five salmon species. Some spawning occurs in the side channels of the Chakachatna in the upper parts of this section near the confluence with Straight Creek. Chum salmon appeared to be most plentiful there, with small numbers of sockeye also present. This area appeared to be moderately important as a nursery area for coho, chinook, and sockeye salmon. Dolly Varden juveniles and adults were abundant here as well.

H The Noaukta Slough. The slough is probably a major nursery area for the McArthur and Chakachatna drainages. Coho, chinook and sockeye juveniles were abundant there, as were Dolly Varden and pygmy whitefish.

I Lower McArthur River. This area is part of the migratory pathway of the five salmonid species that spawn in the McArthur drainage or that ascend the lower Chakachatna River or Noaukta Slough to spawn in the Chakachatna River drainage. This area provided nursery habitat for juvenile sockeye, coho and Dolly Varden.

J The area adjacent to the McArthur River Canyon. This part of the river provided a migratory pathway to the upper sections of the river (L) and also served as nursery habitat for coho salmon and Dolly Varden.

K The southern channel of McArthur River originates at the Blockade Glacier and has its confluence with the northern channel near the Noaukta Slough. This area served as nursery habitat for chinook and sockeye salmon as well as for Dolly Varden. It is unknown whether migratory adult salmon use this area but it appears to be unlikely.

L Upper McArthur River. This area includes spawning habitats for chinook, coho, sockeye, chum, and pink salmon. Anadromous Dolly Varden, in addition to spawning in this habitat, utilize the middle reaches as a nursery zone. The lower reaches containing sufficient cover were used by sockeye, coho, and Dolly Varden as a nursery area. Migratory adults of all five salmon species pass through this area.

M Tributary streams of the McArthur River. All five salmon species were found to spawn in these streams. Chinook and coho salmon were more abundant than in the upper McArthur (area L). Pink salmon were more abundant in the streams flowing from the mountains. The streams were also used as nursery areas by juvenile Dolly Varden and chinook salmon.

6.3.4 Summary and Conclusions of 1981 Studies

Although of limited duration, the 1981 studies of the Chakachatna and McArthur River systems, provided a substantial amount of data which indicated that:

- o Large numbers of sockeye salmon utilize Lake Chakachamna as a nursery area and the Igitna and Chilligan Rivers as spawning sites.

- o Side channels and sloughs in the Chakachatna River are used as spawning sites by chum, pink and sockeye salmon.

- o Side channels and sloughs in the upper McArthur River are used as spawning sites by chinook, chum, coho, pink, and sockeye salmon, and also by anadromous Dolly Varden.

- Clearwater and other tributary streams are used for spawning by chinook, chum, coho, pink, and sockeye salmon.

- The intertidal areas of both river systems do not contain suitable substrate for salmonid spawning.

- Areas with cover and low water velocities are used as nursery areas.

- Noaukta slough is used extensively as a nursery area, particularly by coho and sockeye salmon.

- Migratory pathways for spawning adults and outmigrant juveniles include most reaches of both river systems.

6.4 Terrestrial Vegetation and Wildlife

6.4.1 Background

The objective of the terrestrial component for the environmental study of the Chakachamna Hydroelectric Project was to analytically characterize the vegetative and wildlife communities. Because this project could affect the lands and waters of both the Chakachamna and McArthur drainage systems, qualitative data were collected throughout the study area and vegetation and wildlife habitat maps were prepared so that areas of a sensitive or critical nature could be identified.

Previous investigations conducted in the area by the Alaskan Department of Fish and Game (ADF&G) and the U.S. Fish and Wildlife Service (USFWS) have concentrated on documenting waterfowl utilization of the coastal marshes of Cook Inlet. In addition to annual aerial surveys of the Trading Bay State Game Refuge performed by the personnel of ADF&G, personnel of USFWS have conducted aerial swan surveys encompassing the lands in and adjacent to the refuge. Although the main purpose of these surveys has been to census waterfowl, information has also been gathered on bald eagle nest sites, moose calving grounds, and the occurrence of Beluga whales near the McArthur River.

6.4.1.1 Study Area

As previously discussed, the study area encompasses all of the lands and waters from the tributaries of Chakachamna Lake to Trading Bay in Cook Inlet in addition to the lands and waters of the McArthur drainage system. Located approximately 60 miles west of Anchorage on the west side of Cook Inlet, this area supports a wide variety of wildlife and vegetation.

From the tidal flats in Trading Bay the land rises slowly, forming a continuous array of marshes, bogs, and ponds. At the mountains, the land supports a totally different vegetative community. Overall, eight habitat types were identified. These areas which are described in subsequent sections included coastal marshes, the riparian zones around the streams and rivers, bogs, and the rocky slopes around the lake.

6.4.2 Study Objectives and Methodology

The major objectives during the vegetative studies were to describe the vegetative communities within the study area and to provide vegetation maps at a scale appropriate to delineate wildlife habitats. To accomplish this, a combination of aerial surveys, ground surveys, and an analysis of true color aerial photographs were utilized. Throughout the study period (14-25 September), 22 low elevation aerial surveys (50-200 feet AGL) were flown in a random route such that the entire study area was covered. Two observers on opposite sides of the aircraft recorded the location and relative abundance of vegetative stands. In addition, 23 quadrats, each averaging 2 square miles were selected for ground surveys (Figure 6.23). The quadrat sites were not selected in a random fashion, but instead were chosen to be a representative sampling of vegetative types in the area. During these observations, all species of woody vegetation, the major species of herbaceous vegetation, and their relative abundances were noted. Finally, the information gathered on each of the quadrats was used in conjunction with the aerial photographs to interpret the vegetative composition of the remainder of the study area.

The primary objective of the wildlife study was to identify important wildlife resources in the study area, their use of the area, and the importance of identified vegetative and aquatic communities to these resources. To accomplish these objectives, the same 22 low elevation aerial surveys that were used to identify vegetative types were used to classify bird and large mammal distribution and abundance. These observations totaled 12.8 hours and were conducted at various times of the day, ranging from 0730 to 1900 hours. In addition to the aerial surveys, the 23 quadrats used for vegetative analysis were searched for evidence of birds and mammals. Forage areas were studied to determine the species and number of individuals utilizing the area as well as the species that were being consumed. The identification of tracks yielded additional information on both nocturnal and uncommon species and the analysis of scats further defined the species composition, distribution, and food habits.

Due to the difficulty in observing small rodents, a qualitative trapping program was conducted along transects in five representative zones of the study area. These five areas were located at the mouths of the Chilligan and Nagishlamina Rivers, along the edge of the floodplain on the Chakachatna River near the confluence with Straight Creek, in the heavily wooded area west of the Chakachatna River, and on McArthur Flats near Seal Slough. At each location, 40 snap traps were set for a period of 48 hours.

Vegetation and habitat type maps were prepared based on the classification methodology outlined by Phister et al. (1977). After the field data collections, a subjective grouping of possible types was developed, based on structural differences in the vegetation. Second, a Bray-Curtis ordination was applied which provided a graphical arrangement of the types based on similar species composition. The vegetation type terminology for this classification differs from most type approaches in that the understory species named could either be an understory dominant or simply be an indicator species (important just by its presence or absence). Overall, this classification scheme is more directly related to habitat types than a dominant species approach because it is sensitive to both vegetative structure and relative species composition.

6.4.3 Results and Discussion

6.4.3.1 Vegetation

Within the study area, 40 species of woody vegetation and nine taxa of herbaceous vegetation were identified. Paper birch had the highest frequency among the woody species, having been found in 65 percent of the quadrats. Black cottonwood had the second highest frequency (61 percent) while diamondleaf and feltleaf willow both occurred in 13 of the 23 quadrats (57 percent). Grasses had the highest frequency among all the plants, having been found in all 23 quadrats sampled. Although not all of the grasses present were identified, two of the most common were *Poa* sp. and *Fetuca* sp. The remaining eight taxa of herbaceous plants were fairly site specific with only horsetails being found in more than 50 percent of the quadrats.

Based on the vegetation classification scheme outlined earlier, the terrestrial vegetation within the study area was divided into eight types (Table 6.10 and Figure 6.24):

Upland Alder Thicket (UAT);
High Altitude Riparian (HAR);
Black Cottonwood Riparian (BCR);
Coastal Marsh Riparian (CMR);
Black Spruce Transitional (BST);
Resin Birch Bog (RBB);

Willow Thicket Riparian (WTR);
and Black Spruce Riparian (BSR)

Upland Alder Thicket

This type occurred mainly on the steep slopes above Chakachamna Lake and on the canyon walls above the Neacola, Igitna, Chilligan, Nagishlamina, and McArthur Rivers. It was also interspersed with the other types on Kustatan Ridge near Cook Inlet. These sites were characterized by an abundance of black cottonwood, Sitka alder, and paper birch. Diamondleaf and feltleaf willow were abundant in some locations while herbaceous plants were uncommon, except for grasses.

High Altitude Riparian

This type was more restricted in its distribution, being found only on the floodplains of the rivers flowing into Chakachamna Lake and in the Chakachatna River canyon. This form of riparian habitat was characterized by an abundance of Sitka alder, paper birch, and white spruce. Diamondleaf and feltleaf willow were also widespread. Herbaceous plants included ferns, fireweed, and moderate amounts of grasses.

Black Cottonwood Riparian

At elevations lower than the McArthur and Chakachatna River canyons, this type replaced the high altitude riparian and was found along the shores of most of the streams and rivers. Characterized by an abundance of black cottonwood, thinleaf alder, and paper birch, numerous species of willow were also present, including diamondleaf, feltleaf, Barratt, undergreen, and grayleaf. Herbaceous plants include Artemesia tilesii, ferns, sedge, and fireweed.

Coastal Marsh Riparian

This type encompassed most of the area within one mile of Cook Inlet in addition to a few areas along the McArthur River. These sites were characterized by almost a total absence of woody vegetation, and an abundance of grasses, sedge, and horsetails. These sites were better drained than the bogs and were laced with an array of ponds and streams that were often inundated by fluctuating tides.

Black Spruce Transitional

This type was very limited in its distribution, mainly composing the later successional stages in and around the open bogs. Characteristic of an ecotone, these sites hosted a mixture of riparian species (black cottonwood, thinleaf alder, and paper birch) and bog species (black spruce, bog rosemary, and bog blueberry). Herbaceous taxa were well represented in both number and distribution. Physically, these sites were also intermediate between bog and riparian sites with part of the area dry and well drained while other areas were wet and spongy.

Willow Thicket Riparian

The distribution of this type was limited, only being found along the floodplain of the McArthur River canyon. This riparian area was characterized by an abundance of willows (seven species), black cottonwood, and thinleaf alder. Herbaceous plants were sparse but included fireweed, grasses, and lupine.

Resin Birch Bog

Although this type was found throughout the lower elevations of the study area, it dominated the area north of Noaukta Slough. Characterized by a predominance of bog shrubs such as resin birch, bog blueberry, and narrow-leaf Labrador-tea, these areas also hosted an abundance of herbaceous plants including sedge and grasses. Physically, these sites were poorly drained and supported large mats of floating vegetation.

Black Spruce Riparian

This type was common at intermediate elevations, between the higher elevations of the Resin Birch Bog and the lower elevations of the Coastal Marsh Riparian and was the dominant type found on the Trading Bay Refuge. These areas were characterized by an abundance of diamondleaf willow, black spruce, and an absence of black cottonwood. Both species of alder were present along with an abundance of sedge and grasses. Physically, these sites were poorly drained, but unlike the bog, there was no mat of floating vegetation to cover the large amounts of water.

6.4.3.2 Mammals

Of the 16 species of mammals that were identified, the grizzly bear, black bear, and moose had ranges occurring throughout the study area. Also common were the coyote and gray wolf, both of which were found in more than 50 percent of the quadrats sampled. Less common mammals included the river otter, barren ground caribou, and wolverine.

The same eight habitat types used to classify the terrestrial vegetation were also used to classify the distribution and relative abundance of the mammals that occurred in the study area (Table 6.11). Grizzly bears, black bears, and moose were found to utilize all eight habitat types. During the two weeks in September that this study encompassed, the grizzly bear appeared to be most abundant in the High Altitude Riparian and Black Cottonwood Riparian habitats. The black bear appeared most abundant in the Upland Alder Thicket and High Altitude Riparian habitats, while the moose was most abundant in High Altitude Riparian and Black Cottonwood Riparian habitats. Unlike the distribution of most of the other mammals, moose were common in all habitats except in the upland Alder Thickets.

The only other ungulate that occurred in the project area besides moose was the barren ground caribou, and its distribution was restricted to the High Altitude Riparian habitat. Both species of Canids that were present, occurred over a fairly large range. Although not as abundant as the coyote, the gray wolf was found in all habitats except the Resin Birch Bog and the Black Spruce Riparian while the coyote was found in all eight types.

The order that was best represented in the study area was Rodintia. The two largest members of the order, beaver and porcupine each occupied three habitats while the muskrat inhabited four types.

The habitat type that had the highest diversity (as measured by the number of species) was the Black Cottonwood Riparian. This habitat contained 15 of the 16 mammals found in the study area. The lowest diversity (five species) was found in the Resin Birch Bog habitat.

The analysis of scats, tracks, and feeding areas supplied additional information on the seasonal distribution and food habits of some species. Both species of bears appeared to be consuming berries, salmon, and grasses. Although the direction of travel for most of the bears was towards the High Altitude Riparian habitat it is not known if this is indicative of the location of winter denning sites. During the two weeks of this study, moose were feeding mostly on willows that were taller than five feet and were seldom seen very far from tall dense vegetation. Calving grounds, as indicated by the skeletal remains of juvenile moose, appeared to be located in and near the Black Cottonwood Riparian habitat around the Middle River, Noaukta Slough, and the McArthur River. Wintering areas, as indicated by shed antlers, were found throughout the High Altitude Riparian habitat above Chakachamna Lake. Beaver, otter, and muskrat had more limited distributions. While beaver and muskrat were found throughout the Black Cottonwood Riparian, Willow Thicket Riparian, and Black Spruce Riparian habitats, porcupine were found in the High Altitude Riparian, Black Cottonwood Riparian and Coastal Marsh Riparian habitats. Areas that are utilized by these mammals were identified by the presence of beaver lodges, woody plants, chewed by beaver, muskrat houses, otter slides and tracks.

In addition to the terrestrial mammals, two species of marine mammals were present. A harbor seal was sighted at the mouth of the McArthur River and although Beluga whales were not observed during this study, personnel of ADF&G have sighted whales in Trading Bay.

6.4.3.3 Birds

Within the study area, 56 species of birds were identified. Of these, the three that occurred in all 23 quadrats sampled, were the bald eagle, common raven, and black-billed magpie. Also common in the area were marsh hawks, black-capped chickadees, and various species of waterfowl. Species that were only sighted occasionally included fox sparrows, Swainson's hawks, brown creepers, and snow buntings.

The same habitat types that were used to describe the distribution of mammals and vegetation were used to describe the distribution and relative abundance of the 56 species of birds (Table 6.12). The habitat that hosted the largest diversity of avifauna was the Coastal Marsh Riparian. Included is the 38 species sighted in that type were trumpeter swans, bald eagles, black bellied plovers, short-billed dowitchers, and lapland longspurs. The Upland Alder Thicket type only hosted 10 species, most of which were common throughout the study area. Nearly as low in species richness were the Resin Birch Bog and Willow Thicket Riparian habitats, containing 11 and 12 species of birds, respectively.

Two of the larger species that nest in the study area are the bald eagle and the trumpeter swan (Figure 6.25). As of May 1980, ADF&G personnel had documented the location of five eagle nests on the Trading Bay Refuge. During this two week study, eagles were observed from the Chilligan River to Cook Inlet, however, they were concentrated near the confluence of Straight Creek and the Chakachatna River. In August, 1980, personnel of USFWS recorded the location of trumpeter swan nests in and near the refuge. At the time of the survey, there were 25 pairs of breeding swans and a total of 143 swans in the project area. Similar to the distribution of eagle nests, swan nests were concentrated near Cook Inlet. The area within seven miles of the tidal mud flats provided habitat to 55 percent of the total population, 48 percent of the nesting pairs, and 63 percent of the fledgling cygnets (Figure 6.26). Although the largest proportion of the population was near Cook Inlet, the area with the highest density was from Noaukta Slough to the Blockade Glacier, along the McArthur River. This area, encompassing 70 square miles, contained 56 trumpeters (0.8 swans/mile2).

A species that is commonly found feeding in the study area, (Timm and Sellers, 1981) yet was not observed during this study, is the tule white-fronted goose (*Anser albitfrons gambelli*). Currently, the only known nesting areas for the tule goose in Cook Inlet are at Redoubt Bay and Susitna Flats. Although personnel of USFWS and ADF&G have searched the study area for nesting pairs, no evidence exists that would support the contention that this species nests on the Trading Bay Refuge. However, since this species often nests in dense vegetation, undetected nesting sites may exist.

Of all of the species of plants, mammals, and birds that were identified in the study area, none of the species that are present are listed as threatened or endangered by the Federal Government. However, as of May 1981, it was proposed that the tule goose be considered for threatened or endangered status (M. Amaral, USFWS, personal communication 2 November 1981).

6.4.4 Conclusions

The relatively high diversity in both flora and fauna found within the study area is the product of climate topography and fluctuations in the stream and river discharge. Due to periodic tidal inundation of the coastal marshes, both salt water and brackish marsh vegetation is found. Surface flows resulting from precipitation are apparently retained for long periods of time in bogs. Combined with these factors are dynamic river channels and varying successional stages. As a result, the study area is composed of a variety of vegetation types that, individually and collectively provide important habitat to species of wildlife throughout the year. Although all species of plants and animals in the area are important, there are several vegetative types that are more critical to the overall stability of the community than others. Two of these are the High Altitude Riparian and the Black Cottonwood Riparian habitats. These areas not only provide food and cover to a wide variety of animal life throughout the year, they also provide wintering and calving grounds for moose, nesting sites for bald eagles and trumpeter swans, and feeding areas for grizzly and black bears. The other two critical areas are the Coastal Marsh Riparian and the Black Spruce Riparian habitats. Due to the large expanses of standing water and dense vegetation, these areas provide nesting and staging areas for waterfowl and shore birds.

6.5 Human Resources

6.5.1 Background

The Human Resources element of the report was prepared with several objectives in mind:

(1) identification of concerns of government agencies and general public

(2) evaluation of project alternatives,

(3) conformance with FERC guidelines, and

(4) preparation of the 1982 scope of study.

Accordingly six areas of study were selected: archaeological and historical resources, land ownership and use, recreation, socioeconomics, transportation, and visual resources.

The general project area has a long and varied history of human habitation, and therefore has a high potential for archaeological and historical resource sites. However, little field work has been done in the project area and the distributrion of potential resource sites is unknown Federal and State agencies and Native corporations involved in the proposed project have varying requirements for the protection of archaeological and historic resources.

As elsewhere in the state, land is owned by a mix of federal, state, Native, and private entities. The status of land selections, conveyence and patents is complicated and often involves several parties in the management of one parcel of land. Land use revolves around resource extraction, processing, and transportation.

Recreational use of the project area is currently limited, but increasing in popularity. Recreation activities in neighboring Lake Clark National Park and Trading Bay Game Refuge could have a bearing on the project. In addition, the State Division of Parks will be inventorying recreation resources in western Cook Inlet in the near future and is interested in the Chakachamna River area.

Project construction and operation will both create jobs and impact the socioeconomic characteristics (population, employment, income, infrastructure and subsistence) of the region. Impacts will affect the village of Tyonek, the Kenai Peninsula Borough, and the greater Anchorage area.

The remoteness of the project site emphasizes the importance of existing transportation networks. Project use of roads, docks, and air strips may conflict with existing uses, and new facilities required for the project may provide new public access that is not desired by local residents.

Both the Bureau of Land Management and FERC have specific requirements regarding visual resources. The scenic nature of the project area led to its consideration for inclusion as national interest lands under Section

17(d)-2 of the Alaska Native Claims Settlement Act. Project proximity to Lake Clark National Park and Trading Bay State Game Refuge may place more importance on visual resource impacts.

This Human Resource element was prepared using three methods. Field reconnaissance was employed to evaluate the potential for archaeological resource sites. Several recent reports associated with coal and petroleum resource development proposals were also utilized. Finally, federal, state, and Native entities were contacted to obtain resource data and concerns about the project.

6.5.2 Archaeological and Historic Resources

6.5.2.1 Introduction

This section evaluates the historic and archaeological resources of the area through a literature review, personal contacts, and consultations with the State Historic Preservation Officer and the State Archaeologist. A one day helicopter reconnaissance allowed a field evaluation of the power generation facility sites.

6.5.2.2 Historical Background

The project area lies within the traditional territory of Tanaina Athapaskan Indians. The earliest record of European contact with the Tanaina resulted from Captain James Cook's voyage to the upper inlet in 1778 (Cook 1784). In July of 1786, two English ships captained by Dixon and Portlock made a trading trip to Cook Inlet.

The bay in which they anchored was named Trading Bay by Capt. Portlock. Trading lasted for about a week (Dixon 1789; Portlock 1789). During this same period Russian presence was increasingly more evident in the Cook Inlet region (Bancroft 1886; Townsend 1965).

After the Russians settled in the area there began a period of struggle between the various Russian trading companies. The Tanaina were caught up in this struggle and open hostilities broke out between the Tanaina and the Russians. The Russian American Company was founded in 1799" (Van Stone and Townsend 1970:14). An outpost had been established by the Russians at Tyonek around 1790. In 1797 the Tyonek Outpost was destroyed. "Dissension among the Russians and persecutions of the Natives reached such an extreme that the infuriated Kenais (Tanaina) destroyed the two outposts at Iliamna and Tuiunuk (Tyonek), killed 20 Russians, and almost 100 subject natives" (Tikhmenev 1978:46).

After 1800, hostilities between the Tanaina and the Russians seem to have subsided. This relatively peaceful period saw renewed trade and the introduction of Christianity (Townsend 1965:55). Unfortunately, a smallpox epidemic swept through the region in the late 1830s.

With the sale of Alaska to the united States in 1867 the Russian-American Company assets were purchased and reorganized to form the Alaska Commercial Company. The Alaska Commercial gained a virtual monopoly in 1883 after the Western Fur and Trading Company sold out.

During the late 1890s and early 1900s, Tyonek became a major disembarking point for both goods and people as prospectors and miners moved into the Cook Inlet region.

Aboriginal use of the project area appears to have been extensive and ancient. Extensive use of several mountain passes and trails is well documented for the late prehistoric/early historic period. The Tanaina from the Tyonek area utilized the interior region for hunting and trading purposes as did the inland Tanaina groups from Lake Clark, Mulchatna, Stony River, and the Susitna basin. Key subsistence items for the Tyonek Tanaina, however, centered on marine resources. Procurement of food items such as salmon, eulachon, seal, and beluga made it possible for the Tanaina to maintain semi-permanent villages along the coast. In late April the Tyonek Tanaina would move to traditional fish camps along the inlet. Waterfowl were caught at tidal flats and at the mouths of rivers along Trading Bay. Beluga and Susitna flats were also used. During the spring, fish traps were set for trout at interior lakes. Beaver were also hunted inland at streams and lakes (Chickalusion and Chickalusion 1979). The favored land hunting area for the Tyonek Tanaina was the region around Chakachamna Lake. Inland hunting was concentrated during late August through October. Moose seemed to be scarce throughout the region during early historic times. In addition to hunting in the Chakachamna Lake region the Tyonek people would sometimes cross the Hayes River Pass (Tubughna Kalidiltuni) to Rainey Pass (Htal) to hunt caribou and sheep. Here they would meet and trade with Susitna Tanaina (Fall 1981:193).

The Tyonek people had a tradition of trading with other groups from the interior. They would meet upper Kuskokwim Natives at Merrill Pass in the summer or fall to conduct trading. Apparently the Tanaina enjoyed the role of middleman traders between the Russians at Cook Inlet and the deep interior upper Kuskokwim Indians (Zagoskin 1967:16B-169).

A review of the archaeological literature indicates that the project area and immediate vicinity have not been studied. Most of what is known of the prehistory in the Cook Inlet region pertains to the western side of Knik Arm (de Laguna 1975; Dumond and Mace 1968), the northern shore of Turnagain Arm (Reger 1977b, 1981), Kenai Peninsula (Kent et al. 1964; Borras 1975, 1976; Reger 1977a), Kachemak Bay (de Laguna 1975; K. Workman 1977; W. Workman 1977), and the Matanuska River (West 1975, 1980; Bacon 1978). The only archaeological investigation very close to the project area is that of de Laguna at Kustatan in 1930. She briefly investigated a prehistoric midden on the first bench behind the cannery. On the second bench she observed several house pit depressions and excavated one of them (de Laguna 1975:138). De Laguna commented that although the collection was meager (faunal remains and a few artifacts) it appeared similar to Kachcmak Bay collections (de Laguna 1975:148).

The following outline of Cook Inlet prehistoric cultural events is based upon Reger's recent summary (Reger 1981).

A. The earliest cultural remains recognized in the Cook Inlet region are from component I at the Beluga Point-North site on Turnagain Arm. It consists of a core and microblade technology which can be compared to other sites dating between 8000 and 10,000 years ago. These sites fall within the broad American Paleoarctic tradition described by Anderson (1968:29). This tradition includes collections from interior Alaskan locations such as Dry Creek (Nenana Valley), Healy Lake (Tanana Valley), and Onion Portage (Kobuk Valley). These sites have consistently been associated with an environment thought to support herds of bison, horse, mammoth, and caribou. Thus, these early cultures are believed to have been primarily exploiters of large land mammals. Heusser's reconstruction of the early post-glacial vegetation for southcentral Alaska postulates generally treeless tundra and somewhat moister conditions than the deep interior (Heusser 1960). A greater expanse of tundra than at present would have been able to support a large number of caribou.

B. The next occupation in the sequence is found in Beluga Point-North component II and Beluga Point-South component I. Artifact comparisons with surrounding geographic areas, i.e., the Alaska Peninsula, Afognak Island, and Lake Iliamna indicate an age of 3000 to 4000 years old.

C. Norton related culture (cf Dumond 1977:106) is represented by Beluga Point-South component II. "The time period of approximately 1500 to 3000 years ago was a period in which influences (Norton culture) from Bristol Bay diffused into Cook Inlet as indicated by the BPS-II collection" (Reger 1981:202). Although there was a fairly strong Norton influence during early Norton times, the archaeological record indicates that cultural influences between Bristol Bay and Cook Inlet had ceased during late Norton times.

D. Reger suggests that Kachemak culture (de Laguna 1975), which flourished in the Kachemak Bay area, may have provided a mechanism for limiting Norton influences in the Cook Inlet area. He feels that between 1500 to 2000 years ago a separate cultural pattern developed in the upper inlet which was based on seasonal use of riverine and interior resources "Such a pattern appears to be evident at the Moose River site and the Merrill site, and by inter- pretation will probably be found in the Upper Inlet area" (Reger 1981:205).

E. Between 600 and 800 years ago another cultural occupation was present at Beluga Point, Beluga Point-North component III. This component is distinct with only a few traits showing close comparison with nearby collections, i.e., from Prince William Sound, Kodiak Island, and Kachemak Bay. The presence of native copper implements indicates trade contacts with interior Indian groups, possibly Atna Athapaskans of the Copper River country.

F. The late prehistoric period in the upper Cook Inlet region is poorly documented. It is generally believed that interior Athapaskan influences were introduced by the arrival of Tanaina Indians, perhaps during the second half of the 18th century A.D.

6.5.2.3 Methodology and Results

The Alaska Heritage Resource Survey File (AHRS), maintained by the State Historic Preservation Office, was searched for any reference to historic or archaeological sites at or near the Chakachamna Hydroelectric Project. No sites are listed for the project area. A review of the archaeological, ethnological, and historical literature indicates that the project area has not been well studied.

The potential for prehistoric human use and habitation within the project area is moderately high. The literature indicates that prehistoric peoples were ranging throughout the Cook Inlet and Susitna basin region over many thousands of years, perhaps as early as 8000 B.C.. Several diverse cultural traditions have exploited the region. Thus far, nearly all of the archaeological investigations in the Cook Inlet region have been at coastal sites. The interior exploitive pattern has only recently been investigated.

De Laguna made note of four old village sites between Trading Bay and Beluga River, although she did not visit any of them.

> Ladd. The modern village is on an ancient site, Tsluiltna from which the name of the river, Chuit, is probably derived.
>
> Tyonic or Moquawkie. There is an old village site, Qalqesle, near the modern village. In the woods at the top of the hill behind the village are the houses where the natives used to live for fear of raids made by the Kodiak Eskimo.

Old Tyonic. This village is called Tatlnaq, and may be old. This seems to be the "Toyonek" of Petroff's map.

Granite Point. The site of Tsilalxna is at a small stream south of Granite Point (de Laguna 1975:139).

The one-day helicopter reconnaissance provided an overflight of the potential power generation facility sites, on the southeast shore of Chakachamna Lake and near the upper limits of McArthur River. The lake shore in sections 18 and 19 of Township 13N/Range 17W and section 24 of Township 13N/Range 18W, Seward Meridian was examined from the air. There was no landing area for the helicopter because the steep, rocky slope decends abruptly into the lake and the helicopter was not equipped with pontoons. The possibility of any impact to cultural resources resulting from the facility at Chakachamna Lake is so unlikely that an on-the-ground archaeological survey is not considered necessary.

The porbable location of the powerhouse lies somewhere within section 30 of Township 12N/Range 17W, Seward Meridian. This area, a small narrow valley with steep walls, was examined from the air only. Although it appears unlikely that any cultural resources will be impacted by the facility, an on-the-ground archaeological clearance should be done after the exact location is selected and the limits of the construction zone determined, but prior to the actual construction.

Because transmission line corridors and access road alignments have yet to be finalized, only a reconnaissance flight over the broad zone of probable impact was possible. It is here that potential impacts to cultural resources are most likely to occur, especially with the building of roads and development of borrow pits. Therefore, archaeological on-the-ground survey will be necessary prior to any construction activities involving transmission lines and roads.

The likelihood of archaeological site occurrence can be depicted on maps as areas classified high, medium, and low potential. Such areas can be identified using basic criteria of vegetation communities, physiography, slope, aspect, soils, and proximity to resources such as food, fuel, raw materials, and water. Mapping of archaeological potential can be aided by air photo interpretation, but primarily depends on the judgement of the archaeologist. This judgement is based upon experience in site survey, familiarity with specific geographical areas, and the data base of identified archaeological sites found in similar environmental settings throughout Alaska.

Areas of low potential are generally flat wetlands or have high topographic relief. Either condition is restrictive to human habitation. Low potential areas also include active floodplains where periodic flooding and erosion would have destroyed evidence of past human activity. High potential areas are generally those with moderate topographic relief which ordinarily are well-drained. Areas of medium potential might include some portions of high and low potential but are not classified predominately high or low.

6.5.3 Land Ownership and Use

6.5.3.1 Land Ownership

Figure 6-27 shows the existing land ownership in the proposed project area. Historically the federal government owned all the land in the area as "public domain". Large areas of federal land have been transferred to Alaskan Natives and the State of Alaska. A small amount of state land was subsequently transfered to the Kenai Peninsula Borough. Land ownership patterns have not been finalized in the area. The largest unresolved matter involves the settlement of land claims associated with the Alaska Native Claims Settlement Act (ANCSA) of 1971. Extensive federal and state lands have been selected by the Natives but not all the legal transfers have been completed. Native landowners include Cook Inlet Region, Inc., Tyonek Native Corporation and the Native Village of Tyonek.

A number of small parcels have been patented to individuals, primarily along the coast, by both the federal and state governments. Numerous easements and rights-of-way exist in the area, again primarily along the coast.

Rights to various resources, including timber, petroleum and coal, have been sold in the area by both the state and the Natives. Resource development activities will continue to have a major impact on the area.

6.5.3.2 Federal Land

Federal lands in the area have been involved in complicated proceedings due to often times overlapping selections by the state and Alaska Natives and the establishment of the boundaries of Lake Clark National Park. Native selections on federal lands in the area have been unofficially relinquished (CIRI, personal communication, November 10, 1981). State selections are still in force and are being processed. Thus, the state may eventually gain patent to some of these lands. All federal lands outside of the park are administered by the Bureau of Land Management. Federal land in the park is administered by the National Park Service.

Bureau of Land Management

Federal lands administered by BLM include the Lake Chakachamna power site and a number of townships surrounding the power site. In 1947 lands in the immediate vicinity of Lake Chakachamna system were withdrawn as a power site under Power Site Classification 395 (USS 3970). The power site includes all public lands lying within one-quarter mile of Chakachamna Lake, Kenibuna Lake, and the Chakachatna River from the outlet at the lake to the mouth of Straight Creek.

The remaining BLM land, some of which is unsurveyed, is being passively managed. Most of these townships have been selected by the state. Native selections have also been made on some townships but these selections are to be officially relinquished in the near future (personal communication, CIRI, November 10, 1981). Until official relinquishment is made BLM cannot act on the state selections. Townships or portions of townships selected by the state in the area but not selected by the Natives, are on the state's priority list and may be conveyed in the near future.

Lake Clark National Park

The park is administered by the National Park Service. Lake Clark National Park and Preserve were established on December 2, 1980 by the Alaska National Interest Lands Conservation Act. This act provided for a national park of approximately 2,439,000 acres and a national preserve containing approximately 1,214,000 acres. The federally owned or controlled lands of the park and preserve, by virtue of their becoming part of the National Park System, are subject to title 16 of the United States Code and title 36 of the Code of Federal Regulations. Management of all areas of the National Park System follow the administrative policies setting forth broad guidelines for park managers.

The portion of the park bordering the study area including the Chilligan River, Lake Kenibuna and its tributaries is designated as wilderness.

Use of the park is discussed in the recreation section of this report.

6.5.3.3 State Land

Land in the proposed project area has been conveyed to the State of Alaska by the 1953 Submerged Lands Act, the 1956 Mental Health Enabling Act and the 1958 Alaska

Statehood Act. State lands have been classified according to the system described below.

The State Land Classification System which is currently being revised is similar to zoning, in that there are different classification categories which reflect the capabilities and different potential uses of the land. Unlike zoning, however, the classification system applies to State-owned land only. Also unlike zoning, the present state classification system contains no provisions to guarantee that once title to State-owned land is passed, it will continue to be used for the classified purpose. The classification system is presently undergoing revision within the Division of Lands. (State Division of Lands, CZM Report, December 31, 1977.

In the proposed project area the following land classifications exist: Resource Management Lands and Industrial Lands.

Resource Management Lands

Resource management lands contain an association of surface and/or subsurface resources which are especially suited to multiple use management.

In the proposed project area, resource management lands are being used in several ways: oil and gas leasing, coal prospecting and leasing, a timber sale and mining permits, with some uses overlapping.

Industrial Lands

Industrial lands are those which, because of location, physical features or adjacent developments, may best be utilized for industrial purposes. According to the State Administrative Code, these lands may be disposed of by lease or sale (11 AAC 52 070).

There are currently several sites of varying sizes which are classified as industrial sites. These include the Kodiak Lumber docking facility at North Forelands and other sites operated by Texaco and Atlantic Richfield. See Table 6.13 for list of industrial sites.

Lands leased from the State for commercial or industrial purposes can only be used for the purposes designated and are subject to local building and zoning codes, which involves the Kenai Peninsula Borough.

6.5.3.4 Native Land

There are four main classes of Native land ownership in the proposed project area as a result of special legislation:

- o Cook Inlet Region, Inc. (CIRI)
- o Tyonek Native Corporation (TNC)
- o Native village of Tyonek
- o Native Allotments

Other Native holdings or land ownership in the area include patented parcels and set net sites.

Cook Inlet Region, Inc.

Unlike most areas of the state, selection of land entitlements by CIRI was complicated by prior selection of traditional village lands by the State of Alaska under its Statehood Act entitlement. The lack of appropriate land for Native selection led to litigation and establishment of the Cook Inlet Land Exchange.

Under the land exchange, CIRI is to obtain patent to the surface and subsurface estate of approximately 1.23 million acres of land. In addition, it receives subsurface estate to another 1.15 million acres of land, the surface of which is either patented to the village corporations or is within the Kenai National Moose Range.

Village Corporations Associated with CIRI

Within the geographic boundaries of the Cook Inlet Region, Inc., which extend from Seldovia in the south, almost to Mt. McKinley in the north, there are six village corporations: Chickaloon, Eklutna, Knik (Called Knikatnu by the villagers), Ninilchik, Seldovia and Tyonek. The acreage received by the Village Corporations is based on the number of stockholders who traced their heritage back to a village and enrolled to a village corporation. Approximately 6,000 Eskimos, Indians, and Aleuts have enrolled to Cook Inlet Region, making it the fifth largest Native regional corporation.

Under the conditions of the land exchange, six land selection pools were established. By far the largest, the Beluga Pool at 311,040 acres was made available to CIRI by the State of Alaska. Cook Inlet Region, Inc. has selected all of the lands in the Beluga Pool and expects convenyance of all except T.14N, R.15W. The northern half of that township covering the central part of Capps Glacier was not state land and should not have been set aside initially in the State's Beluga Pool.

Because the Beluga Gas Field subsurface and the Nikolai Gas Field subsurface were both excluded in the exchange agreement, Cook Inlet Region expects to receive only the surface estate to the affected land located in T.12 and 13N, R.10W. (Beluga Gas Field) and T.11N, R.12W. (Nikolai Gas Field). Land selected by the Kenai Peninsula Borough in T.12N, R.10W are available to CIRI for the subsurface only. The surface estate will go to the borough. Inasmuch as there is more subsurface estate available to CIRI from the Boroughs' lands than there is surface available, due to the gas fields' exclusion, there is an imbalance in CIRI's selections.

In an effort to select their full entitlement of 311,040 acres, CIRI has selected somewhat more surface than subsurface in T.16N, R.14W. The above lands are considered the first priority for selection. These selections exclude Beluga Lake and Lower Beluga Lake, and the section of the Beluga River running between the lakes. They also exclude U.S. Survey 3970, which protects Power Site Classification 395 (April 22, 1948) for potential hydroelectric development at Chakachamna Lake and Chakachatna River.

Conveyance of the Beluga Pool Land to CIRI was subject to any lawful reservations of rights or conditions contained in the State conveyance as provided by the Terms and Conditions document. Within two years after initial conveyance, the Secretary of Interior is authorized to identify and reserve any easement he could have lawfully reserved before conveyance. All valid existing rights to coal prospecting permits, coal leases, oil and gas leases, mineral leases, etc. are protected under terms of the exchange.

The attitude of Cook Inlet Region, Inc. toward rights-of-way across their lands, is quite different than that of Tyonek Native Corporation. While the Tyonek Native Corporation has been opposed to all rights-of-way and easements, CIRI is willing to consider them. They recognize that in order to remove the natural resources, such as coal, easements must be made available.

Tyonek Native Corporation

One of the six CIRI village corporations, the Tyonek Native Corporation was organized as a result of the passage of the Alaska Native Claims Settlement Act by Congress and represents the 303 Native people enrolled to the village of Tyonek. The Tyonek Village entitlement according to Section 14(a) of ANCSA is 115,200 acres - substantially larger than the 69,120 acres most villages receive. The size of Tyonek's entitlement is based on the fairly large Native population which the village had on the 1970 census enumeration date. Villages with a population between 200 and 399 were entitled to 115,200 acres.

The lands patented to Tyonek Native Corporation will be limited to just the surface estate of the lands - in accordance with Section 14(a) and (b) of ANCSA. Patent to the subsurface estate will be made to Cook Inlet Region, Inc. according to Section 14(f) of ANCSA.

A stipulation of the regional corporation patent to the subsurface estate is that the right to explore, develop or remove minerals from the subsurface estate in the lands within the boundary of Tyonek Village, are subject to the consent of the Village. Essentially this provision gives Tyonek a "veto power" over unwanted development by Cook Inlet Region.

Because there are not sufficient lands available for selection to meet the village entitlement from among lands surrounding the village, the Secretary of Interior set aside "deficiency lands" from nearby unreserved, vacant and unappropriated public lands. Thus, much of the Tyonek Village's land selected under ANCSA is not adjacent to the village site. Adjacent selectable lands consisted of the Moquawkie Indian Reservation (the Tyonek Village Indian Reserve) and State tentatively approved lands. Several miles across Cook Inlet from the village, lands within the Kenai National Moose Range were also selected.

Deficiency selections were made south of the village along the West Coast of Cook Inlet and from lands in the upper Susitna River area, where the Susitna Hydroelectric Project is planned.

Tyonek Native Corporation has leased land to Kodiak Lumber Mills, Inc. for the lumber camp, chip mill, and access roads and to various petroleum companies for access roads.

Native Village of Tyonek, Inc.

Tyonek, which is located on the former Moquawkie Indian Reserve is not incorporated as a city under the laws of the State of Alaska. However, it is a Federally chartered Native village, governed by an IRA (Indian Reorganization Act) Tribal Council. The Tribal Council -- also called the Village Council -- is the political arm of Tyonek and which, prior to December 18, 1971 (the date ANCSA was enacted) controlled the lands within the former Moquawkie Indian Reserve under a trust relationship with the U.S. Department of Interior, Bureau of Indian Affairs. On December 18, 1971, this Reserve was abolished by Section 19 of ANCSA, and the lands came under the jurisdiction of the U.S. Department of Interior, Bureau" of Land Management. The Tyonek Native Corporation succeeded to the rights of the surface estate of the Reserve under terms of ANCSA that had been enjoyed by the Village Council. Because the Village of Tyonek was located on the Moquawkie Indian Reservation, Section 19(b) of ANCSA came into play. This section of the Settlement Act provides for an election of its members to decide whether to retain the Indian Reserve and receive the surface and subsurface estate to the reserve or to opt for benefits of ANCSA. Tyonek Native Corporation voted for the provisions of ANCSA. Had they taken the former reserve, the village would have received fee simple title (both surface and subsurface estates) to 26,918.56 acres of land compared to the 115,200 acres of surface lands they are to receive under their ANCSA entitlement.

The Village Council may own lands under reconveyance provisions of Section 14(c) of ANCSA. The Village Council has been considering incorporation as a city under the laws of the State of Alaska. One reason stems from an interest in retaining control of village lands and lands destined for village expansion. Under ANCSA, it is necessary for the village corporation, the Tyonek Native Corporation, to convey "the remaining improved land on which the Native Village is located and as much additional land as is necessary for community expansion, an appropriate rights-of-way for public use, and land for other foreseeable community needs" to the appropriate municipal corporation where one exists or otherwise to the State in trust for any municipal corporation established in the Native Village in the future. The amount of land to be transferred to the municipal corporation or in trust shall be no less than 1,280 acres, an area equivalent to two (2) square miles. Tyonek Native Corporation will be receiving title to the lands for the future city. If Tyonek were an incorporated city under State law, Tyonek Native Corporation would reconvey title to the City (their own tribal members) rather than to the State to be held in trust for them.

The Tyonek Airfield is one of several private airfields in the area. The field is maintained by the Village Council and has been found to be a costly public improvement. At one time, the Village Council attempted to transfer the airfield to the State in an effort to ease their financial burden. At that time, the offer to give the airfield to the State was not accepted. The Village Council has retained the right to refuse landing privileges to unwelcome aircraft. The village residents prefer to have control over who visits their community and because of their outright ownership of the airfield they have had some control. However, the villagers do not like the costs associated with ownership.

The surface estate of the existing Tyonek airport, airway beacons, and other navigational aids, together with such additional acreage and/or easements as are necessary to provide related services and to insure safe approaches to the airport runways must be reconveyed to the Federal, State or Municipal government according to the requirements in Section 14(c).(4@ of ANCSA.

Native Allotments

The Native Allotment Act of May 17, 1906, as amended August 2. 1956, authorized the Secretary of Interior to allot land to any Indian, Aleut, or Eskimo of full or mixed blood who resides in and is a Native of Alaska and who is the head of a family or is 21 years of age. A land area not to exceed 160 acres of vacant, unappropriated and unreserved non-mineral land in Alaska, or subject to the provisions of the Act of March 8, 1922, certain vacant, unappropriated and unreserved public land in Alaska that may be valuable for coal, oil or gas deposits or under certain conditions of National Forest Lands in Alaska was made available if various conditions were met.

The title to a Native Allotment is under a restricted title; the land cannot be mortgaged, leased, sold, or deeded away without the approval of the Secretary of Interior or someone designated by him. The allotee or his heirs may deed the allotted land to another with the approval of the Secretary of Interior and the purchaser will then receive an unrestricted or fee simple title unless the purchaser is a Native whom the Secretary of Interior determines should continue to have a restricted title.

There are six Native Allotments in the proposed project area. Two have been patented, and four are still in the application stage and have not been fully adjudicated by the Bureau of Land Management; see Table 6.14.

Private Land

Five private patented land holdings (U.S. Surveys) are located in the project area and shown in Figure 6.27. Privately held leases are discussed in the following land use sections. Many of the parcels of lands that have been transferred to the state and Natives in the area have ROW reservations. Approximately 29 ROW permits and applications are on file with Alaska DNR.

Easements Across Native Lands

One of the thorniest issues of land rights in the proposed project area has been that of easements across Native lands. The Tyonek Native Corporation has adamantly refused to accept any easements across their former Moquawkie Indian Reserve and has also taken a very strong position relative to easements across lands they have selected north of the reservation (Division of Energy and Power Development). However the Interim Conveyance, I.C. 087, to their former Moquawkie Indian Reserve, contains several easements, at least temporarily set aside by the federal government.

Easement On and To the Marine Coastline

Interim conveyance documents cite a continuous 25-foot wide linear easement along the coastline for purposes of public access and recreation. The Department of Interior has suggested reducing the continuous easement to site easements along the coast at appropriate points to facilitate travel purposes only, such as beaching of water craft. A limited number of linear access easements perpendicular to the coast would be reserved to allow access to interior public lands.

Easements On and To Waterways (Rivers, Lakes and Streams)

The present federal policy of reserving easements along recreational rivers and streams is restricted to periodic points along "major" waterways. Major waterways are to be defined by the criteria of significant commercial or transportation use, or significant resource value (including recreation). The use of these site easements will be limited to activities related to travel along the waterway (e.g beaching of boats and float planes). Some linear access easements to "major" waterways and to public lands beyond conveyed Native lands may be reserved.

Transportation and Utility Corridors and Statutory Easements

Interim Conveyances retain rights-of-way for ditches, canals, telephone and telegraph lines and railroads constructed by the authority of the federal government. Easement corridors for energy, fuel, and natural resources transportation were also reserved and included the right of eminent domain. These easements must be justifiable, and site specific at the time of conveyance.

Section Line Easements

Section line easements of 33 feet on each side of the section line for a total of 66 feet provide legal access to federal lands. State lands have a 50-foot section line easement, 50 feet on each side of the section line. Although section line easements do not provide access that relates to the topography, they do provide legal access across the land.

An important question regarding the existing right-of-way between section lines is the possible and potential usage of the land for purposes other than highways, or in conjunction with highways. Alaska Statutes 19.25.010 provides the legal authority and required approvals for the use of utilities along the constructed highways rights-of-way. There is presently considerable overlapping of authority of the rights-of-way. The Department of Transportation and Public Facilities and the Division of Lands, are currently establishing regulations which will disentangle the overlapping authority, clarify accepted uses and revise procedural materials.

6.5.3.5 Land Use

The major land uses are shown in Figure 6.28.

Timber Harvesting

On August 22, 1973, the state sold the timber rights on 223,000 acres to Kodiak Lumber Mills, Inc. (KLM). Much

of the timber had been damaged by spruce beetle infestation and is only useful for salvage. The quantity of timber involved in the sale is estimated to be 6 million board feet. KLM's 30 million dollar chip mill, camp, and pier are located 5 miles south of Tyonek on land leased from the Tyonek Native Corporation. A network of logging roads has been constructed to gain access to the timber. The majority of workers are transients who are housed in the camp. From time to time, 5-15 villagers work for the company. The current slump in the chip market has led to a reduction in shipping activities during 1981.
The current timber leases expire in 1983. The state is considering leasing more land for additional salvage purposes. If Kodiak Lumber Mills is the successful bidder, another 5-6 years of work could be anticipated.

Petroleum

Interest has been shown in the area's oil and gas resources since the late 1950's. There have been several state, federal, and private lease sales, both on and offshore, since the mid-1960's. Extensive seismic testing and test drilling has been and continues to be conducted on many of the leases. Several gas fields have been discovered onshore and both oil and gas fields have been discovered offshore. Information on each of these fields is presented in Table 6.15.

Other than pipelines there are two petroleum-related facilities on the west side of Cook Inlet in the vicinity of the proposed project. Marathon Oil Company has an oil and gas treatment plant 20 miles southwest of Tyonek on Trading Bay. The other facility is the Drift River Petroleum Terminal, which is described in the trans- portation section of this report.

The most recent State lease sale in the area, Number 33, held on May 13, 1981, received strong interest (Anchorage Daily News, May 15, 1981 p. A-3). Two State lease sales are now scheduled or proposed that will probably include tracts on or near the proposed project's area. They are listed in Table 6.16.

Oil and Gas Leases

The Department of Natural Resources, through the Division of Minerals and Energy Management, is authorized to lease subsurface oil and gas resources on a competitive and noncompetitive basis. All lands in the public domain are open for oil and/or gas exploration and development. The provisions of the Miscellaneous Land Use Permit apply to surface oil and gas related activity on state lands where no lease has been issued. In addition, the state, under provisions of the Alaska Land Act, reserves rights to all subsurface gas and oil resources on lands disposed for any other purpose.

Federal leasing in the area has all taken place on offshore tracts, further south, in lower Cook Inlet.

Coal

Both coal prospecting permits and coal leases are available on State lands.

Coal Prospecting Permits

A coal prospecting permit allows the permittee to determine the existence or workability of coal deposits in an unclaimed and undeveloped area. The permit is valid for two years and each permit may include up to 5,120 acres. If within the period of two years, the permittee shows that the land contains coal in commercial quantities and submits a satisfactory mining plan for coal rerovery, the permittee can obtain a lease. A coal prospecting permit may be extended for a period of two years if the permittee can provide adequate reasons (regulated by the Department of Natural Resources).

Coal Leases

Coal leases run for an undetermined period of time, conditional upon the continued development and/or operation of a mine. Coal lease contracts can be assignable, upon the approval of the Director of the Division of Lands, by the lessee subject to the laws and regulations applicable to the lease.

There are three major coal lease areas in the vicinity of the proposed project: the Capps lease area, the Chuitna Lease area and the Three Mile lease area. Table 6.17 indicates the number of workers expected in each project and an expected start-up date.

A coal-to-methanol plant has been proposed in the area but with recent federal budget cuts the probability of the plant being financed solely by private money at this time is uncertain.

Most of the coal in the area is planned to be open-pit mined but the methods for transporting the coal to tidewater have not yet been determined.

Mining Claims

There has been some interest shown in the mineral resources, other than coal, on state lands in the proposed project area. Many of these claims were filed quite recently. A large block of mining claims is located along the Upper McArthur River.

Subsistence

Subsistence activities of the villagers are described in the Socioeconomics section of this report. The discussion in this section focuses on the location of these activities. Subsistence activities of the villagers occur both on Tyonek Native Corporation land and on adjacent coastal areas. Subsistence use areas are identified in Table 6.18. The general area of greatest use extends from the village south to the Polly Creek area and north along the coast to the mouth of the Susitna River. The use an area receives is dependent both upon access and the availability of resources. For example, coastal areas, river banks, and areas along the road system where boats and vehicles can be used to transport hunters and game are used more extensively than areas only accessible by foot. The use of areas within the general subsistence harvest area may also vary from year to year depending upon the availability of subsistence resources.

Subsistence users of resources, other than Tyonek residents, may also be in the area of interest. Of the 1600 subsistence permits for salmon issued for upper Cook Inlet in 1979, 62 permits were used in the area from the Susitna River to West Forelands (A. p. 67).

Shore Fishery Lease -- Set Net Sites

Possibly as little as ten percent of the fishermen using set nets along the coast have obtained shore fisheries leases. Normally leases are obtained only when encroach- ment is threatened by other fishermen. Although shore fishery leases protect the fishing site from the encroachment of other fishermen, leases do not protect the shore fishery lease holder from other uses, such as a dock. Although apparently not required by state law, it is suggested that set net fishermen with shore fishery leases and fishermen without leases be reimbursed for the loss of livelihood, once that loss has been established, or another site of equal productivity satisfactory to the fishermen be sought as a replacement. The State of Alaska, Department of Fish and Game can identify any affected set net fishermen in the area, all of whom must also have Limited Entry Permits to fish in the Inlet.

6 5.4 Recreation

While the project area under consideration is remote and sparsely populated, considerable recreational use is made of it. Recreational use is concentrated toward the coast but is increasing on Chakachamna Lake and tributaries feeding into the lake.

Water related recreation occurs most frequently along the coast where the Chakachamna and McArthur Rivers empty into Trading Bay. Recreational use of the Trading Bay State Game Refuge is somewhat quantified and is discussed in the following subsection.

Recreation activities have been increasing in the vicinity of Chakachamna Lake, primarily fly-in hunting, fishing, hiking, and kayaking. Future promotion and use of Lake Clark National Park could increase use of Chakachamna Lake.

6.5.4.1 Trading Bay State Game Refuge

The 168,930 acre Trading Bay State Game Refuge (TBSGR) was created in 1976 for the protection of waterfowl and big game habitat. The refuge includes uplands, tidal and submerged lands. Public access is by small aircraft, both wheel and float equipped, and less commonly by boat.

A series of shallow brackish marshes, encompassing approximately 2500 acres, runs the length of Trading Bay. These marshes support vast numbers of migrating ducks, geese, swans, and shorebirds in both spring and fall, as well as providing nesting for a substantial number of dabbling ducks. Nesting geese are unknown in this area, although nesting occurs to the north at Susitna Flats and to the south at Redoubt Bay.

The Trading Bay Refuge is the ninth most important waterfowl hunting area in the state. In 1978 there were 735 hunting days of effort expended in the refuge, 1.1 percent of the state waterfowl hunting total. (Seller, 1979)

Coastal areas of western Cook Inlet, which includes the Trading Bay Refuge, are considered critical calving and overwintering moose habitat. The latest harvest figures indicate that a number of moose were taken in this area in 1980.

Nikolai Creek receives limited fishing pressure. The creek contains rainbow trout, Dolly Varden, and pink and silver salmon.

A number of cabins (2 on private land, 13 on state land) have been built within the refuge by waterfowl hunters. In June, 1978, ADF&G announced a moratorium on new cabin construction on state game refuges. Although ADNR was given authority to issue permits for cabins on state land within Trading Bay Refuge, no permits have been issued to date. The Shirleyville lodge caters to recreationists in the area and several air charter businesses provide access to the refuge.

6.5.4.2 Chakachatna/McArthur Rivers

Recreational use of the upper stretches of the Chakachatna and McArthur Rivers is less well known. The rapids in the upper reaches of the Chakachatna are quite difficult but they are thought to be navigable (DNR Division of Parks, personal communication). Thus kayak trips from a starting point in Lake Chakachamna are a possibility but this potential use is undetermined.

6.5.4.3 Chakchamna Lake

Lake Clark National Park rangers report the use of the western end of Lake Chakachamna as a staging area for recreational use (personal communication). Gravel bars on the east end of the lake and other gravel bars at the river deltas are used to unload visitors from float and wheeled planes both air taxi and privately owned (personal communication, Hartell). People kayak on the lake and hike by the lake and up the many drainages such as the Chilligan River. One of these routes goes west toward Lake Kenibuna and leads into Lake Clark National Park.

6.5.4.4 Lake Clark National Park

The eastern boundary of Lake Clark National Park crosses Kenibuna Lake. This portion of the park is classified as wilderness, and is considered by the park supervisor to be the heart of the park (personal communication Hartell). No formal recreation facilities have been planned for this area, nor are any use statistics available.

6.5.5 Socioeconomics

The proposed project is located in an isolated and sparsely populated area within the Kenai Peninsula Borough. Tyonek, a Native village, is the only community in the vicinity of the project area. The proposed Chakachamna Hydroelectric project has the potential to create population, employment, income, infrastructure and subsistence impacts in the Tyonek area. Because it has the responsibility for providing government services the Kenai Peninsula Borough (KPB) will be the principal impacted local government entity. Due to the small population of Tyonek, employment impacts will primarily occur on the Kenai Peninsula and in the greater Anchorage area. For each impact area (Tyonek, KPB and Anchorage), baseline socioeconomic information is presented.

6.5.5.1 Tyonek

The Native village, Tyonek, is located on the western shore of Cook Inlet, 42 miles east of Lake Chakachamna and 22 miles northeast of where the Chakachatna River enters Cook Inlet.

Population

The census figures for Tyonek are reported below:

Year	1880	1890	1900	1910	1920	1930	1940	1950	1960	1870	1980
Population	117	115	107	N/A	58	78	136	132	187	232	239

Source: U.S. Census

The recent Tyonek population has seen periods of relative stability broken by significant increases in population. The 1980 census has not been officially completed, but the population appears to have stabilized since 1970.

The 1970 census indicated that 95% of the population was Native with 127 males and 105 females. Median ages were 16.6 and 18.6 years for males and females, respectively. Non-Native residents are, for the most part, teachers who remain in the village for one to several years.

Employment

In many respects Tyonek is a traditional Alaskan Native village. Commercial fishing is the primary source of earned cash income. In addition to the limited number of service jobs available within the village, work is also obtained with the nearby timber operation and occasionally with petroleum exploration activities in the area. Like many Native villages, a heavy reliance is placed on subsistence resources. The following indicates the employment status of a sample of Tyonek's population.

EMPLOYMENT BREAKDOWN BY PERCENT OF HOUSEHOLD RESPONSE

No. of Members in Household	Full time Percent	Part-Time/ Seasonal	Retired	Unemployed
0	55	38	91	-
1	38	54	9	26
2	7	8	-	16
3	-	-	-	26
4	-	-	-	16
5	-	-	-	10
6	-	-	-	3
7	-	-	-	3

Source: Report on the Survey Conducted in Tyonek, 1980 ADF&G, Alice Stickney, Subsistence Section, Anchorage.

Commercial fishing (limited entry) permits are held by 27 residents. A permit holder may employ up to six people as crew. The fishing season is usually open only 2 days a week from July 1 to August 15. Salmon are the target species with most of the permits for set gill nets and a few for drift gill nets. Commercial catches tend to be low and profitability is further hampered by the lack of a processor or cannery in the vicinity. Fish are either flown out, pot scows utilized or a tender cooperatively hired. Most fishermen use little if any of their catch for subsistence needs, opting rather for cash sales to pay expenses.

The majority of workers employed by the Kodiak Lumber Mills'operation near Tyonek are transients who are housed in the camp. Employment of villagers varies from 5-15 workers throughout the year (Kodiak Lumber Mills, Inc. personal communication). Due to a variety of lifestyle/personal conflicts, full advantage of employment opportunities in the timber operation have not been taken by residents of the Tyonek Village (Braund and Behnke 1980).

Occassionally work with petroleum exploration firms is available on a temporary basis.

Permanent employment opportunities in the village are limited to the following positions: teachers and school support staff - 20, village administration - 6, firemen - 3, store retailers - 2, day care center employees - 2, and one each of the following: constable, community health aide, community health representative, post-mistress, air taxi operator, and emergency responder with the fire department. CETA funded 3 full time positions (supervisor of youth employment, laborer and recreation worker) as well as 16 summer positions for youth in 1981. (Darbyshire and Assoc. 1981). With the recent federal budget cuts the future of the CETA positions is uncertain.

Personal Income

The cash flow through the village economy is low. A profile of incomes obtained through a 40 household survey is shown below.

INCOME BREAKDOWN BY PERCENT OF HOUSEHOLD RESPONSE

Total Income Dollars	Percent of Households	Percent of Commercial Fishery Households	Percent of Other Households
0- 3000	13	0	20
3- 6000	30	16	45
6-10,000	30	47	15
10-15,000	12	21	5
15-20,000	5	5	5
20-30,000	10	11	10

Source: Report on the Survey Conducted in Tyonek, 1980, Alice Stickney, Subsistence Section, ADF&G, Anchorage.

Over 70 percent of all the responding households earned less than $10,000 in gross annual income. Thirty percent of these were commercial fishermen who made up 63 percent of the total responding commercial fishermen. The type of aid coming into the village was also limited. Fifty-five percent of the responding households had only Native/Public Health benefits, while the other 45 percent had additional aid in the form of Social Security, disability, unemployment checks, ADFC and food stamps.

Subsistence

Subsistence, the traditional hunting/fishing/gathering of local resources, is important to Tyonek residents for several reasons. The traditional pursuit of subsistence is interwoven into village social structure and sharing among residents. Because of this, and village preference for local food, subsistence resources cannot be equated in terms of market goods. Additionally, the limited job and income opportunities in Tyonek place great importance on subsistence as a means of providing food.

Subsistence patterns vary with the season and abundance of particular species. Although fish and game regulations have modified traditional patterns, local residents continue to follow a cycle resembling that of their ancestors. Residents of Tyonek fish, hunt, trap, dig clams, and pick berries. Four wheel drive vehicles, snow machines and outboard motors are used in subsistence pursuits.

King salmon comprise one of the important subsistence species. During the 1980 season 67 subsistence fishing permit holders harvested 1936 king salmon and 262 incidental red salmon. Each permit had a limit of 50 king salmon and the maximum season harvest for the community was set at 3000 kings. Sixty-five percent of the allowed harvest was reached.

Moose, ducks, geese, and spruce hens are hunted in season while porcupine are hunted year-round. A few village residents set traps for marten, mink, red fox, and beaver. Euchalon, rainbow trout, Dolly Varden and whitefish also provide a source of food for many residents. Residents of the community also hunt beluga whales and seals. Blueberries, raspberries, high and low bush cranberries, and salmonberries ripen in the late summer and early autumn and are primarily gathered by women in the village.

6.5.5.2 Kenai Peninsula Borough

The proposed project is located within the Kenai Peninsula Borough. Most of the population of the Borough is located on the western half of the Kenai Peninsula, across Cook Inlet from the proposed project. The Kenai Peninsula will be a source of labor and materials for the proposed project.

Population

The population of the Borough is 25,072, up 51.2 percent from 1970 (U.S. Census 1980). The Kenai census division which encompasses the western half of the Kenai Peninsula has a population of 22,271.

Employment

The labor force as of August, 1981, contained 12,300 workers, 9.8 of whom were unemployed. (Alaska Department of Labor 1981). Both the labor force and the unemployment rates exhibit marked seasonal variations. The following table (Table 6-19) indicates employment and wages by industry for the Kenai-Cook Inlet Division.

The Kenai Peninsula is likely to be a significant source of labor for the proposed project. Employment impacts are not quantifiable at this point in the feasibility study.

Personal income impacts while not quantifiable at this time are likely to be minimal. The unemployment rate may drop somewhat and thus reduce the amount of unemployment insurance payments.

6.5.5.3 Anchorage

Alaska's largest city, Anchorage is located approximately 60 miles east of the proposed project area. Anchorage is likely to serve as a major supply center for both labor and materials.

The Anchorage area is likely to be the major source of in-state labor for the proposed project but the employment impacts are not quantifiable at this time. Many of the area's construction workers are available for out of town work. The extent of their availability will depend on the status of other construction projects in the state such as the North Slope, Susitna dam, etc.

Population

The Municipality of Anchorage has a population of 173,992 as of 1980, up 37.7 percent from 1970 (U.S. Census 1980).

Employment

As of August, 1981, the Municipality had a labor force of 91,671 persons with 6.9 percent unemployment (Alaska Economic Trends, October 1981, Department of Labor, State of Alaska). Table 6-20 indicates employment and wages by industry.

6.5.6 Community Infrastructure

6.5.6.1 Housing

There are 89 homes in Tyonek, almost all of which are owned by the Tyonek Village IRA Council. Approximately

60 prefabricated homes were barged to and erected in Tyonek in the mid-1960's. These homes, as well as 6 trailers, (2 of which are owned by the KPB school district for teacher housing), form the housing stock of the older part of the village. Outbuildings such as smokehouses and steambaths are situated in this portion of town.

An additional 27 wood-frame homes were built in 1978-79 through the joint efforts of the Department of Housing and Urban Development and Cook Inlet Native Association. These homes are located west of the airstrip in Indian Creek subdivision or the "new subdivision" as it is referred to by the townspeople.

All the transient employees of Kodiak Lumber Mills, Inc. are housed in the company camp south of Tyonek. The camp can accommodate up to 200 people. The camp has six 20-person bunkhouses, five 3-bedroom modular homes, about 12 trailers and six duplexes. The Shirleyville Lodge is located adjacent to the Nickolai Creek airstrip. The lodge includes trailers and cabins that can accommodate 24 people. Meals are also available.

6.5.6.2 Education

Bob Bartlett School serves grades K through 12 and is financed and managed by the Kenai Peninsula Borough School District. Located in the Village of Tyonek, it is the only school serving the area. The school has four regular classrooms, a home-economics suite, and a portable classroom, for a total capacity of 240 students.

Enrollment history and school district projections are presented below. The total 1976-1977 enrollment was 108, with 75 in grades K-8, and 33 in grades 9-12. As of May 1978, 98 students were enrolled and 7 teachers (5 regular and 2 cultural resource teachers) were employed. The Borough's 1977 school-construction report indicates that no facilities other than a new home-economics suite need to be provided during the 5-year period ending in 1982.

When the Kodiak Lumber Mills' mill was in full operation, approximately 20 children were bussed from the camp to the village to attend the school.

PUPIL ENROLLMENT AND PROJECTIONS, BOB BARTLETT SCHOOL, TYONEK

School Year	K-8	9-12	Total
1972-73	76	21	97
1873-74	65	22	87
1974-75	73	18	91
1975-76	87	28	115
1976-77	75	33	108
1977-78	82	34	116
1978-79	90	34	124
1979-80	95	37	132
1980-81	103	38	141
1981-82	110	41	151

Source: Kenai Peninsula Borough School District, Enrollment Projections and School Construction Report, April 1977.

6.5.6.3 Police Services

Police services in the Tyonek area are provided by the Alaska State Troopers through a resident constable. The constable serves the area from the Beluga power station south to Trading Bay, including the oil and gas facilities at Trading Bay and Granite Point and the lumber mill camp near Tyonek. A four-wheel drive vehicle is used by the constable to patrol the area and an airplane is available to fly the area if the need arises.

The constable at Tyonek has the time and ability to handle an additional number of complaints and other police activity, but the point at which population increases will require the state troopers to add another policemen is difficult to estimate.

In a work-camp situation, the troopers encourage private companies to hire their own staff for internal security. The troopers are then available to provide emergency assistance. The temporary assignment of additional troopers to the area is another option, especially if camp activity is short-term or seasonal. In the proposed project area, this would involve assigning staff from the Soldotna regional office of the state troopers.

6.5.6.4 Fire Protection

Publicly provided fire protection services are currently available in Tyonek through the U S. Department of Interior, Bureau of Land Management.

6.5.6.5 Health Care and Emergency Medical Services

The state troopers are responsible for supervising rescue operations for emergency situations in the proposed project area. Medical evacuations are usually accomplished by private charter plane. The U.S. Air Force also handles some emergency evacuations.

Health care services are available to the residents of Tyonek through a medical center located in the village. The facility handles both medical and dental work and is staffed by a resident, licensed practical nurse. The clinic also has a community health aide (and alternate) provided through the U S Public Health Service. The health aide may provide services to non-Natives on an emergency basis only. Non-Natives are billed for the service. Emergency medical care is received at the ANS hospital in Anchorage.

The Kenai Borough's Central Hospital service area encompasses over 1000 square miles of land on both the east and west side of Cook Inlet. On the west side of Cook Inlet, the service area extends from Beluga River to Drift River, including the study area. A 32-bed hospital is located at Soldotna.

6.5.6.6 Water and Wastewater Systems

The existing water source for the village of Tyonek is a nearby lake. The former ground water supply was abandoned because of its high iron content (with manganese). The water system, which includes an infiltration gallery and pump house, was installed by the Village in 1976. The lake water is chlorinated, stored in a tank, and filtered with activated carbon before being delivered to the underground distribution system, which was completed in 1972 under an EDA contract. A previous groundwater well was developed in 1964 by the U S. Public Health Service, but is used only for public water supply. Each house and the school is served by the distribution system. The 27 new housing units planned for the village by Cook Inlet Housing Authority will be connected to the distribution system.

The primary method of wastewater disposal at the village of Tyonek is by septic tanks with subsurface leach fields; some cesspools are also used. The septic tanks were installed in 1965, have a capacity of 200 to 400 gallons, and are constructed of low-grade steel. Some of the tanks are rusting. The soils have a gravel base, making them good for subsurface disposal. The problems that have developed with the onsite systems are probably a result of the small size of the tanks and inadequate maintenance. An unfenced sanitary landfill is located 4.2 miles from the village. The Kenai Peninsula Borough is in the process of establishing a new landfill for the village, but it may be some time before all approvals are obtained

Water for the Kodiak Lumber Mills Camp is supplied from three wells, which have been adequate to support 200 people to date; no water shortages have occurred. The water contains an excessive amount of iron and barely meets water quality standards. However, no bacteria problems exist. Water is distributed through an underground system that requires standard maintenance. No winter freezing problems have been encountered.

Septic tanks with perforated-pipe drainfields are used for waste disposal. The systems have required normal maintenance; no special problems have developed. The soils (consisting of a gravel base, covered with a few feet of sandy loam and some clay) are good for subsurface disposal.

Water for Trading Bay is supplied from wells at Marathon Oil Company's Trading Bay facility and no shortages have occurred. Septic tanks with drain fields have also been used with very few problems.

6.5.7 Transportation

Transportation facilities on the west side of Cook Inlet are few and small in size. These facilities consist of logging and petroleum exploration roads, several airfields, a wood chip loading pier and a petroleum loading dock. The numerous resource development potentials in the area may eventually lead to an expansion of facilities.

Roads

All roads in the area of the project are shown in Figure 6.29. Most of the road system in the proposed project area has been developed by Kodiak Lumber Mills in the form of logging roads. The road system connects Granite Point, Tyonek, Nicolai Creek, Kaloa, North Foreland, and Beluga. There are about 100 miles of primary and secondary roads. These roads are in good condition, especially the main roads. Some of the bridges on the secondary roads have washed out and have not been replaced. The main logging road extends approximately 16 miles northwest of Congahbuna Lake to within 8 miles of Capps Coal Field. Most roads are sand, overlain with gravel, and require no special maintenance. The roads are resurfaced following breakup.

Road rights-of-way (100 feet wide) are established along the section lines of all state land (or land acquired from the state). All other land has a 66-foot right-of-way along section lines. Some legal questions have been raised about how this right-of-way provision applies to land "reserved for public use." No rights-of-way are associated with the network of logging roads. Access was permitted as part of the state's timber sale contract with Kodiak Lumber Mills.

The Beluga area, north of Tyonek, and Anchorage are not connected by a year-round road; however, a winter road has been used in the past when the Susitna River was frozen. The road was originally constructed to carry large, heavy equipment to the area, but it has not been used since the mid-1970's.

The Alaska Department of Transportation and Public Facilities has studied the Beluga area and developed plans for river crossings and roadways. A proposed highway would run from Tyonek to Goose Bay (about 65 miles), crossing the Susitna and Beluga Rivers. Existing roads already connect Goose Bay to Knik (10 miles), Knik to Wasilla (19 miles), and Wasilla to Anchorage (47 miles).

The proposed highway is not likely to be constructed in the near future, primarily because the economic benefits to be derived from it do not justify the co@struction costs. The proposed highway may become more attractive as additional projects for resource and industrial development in the Beluga area (aluminum smelter, coal generating plants, etc.) are proposed or become feasible.

Two historic trails, identified in Table 6.21, in the area were identified in a 1973 inventory done by the State Department of Highways (now the State Department of Transportation and Public Facilities). The Highway Department claims legal access through prescriptive rights along these traditionally travelled ways.

6.5.7.2 Air

The larger air facilities within the vicinity of the project are identified in Table 6-22. The airport in Tyonek is operated by the Native Village of Tyonek. Planes as large as DC-6's and Hercules can be accommodated. Pilots must obtain permission from the Village before landing. The FAA estimates that there are approximately 2000 annual air taxi landings at Tyonek. Air taxi operators serving Tyonek include Trading Bay Air Taxi, Spernak Airways, Wilbur's Flight Operations, Hudson Air Taxi, Gil's Aircraft Service, and Alyeska Air Service, Kenai Air, Kenai Aviation, and Arctic Aviation.

Other airstrips in the area include a poorly maintained 3500-foot City Services Oil Co. field, 8 to 10 miles west of Beluga; a 1700-foot airstrip in good condition at North Foreland that will handle a Sky Van; and several light aircraft strips, including two 900-foot strips at Capps Field.

All airfields in the Tyonek-Beluga area are privately owned and maintained. Use of the airstrips requires permission of the owners.

6.5.7.3 Marine

A private wood chip loading pier owned by Kodiak Lumber Mills is located 3 miles south of Tyonek. The pier is 260 feet long with 685 feet of berthing space and a depth alongside of 35 feet at mean low water. The dock would need to extend about 3700 feet from shore to reach a 60 foot depth. The dock is used from April to November depending on shipping schedules. The largest ship to dock here was 607 feet long and 45,000 metric tons. During 1980 only six freighters were loaded from the pier and with the decline in the chip market even fewer will dock in all of 1981. Recently, a test shipment of coal was loaded from the pier onto a freighter headed for Japan.

A special purpose petroleum dock owned by Cook Inlet Pipeline Co. and operated by Mobil Oil is located at Drift River, 47 miles southwest of Tyonek. The terminal at Drift River was built in 1966 and is used solely to load tankers with crude oil which is transferred to Drift River via pipelines from offshore wells in Cook Inlet. The dock is 100 feet long with a 100 foot face and depth alongside is 70 foot. There is 780 feet of berthing space with breasting and mooring dolphins. The dock can accommodate 150,000 dead weight ton tankers (medium size).

There is also a barge off-loading ramp, owned by Standard Oil, located 4 miles southwest of the Beluga River.

Tyonek and the Tyonek Lumber Mills' camp both receive supplies by barge which are off-loaded on the beach.

6 5.8 Visual Resources

The project area falls into three categories of landform characteristics: steep mountainous terrain, vegetated uplands and coastal wetlands. Chakachamna Lake, Chakachatna River Canyon, and the headwaters of the McArthur River are located in narrow glaciated valleys surrounded by steep, rugged mountains. Scenic quality is high, particularly on Chakachamna Lake and the Chakachatna River. The lake allows a long view where hanging glaciers drop to lake level, and tributaries to the lake form symmetrical deltas. The Chakachatna River exits the lake into a canyon surrounded by steep mountains. At this point the river alternates between single channel and braided systems, and has relatively continuous whitewater. Because of its scenic quality, Chakachamna Lake was originally considered for inclusion as national interest lands under Section 17(d)-2 of the Alaskan Native Claims Settlement Act of 1971. The braided floodplain of the upper McArthur River is 3/4 of a mile wide, and is roughly 50 percent vegetated with contrasting exposed sandbars. Because of the twisting nature of the canyon, the length of viewshed is relatively short. Vegetation on the steep lower slopes of the lake and both drainages consists of a thick mixture of conifers and deciduous birch and alders, above which lies a band of shrub thicket, and alpine vegetation. This vegetation provides a contrast to both the lake and river floodplains.

Upon leaving the mountains both the Chakachatna and McArthur Rivers enter well-vegetated uplands. Here the broader river valleys fluctuate between braided and single channels. The dense vegetation of cottonwood, white spruce and willow limits views from the rivers and screens out the backdrop of mountains. Two relatively unusual visual areas are located within the upland landform. An expanse of dry sand flats is found along the middle reach of the McArthur River. This dune-like area provides visual relief (texture and color) from the dense vegetation, and allows longer vistas of the surrounding mountains. A border of lichencovered flats further contributes to the aesthetics of this area. Similar, but smaller, areas of lichen flats are located along the Chakachatna River at the logging road bridge.

The vegetated uplands gradually give way to open wetlands along both rivers. These coastal wetlands extend inland roughly five miles from the coast. The low vegetation of grasses and sedges and open water allows long vistas of the surrounding mountains, Cook Inlet, and the Kenai Peninsula across the Inlet. The primary river form in these wetlands are meandering single channels with steep mud banks. Tidal influence extends four or more miles upchannel in some instances. These coastal wetlands provide excellent waterfowl habitat, and have relatively high visitor use compared to other portions of the project area.

6.6 ENVIRONMENTAL STUDIES - 1982

As described in Section 6.1, field studies were planned for 1982 which would aid in meeting the primary objectives of this feasibility study, namely to:

- o Obtain sufficient information on the environment of the study area to identify constraints that may be placed on the project, potentially affecting its feasibility; and
- o Obtain sufficient information to prepare the required environmental exhibits for the FERC license application.

The studies conducted during 1982 were reduced from their planned levels by budgetary constraints and only fisheries and hydrology investigations were conducted. The principal emphasis of the program was on the fisheries studies. These studies provide an incremental increase in our knowledge of the aquatic resources of the study area and also allow better planning for future studies to meet the project objectives.

During 1982, there were four fishery investigations conducted between March and June under the FY82 budget. Fishery and hydrology studies conducted from July through October were conducted under the FY83 budget.

The following sections present the objectives and results of the 1982 studies by discipline.

6.7 ENVIRONMENTAL HYDROLOGY - 1982

6.7.1 Introduction

The purpose of this chapter is to describe the hydrologic studies conducted in the late summer and fall of 1982 (FY83) in support of the environmental program leading toward the feasibility assessment of the Chakachamna Lake Hydroelectric Project. The overall objective of the FY83 environmental hydrology studies is to collect baseline data to assist in future evaluation of the physical processes of the Chakachatna and McArthur River systems, correlation of these processes with fish and wildlife habitats, and to aid in the design of future studies. Studies conducted during FY82 and before were summarized in a report to which this chapter is an addendum (1981 Interim Report).

The study area was described previously, in sections 6.1 and 6.2 of this report. The FY83 hydrologic studies were conducted at 14 sites on the Chakachatna River system below the Chakachamna Lake outlet and 5 sites on McArthur River below the powerhouse location (Figure 6.30).

The following sections of this chapter include presentations of:

- o the study approach, including field and office methodologies,
- o stream flow characteristics,
- o water temperature characteristics,

o sediment characteristics, and

o a summary of results.

The physical characteristics of the system are discussed further in the following chapter in the context of how they relate to the fisheries habitat in the Chakachatna and McArthur River systems.

6.7.2 Study Approach

6.7.2.1 Field Data Collection

Hydrologic field data were collected during a two-month period from mid-August to mid-October, 1982. Two site visits were conducted by the hydrology crew (11-17 August and 8-17 October). Equipment installed in August included:

o two recording gages using Datapod Model DP211SG dual channel recorders to record stage and temperature of:

  - Chakachatna River near the lake outlet
  - McArthur River downstream of the powerhouse location, and

o staff gages at 15 study sites.

Data collected in August included:

o gage reference elevations, and
o water surface profiles.

Data collected in October included:

o discharge measurements at 12 gage locations,

- water surface profiles, and

- sediment characterization.

The Chakachatna River Datapod Model DP211SG recording gage was installed on 11 August 1982 in the stilling well of the former USGS gage No. 15294500 near the outlet of Chakachamna Lake. This location was selected in order to extend the period of record at that site and to allow comparison of discharges during sampling periods to averages and extremes for the period of record. The recorder was programmed to sense hourly water levels and temperatures, and record the average of the interrogations on a 6-hr interval. The data through noon on 13 October were retrieved, and the unit was set to continue operation through the 1982-83 winter period (Table 6.23).

The McArthur River Datapod Model DP211SG recording gage was installed on the river bed immediately upstream of the beginning of a long series of rapids between the McArthur Canyon and the confluence with the first tributary from Blockade Glacier (Site 13.5, Figure 6.31). This location was selected to provide baseline information on the hydrologic and temperature regimes of that portion of the Upper McArthur River where the greatest post-project change is anticipated. The unit was installed on 11 August 1982 and programmed to sense hourly water levels and temperatures and record averages at 6-hr intervals. The data collected were reviewed on 17 August and found to have a significant diurnal variation of both water levels and temperature. To document this variation, the unit was reprogrammed to record at hourly intervals. Approximately one week of data was lost when a September storm caused floods that dislodged the gage. By late fall, the diurnal fluctuation was significantly less than that observed in August. On 16 October, the data were retrieved and the unit was reprogrammed to a 6-hr recording interval to allow it to operate unattended for the duration of the winter (Table 6.23).

A Peabody-Ryan Model J-90 thermograph was installed by the fisheries crew at the McArthur River gage location for the period 20 August through 23 September. Another Peabody-Ryan thermograph was installed at the powerhouse study site (Site 15, Figure 6.31) for the period 20 August through 18 September.

Staff gages typically consisted of a fiberglass facing replacement for a surveying rod, nailed to a length of 1 in. x 2 in. board which was then affixed to a fence post driven into the streambed. A few staff gages were aluminum meter sticks affixed to 6-ft long rebar driven into the streambed. Staff gage readings were referenced to temporary bench marks using standard differential leveling techniques. Staff gage readings were conducted at various intervals by the aquatic biology field crew for a two-month period (Table 6.24).

The stream and floodplain transect data were collected using one or a combination of the following methods:

- o using a self-leveling level to obtain ground elevations, and tape or stadia to obtain distance along a transect,

- o using transit and electronic distance measuring equipment to measure horizontal and vertical angles and distances to locations along the transect, and

- o using data collected for discharge measurements for transect data below water level.

Some transects consisted only of the portion of the transect below water level. Stream gradients were surveyed using a transit and electronic distance measuring equipment, or a self-leveling level. Stream bed material size was described qualitatively and documented in some cases with photographs.

Discharge measurements were taken at study locations 1, 3, 4, 6, 13.5, 15, 16, 17, 17d, 18, 22, and C (Figure 6.30) using procedures similar to those of the U.S. Geological Survey. A Marsh-McBirney flow meter was used to measure velocity. A wading rod was used at all sites except the Chakachatna River gage site (c), where a suspension system was used. A metal cable tag line was used to keep the boat stationary and on line for all boat measurements.

6.7.2.2 Data Analyses

The data collected during the mid-August through mid-October period were analyzed on an IBM Personal Computer. The analyses included:

- o reducing raw data to obtain
  - discharge values,
  - transect coordinates,
  - water surface gradients,
  - stage data summaries, and
  - temperature data summaries;
- o hydraulic analyses to establish preliminary rating curves at discharge measurements transects, curves

- application of selected rating curves to stage data to develop flow hydrographs,
- comparison of flow hydrographs to characterize the flow distribution in the system, and
- description of sediment characteristics in the system.

The Manning equation was used in the hydraulic analyses to establish preliminary rating curves. Channel geometry and energy gradient were obtained from the stream and floodplain transects and water surface profiles measured in the field. Manning's roughness coefficients (n) were back-calculated from field data. The values were compared with standard values and where large discrepancies existed, the standard values were used. When computing Manning's n values from field surveyed water surface slopes, discrepancies are typically due to difficulties in defining the reach location and length that dictate flow conditions at the selected transect. Transect data, discharge data, and hydraulic data are presented in Appendix A1.

The Manning equation was applied to applicable stage data to obtain discharge values corresponding to each of the gage readings. Site 6 had sufficient stage data to develop regression equations for discharge there as a function of the discharge at the Chakachatna River recording site (Site C). The regression equation was used to extend the data base at Site 6 to correspond with the length of record at the Chakachatna River recording gage.

6.7.3 Stream Flow Characteristics

Collection of streamflow data was initiated in 1982 with the installation of two recording gages and numerous staff gages distributed through the Chakachatna and McArthur River systems. Single discharge measurements were taken in October at a number of the sites to form the basis of preliminary rating curves. These discharges, along with comparable discharges measured in September 1981, are presented in Table 6.25.

Heavy rainfall in mid-September resulted in elevated stages throughout the study area. Stage at the McArthur Recording gage rose approximately 3 ft in 12 hrs on 15 September; stage had just begun to drop when the sensor to the gage became dislodged from the bed and was swept downstream by the current. A discharge of 4500 cfs was calculated for the maximum recorded stage. High water marks surveyed in October verified this peak stage. Such a discharge, when compared to estimated flood flows in Table 6.4 (Location 6), is found to correspond to a recurrence interval of about 25 yrs. This discharge also is approximately 50 percent greater than the proposed mean release for the McArthur powerhouse alternative. Associated with this flood were significant amounts of erosion and sediment transport as evidenced by:

- o erosion of the front of the delta at the gage site, which consisted mainly of gravel/cobble material,
- o scour of the bed at the gage, causing it to dislodge from the bed,

- transport and deposition of sands, with subsequent transport at low stage in the form of dunes, and

- sediment deposition causing channel abandonment and diversion of flow in the vicinity of the proposed powerhouse location.

The recording gage was reinstalled in approximately the same location nine days after the peak flow dislodged it. As much as 2 ft of sediment in the form of dunes moved into the gage site cross section during the 3 weeks following the flood (Figure 6.32). The effects of the September rainstorm on the lower McArthur River were much less significant due to the large channel cross-sections developed to convey the large summer meltwater flows from Blockade Glacier.

The September rainfall also affected the Chakachatna River, but because of the influence of the lake, the hydrograph was much broader and the peak flow was delayed by several days (Figure 6.33). The mean daily flows of the Chakachatna River at the lake outlet increased from 3490 cfs to 4670 cfs in 4 days, (September 15-19) increasing gradually to 4700 cfs after two more days (Table 6.26).

The lower Chakachatna River above its split with Middle River was studied to evaluate its hydrologic characteristics for future use in characterizing the fisheries habitat. Discharges computed from measured stages were correlated with corresponding discharges at the Chakachatna recording gage (Figure 6.34). The resulting relation had a statistically significant ($p<0.01$) coefficient of determination of 0.86; it was used to compute mean daily discharges at the lower Chakachatna River site from the records at the recording gage site (Figure 6.33). The computed mean daily discharges compared well with the values computed for actual stage records. These values will require further verification during future studies. Discharge data at various locations in the Chakachatna and McArthur River systems, based on correlations with the Chakachatna recording gage data, are important for establishing flow duration curves at fishery study sites.

A summary of the 1982 streamflow data and corresponding data from U.S.G.S. records is provided in Table 6.27. It can be seen that the average flow during the period of observation from mid-August through mid-October in 1982 was 55 percent of the average during the same period for the 13 years of record of the USGS gage, or more than two standard deviations below average. The previous lowest average flow was 4278 cfs in 1969, 60 percent of the average for the period of record. The trend of very low flows in summer and near normal flows in fall can be seen by comparing average weekly flows:

- o the average weekly flow in mid-August of 1982 was 36 percent of the average for 14 years of record, or much less than the previous low value of 70 percent in 1969;
- o the average weekly flow in mid-September of 1982 during the rain storm runoff was about 77 percent of the average for 14 years of record, and 6 of the 14 years of record had values less than the 1982 value;
- o the average weekly flow in mid-October of 1982 was about 95 percent of the average for 13 years of

record, and 8 of the 13 years of record had values less than the 1982 value.

The average flow for the period of observation at the McArthur River recording gage averaged 12 to 15 percent of the average flow for the 13 years of record on the Chakachatna River. The average flow for the period of observation in the downstream Chakachatna River (Site 6) fluctuated around 9 and 17 percent of the average flow at the lake outlet for the 13 years of record and for 1982, respectively.

The groundwater characteristics of the study area have not yet been investigated in detail. Observations of a spawning channel located on the left edge (looking upstream) of the Chakachatna River floodplain just downstream from the bridge (Station 17, designated LB_{+0}) illustrate the potential importance of the groundwater resource. At the upstream end of the channel a spring emanates from the steep bank of the floodplain. The flow from this spring appeared to remain fairly constant during the period of observation, from March to late October 1982. Flow, generally increases in a downstream direction along this channel, yet it receives no surface water inflow. The flow of the channel at its confluence with the Chakachatna River was 7.6 cfs (3400 gpm) on 15 October 1982. The groundwater in the study area will need to be investigated during detailed feasibility investigations to better define its characteristics.

6.7.4 Water Temperature

Water temperatures were measured on a continuous basis at several locations in the Chakachatna and McArthur River systems and on a periodic basis elsewhere in the systems as part of the fisheries habitat data collection program. Average daily temperatures on the Chakachatna River at the lake outlet ranged from 8° C in August to 6° C in October (Table 6.28).

Water temperatures in the McArthur River at the rapids exhibited large diurnal variations (Figure 6.35 and Table 6.29). On 27 August 1982, temperatures varied from 3° to 9.5° C in a six-hour period. This extreme variation is likely related to the broad, braided configuration of the river for several miles above the gage. In that reach, the cold glacial flow spreads out and receives energy from the warm air and solar radiation during the day, and loses energy to cold air and long wave (black body) radiation at night. Streamflow temperatures in a side channel of the McArthur River at the powerhouse site are summarized in Table 6.30. Temperatures from mid-August to mid-September averaged 1.6° C less at the powerhouse than at the recording gage (station 13.5).

6.7.5 Sediment Characterization

The Chakachatna and McArthur River systems are glacial and thus carry fine glacial silts through much of the open water season. The systems also transport larger materials in suspension and as bed load. The main channel substrate of these river systems under the present flow regime appears to be quite unstable. Table 6.31 summarizes the general characteristics of various stream reaches of the Chakachatna and McArthur River systems.

6.7.6 Summary of Results

The collection and analysis of hydrologic data for the period from late summer through fall of 1982 provided the following results:

- A September rainstorm caused a short duration flood with a peak flow of 4500 cfs at the recording gage on the Upper McArthur River; this flood discharge has a recurrence interval of about 25 years.

- Associated with the September flood on the Upper McArthur River were significant amounts of erosion and sediment transport.

- The Chakachatna River and the lower McArthur River were affected by the September rainstorm, but to a significantly lesser extent than the Upper McArthur River.

- Discharges in the lower Chakachatna River above the split with Middle River correlated reasonably well with the discharges at the recording gage, averaging approximately 17 percent of the flow at the lake outlet.

- The average discharge during the mid-August to mid-October period in 1982 was significantly less than the average for the 13 years of record of the U.S.G.S. gage; August flows were well below average and October flows were near average.

- Groundwater may be an important characteristic contributing to fisheries habitat in the Chakachatna River floodplain.

- Water temperatures on the Upper McArthur River exhibit diurnal temperature variation as large as 6.5°C on warm summer days.

- The Chakachatna and McArthur River systems actively transport sediments.

6.8 AQUATIC BIOLOGY - 1982 STUDIES

6.8.1 Introduction and Objectives

During 1982, studies of aquatic biology concentrated on the fishery resources of the study area. Two series of programs were carried out. One, during the winter and spring of 1982, the other during the summer and fall.

6.8.1.1 Winter - Spring Reconnaissance Program

During the period of March through June 1982, four reconnaissance-level field studies were performed. These studies encompassed a variety of areas within the study site including Chakachamna Lake, Chakachatna River, McArthur River, and tributaries of the preceding water bodies.

These studies were performed to supplement previous reconnaissance studies completed during August and September 1981 which have been included in Section 6.3 of this report. The objectives of these studies were to:

- Extend the data base on habitat use and seasonal distribution of fish;
- Aid in identifying the time spring spawning migration begins; and
- Examine for the presence of out-migrants.

A more extensive investigation was carried out during the summer and fall of 1982.

6.8.1.2. Summer - Fall Sampling Program

This task consisted of two programs. One program was directed at studying adult anadromous fish in the Chakachatna and McArthur River systems study area and was conducted from mid-July through October 1982. The other program was directed at studying the resident and juvenile anadromous fish in the study area during August through October, 1982.

6.8.1.2.1 Adult Anadromous Fish

This program was directed at studying the presence and spawning of anadromous fish in the study area. Emphasis was placed on the five species of Pacific salmon. The objectives of this program were to determine:

- o Estimated abundance of spawning adults for each spawning area;
- o Spawning locations including;
  - main stem areas
  - tributary streams
  - side channels
  - lakes
  - sloughs
- o Timing of migrations and spawning;
- o Migratory pathways and milling areas; and
- o Characteristics of spawning habitat.

6.8.1.2.2 Resident and Juvenile Anadromous Fish

This program was directed at studying the seasonal distribution, habitat use, and relative abundance of important resident species such as Dolly Varden and rainbow trout, as well as the study of the same parameters for juvenile anadromous fish.

The objectives of this program were to:

- o Identify species composition;
- o Identify important seasonal habitat;
- o Measure relative abundance at selected stations; and
- o Identify timing of important life history events.

6.8.1.2.3 Chakachamna Lake Sampling

This program was directed at studying the following:

- o Identify milling areas;
- o Identify shoreline spawning (if it occurs);
- o Collect water quality data; and
- o Examine fish distribution in the lake.

6.8.1.2.4 Habitat Data Collection

This program was directed at measuring the physical characteristics of habitats at each of the sampling stations. This included the following:

- o Water velocity and depth
- o Water quality
- o Sustrate
- o Cover
- o Presence of upwelling

6.8.2 Methodology

A variety of methodologies were utilized to sample and count fish in the study area during the 1982 program. The various methodologies were necessitated by the diversity and complexity of the site and the distances between stations. Access was often a problem due to flooding of sampling areas during normal flow periods and low water levels during other periods. For example, flow was 36 percent of normal during August, and limited site access by boat. In addition during September, a one in 25 years recurrence interval flood flow occurred which limited site access.

The use of gear was also limited by availability, and logistic constraints. Many of the same sampling gears and techniques used during the 1981 studies were also used during 1982 (see 6.3.2).

A plan of study was prepared which consisted of two components, one emphasizing resident and juvenile anadromous fish, and the other adult anadromous fish. These are presented below. The actual methodologies used are detailed in Sections 6.8.2.1 - 6.8.2.12.

RESIDENT AND JUVENILE ANADROMOUS FISH PROGRAM

Habitat Program

A. Identify location of various life functions.

This involved systematic sampling of 24 general sampling stations and some additional locations based upon 1981-1982 reconnaissance data. Sampling was primarily by netting, electroshocking and minnow traps.

Each sampling station was sampled monthly and the more accessible stations, more frequently.

B. Measurements of relative abundance.

This involved use of equal efforts at each station.

C. Measurement of habitat characteristics.

At each biological sampling station a series of individual specific habitats, representative of habitats available at the station were sampled. At each of these sites, in addition to the collection of fish, a series of habitat measurements were made to determine species habitat preference. These sites were selected and sampled in such a way that results were not biased by the effect of biological sampling at nearby stations.

The habitat characteristics that were measured included:

1. Average Water Column Velocity (0.6 depth)
2. Water Column Temperature
3. Water Column pH
4. Water Column D.O
5. Water Column Turbidity
6. Cover
7. Substrate
8. Water Depth
9. River Segment Stage (where appropriate).

ADULT ANADROMOUS FISH PROGRAM

Escapement Estimation and Monitoring

A. Identify migratory pathways used by fish by means of tags and observation or collection up-river of fish tagged at lower system fyke nets.

B. Identify spawning locations by overflights, netting, and electroshocking (low visibility waters). Gear preference was visual and netting, supplemented by pulsed D.C. electrofishing only when necessary.

Sites surveyed included:

- o Chakachatna River (mainstem and side channels)
- o McArthur River (mainstem and side channels)
- o McArthur River tributaries
- o Igitna River
- o Chilligan River
- o Neacola River
- o Another River
- o Nagishlamina River
- o Other unnamed tributaries
- o Noaukta Slough
- o Middle River (including side channels)
- o Chakachamna Lake

C. Tag recovery operations and photo documentation were only conducted on sites where spawning was found.

D. Estimate number of fish spawning in each area by:

1. direct count - ground level (where feasible)
2. aerial count - visual and with photo documentation performed on approximate weekly basis
3. each spawning area estimated with overflight counts was ground-truthed by ground level counts, biweekly.

4. carcasses were counted and checked for tags.

Escapement data was analyzed by integrating by stream, the number of live fish counted over time and dividing by stream life duration (see below).

E. Estimated stream life of a salmon wave was calculated by measuring the time between peak-live and dead counts, where feasible, and by tag analysis.

F. Timing of movements was determined by analysis of tag returns and observations.

G. Age and stock data will be obtained from scales supplied to Commercial Fisheries Division for analysis.

H. Spawning habitat was characterized by measuring the following parameters:

1. Average Water Column Velocity (0.6 depth)
2. Water Column Temperature
3. Water Column pH
4. Water Column Dissolved Oxygen
5. Water Column Turbidity
6. Cover
7. Substrate
8. Depth
9. River Segment Stage (where appropriate).

6.8.2.1 Salmon Spawning Escapement

Escapement to spawning streams and sloughs was monitored on as close to a weekly schedule as field conditions permitted. Counts of spawning salmon and carcasses were generally made from the air, using a Bell 206B Jet Ranger helicopter equipped with bubble windows that permitted an extended field of view. Counts were generally made by two biologists and were tabulated on multiple tally meters. The biologists used polarized glasses to improve vision through water surface glare.

Spawning counts made in sloughs and streams were made on the entirety of stream length. On the longer rivers, such as the Igitna, Chilligan, Another, Neacola, and Nagishlimina, the water course was monitored at least several miles above reaches of observed spawning activity, and well above reaches containing suitable substrate. Although no salmon spawning was observed in the Another, Neacola or Nagishlimina Rivers, routine monitoring of these streams was still carried out. A regular part of the escapement monitoring procedures included ground-level counts to verify the aerial counts. Where necessary, nets or electroshocking were also employed.

Emphasis was placed on counting live fish. Although counts of carcasses were also made, this was a secondary objective. Activity of wildlife, such as bears, often resulted in limited information being gathered on carcass abundance. Ground level investigations revealed that carcasses were often removed from the immediate stream area and crushed into the ground or surrounding vegetation.

Photo documentation of spawning areas was also performed. A Canon A-1 Camera with motor drive and data-back was used to take photographs. A polarized filter was used to reduce the effect of surface glare. Each photograph was labelled as to location and date (Cousens et al. 1982).

In May and June, three aerial reconnaissances were conducted as part of an investigation into the timing of migratory movements of anadromous fish. Aerial escapement counts were performed from July 17 through October 19, on an approximately weekly basis. All waterbodies identified during 1981 studies as containing spawning salmon (see Figures 6.13, 6.19) were monitored. In addition, waterways hypothesized as being migratory pathways or milling areas were also surveyed. Where such areas were identified they were described in the text and plotted on a topographic map of the system. Figure 6.36 shows the Chakachatna and McArthur systems and delineates areas which were examined in detail and are discussed in Section 6.8.3.2.1. The calculation of these estimated escapements followed methodologies described by Barrett (1972), Neilson and Geen (1981), Atkinson (1943), Washington Department of Fisheries (1979), and Bell and Atkinson (1982).

The method of calculation was to plot the number of live fish (y-axis) versus consecutive days (x-axis), and then to calculate the area under the curve. An example of a plot of the number of live fish versus days is shown in Figure 6.37. In order to estimate the number of fish, the total area under the curve is then divided by the estimated stream life (in days) of the species. This results in an estimate of the total escapement of that species to the stream. Information on stream life (Table 6.32) was obtained from three sources: 1) available literature, 2) calculations based on the difference in days between the peak live salmon count and the peak count of carcasses (Bell and Atkinson, 1982), and 3) calculations based on observations of tagged fish in the spawning stream.

Carcass counts on a number of streams within the study area could not be used as reliable information because of flushing from the area of interest by stream flow and their removal by wildlife. Also, in general, carcasses are not as readily identifiable to species as are live fish.

Tag data, which are used in estimating the stream life of adult salmon are dependent upon observing or recapturing tagged fish in streams being investigated. For many streams, observations could only be made on a once a week basis, thus limiting the accuracy of stream life estimates attainable.

Stream life of individual species is discussed under separate accounts of the spawning and migration of each salmon species.

6.8.2.2 Fyke Nets

Fyke nets were employed to collect data on the relative abundance of fish and to capture fish for tagging. The nets were deployed in the lower portions of the Chakachatna and McArthur River systems in areas suitable for their uses. Fyke nets consisted of a stainless steel 1.8 x 1.2 m (6 x 4 ft) trap mouth, flanked by wings ranging from 15.2 to 91 m in length (50 to 300 ft); the wings were covered with 2.5 cm (1.0 in) bar mesh. The trap portion was constructed of 1.3 cm (0.5 in) bar mesh knotless nylon with two funnels. Leads of 15.2 to 91 m (50 to 300 ft) were employed at a variety of sets, depending upon depth and water current. All nets were set in less than 1.2 m (4 ft) of water in velocities of approximately 1 m/s (3.3 ft/s) or less.

Fish were removed from the codend of the fyke nets and held in floating 1.2 x 1.2 x 1.2 m (4 x 4 x 4 ft) holding pens made of 0.3 cm ($^1/_8$ in) knotless nylon mesh. As fish were needed for processing they were dipped out of the holding pen and placed in a tub with a solution of MS-222 anesthetic. Anesthetized fish were then processed (See Section 6.8.2.8). At the start of the summer-fall 1982 studies, two fyke nets were available to the project. These were set at stations 6 and 11. Table 6.33 lists the deployment schedule for fyke nets.

In September additional nets were set at additional stations. The stations were selected on the basis of the feasibility of setting a fyke net at a given site and on the basis of providing coverage of potential migratory pathways to Chakachatna River spawning areas. Stations at which fyke nets were set included stations 1 (1D) and 11 on the McArthur River, stations 3, 4, 6 on the Chakachatna River and station 9 on the Noaukta Slough (Figure 6.30).

Fyke net catch per effort (c/f) was defined as catch per net per day (24 hours).

6.8.2.3 Minnow Traps

The primary sampling method for sampling age 0+ and small juvenile fish was the baited minnow trap. This has been an effective sampling device for collecting juvenile fish used in many other studies in Alaska (Wilson et.al, 1981, ADF&G, 1982b, 1982c,). Standard minnow traps (43.2 x 22.9 cm 17 x 9 in., 3.2 mm, 0.125 in mesh) were deployed in sets of four at each of the sampling stations, one through 24, where feasible. Each station was sampled during August, September and October where site access was permitted. Traps were baited with salmon eggs and set overnight in representative habitats. Physicochemical habitat data were measured at each trap. A unit effort of sampling was considered to be one trap set for one day (24 hours).

6.8.2.4 Seines

The same seines were used as in 1981 (see Table 6.8). These were used both individually and in combination with electrofishing.

6.8.2.5 Hook and Line

Supplemental collections were made using hook and line. This technique was used in deeper or dangerous waters and to verify species identifications in remote locations where other sample gear was not suitable.

6.8.2.6 Electrofishing

Electrofishing collections were conducted using Smith-Root Model XI and Model XV electroshockers. These were operated at 600 volts at 60 hertz. Electronarcotized fish were collected by dipnets and seines. Each collection was processed and summarized separately.

6.8.2.7 Gill Nets

The same gill nets as used in 1981 (Table 6.8) were used in the 1982 studies. These were set for 0.5 to 12 hr sets in Chakachamna Lake. The use of gill nets was kept to a minimum to reduce injuries to adult sockeye. Large numbers of milling adult sockeye were caught in gill nets, even in set periods of as short as 0.5 hour.

6.8.2.8 Processing of Fish Collected

Fish collected by means of the sampling methodologies were generally processed in the same manner. Fish were measured for total length, to the nearest mm. Adult salmon were also measured for fork length, to the nearest mm. Weight was measured to the nearest 0.03 kg (1 oz) for large fish, and to the nearest gram (0.04 oz) for small juveniles (where feasible). Species, life stage (see below), and reproductive condition (see below) were also recorded. All resident fish and larger juvenile anadromous fish larger than 18-20 cm (7.0-7.9 in) total length (large enough to be tagged without undue damage) were tagged with numbered Floy spaghetti tags. Adult salmon were tagged with Petersen disk tags. These tags were color coded. Each tagging location, including fyke net stations, was assigned an individual color for identification.

6.8.2.8.1 Lifestage

Captured fish were classified according to lifestage. The classification emphasized salmonid lifestages but were also used for other species. Fish were classified into the following categories.

Category	Definition
Fry	Yolk-sac or post-larvae which do not have their full complement of fins, finrays, etc.
Parr	Juveniles with distinct parr marks which have full complement of fins; yolk-sac completely absorbed (salmonids only).
Juvenile/smolt	Juvenile of non-anadromous species and smolt of salmonid species; parr marks lost.

Adults	Fish capable of reproduction, whether sexually ripe or not.

6.8.2.8.2 Sexual Maturity

The sexual maturity of fish was identified whenever feasible. Fish were examined externally and classified according to Nikolsky (1963) into the following categories.

Classification of Stages of Fish Maturity

Stage		Definition
I.	(Immature)	young individuals which have not yet engaged in reproduction; gonads of very small size.
II.	(Resting Stage)	sexual products have not yet begun to develop; gonads of very small size; eggs not distinguishable to the naked eye.
III.	(Maturation)	Eggs distinguishable to the naked eye; a very rapid increase in weight of gonad is in progress; testes change from transparent to a pale rose color.
IV.	(Maturity)	Sexual products ripe; gonads have achieved their maximum weight, but the sexual products are still not extruded when light pressure is applied.

V.	(Reproduction)	Sexual products are extruded in response to very light pressure on the belly; weight of the gonads decreases rapidly from the start of spawning to its completion.
VI.	(Spent Condition)	The sexual products have been discharged; genital aperture inflamed; gonads have the appearance of deflated sacs, the ovaries usually containing a few left-over eggs, and the testes some residual sperm.
VII.	(Resting Stage)	Sexual products have been discharged; inflammation around the genital aperture has subsided; gonads of very small size, eggs are distinguishable to the naked eye.

6.8.2.8.3 <u>Scale Methodology</u>

Scales were collected from all adult salmon regardless of condition encountered during routine sampling. This was done to assure that the maximum number of useable scales would be obtained. The Alaska Department of Fish and Game (ADF&G) statewide stock assessment scale sampling methodology was used. Adult scales will be read by ADF&G. Other fish (e.g., juveniles) scales collected were read using a microprojector.

6.8.2.9 Habitat Data Collection

A variety of habitat data were collected to characterize the various sampling areas and to provide information on fish habitat preference. The data collected to characterize fish habitat preference will be necessary for future impact analyses.

Environmental data were collected at each electrofishing and minnow trapping site. The habitat data collected included measurements of: water depth, water velocity, water temperature, dissolved oxygen, turbidity, conductivity, substrate, cover, and stage (from staff gage). Water depth was measured using a top-setting wading rod, and water velocity was measured with a Marsh-McBirney Model 201 electromagnetic current meter.

Water quality parameters were measured with a Horiba Model U-7 Water Quality Meter. This instrument measures temperature, dissolved oxygen, pH, specific conductance (conductivity) and turbidity. The instrument was calibrated daily prior to use. The instrument comes equipped with an 10 meter (33 ft) cable for in situ measurements. At depths greater than 10 meters, a 4.2 liter (4.45 quart) Van Dorn bottle equipped with a 91.4 m (300 ft) cable was used to collect water samples. These samples were then measured at the surface using the U-7 Water Quality Meter.

Water temperatures were also recorded by Data-pod recording water level gages and by two Peabody-Ryan temperature recorders set in the McArthur River (see Section 6.7.4). River stages were measured using staff gages installed at many sampling stations (see Hydrology Section 6.7.3). Staff gages were installed at all stations indicated by circles on Figure 6.30. Recording water level gages were installed on the Chakachatna and McArthur Rivers (see Section 6.7.3).

6.8.2.9.1 <u>Substrate and Cover</u>

Substrate and cover are important descriptors of the physical habitat used by fish and can affect the utilization of available habitat (Bovee, 1982). There have been a variety of descriptors used to describe both substrate and cover, many of which are complex and difficult to implement under field conditions.

<u>Substrate</u>. Based upon the advice of the USFWS - Cooperative Instream Flow Group (IFG) (Bovee, pers. comm) substrate characterization was based on a simple system that had the potential to be further summarized if needed.

The coding system was in many respects quite similar to the Brusven Substrate Index (Brusven, 1977) which has been used in previous instream flow assessments. The scale consisted of two sets of two digits separated by a decimal point (i.e. —— —— . —— ——).

Digit one was used to designate the dominant substrate material other than fines, if more than one non-fine material was present. Digit two denoted the second most common substrate material (usually other than fines), if such a material was present. The third and fourth digits were used to designate the percentage of fine materials such as sand or silt and less coarse materials.

The scale used was:

Category	Description
1 - Fines	sand and silt
2 - Small gravel	4 - 25 mm
3 - Large gravel	25 - 75 mm
4 - Cobble	75 - 225 mm
5 - Rubble	225 - 300 mm
6 - Small boulder	300 - 600 mm
7 - Large boulder	600 mm
8 - Bedrock	actual bedrock
9 - Other	vegetation, man-made materials

Therefore a substrate code such as 23.50 describes a substrate which was 50 percent fines and had a non-fines portion in which small gravel made up more of the substrate than large gravel. Where possible, substrate was described based upon direct observation of the bottom. Where such observations were infeasible, grab samples (Petersen dredge) were collected and characterized.

Cover Code. Cover has been described by a number of coding systems in the past. Many of these systems have been quite complex (Bovee, 1982). Current recommendations made by the IFG have emphasized the use of relatively simple cover codes as descriptors (Bovee, 1982; Bovee, Pers. Comm). These simple codes are often more compatible with such forms of analysis and impact prediction as the IFG incremental flow methodology.

Cover is usually described in terms of two types of cover: overhead and object. Overhead cover includes those features of the environment both biotic and abiotic which "cover a fish from above." This could include floating logs, tree branches, cut banks and similar features or anything a fish can get under (Bovee, 1982). Object cover includes those features of the environment that can provide shelter for the fish within the stream, particularly shelter from flows.

The code chosen for this study allowed a variety of information to be recorded which could then be directly used or further summarized. The code included the following categories:

Code	Cover
1 -	no object cover
2 -	object cover < 0.3 m (1 ft)
3 -	object cover > 0.3 m (1 ft)
4 -	no overhead cover
5 -	overhead cover above water surface
6 -	overhead cover in water
7 -	overhead cover in and above water surface

A specific cover code was defined by two digits. The first digit signified object cover, the second, overhead cover. In this manner, combinations of both types of cover can be encoded.

The relative percentage of the designated cover and the distance of the sampling area from shore was also recorded.

6.8.2.10 Hydroacoustics

Hydroacoustic or echosounding was used to detect fish during the winter 1982 reconnaissance study and during the September 1982 study. Both studies were conducted on Chakachamna Lake.

6.8.2.10.1 Winter Reconnaissance

Hydroacoustic sampling was used to examine the relative distribution of fish at the two sampling sites. This technique provided a means of sampling a large volume of water and determining the distribution of fish within it. In addition, it allowed a relatively unbiased evaluation of fish distribution since it was not dependent upon fish behavior or activity as nets would be. A Biosonics model 101 echo sounder (Figure 6.38) was used, with a horizontally deployed transducer (Figure 6.39) to detech fish under the lake ice. The transducer was pivotable so that the volume of water beneath the transducer could be scanned at all depths and directions and so it could also be angled to detect fish immediately below the ice without undue interference from ice ridges (Figure 6.39). Two sites were sampled at the eastern end of the lake (Figure 6.40).

6.8.2.10.2 September 1982 Field Program

The hydroacoustic sampling during this study was conducted utilizing a Biosonics model 101 echosounder, a Ross Chart recorder, Sony tapedeck, and a V-Fin mounted 10^{o} transducer. The schematic of this gear is shown in Figure 6.41. A total of three transects were completed in the lake as shown in Figure 6.42. This represents approximately 9.4 kilometers (5.8 miles) of sampling.

6.8.2.11 Data Management and Analyses

Data were entered from key punch compatible field forms to magnetic tape and were managed and principal analyses run on a PDP-11/23. All data were subject to verification and quality control routines and checks.

Mathematical and graphic analyses were principally computer generated. Computer graphics were generated using the Statistical Analysis System (SAS), Mellonics propriatory software (IBM 370), and Hewlett Packard (HP) system 9845 graphics software.

Analytical routines included SAS, HP statistical programs, and Woodward-Clyde Consultants statistical programs. Statistical analysis was conducted according to Sokal and Rohlf (1980). Results of Analysis of Variance (ANOVA) and other tests performed were subject to tests for homogeneity of variance, normality and additivity, as appropriate. Where necessary, data were transformed to meet necessary test assumptions, or non-parametric statistics used. Data analyses in the text were conducted by ANOVA and multiple contrasts, unless otherwise stated.

6.8.3 Results

6.8.3.1 Winter - Spring Reconnaissance Program

A program of reconnaissance-level studies was conducted during the winter and spring of 1982, primarily to provide information on the seasonal distribution, timing of seasonal movements and habitat use of fish within the study area. Due to the relatively low-level of effort, the amount and detail of these data are not directly comparable with those collected during the summer and fall of 1982 (when a much greater level of effort was expended).

The emphasis of the winter-spring studies was to provide some data on the use of the river systems during the winter and spring when important events in the life histories of Pacific salmon occur. Since no site specific data were available on the winter and spring behavior of fish in the study area, the timing for the studies was based on data from the literature and other investigations being conducted in upper Cook Inlet.

6.8.3.1.1 Winter Studies 1982

Winter reconnaissance studies of seasonal distribution and habitat use were conducted during March 18-23, 1982. These studies were directed at,

- o Locating potential overwintering areas;
- o Evaluating specific habitat sites identified during the 1981 program; and
- o Studying fish distribution in Chakachamna Lake.

Stations referred to in this discussion are the same as those shown in Figure 6.30. A variety of study sites were evaluated during this study ranging from Chakachamna Lake to the Middle River for the Chakachatna River system and the McArthur River from the McArthur Canyon area downstream to its confluence with Noaukta Slough. Fish collection data for these studies are contained in Appendix A3. These areas are discussed by site.

Chakachamna Lake. No winter data were available from previous studies on fish distribution within Chakachamna Lake nor on physicochemical conditions. Most project alternatives involve a deep withdrawal of lake water through a tunnel to a turbine and penstock. An objective of this study was to evaluate the distribution of fish in the vicinity of the proposed intake location and to gain insight into winter behavior of these fish.

The limited visibility of the lake water and the difficulty of maintaining access to the lake during winter limited the extent of studies on the lake.

Measurements were taken of physical conditions on and in Chakachamna Lake. Ice cover on the lake was continuous and generally solid. Some pressure ridging was in evidence, but no leads were observed. Ice cover was measured at 0.99 meters (3.25 ft) with approximately 0.3-1.0 meters (1.0-3.3 ft) of drifted and/or compacted snow above. Some under-ice ridging was detectable by means of hydroacoustics (see below).

Two study sites were examined on Chakachamna Lake (Figure 6.40). Site one corresponded to the proposed lake intake location, and site two represented a mid-lake area (approximately 1.6 km (1 mi) offshore with depths greater than 76.2 meters, 250 ft) also in the eastern part of the lake. Water temperature and dissolved oxygen were measured in situ (see Methodology). One profile was taken at site one; at site two, the instrument subsequently froze and failed. These data are presented in Table 6.34 and show an inverted temperature profile. Dissolved oxygen (DO) levels were high throughout the water column; there was, however, a slight decrease in DO at 13.7 m (45.0 ft).

Hydroacoustic sampling was used to examine the relative distribution of fish at the two sampling sites. This technique provided a means of sampling a large volume of water and determining the distribution of fish within it. In addition, it allowed a relatively unbiased evaluation of fish distribution since it was not dependent upon fish behavior or activity as nets would be. A Biosonics model 101 echo sounder (Figure

6.38) was used with a horizontally deployed transducer (Figure 6.39) to detect fish under the lake ice. The transducer was pivotable so that the volume of water beneath the transducer could be scanned at all depths and directions and so it could also be angled to detect fish immediately below the ice without undue interference from ice ridges (Figure 6.39). The data from the scans were analyzed to determine the depth distribution of fish. The results of this analysis are given in Table 6.35 for the 45° and 15° transducer deployments. These were selected for evaluation of depth distribution because they sampled more water volume at depths greater than 3.0 meters (10 ft) than the scans used to sample directly beneath the ice cover.

Overall, fish were most abundant within 6.1 meters (20 ft) of the surface, and over 83.4 percent of the fish detected were found there. Between 65 and 100 percent of the fish detected were located at depths of 0-3 meters (0-10 ft).

A deployment angle of 15° or less generally provided better resolution in the shallower depths and the 45° deployment angle provided better resolution at greater depths.

Relative densities of targets (presumed to be fish) just under the ice, where densities were greatest, were compared between sites one and two. Target density at site two was 29.1 percent greater.

The reason for the overwhelming abundance of fish in the upper 6 m (20 ft) of the water column is unclear. One possible hypothesis is that planktonic organisms used as food by some fish (i.e., sub-adult sockeye, lake trout, Dolly Varden, etc.) may be more abundant at these shallow depths under the ice.

In cases in which fish crossed the beam of the transducer, the swimming speed (time of passage) of the fish observed could be estimated. Many of the fish observed remained essentially stationary. Swimming speeds of five fish were estimated. These were in the range of 0.2 to 0.4 cm/s (0.1-0.2 in/s). This method has been used for estimating fish swimming speeds in Prudhoe Bay and in other places (Tarbox and Thorne, 1979).

Chakachatna River. Habitat stations in the Chakachatna Canyon were overflown and observed. There were large reaches of open water in this area and some of the tributary streams located within the canyon were open and flowing. Ice covered areas were generally confined to the banks and to overflow channels. Generally, open water areas were prevalent throughout the upper Chakachatna River extending from below the lake outlet to the division with the Noaukta Slough. Most areas downstream of that division were ice covered with few open leads present.

Sloughs along the Chakachatna River located at station 17 (Figure. 6.30) were open or had partial ice cover, this was true of sloughs along both the left and right banks (looking upstream). The left bank slough was completely open. This slough was observed to be spring fed, with discernible flow coming from the elevated south bank.

Sockeye and chum salmon had been observed spawning in this area in 1981 and again in fall 1982. Habitat measurements were made in both the left and right bank sloughs. These data are summarized in Table 6.36. The water temperatures in the left bank slough were measured with a YSI model 57 temperature-dissolved oxygen meter. The meter failed prior to the collection of data in the right bank slough. Two days later water temperature was measured with a mercury thermometer in a side channel of the Chakachatna River along the left bank. The water temperature was 1°C, similar to water temperatures measured in the upper water column in Chakachamna Lake (Table 6.34). It was also less than the water temperature in the left bank slough.

Fish were sampled in the left bank slough by means of baited minnow traps, observation and electrofishing. A Dolly Varden parr and a slimy sculpin adult were collected (Appendix A3 - Table 1). Both had eaten the salmon egg bait. Electrofishing in the same area collected many fry and parr. Because of the large number of redds observed in the area, a relatively small area was sampled in order to reduce potential damage to the fry present (Appendix A3 - Table 2). The fry collected varied in development from yolk-sac fry with prominent yolk-sacs, to those in which the yolk-sac was completely absorbed and the parr marks were present and distinct. The identification of fry of chinook, sockeye, coho and chum salmon as well as of Dolly Varden and an unidentified whitefish (*Prosopium* sp.) confirms that this slough was successfully used as a spawning and incubation area by these species during 1981. It should be noted that this sampling confirmed use of this station by species not previously identified as having spawned there. Pink salmon had been observed spawning in the general station vicinity but no fry had been collected.

Approximately 50-100 fry were observed swimming above the gravel in the left bank slough. Two adult Dolly Varden were observed in the adjacent side channel. These fish were estimated to be approximately 0.3 m (1 ft) or larger in size. Sampling in the right bank slough resulted in the collection of sub-adult Dolly Varden and coho salmon. The coho was age I+ and the Dolly Varden were age O+.

The lower Chakachatna and Middle Rivers were overflown to observe ice cover conditions. Ice cover was generally complete with only a few leads present. Snow drifts of up to 1.5 m (5.0 ft) were found in these areas.

Straight Creek. The Straight Creek area, near station 18 was also examined for the presence of overwintering habitat. There was a solid ice cover over the entire creek, holes augered through the ice revealed a mean depth of ice of 1.1 meter (3.6 ft) under a snow cover of 0.8 to 1.0 meter (2.5-3.5 ft). The ice cover was solid and extended to the substrate. Flowing water was found under the ice cover only along the right bank of the creek, originating from the upstream clearwater tributary (Stream 19). A depth of 0.1 meter (0.25 ft) of water flowing at 0.23 m/s (0.75 ft/s) was measured under the ice at this point.

Noaukta Slough. Potential overwintering habitat had been identified in the Noaukta Slough near station 10 during 1981. The site was characterized by relatively deep water and wide channels, and consisted of a main and a side channel area. Both sites were completely ice covered and no leads were visible. The main channel site had 1.5 meters (4.9 ft) of ice cover with 0.4 meter (1.3 ft) of water underneath. The side channel site had 1.0 m (3.3 ft) of ice cover with 1.8 meter (5.9 ft) of water underneath. The water temperature at both sites was 1°C. Biological sampling was not conducted there.

McArthur River. The McArthur River was overflown from the area below its confluence with the Noaukta Slough through the McArthur Canyon. Below the confluence with the slough, the ice cover was continuous with a few leads. Above this area, there were large open areas in the vicinity of station 13 and the ice cover was discontinuous in the canyon area.

Sampling was conducted in the vicinity of station 15, where many leads were present and several channels were open. Water depths (Table 6.37) ranging from 0.1 to 0.6 m (0.4-2.0 ft) were found and water column velocities (at 0.6 depth) were measured at 0.11 m/s (0.35 ft/s). Water temperatures in this vicinity ranged from 1.0 to 1.5°C. These relatively high temperatures are an indication of possible groundwater flow. Ice cover was nearly continuous at station 14 in the downstream portion of the canyon.

Downstream at station 13, the river, although somewhat narrow (12.8 m, 42.0 ft), was completely open and flowing. Velocities of up to 0.63 m/s (2.00 ft/s) were measured in a riffle area (Table 6.37). Ice along the shoreline was rotten and was partially melted.

Minnow traps were set in this area and Dolly Varden collected (Appendix A3 - Table 4). Two coho sub-adults were also observed near the banks.

McArthur Tributaries. Portions of Streams 13X, 12.1, and 12.2 were overflown and ice conditions observed. Lower portions of all three streams had large leads in various stretches. The open areas varied in width from approximately 1 m (3.3 ft) to 10 m (33 ft). It was clear from even this brief study that considerable amounts of overwintering habitat were available and that water sources other than glacial melt were contributing to flow.

6.8.3.1.2 Spring Studies, May 25-27, 1982

The second study was conducted during May 25-27, 1982. The objectives of the reconnaissance included:

- The investigation of spring habitat conditions;
- Habitat use by resident and juvenile anadromous fish;
- Observations for the presence of early upstream migrants (anadromous fish); and
- Examination for the presence of outmigrants.

Due to the short duration of the effort, study intensity was limited.

Aerial observations showed that ice and snow had melted at the elevations of most of the large water bodies. There were some patches of ice and snow present on the shoreline areas and islands, particularly above Chakachamna Lake.

Sites Above Chakachamna Lake.

Access above the Kenibuna Lake outlet was limited due to hazardous wind shear conditions. It was possible to conduct physicochemical and biological sampling at the

Kenibuna Lake outlet (station 29)(Figure 6.30). Snow cover was present, although approximately 2-5 meters (6.6-16.4 ft) back from the waters edge. The mean water temperature was 5.25°C (Table 6.38), which indicated that seasonal warming of the water was well advanced. Electrofishing efforts (Appendix A3 - Tables 5 and 6) resulted in the collection of several sculpins. It appeared that there was relatively little use of this area by fish at that time.

Sampling was also conducted in the Chilligan River (station 30). Water temperatures in the side channel sampled were relatively high, 8.4°C (Table 6.38). No fish were collected by electrofishing in that area.

The Nagishlamina River (station 26) was also sampled, water temperatures were somewhat lower than the other stations, (4.2°C, Table 6.38). Electrofishing was also conducted, but no fish were collected.

Chakachatna River. Sampling of the Chakachatna River stations also included both biological and physico-chemical sampling. Some small amounts of snow were present on islands and river banks, but usually it was well back from the waters edge.

Sampling at station 22, in the relatively large pool and side channel area indicated considerable warming, water temperature was 6.7°C (Table 6.38). Electro-fishing efforts (Appendix A3 - Table 7) produced two Dolly Varden sub-adults and a juvenile whitefish (*Prosopium* sp.). The numbers collected were well below those collected in this area at other times.

Fish were generally more abundant and diverse downstream (Appendix A3 - Table 8). At station 17 many age 0+ coho, chinook, sockeye and chum salmon, and Dolly Varden were collected from cover in the side channel. The area sampled was downstream of the left bank slough where salmon spawning was observed. The side channel received both slough and river flow, and was designated LB_{+2} to differentiate it from the left-most slough (LB_{+0}) and other water bodies at this station. Adult rainbow trout and round whitefish were also collected at this station. The rainbow trout had been feeding on salmonid juveniles.

The left bank slough at station 17, (LB_{+0}) was also sampled in the same pool investigated during March. Sub-adult Dolly Varden, slimy sculpin, and sub-adult chinook, sockeye, and chum salmon were collected (Appendix A3 - Table 9). Another area sampled in the same slough, further downstream (Appendix A3 - Table 10) also resulted in collection of the same species. The Dolly Varden collected in this area also included older juveniles (up to 14.1 cm, or 5.5 in. total length). The chums collected showed some evidence of initial smoltification, but parr marks were generally still distinct. There was a definite temperature difference between the slough(LB_{+0}) and the side channel (LB_{+2}), 2.3°C versus 4.2°C, respectively (Table 6.38). There were also differences in conductivity and turbidity, 83 umho/cm versus 70 umho/cm and 23.5 mg/l versus 65.5 mg/l, respectively.

Physicochemical sampling was also conducted at station - 17D. The water temperature was slightly warmer than in the station 17 side channel, however, conductivity and turbidity were very similar (Table 6.38).

Middle River. The Middle River was sampled at station 5; few fish and no salmonids were collected.

Noaukta Slough. Station 10 had been identified during 1981 as a rearing habitat (Section 6.6). Juvenile Dolly Varden and coho salmon were relatively abundant there (Appendix A3 - Table 12). The lengths of fish collected indicated the probable presence of at least two year classes for each species. Water quality data indicated some similarity to data collected upstream at station 17D.

Straight Creek. Straight Creek (Station 18) was completely ice-free with some snow cover still present on islands. Water temperatures and conductivity were considerably different from the Chakachatna River (Table 6.38). Turbidity was much lower than measured during other periods. A significant portion of the flow appeared to be derived from the Clearwater tributary (Stream 19).

Electrofishing resulted in the collection of coho and chinook salmon, Dolly Varden, and a slimy sculpin. The salmon were age I+ fish.

McArthur River. Sampling in the McArthur River was conducted from below the McArthur glacier, downstream to the confluence of Stream 13U. The station closest to the McArthur glacier (station 15.5) was sampled during 1981; no fish were collected then or during 1982 investigations. Water temperature at this station was 1.1°C (Table 6.39).

More than 70 age 0+ and age I+ Dolly Varden, chinook, and sockeye and coho salmon (Appendix A3 - Table 14) were collected downstream, at station 15. The collection of age 0+ chinook, sockeye and coho salmon was evidence of successful spawning and incubation of these species.

Downstream of the canyon at station 13, water temperatures were higher than station 15; 4.9°C (Table 6.39). Sampling at this station resulted in the collection of similar species (Appendix A3 - Table 15) to those collected during March, including Dolly Varden age 0+ through age II+, age I+ coho and chinook salmon, and one sculpin.

6.8.3.1.3 System-wide Outmigrant Sampling

Outmigrant sampling was conducted to investigate the timing of downstream movements; stationary 0.5 m (1.6 ft) plankton nets were used. Due to constraints on site access, most sampling had to be performed during daylight. Nocturnal sampling was performed at station 17. Table 6.40 lists the results these sampling efforts. Few fish were collected and none of these had undergone smoltification. Combined with the results of electrofishing, the results of this sampling indicated that fish such as chum salmon were in early stages of smoltification.

6.8.3.1.4 Spring Studies June 8-11, 1982

The June 8-11 reconnaissance trip was conducted as a continuation of studies started during the May 1982 field trip.

An aerial survey was conducted of known spawning areas and of migratory pathways in the lower portions of both river systems. No adult salmon were observed, but eulachon (Thaleichthys pacificus) were identified in the system for the first time. The eulachon were observed spawning only in the lower McArthur River. Spawning habitat and the extent of spawning is reported in Section 6.8.3.2.1. Sockeye and chum salmon smolts were collected in the lower portions of both river systems. This indicated that outmigration had begun. The results of the habitat and outmigrant sampling are described below.

Sites Above Chakachamna Lake. Improved weather permitted access to areas above Kenibuna Lake.

Neacola River - The Neacola River was sampled at station 31, approximately 7.2 km (4.5 miles) above its confluence with Kenibuna Lake. This area was selected because it contained substrate suitable for salmonid spawning, although the substrate was largely sand with only a small amount of gravel. Dolly Varden (age I+ - II+) round whitefish, and slimy sculpin were collected in order of decreasing abundance (Appendix A3 - Table 16). Sampling in an adjacent pond area (Appendix A3 - Table 17) resulted in the collection of six fish. Although juvenile Dolly Varden were collected at station 31, the absence of age 0+ fish suggested that Dolly Varden may not spawn in that area. Age 0+ fish were present at all other sites where spawning was identified.

Physicochemical measurements were taken in both the river and pond sites. Water temperatures at both sites were greater than at any other stations sampled during that reconnaissance (Table 6.41).

Another River - Electroshock sampling in the Another River (station 33) collected two species, Dolly Varden and slimy sculpin. The Dolly Varden ranged from age 0+ to II+. The presence of age 0+ fish indicated that Dolly Varden probably spawned in this area. Spawning was observed during fall 1982 studies. Water temperatures in the Another River were relatively warm (7.2° C) and similar to those of the Igitna River (7.0°) (Table 6.41), and its conductivity was the lowest in the Chakachatna River drainage.

Ignitna River - Eleven Dolly Varden were collected in the Igitna River (Appendix A3 - Table 19). No sockeye salmon were collected, although spawning had been observed there.

Chilligan River - Dolly Varden (4), sockeye salmon (14) and sculpin (1) were collected at station 30, in the Chilligan River (Appendix A3 - Table 19). Age 0+ sockeye and age 0+ to age I^+ Dolly Varden were collected.

Chakachamna Lake. Water quality sampling was conducted at station 27 on the north shore of the lake (Table 6.41). The lake surface was too rough to set gill nets or electrofish.

Station 25 on the south shore of the lake, was more amenable to sampling, being in the lea of the wind. Water temperatures were found to be lower than further upstream at station 27 and in the tributary waterbodies. No fish were found at this station.

Chakachatna River. Dolly Varden were collected at station 24 in the upper Chakachatna Canyon (3 fish, Appendix A3, Table 21). Water temperature and conductivity were similar to that at station 25, near the lake outlet.

At station 22, located in the downstream end of the Chakachatna River Canyon, fish were more abundant (30 versus 3 fish, respectively) than at station 24, based upon greater catch-per-effort (Appendix A3 - Table 22). Dolly Varden were most abundant and ranged from age 0+ to age III+. One sockeye and lake trout sub-adult were also collected. The lake trout was evidently transported downstream from the lake. Both temperature and conductivity were higher at station 22 than further upstream.

Collections at station 20 contained a greater number of species than collections further upstream (five species as compared to three or less) Appendix A3 - Table 22. Dolly Varden, sockeye and chinook salmon were common. Dolly Varden included age I+ through age III+ , sockeyes included age I+ - age II+ fish, and chinooks included age 0+ to age I+. This station consisted of backwater areas off the main river channel. The salmon collected may have originated from upstream tributaries.

Water temperature at station 20 was higher than at upstream stations on the river. Conductivity was also greater (Table 6.41).

At station 17, both the main river channel and the left bank side channel (which received slough flow) were sampled. Coho salmon, Dolly Varden and slimy sculpin were common in the main channel (Appendix A3 - Tables 24 and 25). Dolly Varden collected ranged from age 0+ to III+, coho ranged from age 0+ to I+. Catches in the left bank side channel, were dominated by Dolly Varden, and chum, coho and sockeye salmon. One chinook salmon and one sculpin were also collected. Dolly Varden ranged from age 0+ to II - III+. Sockeye appeared to be primarily age 0+. One coho age 0+ and one age I+ were present. Chum (age 0+) showed definite signs of smoltification.

Sampling in the Chakachatna River just above its confluence with the McArthur River (station 1) resulted in the collection of two smolts, one sockeye (age I+) and one chum salmon (age 0+). Sculpins and threespine sticklebacks were also collected. Water temperatures at station 1 were higher than at the upstream stations.

Middle River. At station 5, coho and sockeye salmon were collected, as well as three-spine sticklebacks (Appendix A3 - Table 27). The coho salmon were age I+ to age II+ and were showing distinct signs of smoltification. The sockeye were age I+ and showed no sign of smoltification. Water temperatures (7.7° C, Table 6.41) were warmer than station 17 (upstream). Conductivity at station 5 was very similar to that in the Chakachatna main channel at station 17.

Noaukta Slough. Sampling in the Noaukta Slough was conducted at two stations; station 10, where overwintering sampling was conducted, and at station 16A in the upstream area of the slough (Figure 6.30). This area was used extensively as rearing habitat during the 1981 studies.

At station 16A, sampling was conducted at two sites, one in a main channel area and the other in a backwater area filled with snags and debris. Sampling resulted in the collection of over 120 fish. Fish ranged from age 0+ to age II+ fish. It is hypothesized that the numerous juvenile salmonids originated, for the most part, from spawning which had occurred upstream. The chum salmon collected showed varying degrees of smoltification. None of the sockeye, chinook, or coho salmon collected showed evidence of smoltification (Appendix A3 - Tables 28 and 29).

Seven species of fish were collected at station 10 (Appendix A3 - Table 30). Fish were less abundant than at station 16A. Most sub-adult salmon present were age 0+. One age I+ coho and Dolly Varden ranging from age I+ to II+ were also present.

Water temperatures at station 16A were lower than at station 17 upstream, or at station 10, downstream (Table 6.41). Conductivity was also lower than at either of the other stations. This may indicate that the western portion of the slough is receiving inflow from upwelling or drainage from the adjacent wetland. Observations of clear water flow in this area during late October 1982 support this hypothesis.

Straight Creek. Coho and chinook salmon, Dolly Varden and slimy sculpin were collected at station 18. None of the salmonids had smolted.

McArthur River Drainage. The McArthur River was also sampled to examine for the presence of outmigrants and to determine habitat usage.

Collections made at station 15 (Appendix A3 - Table 33) included Dolly Varden, chinook salmon, and sculpin. Dolly Varden were primarily age 0+ and included yolk-sac fry. Chinook were also primarily age 0+ and age I+.

Samples collected at station 13 (Appendix A3 - Table 34) included pygmy whitefish, Dolly Varden, and coho, sockeye, and chinook salmon. The Dolly Varden included age 0+ to II+, coho salmon were age I+ and age II+, sockeye and chinook salmon were all age 0+.

Station 12 was sampled, but only two fish were collected (Appendix A3 - Table 6-35).

Station 11.5 (Figure 6.30) was sampled to aid in determining how far upstream eulachon had migrated. Coho and Dolly Varden were also collected. Examination of water quality data (Table 6.42) clearly indicated the change in temperature, conductivity and turbidity between stations 12 and 11.5. This was due to the influence of the inflow of water from the Noaukta Slough.

Eight species of fish were collected at station 11 including adult eulachon, which spawned in this area. Numerous chum salmon smolts were also found at this station. Sockeye age 0+ and age I+ smolts were part of this collection.

Eulachon were very abundant at station 1D (Figure 6.30) in the lower McArthur River (28 adults collected, Appendix A3, Table 38). Two chum smolts salmon and one sockeye smolt were also collected at this station (Appendix A3 - Table 38). Water temperatures and conductivities were lower than measurements made at station 11. These were probably caused by the inflow of water from the Chakachatna River, upstream.

6.8.3.1.5 Spring Studies June 24-25, 1982

Fish collections were made at stations representing 1981 spawning areas or probable migratory pathways for outmigrants (Appendix A3 - Tables 39 - 45).

Chakachatna River. Sampling at station 17 resulted in the collection of many age 0+ to older fish. No chum salmon were not collected, although they were present during the previous sampling trip. This indicated that the chums had probably migrated downstream prior to this sampling.

Middle River. Fish collected at station 4 consisted of Dolly Varden, and a sculpin (Appendix A3 - Table 40). Six sockeye salmon were collected at station 5 further downstream in the Middle River. Two of the sockeye had smolted. The other four fish were age 0+ and still had distinct parr marks.

Straight Creek Clearwater Tributary. Two age 0+ chinook salmon were collected at station 19.

McArthur River. The stations sampled during June 8-11 were again sampled during June 24-25. Station 15, as in the previous survey was found to contain primarily Dolly Varden and chinook salmon. During this trip, a Dolly Varden of age II+ was also collected. Age 0+ fish did not appear to be as abundant as during the previous survey. This may have been due to downstream migration, natural mortality or both.

At station 13, fish other than Dolly Varden were collected at greater abundance than during the previous trips, lending credence to the hypothesis that age 0+

fish were moving downstream. Four of the 18 sockeye collected at this station had smolted indicating that the sockeye outmigration was continuing.

At station 1D (McArthur River), chum and sockeye salmon age 0+ smolts were collected.

Overall, the outmigration appeared to be continuing, particularly in the McArthur drainage. Outmigrants, including chum, sockeye and coho salmon, left many of the upstream spawning areas by June 25.

6.8.3.2 Summer - Fall Sampling Program

6.8.3.2.1 Adult Anadromous Fish

Reconnaissance studies were conducted during the spring, and salmon were observed moving into the system on June 25. The first aerial escapement survey was conducted on July 17. Spawning survey results are given in Appendix A2, Table A2-1 through A2-15. These are corrected actual counts of escapement by stream for each species of Pacific salmon counted between July 17 and October 19, 1982. These counts were used to calculate estimated escapement to each stream and slough. The following discussion presents the results of these counts for each species of salmon.

Chinook salmon. Chinook salmon were observed entering the McArthur and Middle River systems during the June 24 - 25 1982 reconnaissance. Results of the previous reconnaissance studies (May 25 - 27 and June 8 - 10) had not indicated that any chinook were ascending the waterbodies.

By July 17, chinook were observed in Stream 13U in the McArthur drainage (Figure 6.30) but were not observed on the clearwater tributary to Straight Creek (vicinity of station 19), and Stream 13X was not surveyed. On July 22, chinook were found in Streams 13U, 13X, 19, and 12.2 and were observed milling near the mouth of Stream 19 at its confluence with Straight Creek. The chinook spawning areas are shown in Figure 6.43. Adult chinook were not observed in any other streams.

There were some differences noted between chinook spawning locations during 1981 and 1982. Chinook were not observed spawning in the vicinity of the clearwater sloughs at station 17, nor in the side channels and sloughs of the McArthur Canyon in 1982 as they had been during 1981. The 1981 spawning was confirmed by collection of chinook fry at both of these stations during early-late spring 1982 (Section 6.8.3.1).

A small, unnamed tributary that joined stream 13X (Stream E, Figure 6.21) was blocked by a beaver dam during 1982. This stream had been used for salmon spawning during 1981, but had become inaccessible during 1982.

Chinook were observed earliest in McArthur tributaries and these fish died off earlier than fish in Stream 19 (Chakachatna system). Live adult chinook were observed in Stream 19 as late as August 25. One late migrant, a jack chinook, was collected at station 3 on October 15.

Plots of live chinook spawners versus consecutive days are shown in Figures 6.37, 6.44, 6.45, and 6.46, for the Straight Creek clearwater tributary (Stream 19), and Streams 13X, 13U, and 12.2, respectively.

Stream life of chinook was estimated to be 12 days, based upon observations of marked fish remaining on the stream between 10 and 14 days. Estimated stream life was similar to that found by Neilson and Geen (1981). Using this value, the chinook escapement for each stream was estimated. The beginning of the chinook run on Stream 13X occurred prior to the July 22 observation of that stream (Figure 6.44). Examination of the shape of plots of live chinook over time for other streams (Figures 6.37, 6.45, 6.46), shows that the shape of each plot was generally symmetrical. Therefore, in order to estimate the probable actual escapement for Stream 13X, the calculated escapement was doubled.

The estimated escapements are shown in Table 6.43. In addition to the estimated escapements, the table includes the peak counts of live and dead chinook for comparison with these estimates. The peak counts were expected to be lower than the estimated escapement because of the removal of carcasses by flows and scavengers and the potential movement onto the stream of fish arriving after the peak. Peak counts are often used as an index of escapement.

Estimated numbers of spawning chinook were considerably greater than those observed by ADF&G in earlier surveys (ADF&G, unpublished data) which were based on single yearly counts. The highest estimated escapement of chinook (1,633 fish) occurred in Stream 13U.

Chinook were found to spawn further upstream in a given stream than other species. On both Streams 13U and 13X, areas above small rapids or chutes were found to contain a few spawning chinook and no other species. Subsequent observations showed that those areas were not utilized by other species. Several chinook spawning areas on Streams 19, 13U and 13X were observed in detail. Chinook were observed to spawn on substrates ranging from small gravel to cobble. The substrates usually contained less than 25 percent fines. Areas that contained up to 75 percent fines were occassionally used.

Chinook were observed spawning in areas with higher velocities than most other salmon species. Other characteristics of spawning areas included:

- o Water column velocities (at 0.6 total depth) measured between 0.55 and 1.07 m/sec (1.8 and 3.5 ft/sec);

- o Water depths between 0.4 and 0.55 m (1.3 and 1.8 ft);

- o Turbidity between 2 and 34 mg/l; and

- o Dissolved oxygen values greater than 10.0 mg/l.

Sockeye Salmon. An aerial reconnaissance conducted on July 22 did not reveal the presence of sockeye in any of the spawning streams, however, milling fish were observed at the mouths of Streams 19, 13U and 13X at that time. These were assumed to be sockeye (Figures 6.47 and 6.48, areas E and F on Figure 6.36, respectively). Approximately one week later (by July 31 and August 1) sockeye had ascended Streams 13X, 13U, 12.1, 12.2, 12.3, the McArthur Canyon sloughs and side channels (areas near stations 14 and 15, including beaver ponds shown in Figure 6.20), the Straight Creek clearwater tributary (19), and sloughs at station 17. In many of these streams, peak abundance of sockeye did not occur until one to two weeks later. At station 17, for example, peak numbers of spawning fish were observed in September (Appendix A2, Table A2-2). Other streams in which spawning sockeye were observed included Streams 12.4, and 12.5, the Straight Creek mouth area sloughs, Chakachatna Tributary C1, Chakachatna Canyon sloughs, and the Chilligan and Igitna Rivers. Each of the sockeye spawning areas that was identified during 1982 is shown in Figure 6.49.

Milling fish were also found to utilize backwater areas of the Chakachatna River Canyon (station 23 and above, see Figure 6.30), and Chakachamna Lake (Figure 6.50). Just prior to the sockeye ascending the Chilligan River, many were found milling in the mouth of the river and backwater areas near the mouth (Figure 6.51). Sockeye also entered the Igitna River later than the streams lower in the system. Sockeye were observed milling in the alluvial fan of the Igitna River on August 18, one week prior to the observation of spawners in the river itself. The milling area is shown in Figure 6.52.

The largest numbers of sockeye were observed in the Chilligan River located upstream of Chakachamna Lake (Area C, Figure 6.36). Spawning adults were not found in channels of the Chilligan River until August 18 and peak counts of live fish were made on September 9 (Appendix A2, Table A2-15).

Escapement estimates were made utilizing the same techniques as used for chinook, and plots are shown in Figures 6.53 through 6.67. In cases where the decline in the abundance of spawners over time was not followed completely to zero, the zero date was estimated by linear regression, or by continued plotting of the downward line to the x-intercept.

Estimated stream life of sockeye (Table 6.32) varied in different water bodies. The sockeye within streams in the Chakachatna drainage, such as the Chilligan River and the sloughs at station 17, had stream lives of approximately 12 days. Barrett (1972) found similar results for sockeye in the Kasilof River system. In some streams in the McArthur drainage (i.e., Streams 12.1 through 12.5 and Stream 13X) sockeye appeared to have considerably shorter stream lives, averaging about six days. This may have been due in part to greater levels of predation on fish. The streams are shallow, narrow and have limited cover.

Estimated escapements of sockeye are shown for each stream in Table 6.44. Estimates of escapement for McArthur streams were made using both 6 and 12 day stream life to indicate the potential range of escapement. As stated above, the greatest escapement was found in the Chilligan River (38,576 fish). In the Chakachatna drainage the second greatest escapement of sockeye was in the Igitna River (2,781 fish). Both waterbodies are located upstream from Chakachamna Lake. Downstream from the lake, the greatest sockeye escapement occurred in the sloughs at station 17.

In the McArthur drainage, the greatest escapement occurred in Stream 12.1, followed by 12.2, and 13X. Over 90 percent of observed sockeye spawning in the McArthur drainage, occurred in tributaries located downstream of the McArthur Canyon.

Observed sockeye spawning areas spanned a variety of habitats including tributaries, sloughs, and side channels. Fish were also found spawning in a few mainstem areas of the Chilligan River. The mainstem areas were generally low velocity areas receiving some slough or upwelling flow. Many side-channel habitats in which sockeye spawning was observed in the Chakachatna River and McArthur Canyon areas also contained upwelling flow. This was confirmed by observations in the fall after river levels dropped.

Spawning generally occurred over substrates ranging from small gravel to cobble, but usually over some substrate containing large gravel. Fines in spawning areas ranged from 10 to 80 percent. Where fines were over 50 percent of the substrate they were surficial. Other characteristics of spawning areas included:

- o Water velocities ranging from 0 to 0.6 m/sec (0 to 2.1 ft/sec).

- o Depths ranging from 0.2 to 0.7 m (0.5 to 2.2 ft) in stream and slough habitats, as deep as 1.2 m (4.0 ft) in the Chilligan River.

- o Dissolved oxygen between 9.4 mg/l and 13.3 mg/l.

- o Turbidities between 1 and 28 mg/l.

Pink Salmon. Pink salmon aerial counts are listed in Appendix A2 (Table A2.1-14). Pink salmon were first observed in spawning areas in the Chakachatna and McArthur Rivers on July 31. Observations of pink salmon were made in McArthur tributaries 13X, 12.1, 12.2, and 12.5, and in the sloughs at Chakachatna River station 17, with peak numbers observed in mid- to late

August. On Stream 19, the Chakachatna Canyon sloughs, Streams 13U, 12.3, and 12.4, and the McArthur Canyon area, pink salmon were first observed in August with peak numbers of live fish observed in mid - to late August. Spawning adults had disappeared from many streams by the beginning of September and from all streams after September 10. Pink salmon spawning areas identified during 1982 are shown in Figure 6.68.

Observations in the various streams indicated that pinks spawned primarily in the lower portions of streams. Pinks were not observed to ascend as far upstream as chinook, sockeye, or coho.

Pink salmon were observed milling near the mouths of several streams prior to their appearance in the stream, or prior to the observation of peak numbers. Milling areas were identified for the Chakachatna Canyon, and Streams 19, 13X, and 13U. The milling areas on Streams 19, 13X, and 13U (Figures 6.69 through 6.71) largely corresponded to the sockeye milling areas at the mouths of these streams. Based on observations of milling fish and the fact that relatively few were ascending the streams, it appeared that many pink salmon had entered fresh water prior to the first week of August.

Fish tagged at fyke net station 6 were later observed spawning in Stream 19, Chakachatna Canyon sloughs, and sloughs at station 17 (Figure 6.30). A fish tagged at station 11 was found on Stream 12.1. These data indicated the migratory routes used by pink salmon.

Plots of observed live fish counted versus consecutive days for pink salmon are shown in Figure 6.72 through

6.82. Stream life of pinks was estimated to be approximately seven days (Table 6.32), based upon data collected in the Chakachatna and McArthur River Systems. Table 6.45 lists the estimated escapements by stream.

The Straight Creek clearwater tributary (Stream 19) had the greatest estimated escapement of pinks in the Chakachatna drainage (7,925 fish). Few pinks were found in other streams of that drainage. The greatest estimated escapement of pinks in the McArthur drainage (8499 fish) was on Stream 12.1. Streams 13U, 13X, and 12.2 also contained high numbers of spawning pink salmon with 5402, 4225, and 1566 fish, respectively.

Long term commercial catch data for Cook Inlet have been interpreted to indicate that even-numbered year pink salmon runs are greater than those of odd-numbered years. Commercial catch data for the last 28 years (ADF&G, 1982h) indicate that the 1982 catch was the third lowest even-numbered year catch for the period of record, amounting to less than 50 percent of the 1980 or 1978 catches, and 46.4 percent of the mean even-numbered year catch. Although factors other than run size can affect the catch, it does suggest that the 1982 run of pink salmon was smaller than average. During a year with a larger spawning run (Krueger, 1981a) more streams and stream areas are utilized for spawning than during other years. Therefore, other unidentified areas within the Chakachatna and McArthur system may be utilized for spawning during such runs.

As stated above, pink salmon generally spawned in the lower sections of streams. Since pinks were spawning concurrently with sockeye on many streams, there may have been some interaction between the species which influenced pink salmon distribution.

Pinks were observed spawning on substrates ranging from small gravel to a cobble-gravel combination. The majority of observations were made on substrates containing small gravel. Fines (sand and silt) in spawning areas varied between 10 and 80 percent and were often mixed in the gravel to a depth of 0.3 meters (1 ft) or more. Pink salmon were observed spawning in areas where:

- o Mean water column velocities ranged from 0.06 to 1.07 m/sec (0.2 and 3.5 ft/sec). The observation at 1.07 m/sec was the only datum found in excess of 0.46 m/sec (1.5 ft/sec). Most (86.7 percent) of observed pink salmon spawning occurred at velocities under 0.3 m/sec (1 ft/sec).

- o Depths of water used varied between 0.21 to 0.67 m (0.7 to 2.2 ft). In larger streams such as in 13U, 13X and the McArthur Canyon area, pinks were found mainly near the stream edges and near cover. These are generally habitats with low velocities and may explain the apparent preference of pinks for these areas.

- o Dissolved oxygen levels were between 10.6 and 13.3 mg/l.

- o Turbidity levels were measured between 1 and 9 mg/l.

- o Temperatures at which most pinks were observed spawning varied between 9.0° and 14.2°C.

Recorded temperatures at station 15 in the McArthur Canyon measured by a thermograph from August 20 to September 18 (See Section 6.8.3.2.4) showed considerable diel variation. Temperatures reached as low as

1.8°C during the period pinks were spawning in the McArthur drainage. The mean temperatures during the August 20 to September 18 period did not exceed 3.5°C (Table 6.30). This temperature is well below the spawning, migration, and lower threshold hatching temperatures for pinks (Bell, 1980).

Chum Salmon. Chum salmon were first observed in the Chakachatna River system on August 25 at station 17; in the McArthur River system on September 1 in Stream 13U. On the latter date, chum were found in the Chakachatna Canyon sloughs, station 17, and Stream 13U. Peak numbers of live fish were found in most streams in mid-September, but in some, the numbers peaked on September 1 (Stream 13U) and in others as late as October 9 (Straight Creek mouth area sloughs).

Chum, as compared to other salmon species, were generally found in relatively few streams and in limited numbers. Spawning chum were found in the Chakachatna Canyon sloughs, Tributary C1, Straight Creek mouth sloughs, station 17, McArthur Canyon, and Streams 13U, 12.1 and 12.4. (Figure 6.83).

Few chum salmon were collected migrating upstream during August and September. Those collected had migrated through the Noaukta slough, into the Chakachatna River, and up to sloughs at station 17 and the Straight Creek mouth area (Figure 6.83).

The lack of chum migrants captured in the Middle River during periods when fish were being caught on the lower McArthur indicates that many of the fish found in the Chakachatna and McArthur systems had entered via the McArthur River. This finding must be considered preliminary due to the overall low numbers of chum collected.

Heavy rains during mid-September made counting fish in certain streams difficult, particularly Streams 13X and 19, causing some underestimation of the number of chum salmon. The high turbidities caused by the associated run-off may also have deterred chum from using these and other streams. Hale (1981) indicated that chum salmon may not enter streams when suspended sediment loads are high, as was the case in mid-September, 1982.

Plots of numbers of live fish versus consecutive days for spawning adults are depicted in Figures 6.84 through 6.90. Those streams that contained few chum were not plotted. Escapement estimates of chum salmon were made (Table 6.46) using an estimated stream life of 10 days (Table 6.32). The greatest estimated escapement of spawning adults (1482 fish) was observed in the sloughs at station 17. This accounted for 77 percent of the observed chum spawning in the Chakachatna River system. Observed chum spawning in the McArthur River system was low and represented less than two percent of that estimated for the Chakachatna River.

All observed chum spawning occurred in clearwater tributaries, sloughs, or in side channel areas directly receiving slough or upwelling flow. In side channels where spawning chum were observed, more chum spawned in areas receiving direct discharge from sloughs.

Chum salmon utilized spawning substrates ranging from small gravel to gravel-cobble combinations. In all cases, the amount of surficial fines in these spawning areas was estimated to be less than 45 percent of the substrate. Chum spawning areas were characterized by:

- o Mean water column velocities less than 0.15 m/sec (0.5 ft/sec). At over 90 percent of slough spawning areas examined, velocities were less than 0.03 m/sec (.1 ft/s).

- o Water depths ranging from 0.15 m to 0.5 m (0.5 and 1.6 ft).

- o Dissolved oxygen levels ranging from 10.1 to 11.7 mg/l.

- o Turbidities ranging from 9 to 15 mg/l.

Coho Salmon. Adult coho salmon were first observed in the McArthur River system on August 19, when fish in varying states of reproductive maturation were observed milling at the mouth of Stream 13U and in the mouth area common to Streams 13X and 12.1 through 12.3 (Figures 6.91, 6.92). Many coho were found in spawning streams on September 1, when they were counted on Streams 19 and 13X in greater numbers. During September, coho moved into and spawned in Streams 19, 13X, 13U, 12.1, 12.2, 12.3, 12.4, 12.5, McArthur Canyon, Chakachatna Canyon sloughs, Tributary C1, the Straight Creek mouth area sloughs, and sloughs at station 17. These spawning areas are shown in Figure 6.93. During escapement surveys in September, additional coho milling areas were identified in both the Chakachatna and McArthur systems.

Milling areas were identified in the Chakachatna Canyon (Figure 6.94), station 17 slough area (Figure 6.95) and the McArthur Canyon (Figure 6.96).

Migration routes from the lower McArthur and the Middle River were identified from tagging studies (Figure 6.97). Fish entering the lower McArthur River migrated up the McArthur system and Chakachatna Rivers to spawning areas. This included movement through the lower Chakachatna River and Noaukta Slough. Fish entering the Middle River were observed to migrate to spawning areas on the Chakachatna system only.

Escapement estimates were calculated using an estimated stream life of 10 days (Table 6.32). Numbers of live fish observed versus consecutive days are presented in Figures 6.98 through 6.109. Estimated escapements for coho are shown in Table 6.47. Limited visibility because of a mid-September storm may have resulted in under-estimation of coho in Streams 19 and 13X.

The greatest number of coho estimated in the Chakachatna River system were in sloughs at station 17. These 1560 coho constituted 60 percent of the estimated escapement in the Chakachatna system. Coho escapement in sloughs in the Chakachatna Canyon, 608 fish, represented 23 percent of the estimated escapement in the Chakachatna system.

The greatest estimated escapement of coho in either system occurred in Stream 12.1. These 2,000 coho were 42 percent of the estimated coho escapement on the McArthur system. Streams 13X and McArthur Canyon also contained large numbers of spawning adults, comprising 35 percent and 25 percent, respectively, of estimated coho escapement on the McArthur system.

Coho were observed spawning in tributary streams, side channels, and sloughs. Spawning adults were widely distributed on spawning streams.

Coho spawning areas were characterized by substrates consisting of small to large gravel, in combination with larger gravel or cobble. Most spawning sites were observed to contain small gravel. Fines were estimated to be less than 45 percent of the surficial substrate. Other spawning characteristics included:

- o Water column velocities in sloughs and side channels near station 17 were 0.03 m/sec (0.1 ft/sec) or less.

- o Water depths ranging from 0.15 and 0.49 m (0.5 and 1.6 ft).

- o Dissolved oxygen levels of 10.2 to 11.7 mg/l.

- o Turbidities were between 9 and 15 mg/l.

Dolly Varden. Dolly Varden in the Chakachatna and McArthur River systems probably include both resident and anadromous fish. Adult Dolly Varden were observed in many streams during aerial surveys in July. They were observed milling in Stream 13X on July 17 and in the Chilligan River on July 31. Dolly Varden were observed on every stream surveyed, including several which did not contain salmon, including the Neacola River, the Nagishlamina River, and the Another River. Regarding these rivers, spawning of Dolly Varden was observed only in the Another River. Dolly Varden continued to enter the system well into mid-October, when tagged fish were traced moving upstream. At that same time other Dolly Varden were recaptured having moved downstream.

The movements of Dolly Varden were complex, fish were recaptured having moved between both river systems going in both directions. Fish which had apparently entered fresh water in the Middle River (station 4) and were tagged there, moved into the McArthur River and spawned in Stream 12.1 At least one of the fish which spawned on that Stream (12.1) had moved up the Chakachatna River (station 6) after entering fresh water. Figure 6.110 summarizes some of the movements of Dolly Varden observed during 1982.

Dolly Varden spawning areas identified during 1982 are shown in Figure 6.111. Dolly Varden spawning areas were more widespread than most other species studied. Spawning Dolly Varden were found in the Igitna and Chilligan Rivers, the Chakachatna Canyon sloughs, Tributary C1, Stream 19, the McArthur Canyon, Streams 13X, 13U, 12.1, 12.2, 12.3, 12.4, and 12.5. In addition, spawning Dolly Varden were found on the Another River and at station 20. The mouth area at Straight Creek and station 17 were the only areas utilized for spawning by another species (sockeye) in which spawning Dolly Varden were not observed. Data collected during Spring 1982 indicated that Dolly Varden had also spawned in the sloughs at station 17 during 1981.

Dolly Varden were observed to spawn in a variety of areas over a wide variety of substrates. Spawning areas included streams, sloughs and side channels. Substrates in Dolly Varden spawning areas varied considerably. Dolly Varden were observed to spawn over substrates ranging from small gravel to large cobble.

<u>Bering Cisco</u>. Sexually mature Bering cisco (<u>Coregonus lauretta</u>e) were collected during fall 1982. This was the first reported collection of this species in the McArthur River system. Both adult and juvenile Bering

cisco were collected in the lower McArthur River (station 1D) during September and October 1982. No cisco were found to enter the Middle River nor to migrate up the lower Chakachatna River. Bering cisco were collected as far upstream on the McArthur River as station 11, and none were collected in Noaukta Slough. Spawning areas of Bering cisco were not identified, but spawning probably occurs in tributaries of the McArthur River. Two cisco collected were observed to have injuries in the dorsal area similar to those normally associated with a lost anchor tag. Since cisco had not been tagged in this study prior to these captures, it was hypothesized that these fish may have been tagged in the Susitna River.

Longfin Smelt. Sexually mature longfin smelt (*Spirinchus thaleichthys*) were first collected in the McArthur River during October of the survey. They were collected only at station 1D in the lower McArthur River, and the catch increased during the latter half of October. Spawning areas were not identified, although this species probably spawns in the McArthur drainage. Morrow (1980) state that little is known about this species, but that spawning occurs between October and December.

Rainbow Smelt. One rainbow smelt (*Osmerus mordax*) was collected during October 1982 at station 1D. This was the only rainbow smelt collected in either the McArthur or Chakachatna Rivers. Since this is a spring spawning species (Morrow, 1980) its entry into freshwater may have been inadvertent.

Eulachon. Eulachon were first reported in the McArthur River system during the June 8 - 11, 1982 reconnaissance study (Section 6.8.3.1.4). Eulachon were abundant in the lower McArthur River at that time. Eulachon were observed to spawn in the McArthur mainstem from the mouth of the river to approximately 2 miles downstream of the Noaukta Slough (Figure 6.112). The substrate in that area was sand. The duration of spawning is unknown, but it began prior to May 27 and was finished prior to June 24. The lower Chakachatna and Middle Rivers were investigated during June 8-11, but no eulachon were found.

During the 1982 fall surveys, ripe eulachon were again observed entering the McArthur River (station 1D). These fish were first collected during late September and continued to be collected in October. No eulachon were collected during fall surveys in the Middle or Chakachatna Rivers, although one fish was collected at station 9 in the Noaukta slough. Reports of fall spawning eulachon, which normally spawn in the spring, were not found in the literature.

6.8.3.2.2 Resident and Juvenile Anadromous Fish

Seasonal distribution and habitat studies conducted during the period of August through October, 1982, emphasized the collection of data on resident and juvenile anadromous fish. In the following sections results are reported for:

- Fyke nets - emphasizing adult and older juvenile fish, and
- Minnow traps and other supplemental sampling methodologies - emphasizing smaller juvenile fish.

<u>Fyke Net Sampling</u>. Fyke nets were set in four sampling areas (Figure 6.30):

- the McArthur River (stations 1D and 11)
- Noaukta Slough (station 9)
- the Chakachatna River (stations 3 and 6)
- the Middle River (station 4)

These nets collected a total of 15 fish species during August through October 1982 (Table 6.48). Species composition was dominated by Dolly Varden in all months, and Dolly Varden, coho salmon, and rainbow trout together comprised 91 percent of all fish collected by the fyke nets (and at net 6, Table 6.49). The overall species composition remained relatively unchanged for all three months (Wilcoxon's test, p greater than 0.3).

Although the percentage composition did not change significantly, the c/f and total numbers did (Table 6.50, and Appendix A4, Tables 4-6, respectively). The majority of fish caught at most nets were juveniles (Table 6.51).

More species were collected in the McArthur River and Chakachatna River (13 and 11 species, respectively) than in Noaukta Slough (9 species) or the Middle River (9 species), but this may be an artifact of greater sampling effort in these rivers (Table 6.52). Bering cisco, longfin smelt, and rainbow smelt were collected only in the McArthur River, and eulachon were most abundant in the McArthur River.

<u>Dolly Varden</u> - From August through October the c/f of Dolly Varden increased significantly (p less than or equal to 0.05) for all nets combined (Table 6.50).

Examination of data for net 6, which was the only net in place throughout all three months, indicated that juvenile Dolly Varden comprised an increasing percentage of the total catch with each succeeding month (Table 6.53). Catch per effort among the various reaches (Table 6.54) did not differ significantly (p greater than .15) during the three-month period.

Length-frequency data indicated that several age groups of Dolly Varden were present during August through October (Figure 6.113); the modal length distribution was similar for each month (Figures 6.114-6.116). The bulk of the fyke net collection was comprised of fish greater than 15.5 cm (6.1 in) total length, which corresponds approximately to the length for age II+ to age V+ fish.

Mark - recapture data indicated that Dolly Varden moved both upstream and downstream during the survey period, however, the majority of adult Dolly Varden moved upstream. For example, Table 6.55 shows the results for 224 of the Dolly Varden and rainbow trout recaptures. Ten out of 14 recaptured Dolly Varden tagged at station 1 were recaptured upstream at stations 3, 6, 9 or 11 (Figure 6.30). Twelve Dolly Varden marked at stations 3, 4, and 6, had moved downstream to station 1. Analysis of the tag-recapture data indicated that almost every possible route between fyke net stations was utilized and no preferred routes were detected. It appears that Dolly Varden move throughout the system in a highly dispersive manner. Based on the Dolly Varden tagged at stations 6 and 4 (in the Chakachatna and Middle Rivers, respectively), and recovered in a spawning tributary of the McArthur, it appears that Dolly Varden do not need to enter the system in an area which receives flow from the stream in which they spawn.

During October, tag recaptures of large juveniles denoted a definite upstream movement. Transit times were one day between tagging at station 4 and recapture at station 6, and three days between tagging at station 6 and recapture at station 11. The movement data indicated it is unlikely that Dolly Varden have separate populations in each river system. An inference that can be drawn from the mark-recapture data and the trend of change in c/f is that sexually mature Dolly Varden migrated into the system to spawn. Tagged fish were both observed and recaptured on spawning grounds, such as Stream 12.1.

In October, there was an influx of large juvenile Dolly Varden, many of these appeared to be moving upstream, and recapture data supported this. The inference drawn from this is that they were probably moving from rearing areas to overwintering areas.

Rainbow Trout - From August through October the c/f of rainbow trout increased significantly (p less than 0.01) each month (Table 6.50). A similar increase in c/f was also observed at net 6.

Examination of data from net 6 indicated a significant increase (p less than or equal to 0.05) in juvenile rainbow trout during October. Age-length data for rainbow trout from the Susitna River (ADF&G 1981c), when compared with data from the Chakatchatna River, indicated that the rainbow trout in the size range collected by fyke nets probably included age I+ to age VII+ (Figure 6.117). This assumed growth rates in the two study areas were similar.

Mark-recapture data indicated that rainbow trout moved both upstream and downstream during August (Table

6.55). Rainbow trout were also observed to have moved between the McArthur and Chakachatna Rivers. The movement data suggest that rainbow trout do not have separate populations in the two rivers.

The pattern of the c/f and tag-recapture data indicate an upstream movement for fish collected during September and October. This probably represents a movement from summer rearing habitat to overwintering areas.

Coho Salmon - From August through October the catch per effort of coho salmon increased significantly (as determined by ANOVA, p less than or equal to 0.05) for all nets combined (Table 6.50). A significant increase in c/f (p less than or equal to 0.05) was also observed at station 6 in October. The data indicated that a significant increase (p less than 0.05) in juvenile (including parr) coho salmon occurred during these months (Table 6.53). These made up over 97 percent of the coho caught at net 6 in October. The greatest c/f of coho for all nets for all three months combined was in the Chakachatna River (Table 6.54), however this was not significantly different from other locations.

Length frequency data for coho salmon indicated that age I - II+ coho parr predominated in the fyke net collection (Figure 6.118).

The large increase in juvenile coho salmon c/f in the lower river system suggested a movement to overwintering habitat and/or outmigration. The presence of smolts and smolting parr among the fish collected indicate that at least some of the fish were migrating to sea. Data on downstream migrants from the Susitna River contain evidence of possible outmigrations of coho during the same period (ADF&G, 1982e).

Minnow Traps and Supplementary Collection Methods. The objectives of this program were to:

- o Examine the relative distribution of juvenile fish; and

- o Collect data on juvenile fish habitat preferences.

Dolly Varden - During August, Dolly Varden were widely dispersed and were found throughout most areas of the Chakachatna and McArthur Rivers and their tributaries (Tables 6.56 through 6.58). Rearing of juveniles occurred generally throughout these widely distributed sites and diverse habitats. As water levels and water temperatures dropped in the fall and ice formation started in early October, there appeared to be widespread and significant changes in the relative abundance of juvenile Dolly Varden at sample stations, primarily associated with a migration to overwintering habitat. Potential overwintering habitats that were identified included the upper McArthur River and the Noaukta Slough. A detailed presentation of the results follows.

During August, Dolly Varden juveniles (parr and juveniles) were widespread among the various minnow trap stations (Tables 6.59 - 6.61); including supplemental sampling conducted by electrofishing, juveniles were collected at 95 percent of the river locations sampled (Table 6.62). The minnow trap c/f data summarized by river reach (Table 6.63) indicated relatively high c/f's in the various reaches. The c/f was significantly greater (p less than 0.05) in the Chakachatna River tributaries than in other reaches. These data were indicative of well-dispersed rearing areas throughout both rivers during the summer. High c/f in the tributaries (5.60 fish/trap/day, f/d) was probably due to juvenile Dolly Varden rearing in their natal streams (see Section 6.8.3.2 for Dolly Varden spawning locations).

During September, minnow trap c/f's in most reaches had decreased (Table 6.63), but c/f in the upper McArthur River reach had significantly increased (p less than 0.05) from 1.5 to 3.25 f/d. A decrease in c/f of near significant level (p=0.08) had occurred in the lower Chakachatna River for these juveniles, 3.05 to 0.63 f/d. Catch per effort for larger juveniles, in this reach, as indicated by fyke net collections (see above) had increased during September. This may have been indicative of differences in habitat utilization or movements toward different overwintering habitat by the different sized fish.

The general trend of decreased c/f in most reaches continued during October (Table 6.63). Catch per effort was significantly lower (p=0.06) in the Chakachatna tributaries, 0.13 f/d in October as compared with 2.63 f/d in September, indicating that juvenile Dolly Varden had probably migrated from their natal streams to overwintering habitat. Winter 1982 studies (Section 6.8.3.1) indicated little or no over-wintering habitat present in Straight Creek. Increased c/f was found again in the upper McArthur River (Table 6.63). The c/f's (6.00 and 6.25 f/d; Table 6.61) at the McArthur River Canyon stations were significantly greater (p less than or equal to 0.05) than at any other stations.

Observations of slough and channel habitats in the upper McArthur River (primarily at stations 14 and 15) confirmed that large numbers of juveniles had moved into these areas. Adult Dolly Varden were observed spawning in many of these areas and juveniles were often observed "holding" at the edges of redds. Some of these channels were the same ones that were observed to have been open during March 1982. It was hypothesized that some of these fish may have moved to their overwintering habitat.

Increased c/f was also observed in the Noaukta Slough (Table 6.63) during October, from 1.08 in September to 2.00 f/d. The c/f of Dolly Varden at station 8 (4.25 f/d) in the slough was significantly (p less than 0.06) greater than stations other than those in the McArthur Canyon. Visual observations at this station confirmed the continued presence of clearwater flow, and juvenile Dolly Varden were observed near cover in this area. During March studies, water depths of over 0.4m (1.3 ft.) or more were found under the ice in the slough. These data also indicated a probable migration to overwintering habitat.

Evidence of possible upstream movements could be inferred from an analysis of juvenile Dolly Varden length data. During August through October, the mean length of juvenile Dolly Varden collected by minnow traps in the upper McArthur reach varied but showed no significant changes. However, during the same period the mean length of fish collected in the lower McArthur and Chakachatna Rivers declined sharply, from 11.93 to 9.37 cm (4.7 to 3.7 in) and 11.76 to 9.20 cm (4.6 to 3.6 in), respectively. This indicates a trend of some of the older parr leaving the lower sections of the two rivers and either outmigrating or moving into upstream areas. Increases in mean length of juvenile Dolly Varden observed in collections from the Upper Chakachatna reach (11.95 cm or 4.7 in. in August to

13.1 cm or 5.2 in. in October) and the mid-Chakachatna reach (9.35 cm or 3.7 in. in September to 11.64 cm or 4.6 in. in October) suggests that some of the older parr moved upstream. These observations do not appear to result from gear selectivity since seine collections in the lower river systems indicated an absence of the indicated size ranges of Dolly Varden. When compared to catches made by fyke nets of larger juveniles, fish of the size range 11 - 13 cm (4.3 - 5.1 in.) were largely absent. At the same time, older fish, probably age III+, IV+ and older were collected in the lower system and moved upstream, based on the results of fyke net collections and mark-recapture.

Figure 6.119 is the length-frequency histogram for all minnow trap collections of Dolly Varden during summer-fall 1982. The figure does not show the typical modal peaks associated with specific length intervals which are normally used to differentiate between age classes. Instead, there is a great deal of overlap with one distinct peak near 10 cm (3.9 in.). This mode corresponds to fish of approximately age I+. Analysis of scales of Dolly Varden collected during September 1981 indicated age 0+ fish were between approximately 5 and 9 cm (2.0 and 3.5 in.) in length with a mode of approximately 6 - 7 cm (2.4 - 2.8 in.). A Dolly Varden growth rate reported in the literature is approximately 1.0 - 3.0 cm (0.4 - 1.2 in.) per season (Krueger, 1981b). This indicates that age I+ fish could be expected to be in the length range of 6 to 12 cm (2.4 to 4.7 in.). Analysis of scales of several fish in this length range resulted in estimated ages of age 0+ to age II+, indicating length overlap between age classes. Age III+ was the oldest fish collected from minnow traps; the fish was 15.4 cm in length.

Length-frequency data were also examined by month. This provided greater resolution and reduced some apparent length overlap caused by growth over the three month period. Figure 6.120 is the length- frequency histogram for Dolly Varden caught in August. It contains what could be interpreted as four modal groups, but these do not appear to correspond well with fish age. These groups are not well separated and do not appear distinct in the succeeding two months, (Figures 6.121 and 6.122). Due to the overlap in length between age groups, growth rate could not be estimated from length.

Coho Salmon - Juvenile coho salmon was the second commonest salmonid collected in the Chakachatna and McArthur River Systems. Coho were widely dispersed and found in all river reaches below the Chakachatna River Canyon. During August, juvenile coho were most abundant in coho salmon spawning areas (Section 6.8.3.2.1). Rearing appeared to take place in these areas and portions of the Noaukta Slough, lower Chakachatna and Middle Rivers in the summer. During September and October, as the onset of winter occurred, juvenile coho were found in widely distributed areas, but changes in abundance indicated some movement from summer rearing areas to overwintering sites in the upper McArthur River and Noaukta Slough. Both areas were identified as containing suitable overwintering habitat, and juvenile coho were found in the upper McArthur River during the winter of 1982 (Section 6.8.3.1).

Larger juvenile coho during September and October appeared to move into the lower McArthur River; this may have been part of a migration to sea. Concurrent fyke net collections indicated that some coho salmon smolt were migrating to sea at the same time. A detailed presentation of results follows.

As noted above, juvenile coho salmon was the second most abundant juvenile salmonid group collected in the study streams (Table 6.64). During August, minnow trap data indicated that coho were only found in the upper McArthur River (station 13) and the Straight Creek clearwater tributary (station 19) (Table 6.65). Coho were significantly (p less than 0.01) more abundant in the clearwater tributary to Straight Creek (station 19) than other locations. This was probably the natal stream for these coho.

Examination of electrofishing and seine collections for the presence of juvenile coho at other locations showed that coho were found at many more locations than indicated by minnow traps alone (Table 6.66 through 6.68). During August, juvenile coho salmon were found at 60 percent of all locations sampled (Table 6.62) and in all river reaches below the upper Chakachatna River (Table 6.69). Coho salmon spawn at sloughs near station 22 (Figure 6.30) at the downstream end of the Chakachatna River Canyon (see Section 6.8.3.2.1); however, the sloughs discharge downstream of all collection stations in the upper reach.

Catch per effort data derived from electrofishing and seining indicated that juvenile coho were relatively more abundant as well as more widely dispersed than would be expected from minnow trapping data alone (Appendix A5).

During September, minnow trapping data indicated that coho juveniles were found in all reaches below the upper Chakachatna River reach. The data indicated that c/f had increased in the Noaukta Slough (0.00 to 0.28 f/d), lower Chakachatna River (0.00 to 0.52 f/d), and lower McArthur River (0.00 to 1.42 f/d), but not significantly (p greater than 0.35). Catch per effort had decreased in the tributaries (2.70 to 1.75 f/d) and the upper McArthur River (0.25 to 0.08 f/d) but not significantly, p greater than 0.4). The c/f's in the tributaries and in the lower McArthur River were significantly greater (p less than 0.01) than at all other stations.

The percentage incidence at all sampling locations including electrofishing and seining collections also declined during September (from 60.0 to 46.2 percent, Table 6.62).

During October, c/f in the tributaries continued to decline (1.75 to 0.38 f/d), and c/f in the lower McArthur continued to increase (1.42 to 2.25 f/d) at the Chakachatna confluence with the McArthur River, station 1. During the same period, c/f had also increased in the upper McArthur River (0.08 to 1.00 f/d) and in the Noaukta Slough (0.24 to 1.30 f/d).

Due to high variability (mean squares error), the power of the multiple contrasts test was unable to detect any statistically significant differences between individual stations on reaches. The data indicated a possible trend of coho migration to overwintering habitat in the upper McArthur River and Noaukta Slough.

The coho juveniles collected by minnow trapping in the lower portions of the rivers in October were larger than those collected in September (approximately 9.3 versus 6.8 cm). Coho juveniles caught by lower river fyke nets were only slightly larger in October than

September but were collected at higher c/f's during October. As discussed above, coho were smolting, and some outmigration was taking place.

The outmigration of larger juvenile coho from the lower rivers may explain the increased c/f in those areas also derived from minnow trap data.

Analyses of scales taken from fish collected during 1981 indicated that three age classes were present: ages 0+, I+, and II+. There was considerable overlap in lengths of these fish. Data from the Susitna River (ADF&G, 1982b) also indicated that the lengths of juvenile coho of different age classes may overlap.

Figure 6.123 contains the length-frequency of coho juveniles collected by minnow traps in the Chakachatna and McArthur Rivers during 1982. The distribution is fairly continuous with a mode of approximately 7 cm. (2.8 in.). This mode corresponds to age 0+ fish and was similar to results obtained from the Susitna studies (ADF&G, 1982b). Coho lengths from the Chakachatna and McArthur Rivers were plotted by month to aid in interpretation (Figures 6.124, 6.125, and 6.126). In each plot, the majority of fish appeared to be age 0+, and there appeared to be one or more additional (larger) age classes present. Examination of the fyke net length-frequency plot (Figure 6.118) showed that many of these larger coho were present which the minnow traps were not adequately sampling. Similarly, the fyke net collections did not adequately sample age 0+ fish.

<u>Chinook Salmon</u> - Few juvenile chinook salmon were collected during the summer and fall of 1982. Most juvenile chinook were collected in Straight Creek and

its clearwater tributary, which had been identified as a major chinook salmon spawning area. Much of the rearing activity identified in 1982 was therefore associated with natal streams. A detailed presentation of the results follows.

Chinook salmon juveniles were collected by minnow traps only in the Chakachatna River tributaries, stations 18 and 19 (Table 6.70). Chinook salmon had been observed spawning in the clearwater tributary to Straight Creek (station 19) during 1981 and 1982 (Sections 6.3, 6.8.3.2.1) which flows into Straight Creek (station 18). Juvenile chinook salmon have been collected in that stream in both years.

During August, juvenile chinook salmon were collected at three of the sampling stations (Table 6.66), or 15.0 percent of all locations (Table 6.62), but only in the lower McArthur River and the tributary stream reaches (Table 6.69).

In September, juvenile chinook salmon were again collected at three stations. However, at that time, juvenile chinook salmon were found in the Noaukta Slough and the tributary stream reach. In the Chakachatna River tributary stream reach, chinook were only collected in Straight Creek. This may have been due to the juvenile chinook salmon having been washed out of Stream 19 by the high flows which occurred in September, or by a downstream migration.

During October, juvenile chinook were again collected at three stations (Table 6.68). These were located in the lower Chakachatna River, the lower McArthur River, and in the Chakachatna River tributary streams.

Insufficient numbers of juvenile chinook were collected during the summer and fall of 1982 to draw any detailed conclusions about habitat use and distribution, other than a major amount of juvenile rearing activity appears to be associated with the natal streams.

Sockeye Salmon - The distribution and relative abundance of juvenile sockeye salmon during the August through October study period suggested that the juvenile sockeye collected were downstream migrants and were not rearing in areas of the middle and lower river reaches sampled. The presence of sockeye smolts and parr undergoing smoltification among the juvenile sockeye collected in the lower Chakachatna and McArthur Rivers also suggested that outmigration of juvenile sockeye was taking place into October.

Juvenile sockeye were infrequently collected by minnow trapping (Table 6.71). During August, no juvenile sockeye salmon were collected by minnow trapping, but collections were made at 30 percent of the sampling locations (Table 6.62) utilizing other sampling gear. Juvenile sockeye were collected in the upper Chakachatna River, the mid-Chakachatna River reach, the lower Chakachatna River, and the lower McArthur River. Sockeye collected during August in the above areas included parr undergoing smoltification. An indication of the movement of sockeye was observed over several days at station 17, where the numbers of juvenile sockeye increased for several days until a large school was present, and then all of the juvenile sockeye left the station within one day.

In September, juvenile sockeye were collected by minnow traps at three stations representing the mid-Chakachatna

River reaches, the Noaukta Slough, and the lower McArthur River (Table 6.71). Other sampling methods resulted in the collection of juvenile sockeye at four additional stations (Table 6.68), a total of 26.9 percent of the stations sampled. Sockeye were collected in the lower Chakachatna River in addition to the other reaches (Table 6.69). Juvenile sockeye collected during September included fish undergoing smoltification.

During October, juvenile sockeye salmon were collected at six stations by minnow trapping (Table 6.71) and were collected in 34.6 percent of all sampling locations including the upper Chakachatna River (Table 6.62).

Data from minnow trap collections and seining indicated that juvenile sockeye abundance had increased during October in the lower Chakachatna and McArthur Rivers. As in September, juvenile sockeye collected during October included both smolt and parr undergoing smoltification.

Overall, the juvenile sockeye collected downstream of Chakachamna Lake during the summer and fall of 1982 appeared to have been downstream migrants; few juvenile sockeye were found consistantly in areas other than lower parts of the river systems during September and October.

Rainbow Trout - Juvenile rainbow trout were collected primarily in the lower portions of the Chakachatna and McArthur Rivers and in the Noaukta Slough. Older juveniles dominated the collections, and age 0+ rainbow trout were infrequently collected. Those age 0+ fish collected during the August through October study period were primarily captured in the clearwater tributary to Straight Creek (station 19).

The data suggested that older juvenile rainbow trout utilized widely dispersed rearing areas in the lower river systems and Noaukta Slough, while younger juveniles may have utilized streams or other rearing areas not as intensively sampled.

Few juvenile rainbow trout were collected by minnow traps (Tables 6.56 - 6.58). During August, one rainbow trout parr was collected at station 19 (clearwater tributary to Straight Creek); other juvenile rainbow trout were collected in that same location and in the upper McArthur River (Table 6.66). All other juvenile rainbow trout collected during August were collected by fyke nets in the lower Chakachatna River (Section 6.8.5.2). Juvenile rainbow trout were collected at 15.0 percent of sampling locations (Table 6.62).

During September (Table 6.67), juvenile rainbow trout were collected at 23.1 percent of the locations sampled. This included four river reaches including the mid- and lower-Chakachatna River reaches, the Noaukta Slough, and the lower McArthur River. These collections consisted of an individual rainbow trout parr collected at station 3 and older juveniles collected at the other stations.

During October, no juvenile rainbow trout were collected by minnow trapping. Juvenile rainbow trout in October were again found at 23.1 percent of the sampling locations (Table 6.62). This included the Noaukta Slough, the lower Chakachatna, and lower McArthur

Rivers. All juvenile rainbow trout collected during during October were older juveniles over 10 cm (4 in.) in length.

A length-frequency histogram was prepared for juvenile rainbow trout collected by minnow trapping (Figure 6.127). Those that were collected were all age 0+, with a mean length of 7.6 cm (3.0 in.).

Pygmy Whitefish - Pygmy whitefish were widely distributed in the Chakachatna and McArthur River systems during August through October 1982. The data suggested that rearing occurred in areas throughout the system below the Chakachatna River Canyon.

Pygmy whitefish dispersed to more sampling locations during the period of study and apparently migrated out of the upper McArthur River during October, suggesting that pygmy whitefish overwinter in different areas than other species studied.

The small size, difficulty in differentiating larger juveniles from adults, and the apparent use of similar habitats by juveniles and adult pygmy whitefish (based upon 1981 observations), makes it logical to discuss data collected on all life stages of pygmy whitefish together. Pygmy whitefish were collected in 30.0 percent of the locations sampled during August (Table 6.62). These locations included all reaches below the upper Chakachatna River (Table 6.69). Minnow trapping was completely ineffective in collecting pygmy whitefish during August (Table 6.72).

During September, pygmy whitefish were collected at three stations by minnow trapping, and overall they were collected at more sampling locations (38.5

percent) than in August (30.0 percent, Table 6.62). Although overall, the pygmy whitefish were collected in more locations, the locations were located in fewer reaches of the river systems than during August. Pygmy whitefish were collected in the Noaukta Slough, lower Chakachatna River, and upper and lower McArthur River (Table 6.69).

In October, pygmy whitefish appeared to be more dispersed than in previous months and were collected at 46.2 percent of the sampling locations. Pygmy whitefish were collected at six sampling stations by minnow trapping; these were primarily located in the lower Chakachatna River. Pygmy whitefish were collected (by all collecting methods) in river reaches below the upper McArthur and upper Chakachatna Rivers.

A length-frequency histogram was prepared for pygmy whitefish collected by minnow traps (Figure 6.128). Three length groups were represented, including smaller juveniles with a length of approximately 6.5 cm (2.6 in.), older juveniles with a length of approximately 10.5 cm (4.1 in.), and one adult (gravid female) with a length of 12.8 cm (5.0 in.). The lengths of these fish covered the same range as the majority of pygmy whitefish collected by fyke nets (Figure 6.129).

6.8.3.2.3 Chakachamna Lake Sampling

Chakachamna Lake was sampled during August and September 1982. A sampling trip scheduled for October was cancelled due to high winds which made the lake inaccessible.

August 1982 Field Program. August studies consisted of collecting fish and an investigation of possible shoreline spawning by sockeye salmon. Fish were sampled by means of minnow traps, gill nets, seines, and electroshocking. Sampling was conducted at stations 27 and 28 (Figure 6.30). Station 27 was identified during the 1981 studies as a potential sockeye spawning area and was one of the few areas with suitable spawning substrate in the lake (Section 6.3). Experimental gill nets were set at stations 27 and 28 (Appendix A4) (see Section 6.8.2 Methodology). The set on August 19 was of less than 30 minutes duration at station 27. Large numbers of adult sockeye were caught. Netting efforts were greatly reduced due to the likelihood of killing large numbers of salmon.

The adult sockeye collected were in varying stages of maturation ranging from maturing to fully mature (see Section 6.8.2). This was also true at station 28, which was located at a steep drop-off on the south side of the lake and contained no suitable spawning substrate.

Of the 11 adult sockeye collected on August 18 at station 27, only one was recaptured on August 19 (all were tagged). The fish that was recaptured was not sexually mature at the time of collection. Electroshocking throughout the area resulted in stunned adult sockeye salmon floating to the surface. None of the sockeye had been tagged. The combination of sockeye being present in varying stages of sexual maturity and the failure to recapture mature fish led to the conclusion that spawning was probably not occurring in the area at the time of sampling and that the fish observed were milling fish.

On August 25 and September 9 the station was revisited and observed. No signs of spawning activity were evident on either occasion. In addition, six of the fish tagged at station 27 were positively identified as spawning in the Chilligan River and one in the Igitna River. This strongly suggested that those lake shore areas were used for milling by sockeye but not for spawning.

Observations of other areas in the lake including along steep drop-off's showed sockeye breaking the surface in these areas. It confirmed that extensive milling activing was taking place throughout the lakeshore area.

Minnow traps set at stations 27 and 28 (Appendix A4) did not capture any fish. Electrofishing and beach seine sampling resulted in the collection of sockeye, round whitefish, lake trout and slimy sculpins among the sub-adults. Adult round whitefish and lake trout were also collected. Gill net collections included both juvenile and adult round whitefish, Dolly Varden, and juvenile and adult lake trout. All of these species and lifestages were collected during 1981.

A water quality profile was taken in Chakachamna lake at the time of this study. The results of that sampling are given in Table 6.73. At that time, there appeared to be a nominal thermocline, as defined by Birge, near the surface at that time (a plane of maximum temperature change,

where:

$$\frac{\text{change in temperature}}{\text{change in depth}} > 1°C/_{m};$$ (Hutchinson, 1957).

It is likely that the observed temperature change was the result of the effect of insolation, on a calm lake surface during a warm sunny day.

At depths greater than 9.1 meters (30.0 ft) there were large changes in turbidity. These were attributed to the settling within the water column of small silt particles of glacial origin.

<u>September 1982 Field Program</u>. The September lake sampling study was scheduled to begin on September 12 and was to include fish collections, hydroacoustics and water quality sampling. Equipment was mobilized to the lake but personnel had to be evacuated due to extremely inclement weather. High winds and waves prevented sampling until September 19. It was deemed unsafe to deploy trawls under the prevailing lake surface conditions and the near shore area was too turbulent to utilize other sampling gear. The heavy wave activity near shore eventually resulted in damage to the inflatable vessel carrying the hydroacoustic gear, causing an early cessation of sampling.

The hydroacoustic sampling was conducted utilizing a Biosonics model 101 echosounder, a Ross Chart recorder, Sony tapedeck, and a V-Fin mounted 10° transducer. The schematic of this gear is shown in Figure 6.41. A total of three transects were completed in the lake as shown in Figure 6.42. This represents approximately 9.4 kilometers (5.8 miles) of sampling.

The results of the hydroacoustic survey are given in Tables 6.74 through 6.76 for each transect, one through three respectively. The numbers are densities of fish detected.

There were considerable differences in the density and distribution of fish detected between and within the three transects. The greatest densities of fish detected were along transect two. Fish were most abundant near the north shore area at a steep drop-off, and densities were greatest at depths shallower than 24 meters (78.7 ft). Fish were detected to a depth of 42.7 (140.1 ft) meters. At the north end of transect two there were many small targets. This was interpreted as being due to relatively high densities of juvenile fish.

Transect three had the second greatest density of fish detected. Fish densities were greatest at mid-lake and toward the southern half of the lake. Densities at the northern part of the transect were low. This occurred in an area of generally shallower water with a less steep drop-off. Targets were more evenly distributed with respect to depth than at either transect one or two. At this transect, fish were detected to a depth of 49 meters (161 ft).

The overall lowest density of fish was detected at transect one. Along that transect, greatest densities were detected at the south shore of the lake, at depths between 21 and 33 meters (68.9 and 108.3 ft). Fish densities were low at mid-lake as they were along transect two and occurred at similar depths. Fish were detected to a depth of 49 meters (161 ft).

Overall, the amount of data is probably insufficient to estimate the density of fish in the lake. However, the data on distribution shows that the densities of fish were greater near shore and particularly in areas of steep drop-offs. Fish were found at variable depths with greatest densities at depths to 30.5 m (100.0 ft). No fish was detected below a depth of 49 meters (161 ft).

Water quality data were collected at mid-lake between transects one and two. A profile of water quality data was taken to a depth of 91 meters (300 ft), these data are listed in Table 6.77. High winds, heavy rain, and high waves were present for seven days prior to sampling and the lake level had risen more than a foot. This may have had considerable influence on water quality data collected in the upper 1.5 - 3 meters (5 - 10 ft) of water. Dissolved oxygen data was collected to 9.1 meters (30 ft). Samples from 15.2 meters (50.0 ft) and deeper effervesced and showed signs of being gas supersaturated at having been brought to the surface. No reliable dissolved oxygen readings could be taken for these depths during this sampling.

A correlation analysis was performed to relate the water quality data to the fish distributions detected by hydroacoustics. It was determined that the vertical distribution of fish densities along transects three and two were correlated with the measured vertical distribution of turbidity at a statistically significant level (p less than or equal to 0.05, and p less than or equal to 0.01, respectively). This suggests that the relationship is causal, or that vertical distribution of fish and turbidity may be related to another factor which is causal. The vertical distribution of fish along transect two was also significantly (p less than or equal to .01) correlated with conductivity. Transect one was only weakly correlated with turbidity (not significant).

6.8.3.2.4 Habitat Data Collection

Habitat data were collected in conjunction with fish sampling at most sites. Detailed habitat observations and measurements were routinely made with electrofishing and minnow trap collections to aid in establishing a data base for characterizing fish habitat relationships.

Characterizing these relationships is an important part of the process of evaluating the suitability of a habitat for use by a species at a given lifestage. This evaluation process can be conducted at different flows and can therefore be useful in assessing the effect of changes in flow on habitat and the potential impacts of such changes on fish populations.

Habitat data collected included water temperature, dissolved oxygen, conductivity, turbidity, water depth, water velocity, river stage (staff gage reading), substrate, cover and the presence/absence of upwelling or slough flow. Measurements were taken at the same specific locations at which fish sampling was conducted. The methodology employed in collecting habitat data is discussed in Section 6.8.2.

This section summarizes water quality and other data which characterize fish habitats at collecting stations during the time of sampling. The relationships between habitat and fish will be evaluated when the data base is larger.

Substrate and Cover. Substrate and cover are to some extent a function of river stage. Where substrate varies between the river banks and the channel, the depth of water will control the submergence of cover objects and the availability of shoreline habitat. During each sampling, individual site specific substrate and cover characterizations were made. However, for this report, the stations were described according to their general substrate and cover type (Table 6.78). These are the same stations shown in Figure 6.30 and are presented in somewhat more detail than substrate characterizations made during the hydrology studies. The pattern of substrate distribution is essentially the same as that described in Section 6.7, Table 6.31. The data in Table 6.78 more closely reflect near bank habitats that were intensively sampled, than general mid-channel substrates.

Cover is described on Table 6.78. The importance of cover objects is highly dependent on the size, shape and type of cover in relation to the size of the fish and the flow (depth and velocity) at a specific site. For example, only large cover objects can provide habitat for larger fish, but either large or small cover objects can provide habitat for small fish. In general greater diversity of substrate and cover can provide habitat for a greater variety of fish.

Water Quality. Water quality data were collected as described in Section 6.8.2. Data were collected at each specific site at a station at the time fish were sampled. This may not have been representative of that area for the month as a whole. This was evident in September, when the high flow event caused extensive changes in flow and water quality during the latter half of the month. Measurements made before and after this event were quite different.

The water quality data are presented in Tables 6.79 through 6.82 for July through October, respectively.

These tables list the station, the water quality parameters by mean and standard deviation and the number of readings the listing is based upon. It should be remembered that July data were taken during the course of escapement counts and that no actual ground-level field sampling was taking place at that time.

Variation in water quality parameters often occurred more frequently than over the course of a month. Diurnal variations were present as well. As discussed in Section 6.7, large diurnal variations in temperature were recorded at the McArthur River gage site, station 13.5. A Peabody-Ryan temperature recorder was installed at station 15, upstream of the gage (see Section 6.7.2). This area was a channel which had been identified as a salmon spawning area during both 1981 and 1982, and a juvenile rearing area (see Sections 6.3.3.2, 6.8.3). Large variations in temperature were recorded at station 15 (Figure 6.130). Temperature fluctuations as great as 5°C were found. The recorder was removed in mid-September when the channel filled in and the recorder was buried.

Upwelling Flow. Tributaries and upwelling flows were present in many areas. These flows were often associated with salmonid spawning and in several cases with open water during the winter. Clear water tributaries and sloughs with upwelling flow were among the more important spawning areas.

Other sources of inflow included beaver pond overflow or seepage, land drainage (particularly tundra areas), and overflow channels. Since beaver pond seepage and land drainage represent exogenous sources of water that could affect the use of habitat areas, these were identified for each sampling station. Table 6.83 lists each sampling area and the presence of sources of additional inflow, where found.

Several sloughs located in the Chakachatna River were studied to examine slough flow in relation to flow in the river. Sloughs located in the Chakachatna Canyon and at station 17, (along the left and right bank,) were monitored during October. Staff gages were installed and levels were measured regularly. Despite a decline in river level throughout that period, the water level in the sloughs remained constant. At station 17_{LB+2}, a side channel which received slough flow, water levels dropped until the channel no longer received flow from the Chakachatna River. Flow from the upstream slough continued and the water level remained constant afterwards. Water levels in Slough 17_{LB+0} and the Chakachatna Canyon sloughs also remained constant during this period. These observations suggested that the slough flows at these stations were independent of those of the river (see Section 6.7). However, additional data will be needed to confirm these observations.

Channel and Habitat Stability. Channel configurations and physical habitat in the Chakachatna and McArthur Rivers are neither fixed nor stable. Past changes in configurations have been observed (Section 6.2) and considerable changes were observed during the 1982 field season. Changes were observed in channel slope or shape at the following stations - 15, 19, 17, 16, 11, 12, 13.5, 14, and 13. The changes at stations 15, 14, and 17 included direct changes in the amount and location of spawning substrate. This aspect of habitat investigation will need to be continued as part of both the aquatic biology and hydrology programs.

6.8.4 Discussion

Most of the available information on the Chakachatna and McArthur River systems has been collected as part of the 1981-1982 studies. Therefore, inferences drawn about these systems are based primarily upon these data.

Species of commercial, subsistence and sport interest that are present in these river systems, include chinook, sockeye, pink, chum and coho salmon, Dolly Varden and rainbow trout (Section 6.3). Other fish species collected were identified within the preceding sections and include pygmy whitefish, round whitefish, lake trout, slimy sculpin, threespine stickleback, ninespine stickleback, and arctic grayling (apparently of extremely limited distribution).

The contribution of salmon from the Chakachatna and McArthur River systems to the Cook Inlet fishery is unclear and relatively little was known about the species, size, or distributions of these runs until recent times (Section 6.3, ADF&G 1982d). Commercial and subsistence fishing have been conducted in the immediate vicinity of these rivers. Sport fishing for coho salmon was routinely observed on the McArthur River, while sport fishing for Dolly Varden, rainbow trout, and sockeye salmon was observed less frequently in middle reaches of the Chakachatna River. The significance of the contribution of the two river systems to the fishery, however, cannot be determined at this time.

Inferences and conclusions concerning the fishery resources of the river systems were drawn from current knowledge of the systems, information gathered during studies of the Susitna Project (ADF&G, 1982a, 1982b, 1982c, 1982d, 1982e 1982f, 1982g) and the scientific literature. All inferences are necessarily preliminary in nature and will be refined as more information is gathered. This discussion is organized to address the species of commercial, subsistence and sports interest as well as one forage species (pygmy whitefish) emphasizing site-specific data.

6.8.4.1 Sockeye Salmon

Sockeye salmon adults probably enter the Chakachatna and the McArthur Rivers in early July. Sockeye first appeared on the spawning streams on July 22 in 1982. Spawning continued through the first week of October in various parts of the system and few spawning sockeye were present past early October.

Sockeye adults are known to enter fresh water earlier than July in other Cook Inlet drainages. Data from the Susitna River (ADF&G, 1982g) showed that an early run of sockeye had entered fresh water and moved past river mile (RM) 80 (Sunshine Station). Early run sockeye were found on at least one spawning stream (Fish Creek, RM 97.1) by June 24. Sockeye were not found during surveys conducted for early spawners at known spawning areas in the Chakachatna and McArthur Rivers on June 8-10 and June 24-25 1982.

The timing and duration of sockeye runs varied with location. Runs on McArthur River tributaries peaked earlier than most of those on the Chakachatna River. Spawning adults were present in the Chilligan River and sloughs at station 17 longer than at other sites.

Figure 6.131 presents the phenology of major life history events for the salmon species present and is based upon data gathered in both the McArthur and Chakachatna Rivers during 1981 and 1982, as well as other data (as cited).

Sockeye escapements were estimated for all identified spawning areas. Figure 6.132 and Table 6.84 present data indicating the escapement for the various water bodies. The largest estimated escapement was for the Chilligan River, 38,576 sockeye. A total of 41,357 sockeye were estimated to spawn above Lake Chaka-chamna. Of the other sockeye estimated to spawn in the Chakachatna drainage, 1788 spawned in sloughs or side channel spawning areas receiving slough flow.

In the McArthur drainage, of the 34,933 fish, 98.1 percent of the estimated sockeye escapement occurred in tributary streams. Overall, 44.7 percent of the total estimated escapement of sockeye occurred in the McArthur drainage.

After spawning occurs, the fertilized eggs incubate in the spawning gravel and hatch prior to mid-March, incubation time being dependent upon water temperature (Morrow, 1980). Emergence occurs between April and June (Morrow, 1980). Observations on-site indicate some fry were still in the gravel on the Chilligan River in early June, although fry had left the gravel in other areas.

After emergence, the young move to their rearing areas. Areas identified as sockeye rearing habitat are identified in Figure 6.133. Sockeye spawned in the Chilligan and Igitna Rivers, rear in Chakachamna and Kenibuna Lakes. Rearing areas for fish spawned in

Table 6.84. Summary of estimated salmon escapement by waterbody and drainage for 1982.

	CHAKACHATNA RIVER DRAINAGE								
Species	Straight Creek Mouth	Chakachatna Bridge Side Channels and Sloughs	Chakachatna Canyon Sloughs	Chakachatna Tributary (C1)	Igitna River	Chilligan River	Straight Creek	Straight Creek Clearwater Tributary	Drainage Total
Sockeye Salmon	203	1,193	392	238	2,781	38,576	0	254	43,637
Chinook Salmon	0	0	0	0	0	0	0	1,422	1,422
Pink Salmon	0	59	279	0	0	0	0	7,925	8,263
Chum Salmon	152	1,482	121	165	0	0	0	0	1,920
Coho Salmon	76	1,560	608	183	0	0	0	172	2,599

	MCARTHUR RIVER DRAINAGE			Streams					
Species	McArthur Canyon	Stream 13X	Stream 13U	12.1	12.2	12.3	12.4	12.5	Drainage Total
Sockeye Salmon	666	5,416	1,213	16,711	6,085	2,512	2,328	0	34,933
Chinook Salmon	0	452	1,633	0	22	0	0	0	2,107
Pink Salmon	60	4,225	5,402	8,499	1,566	4	18	3	19,777
Chum Salmon	1	0	23	4	0	0	1	0	29
Coho Salmon	1,182	1,378	32	2,000	46	89	0	0	4,729

the tributaries and sloughs below the lake are more difficult to identify and sometimes difficult to differentiate from areas along the pathways of out migrants. Areas shaded in Figure 6.133 including the Chakachatna River across from the Straight Creek (station 20, Figure 6.30), the Noaukta Slough and portions of the lower McArthur River, appear to be used as sockeye rearing areas. Pre-smolt sockeye appear to rear in the system from as short a time as their first summer to as long as their third year (age II+) prior to migrating to sea. Sockeye outmigrants appear to leave the system from early June to October. Similar observations were obtained from studies in the Susitna River (ADF&G, 1982f). Outmigrants observed included age 0+, I+, and II+ fish.

Since sockeye spawn and rear in such diverse areas of the system, most reaches of the Chakachatna and McArthur River can be considered migratory pathways.

6.8.4.2 Chinook Salmon

Based upon 1982 observations, chinook salmon adults were entering the river systems prior to late June (Figure 6.131). Data collected at Sunshine Station on the Susitna River indicated that chinook were well up the Susitna River as early as June 7, but that peak numbers were not monitored until later in the month (ADF&G, 1982e). Chinook spawning was first observed in the study area on July 17 at Stream 13U in the McArthur system, but spawning could have started as early as the end of June. Live spawning adults were observed as late as August 25.

Figure 6.134 delineates estimated chinook escapement by water body for the study area. The largest estimated escapement occurred in Stream 13U in the McArthur drainage (1633 fish) and the second largest in the clearwater tributary to Straight Creek (1422 fish). All chinook spawning observed during 1982 occurred in tributary streams. The majority of spawning occurred within the McArthur drainage. Two locations that were identified during 1981 as chinook spawning areas, the left bank slough at station 17 and a side channel of the McArthur that received slough flow, did not contain spawning chinook during 1982.

After spawning, incubation of the eggs takes place for seven to 12 weeks or longer. After hatching the alevins remain in the gravel an additional seven to twelve weeks until adsorption of the yolk-sac is complete when the fry move out of the gravel. Observations of redds in late March 1982 showed that yolk-sac fry were still within the gravel at two spawning sites. Emergence in the study area appears to occur between April and late May when fry were found free-swimming in the water column.

Chinook sub-adults rear in fresh water from as short as three months (Morrow, 1980) to well into their third year of life (ADF&G, 1982b). Sub-adult chinook salmon collected in the study area have ranged from age 0+ to age II+. Similar observations have been made for the Susitna River (ADF&G, 1982b).

Chinook rearing areas were identified on the basis of 1981 and 1982 data shown in Figure 6.135. In identifying rearing habitats, areas that are probably used only as migratory routes have been excluded. Chinook sub-adult rearing areas appeared to primarily consist of spawning streams (Streams 13U and 19), low velocity side channel and slough areas (stations 17, 15, and 13) and many areas within the Noaukta Slough.

Chinook outmigration may start as early as June and appears to continue into the fall. Data from the Susitna River (ADF&G, 1982f) indicate that chinook outmigrations primarily occur between mid-June and mid-August.

Migratory pathways for chinook salmon probably include the Chakachatna River system, including the Noaukta Slough from Straight Creek to Trading Bay and the upper McArthur River (station 15) to Trading Bay. These are the parts of the river systems connecting the spawning and rearing areas to Cook Inlet.

6.8.4.3 Pink Salmon

Pink salmon were first observed milling in fresh water in late July (July 22) and first observed on the spawning streams on July 31. Comparable data from the Susitna River indicated that pinks were first collected at the fish wheels in mid-July (ADF&G, 1982e).

Pinks continued to be observed in the McArthur and Chakachatna River tributaries until mid-September (Figure 6.131), with peak counts made in August.

In Cook Inlet, pink salmon runs in even numbered years are usually larger than runs occurring during odd numbered years (ADF&G, 1982d). Since 1982 was an even year, larger than average escapements were expected. However, preliminary commercial catch data (ADF&G,

1982h) indicate that 1982 had a lower than average run for an even-numbered year. Estimated escapements for the various water bodies in the system are shown in Figure 6.136.

The vast majority of pink spawning occurred in tributary streams. In the Chakachatna drainage, 4.1 percent of the 8,263 estimated pink escapement for that drainage occurred in sloughs and side channels, and in the McArthur drainage less than 0.3 percent of the estimated pink escapement occurred in sloughs or side channels. The majority of the total estimated pink escapement, 70.7 percent or 19,777 fish, occurred in the McArthur drainage. No pinks spawned above the sloughs at the base of the Chakachatna River Canyon.

Incubation and alevin retention in the redds usually lasts six to eight months with the fry emerging between March and June (Krueger, 1981a). Emergent pink fry probably move directly down river to the sea (Krueger, 1981a). Rearing in fresh water may be for a period as short as one day (Krueger, 1981a), and thus no rearing areas were identified during the 1981 and 1982 studies. Data from the Susitna River (ADF&G, 1982f) indicate that the downstream migration of fry probably takes place prior to mid-June.

6.8.4.4 Chum Salmon

Chum salmon were in the spawning streams on August 25 and were found at most spawning areas by September 1 (Figure 6.131). Data from the Susitna River indicated that chum salmon entered that system in substantial numbers in the latter half of July with the majority of fish collected during August (ADF&G, 1982e). Analysis of aerial escapement surveys conducted on Susitna River sloughs indicated that peak escapement counts occurred from late August (ADF&G, 1982g) and extended into September. These periods may be one to two weeks earlier than those on the Chakachatna and McArthur River systems.

Chum salmon escapements by water body are presented in Figure 6.137. The total estimated escapement for both the Chakachatna and McArthur River drainages was 1949 fish, which was less than any of the other four salmon species. The majority of these fish (77.2 percent) spawned in the sloughs at station 17 on the Chakachatna River. Over 90 percent of the estimated escapement occurred in sloughs or areas receiving upwelling flow. Hale (1981) reported that fall chum on the Yukon River selected springs or areas of ground water seepage for spawning. Chum did not spawn upstream of the Chakachatna Canyon sloughs.

Chum salmon eggs generally incubate in the gravel for 50 to 130 days with the alevins remaining in the gravel an additional 30 to 50 days until their yolksacs are absorbed (Hale, 1981). Chum collected in the Chakachatna River Sloughs at the end of March, 1982 still had yolk-sacs present.

By the end of May, chum fry were free swimming. Many of those collected were showing signs of undergoing smoltification. In early June, chum salmon fry had moved into lower portions of the river systems and smolts were found at collecting stations near the mouth of the McArthur River. By the end of June, only a few smolts were collected near the mouth of the McArthur River, suggesting that the peak downstream migration had occurred. Because of the relatively short rearing period of chum salmon in freshwater, no specific rearing areas were identified during the 1981-1982 studies.The peak collection of chum outmigrants on the Susitna River occurred during mid- to late June with a few still migrating during early August (ADF&G, 1982f). The areas downstream of the various chum spawning areas must be considered to be migration routes since chum must pass through them during both their spawning run and their outmigration.

Smolts collected near the mouth and lower portions of the McArthur River were generally much larger than pre-smolt fish collected at the spawning sloughs in the Chakachatna River. This indicates that chum were probably actively feeding between the time of emergence and outmigration in mid- to late June. Morrow (1980) states that, in general, chum salmon outmigrants that have longer migrations to the sea feed in fresh water, but others generally do not.

6.8.4.5 Coho Salmon

Coho salmon were first observed in fresh water in mid-August (Figure 6.131). At that time fairly large numbers of coho were observed milling at the mouths of streams on the McArthur River. Coho were observed on spawning streams on September 1 and peak numbers were observed in mid to late September in most water bodies. Spawning was still in progress when the study was concluded in late October and may have continued under the ice in the Chakachatna Canyon sloughs. Morrow (1980) reported that spawning runs may occur from mid-summer to winter but late (December and January) runs generally occur in the southern parts of the range.

Coho salmon in the Susitna River have been collected in fresh water (Yentna Station) as early as mid-July, with peak numbers in late July to early August. Further upstream (Sunshine Station), peak numbers were counted in mid-August and coho continued to be collected into late August and September (ADF&G, 1982e).

Estimated coho escapements for the study area are shown by water body in Figure 6.138. The majority (64.5 percent) of the estimated total coho escapement for the study area occurred in the McArthur River. In the McArthur system, 75 percent of the estimated escapement of 4729 coho occurred in tributaries. The other 25.0 percent took place in side channel and slough areas. Spawning occurred in both tributaries and sloughs. The majority (86.3 percent) of the estimated escapement of 2599 coho in the Chakachatna drainage were observed in sloughs and side channels receiving upwelling or slough flow. The use of sloughs as spawning habitat by coho was not observed in the Susitna River (ADF&G, 1982g). No coho were observed spawning above the Chakachatna Canyon sloughs.

Incubation time for coho varies with temperature, usually taking six or seven weeks, but taking longer in colder waters. Incubation times of up to 115 days have been reported in Asia (Morrow, 1980). The young are reported to remain in the gravel until the yolk-sac is absorbed, two or three weeks or more after hatching (Morrow, 1980). Yolk-sac fry and emergent fry were found in spawning areas in the study area in late March. By late May coho fry were swimming around the substrate.

Morrow (1980) reported that coho fry are positively phototropic and move up into the water column and start feeding soon after emergence. They can remain in fresh water for up to four years. Coho of up to age II+ were common in the Chakachatna and McArthur River systems. Sub-adult coho salmon collected in the Susitna River were also of age groups age 0+ to II+ (ADF&G, 1982b).

Sub-adult coho salmon were among the more widely distributed fish present in the study area below the lake. Figure 6.139 shows areas that were identified as coho rearing habitat based upon 1981 and 1982 data. Areas primarily identified as migration routes were excluded from the figure. Coho sub-adults were generally abundant in tributaries, the Noaukta Slough, and areas in the lower portions of both rivers.

Movements of coho sub-adult, as inferred from changes in captures, indicated substantive changes in distribution during the fall. Observed increases in the abundance of coho in the Noaukta Slough, lower river systems and upper McArthur River probably represented a combination of movement to overwintering habitat and outmigration. The outmigration of some coho confirmed by the collection of smolts in the lower portions of the rivers. Coho smolts were collected in the Chakachatna and McArthur River systems from early June into October.

In the Susitna River, coho sub-adults moving downstream were collected from the date the migrant trap was installed (June 18, 1982) through October 12, when sampling ended (ADF&G, 1982f). Other observations made in the Susitna River (ADF&G, 1982b) indicated that the majority of parr-smolt transformation of coho took place by June 15 in the river reach above Cook Inlet. The majority of smolts in the Susitna River were identified as age II+. The age distribution of smolts in the Chakachatna and McArthur River areas has yet to be established.

6.8.4.6 Dolly Varden

Dolly Varden was the most widely distributed species collected in the study area and was found at almost every site at which fish were collected. They numerically dominated collections made below Chakachamna Lake. Dolly Varden may be resident or anadromous; both types are probably present within the study area. Both adult and juvenile Dolly Varden were observed and collected during the field studies.

Dolly Varden were observed spawning from July 31 through October in the Chilligan River (Figure 6.140). During late October, sexually mature upstream migrants were still being collected in the lower portions of the river systems, and Dolly Varden spawning was still occurring. Dolly Varden spawning was also common in the McArthur River and its tributaries during October. Some upstream migrants which spawned in the McArthur River were observed entering the river systems from the Middle River and then moving through the Chakachatna River. Krueger (1981b) indicated that in southeastern Alaska, peak spawning activity, depending upon stream, occurred between September and early November. Unlike the salmon, adult Dolly Varden survive after spawning and may spawn again in subsequent years; males have a lower survival rate than females (Armstrong and Kissner, 1969).

A population estimate was not made of spawning Dolly Varden during this study. The spawning areas were identified and are shown in Figure 6.106. Dolly

Varden appeared to spawn in the widest range of locations and habitats of any of the species observed, including sloughs, tributaries, and side channels with the proper substrate.

According to Blackett (1968) incubation of Dolly Varden eggs requires 129 to 136 days with the alevins remaining in the gravel another 60 to 70 days until their yolk-sacs have been absorbed. Yolk-sac fry were collected in spawning areas in the study area in late March but by late May all fry had emerged from these areas and were free-swimming.

Dolly Varden sub-adults were widely distributed in the river systems. They were collected from every river sampled, including the Neacola and Another Rivers. Sub-adults (age I+ to II+) appear to be common throughout the river system with larger, older sub-adult fish, including age III+, more abundant in the Noaukta Slough and lower portions of the river.

Dolly Varden appear to move freely throughout the system. Movement of adults and older juveniles were determined between the Chakachatna and McArthur River by means of tagging. Fish were found to move between most of the fyke net stations (1D, 3, 4, 6, 9, and 11).

Rearing areas of Dolly Varden included most portions of the river systems (Figure 6.141). Rearing occurs throughout the year. Overwintering areas used by Dolly Varden included the upper McArthur River and Chakachatna River sloughs (station 17). Areas within the Noaukta Slough and some lower portions of the McArthur and Chakachatna Rivers were used also. Outmigration by juvenile Dolly Varden is difficult to discern because of the large intrasystem movements by resident juveniles.

6.8.4.7 Pygmy Whitefish

Pygmy whitefish were abundant in mid- to lower portions of the study areas (Figure 6.142). Pygmy whitefish were found from below the Chakachatna Canyon to the Middle River, and from station 13 (Figure 6.30) on the McArthur River to its mouth. Pygmy whitefish are apparently utilized as a forage fish by Dolly Varden and rainbow trout: age 0+ whitefish are used by sub-adult coho salmon. Morrow (1980) reported that spawning takes place at night in late fall and early winter at water temperatures of about 4°C. Gravid females were collected during September 1981 and September and October 1982. Spawning was apparently in progress because spent and gravid adults were collected at the same time.

Little is known about the incubation of pygmy whitefish eggs and the behavior of alevins. However, unidentifiable whitefish fry (Prosopium sp.) were collected in Chakachatna River sloughs (station 17, Figure 6.30) in March and in the upper McArthur River (station 15) in late May.

Sub-adult pygmy whitefish were widespread within the river systems with juveniles and adults often collected in the same location. The pygmy whitefish is a resident species and is therefore found in fresh water throughout the year.

6.8.4.8 Rainbow Trout

Rainbow trout were regularly collected in portions of the lower river systems and tributaries. Rainbow trout were collected most frequently in October when large numbers had moved into the lower river system.

Little is known about the spawning of rainbow trout in the Chakachatna and McArthur River systems and few rainbow trout under 10 cm (4.0 in.) were collected. Spawning usually takes place in riffle areas of streams and may occur at temperatures as low as 5°C; spawning usually occurs between mid-April and late June (Morrow, 1980). In many areas of the Chakachatna and McArthur drainages suitable for rainbow trout spawning, water temperatures may have been lower than 5°C until June.

Morrow (1980) stated that under normal conditions development to hatching of eggs takes four to seven weeks. Yolk-sac absorption may occur over three to 14 days with fry usually emerging between mid-June and mid-August. Rainbow trout fry were collected in late May and late June, which suggested that either spawning occurred earlier than expected, or that these were very small age I+ fish.

The distribution of rainbow trout in the Chakachatna River appears to be limited to areas below the Chakachatna River Canyon. During the summer and fall of 1982, sub-adult rainbow trout were collected in the Straight Creek clearwater tributary (19), in the McArthur River (stations 13 and 11) and in the lower Chakachatna River (stations 3, 4, and 6). These and other areas identified during 1981 as probable rearing areas are shown in Figure 6.143. Rainbow trout are a resident species and therefore rear in freshwater throughout the year. Based upon tag return data, rainbow trout appear to move freely within and between the middle and lower portions of both river systems.

6.8.5 Summary and Conclusions

The 1982 studies provided a substantial increase in the data base for the Chakachatna and McArthur River systems. These studies provided a better understanding of the aquatic biota of the system and information necessary for planning future studies. The findings of these studies include:

- Spawning areas utilized by the five species of Pacific salmon were identified and estimates made of escapement to each area (Section 6.8.3.2.1).

- The Chilligan River was estimated to contain the greatest escapement of spawning adult sockeye (38,576) in either river system. The Igitna River was also utilized for spawning (2,781 fish).

- Tributary streams and sloughs were the most important salmon spawning habitat downstream of Chakachamna Lake.

- Spawning areas utilized by Dolly Varden were identified in most suitable habitats (Section 6.8.3.2.1).

- The timing of life history events and migrations of many salmonid species were identified.

- Migratory pathways were identified (Section 6.8.3.1, 6.8.3.2.1).

- Rearing and overwintering habitats were identified in mainstream, slough, and tributary areas of the system.

- o Habitat areas were characterized (Section 6.8.3.2.4).

- o Species previously unidentified including Bering cisco, eulachon, rainbow smelt, and longfin smelt were collected in the study area.

- o Distribution of fish in Chakachamna Lake varied seasonally during winter and fall.

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TABLES

Table 6.1. Relations used in calculating natural mean monthly flows at eight representative locations.

Location Number[a]	River	Relation[b]
1	Chakachatna	Q_{m1} = U.S.G.S. data for Chakachatna River near Tyonek (Gauging Station No.15294500)
2	Chakachatna	$Q_{m2} = Q_{m1} + A_{1-2} \times (B+C)/2$
3	Chakachatna	$Q_{m3} = Q_{m2} + 0.913A_{2-3} \times (B+C)/2 + 0.087\ A_{2-3} \times C$
4	Chakachatna	$Q_{m4} = 0.084\ Q_{m3} + (0\ B4\ A_{3-D} + A_{D-4}) \times C$
5	Middle	$Q_{m5} = 0.016\ Q_{m3} + (0.16\ A_{3-D} + A_{D-5}) \times C$
6	Upper McArthur	$Q_{m6} = A_6 \times B$
7	McArthur	$Q_{m7} = Q_{m6} + A_{6-7} \times B$
8	McArthur	$Q_{m8} = Q_{m7} + A_{7-8} \times C + 0.90\ Q_{m3}$

[a]See Figure 6.2 for locations
[b]Qml = mean monthly flow for any month at location 1.

A_{i-j} = contributing drainage area between locations i and j; a D subscript r@presents the location of the divergence of Chakachatna and Middle Rivers

B = mean monthly flow per square mile based on calculated Chakachamna Lake inflows

C = mean monthly flow per square mile based on the 4 year average of mean monthly flow of the Chuitna River (Station 15294450)

Table 6.2. Locations, date, and results of field discharge measurements during September 1981

Study[a] Area	Loc.[b]	Description	Date	Discharge
D	2	Chakachatna R. U/S of Straight Ck.	21 Sept.	5,813
D	-	Straight Ck. U/S of Chakachatna R.	21 Sept.	471
E	-	Chakachatna R. D/S of Noaukta Sl. Div.	22 Sept.	681
E	-	Noaukta Sl. D/S of Chakachatna R. Div	22 Sept.	1,285[c]
F	-	Chakachatna R. D/S of Middle R. Div.	26 Sept.	428
F	-	Middle R. D/S of Chakachatna R. Div	26 Sept.	80
G	4	Chakachatna R. U/S of McArthur R.	26 Sept.	475
H	5	Middle R. U/S of Mouth	26 Sept.	132
I	-	Upper McArthur R. U/S of Powerhouse	26 Sept.	155
J	-	Upper McArthur R. nr. Powerhouse	24 Sept.	93[c]
K	-	Upper McArthur R. D/S of Powerhouse	26 Sept.	297
L	6	Upper McArthur R.	24 Sept.	417
L	-	Upper Blockade Glacier Channel	24 Sept.	312
M	-	McArthur R. U/S of Lower Bl. Gl. Chan.	25 Sept.	696
M	-	Lower Blockade Glacier Channel	25 Sept.	514
N	-	Upper Clearwater Tributary	25 Sept.	87

[a] Study areas are illustrated on Figure 6.2

[b] Loc. is the corresponding representative location at which flow regimes have been calculated

[c] Partial measurement

Table 6.3. Estimated natural mean monthly and mean annual flows at eight representative locations.[a]

MONTH	B[b] (cfs/mi^2)	C[c] (cfs/mi^2)	Qm1[d] (cfs)	Qm2 (cfs)	Qm3 (cfs)	Qm4 (cfs)	Qm5 (cfs)	Qm6 (cfs)	Qm7 (cfs)	Qm8 (cfs)
JAN	0.45	0.78	613	670	720	69	34	24	170	830
FEB	0.39	0.63	505	550	590	57	28	21	150	690
MAR	0.37	0.53	445	490	520	50	24	20	140	620
APR	0.53	1.1	441	520	580	61	43	29	200	740
MAY	2.0	8.2	1,042	1,530	1,930	250	270	110	750	2,580
JUNE	7.0	8.8	5,875	6,630	7,220	700	370	380	2,620	9,250
JULY	11.0	2.6	11,950	12,600	13,070	1,130	290	590	4,100	15,970
AUG	9.6	1.7	12,000	12,540	12,930	1,100	260	520	3,600	15,330
SEP	4.5	4.3	6,042	6,460	6,790	620	230	240	1,690	7,870
OCT	1.5	2.8	2,468	2,670	2,830	270	130	83	570	3,160
NOV	0.77	1.6	1,206	1,320	1,410	140	69	42	290	1,580
DEC	0.52	1.2	813	890	960	93	49	28	190	1,070
MEAN ANNUAL	--	--	3,645	3,935	4,160	382	150	175	1,215	5,011

[a]See Figure 6.2 for locations

[b]B = mean monthly flow per square mile based on calculated Chakachamna Lake inflows

[c]C = mean monthly flow per square mile based on a 4 year(1976-1979) average of mean monthly flows of the Chuitna River (Station 15294450); mean annual flow not used

[d]Qmi = Estimated natural mean monthly flow at location i

Table 6.4. Natural flood flows at eight representative locations based on a regional flood frequency analysis developed by Lamke (1979).

Location[a]	A^b (mi^2)	P^c (in)	St^d (%+1)	F^e (%+1)	T^f (F^o)	M^g	D^g	$Q_{1.25}$[h] (cfs)	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)
1[i]	1120	-	-	-	-	-	-	13,527	15,848	19,051	21,202	23,962	26,055	28,183
1	1120	75	4	17	0	20,540.2	1.46	14,570	19,289	25,725	30,556	35,391	40,845	47,198
2	1216	75	3.7	17	+1	22,542.4	1.44	16,156	21,150	27,889	32,924	37,914	43,509	50,012
3	1289	75	3.5	18.4	+1	23,799.9	1.44	17,042	22,302	29,426	34,759	40,083	45,996	52,871
4	119	72	2.8	21.5	+2	2,453.2	1.7	1,580	2,387	3,563	4,475	5,370	6,606	8,091
5	50	55	1.4	16.5	+2	1,042	1.81	645	1,029	1,609	2,067	2,518	3,180	3,988
6	54	80	1	8.4	+2	1,758.8	1.8	1,084	1,716	2,686	3,461	4,260	5,364	6,715
7	375	77	1	11.8	+3	10,219.4	1.56	6,926	9,696	13,615	16,609	19,651	23,312	27,628
8	1551	75	2.9	16.6	+2	29,862	1.41	21,650	27,882	36,269	42,533	48,791	55,554	63,401

[a] See Figure 6.2 for location

[b] A=drainage area; values for locations 4,5, and 8 are weighted average

[c] P=mean annual precipitation; values for locations 4,5, and 8 are weighted averages

[d] St=percentage of basin containing lakes; values for locations 4,5, and 8 are weighted averages

[e] F=percentage of basin covered by forest; values for locations 4,5, and 8 are weighted averages

[f] T=mean minimum January temperature; values for locations 4,5, and 8 are weighted averages

[g] M and D are parameters calculated from the basin parameters; they are used in the flood frequency equations developed by Lamke (1979)

[h] Qi=flood discharge with recurrence interval i

i These data are from a flood frequency analysis of gage data (Station 15294500)

Table 6.5 Results of low flow investigations for three locations along Chakachatna River for each of two 6 month periods.

Low Flow Parameter	November-April Gage[a] Data (cfs/mi^2)	November-April Location[b] 1 (cfs)	November-April Location[b] 2 (cfs)	November-April Location[b] 3 (cfs)	May-October Gage[a] Data (cfs/mi^2)	May-October Location[b] 1 (cfs)	May-October Location[b] 2 (cfs)	May-October Location[b] 3 (cfs)
$7Q_{1.25}$	0.43	480	520	550	0.62	689	750	790
$7Q_2$	0.36	403	440	460	0.43	486	530	560
$7Q_5$	0.29	329	360	380	0.33	365	400	420
$7Q_{10}$	0.26	292	320	340	0.29	321	350	370
$7Q_{20}$	0.23	263	290	300	0.26	293	320	340
$7Q_{50}$	0.21	231	250	270	0.24	267	290	310
$7Q_{100}$	0.19	212	230	240	0.23	252	270	290
$30Q_{1.25}$	0.43	482	520	550	1.08	1,207	1,310	1,390
$30Q_2$	0.37	411	450	470	0.77	863	940	990
$30Q_5$	0.30	340	370	390	0.55	613	670	710
$30Q_{10}$	0.27	303	330	350	0.46	512	560	590
$30Q_{20}$	0.24	273	300	310	0.39	440	480	510
$30Q_{50}$	0.22	242	263	280	0.33	371	400	430
$30Q_{100}$	0.20	221	240	250	0.29	330	360	380

[a]Low flow frequency analyses of data from Chakachatna River gage (station 15294500)

[b]Locations are identified in Figure 6.2; location 1 corresponds to Chakachatna River gage site

Table 6.6 Surveys conducted by and for Alaska Department of Fish and Game. (By date, location, method and species found)

Location and Date	Method[a]	Salmon Species: Sockeye	Chinook	Coho	Chum	Pink	Other Species: Dolly Varden	Rainbow Trout	Lake Trout	Round Whitefish	Slimy Sculpin
Chakachamna Lake											
9/52	Vis										
9/53	Vis *										
9/54	ES, Vis										
9/56	ES	+									
1979	GN, ES	+					+		+	+	+
Chilligan River											
9/52	ES, Vis	+									
9/53	Vis *										
8/54	ES, Vis	+									
8/55	ES, Vis	+									
Igitna River											
8/52	Vis	+									
9/52	Vis										
9/53	Vis *										
Another River											
8/52	Vis *										
Kenibuna Lake											
8/52	Vis	+									
9/53	Vis *										
Chakachatna River											
7/52	Vis *, **										
6/58											
1961	Vis, GN	+	+								

Table 6.6. Concluded.

		Salmon Species					Other Species				
Location and Date	Method[a]	Sockeye	Chinook	Coho	Chum	Pink	Dolly Varden	Rainbow Trout	Lake Trout	Round Whitefish	Slimy Sculpin
Straight Creek											
1958	Vis										
1973 ***	Vis		+								
1976 ***	Vis		+								
1977 ***	Vis		+								
1978 ***	Vis		+								
1981 ***	Vis		+								
McArthur River (including Swank Slough and Flat Lake)											
1959	Vis										
7/61		+		+			+				
8/61				+	+						
9/61				+						+	
West Creek											
7/61	GN, Vis	+		+		+	+	+		+	
9/61	GN, Vis						+	+			
#8 Creek											
7/61	GN, Vis	+					+	+		+	
North Fork											
7/61	Vis, GN	+					+				

[a]GN-Gill net; Vis-Visual; ES-Electroshocking
* Too muddy to observe fish
** Two beluga whales at mouth
*** Chinook salmon survey only

Table 6.7. Collection methodologies utilized by waterbody, September 1981 reconnaissance study

Water Body	Visual Observations	Electro-shocking	Hand Seine	Beach Seine	Gill Nets	Fyke Nets	Stationary Drift Nets (Trawl)	Hoop Nets	Minnow Traps
Igitna River	X								
Kenibuna Lake	X								
Another River	X								
Chilligan River	X								
Neacola River	X								
Chakachamna Lake	X	X	X	X	X			X	X
Shamrock Lake	X								
Nagishlamina River	X	X	X	X[a]				X	X
Chakachatna River	X	X	X			X			
Straight Creek	X	X	X				X		
Straight Creek Tributary	X	X	X						
Middle River	X	X	X			X			
Noaukta Sough	X	X	X			X			
McArthur River	X	X	X			X			
McArthur River Tributary	X	X	X						
Chuitkilnachna Creek	x								

[a] At mouth of river in Lake Chakachamna

Table 6.8. Collection gear specifications September 1981 reconnaissance study.

Electroshockers

Coeffelt Model BP-2 - used at 600 v

Smith-Root Model VII - 700 v at 6 millisecond pulse duration at 60 pulses/second

Hand Seine

10 ft x 6 ft - ¼" ace mesh

Beach Seine

100 ft x 6 ft - ¼" ace mesh

Gill Nets

75 ft long, each panel 15' long x 6 ft deep
Panels of nylon monofilament 3/4", 1", 1.5", 2", 2.5" bar mesh

Fyke Nets

6' x 4' double funnel ½" square mesh
Long wings and leads 300 ft - 1" square mesh
Short wings 50 ft - 1" square mesh

Hoop Nets

No leads - Small 34" diameter 1" stretch mesh
Large 48" diameter 1-½" stretch mesh

Table 6.9. Species list and drainage of occurrence August-September 1981.

Species		Drainage of Occurrence: Chakachatna River[1]	Drainage of Occurrence: McArthur River
pygmy whitefish	*Prosopium coulteri*	+	+
round whitefish	*Prosopium cylindraceum*	+	+
Dolly Varden	*Salvelinus malma*	+	+
lake trout	*Salvelinus namaycush*	+	
rainbow trout	*Salmo gairdneri*	+	+
pink salmon	*Oncorhynchus gorbuscha*	+	+
chum salmon	*Oncorhynchus keta*	+	+
coho salmon	*Oncorhynchus kisutch*	+	+
sockeye salmon	*Oncorhynchus nerka*	+	+
chinook salmon	*Oncorhynchus tshawytscha*	+	+
arctic grayling	*Thymallus arcticus*	+	
slimy sculpin	*Cottus cognatus*	+	+
threespine stickleback	*Gasterosteus aculeatus*	+	+
ninespine stickleback	*Pungitius pungitius*	+	+

[1] Includes Lake Chakachamna and Middle River

Table 6.10. Concluded

Species		Habitat[a]							
		UAT	HAR	BCR	CMR	BST	RBB	WTR	BSR
saskatoon serviceberry	*Amelanchier alnifolia*					4	4		3
Pacific serviceberry	*Amelanchier florida*							5	
Labrador-tea	*Ledum groenlandicum*					4	3		4
narrow-leaf Labrador-tea	*Ledum decumbens*					5	2		
prickly rose	*Rosa acicularis*			4		4			
sweetgale	*Myrica gale*			5		4	3		3
rusty menziesia	*Menziesia ferruginea*					3	5		
bog rosemary	*Andromeda polifolia*					4	3		
bush cinqfoil	*Potentilla fruticosa*					4	2		
leatherleaf	*Chamaedaphne calyculata*					5	4		
devilsclub	*Oplopanax horridus*	5		5	5				
fireweed	*Epilobium* sp.	3	3	4	5			4	
sedge	*Carex* sp.			5	2	5	3		3
grass	*Gramminaea*	3	3	3	1	3	2	3	2
Fern	*Polystichum* sp.		5	5		4			
-	*Eriophyllum lanatum*					5	4		5
Horsetail	*Equisetum* sp.		4	4	3	5	4	5	4
-	*Angelica genuflexa*				4				
-	*Artemesia tilesii*	5	5	5					
lupine	*Lupinus* sp.							5	

[a]Upland Alder Thicket (UAT);
High Altitude Riparian (HAR);
Black Cottonwood Riparian (BCR);
Coastal Marsh Riparian (CMR);
Black Spruce Transitional (BST);
Resin Birch Bog (RBB);
Willow Thicket Riparian (WTR); and
Black Spruce Riparian (BSR).

Table 6.11 The species composition and relative abundance of mammals identified within the study area for each of the habitat types. (1=Abundant 3=Common 5=Occasional)

Species		Habitat[a]							
		UAT	HAR	BCR	CMR	BST	RBB	WTR	BSR
grizzly bear	*Ursus horribilis*	3	1	3	3	5	5	3	3
black bear	*Ursus americanus*	1	1	3	3	5	3	3	3
gray wolf	*Canis lupus*	5	3	5	5	5		5	
coyote	*Canis latrans*	3	3	3	1	3	3	3	3
moose	*Alces alces*	5	1	1	3	3	3	3	3
barren ground caribou	*Rangifer arcticus*		5						
wolverine	*Gulo luscus*	5	5	5				5	5
mink	*Mustela vison*	5	5	3				5	3
river otter	*Lutra canadensis*			5				5	5
beaver	*Castor canadensis*			3				3	3
muskrat	*Ondatra zibethica*		5	3				3	3
red squirrel	*Tamiasciurus hudsonicus*	5	5	5	5	5			5
tundra redback vole	*Clethrionomys rutilus*	1	3	3	3	3	3		
tundra vole	*Microtis oeconomus*			3					
porcupine	*Erethizon dorsatum*		3	3	5				
dusky shrew	*Sorex obscurus*	3	3	3					
harbor seal[b]	*Phoca vitulina*				5				
beluga whale[b]	*Delphinapterus leucas*				5				

[a] Upland Alder Thicket (UAT);
High Altitude Riparian (HAR);
Black Cottonwood Riparian (BCR);
Coastal Marsh Riparian (CMR);
Black Spruce Transitional (BST);
Resin Birch Bog (RBB);
Willow Thicket Riparian (STR); and
Black Spruce Riparian (BSR).

[b] sighted offshore near the mouth of the McArthur River.

Table 6.12. The species composition and relative abundance of birds identified within the study area for each of the habitat types. (1=Abundant 3=Common 5=Occasional)

Species		Habitat[a]							
		UAT	HAR	BCR	CMR	BST	RBB	WTR	BSR
trumpeter swan	*Olor buccinator*		5	3	3				3
Canada goose	*Branta canadensis*			5	3				
white-fronted goose	*Anser albifrons*	5	5						
mallard	*Anas platyrhynchos*				1				
pintail	*Anas acuta*	5	5	5	1				5
American wigeon	*Mareca americana*				1				5
green-winged teal	*Anas carolinensis*				1				
greater scaup	*Aythya marila*								5
common goldeneye	*Bucephala clangula*				5				
oldsquaw	*Clangula hyemalis*				5				
common merganser	*Mergus merganser*			5					3
red-breasted merganser	*Mergus serrator*				5				
sharp-shinned hawk	*Accipiter striatus*				3				
marsh hawk	*Circus cyaneus*	5	3	3	3		3	5	3
red-tailed hawk	*Buteo jamaicensis*			5	5	5	5		
Swainson's hawk	*Buteo swainsoni*				5				
bald eagle	*Haliaeetus leucocephalus*	3	3	3	3	5	5	5	3
spruce grouse	*Canachites canadensis*			3		5	5		
willow ptarmigan	*Lagopus lagopus*				5	5			
sanhill crane	*Grus canadensis*				3		5		
black-bellied plover	*Squatarola squatarola*				5				
spotted sandpiper	*Actitis macularia*			5	5				
greater yellowlegs	*Totanus melanoleucus*				5				
short-billed dowitcher	*Limnodromus griseus*				3				
pectoral sandpiper	*Erolia melanotos*				1				3
least sandpiper	*Erolia minutilla*				5				
northern phalarope	*Lobipes lobatus*				5			5	5
common snipe	*Capella gallinago*				5			5	3
glaucous-winged gull	*Larus glaucescens*	5	3	3	3				
herring gull	*Larus argentatus*			5					
mew gull	*Larus canus*	5	3	3	3	5			

Table 6.13. Industrial Sites.

Site Number	Township Location and Size	Description	Date Classified
C 170	T.11N., R.12W., S.M. Sec. 28, 255 B7 ac.	Tidelands	12-13-61
C 1313	T.11N., R.12W., S.M. Sec. 27, 248.64 ac.	O & G Support Facilities	9-30-65
C 1336	T.11N., R.12W., S.M. Sec. 28, 351.45 ac.	O & G Support Facilities	12-27-65
C 1369	T.11N., R.12W., S.M. Sec. 28, 126 ac.	O & G Support Facilities (tidelands)	4-13-66
C 1483	T.11N., R.12W., S.M. Sec. 29. 397 ac., & Sec. 30, 6 ac.	O & G Support Facilities	2-21-68
C 1487	T.11N., R.12W., S.M. Sec. 28 & 33, 36.82 ac	Ship Docking Facility O & G Support Facilities (tidelands)	2-6-68
C 1906	T.11N., R.11W., S.M. ATS 931, 44.86 ac.	Ship Docking Facility Kodiak Lumber Company	5-28-74

Source: State of Alaska, Department of Natural Resources Status Plats. For complete legal descriptions, including aliquot part descriptions, contact Alaska Division of Lands.

Table 6.14. Native allotments in shoreline townships.

Application No.	Location and Size	Certificate No. and Date	Date Occupied
AA 6459	T.12N., R.11W., S.M. M & B, 160 ac.	Apln 8-23-71	1949
AA 7268	T.12N., R.11W., S.M. 160 ac.	Apln 3-20-72	7/1946
AA 7324	T.12N., R.11W., S.M. 160 ac.	Apln 3-23-72	5/1953
AA 7788	T.12N., R.11W., S.M. 160 ac.	Apln 4-20-72	6/1957
A 055082	T.12N., R.11W., S.M. U.S.S. 4547, 119.39 ac.	50-75-0138/3-14-75	11-16-40
A 055680	T.12N , R.11W., S.M. U.S.S. 4546, 160 ac.	50-66-0608/6-20-66	9-15-41

Source: BLM Status Plats, June 1978. For complete descriptions, including aliquot part descriptions, contact Alaska Division of Lands.

Table 6.15. Oil and Gas Fields in the Project Area.

Field	Type	Location	Date of Discovery Well
1. West Foreland	Gas	Onshore	April 1962
2. Middle Ground Shoal (MGS)	Oil	Offshore	June 1962
3. North Cook Inlet	Gas	Offshore	September 1962
4. Beluga River	Gas	Onshore	December 1962
5. North MGS	Gas	Offshore	November 1964
6. Trading Bay	Oil	Offshore	June 1965
7. Granite Point	Oil	Offshore	June 1965
8. McArthur River	Oil & Gas	Offshore	October 1965
9. Moquawkie	Gas	Onshore	November 1965
10. Nicolai Creek	Gas	Onshore	May 1966
11. Ivan River	Gas	Onshore	October 1966
12. Albert Kaloa	Gas	Onshore	January 1968
13. Redoubt Shoal	Oil	Offshore	September 1968

Source: Situations and Prospects Kenai Peninsula Borough 1981.

Table 6.16. State Oil and Gas Lease Sales

Number	Sale Area	Proposed Date	Comment
40	Second Upper Cook	9/83	Scheduled
49	Cook Inlet	5/86	Proposed

Source: State of Alaska Current Five-year Oil and Gas Leasing Schedule - DNR revised 8/31/81 and DNR-DMEM Call for Comments 81.

Table 6-17. Coal Leaseholdings.

Company	Acreage	Employees	Startup Date
Placer Amex Inc. (Beluga Coal Company)	25,926	Construction - ? Operation - 500	1987 (30 years)
Diamond-Chuitna (Diamond Alaska Co)	20,571	Contruction - 2000 Operation - 800	1987
Mobil Oil	23,080	N/A	N/A
AMAX, Inc. (Meadowlark Farms)	3,880	N/A	N/A

Source: Tyonek Community Profile (Draft) Ralph Darbyshire and Associates, September 1981.

Table 6.18. Locations where Subsistence Occurs.

Polly Creek	The beaches in this area are used for clamming in the spring.
Redoubt Bay	The beaches in this area are used heavily and have been relied upon for many years for clams. Use occurs in both spring and fall, but spring use is especially important after winter food supplies have been depleted and before the spring salmon run begins. The beaches south of Drift River Terminal to Harriet Point are used most extensively.
	a. Drift River: Historically, the upper and middle reaches were used most heavily for hunting and trapping. Today, some duck and seal hunting is pursued in the lower reaches.
	b. Kustatan River: The entire vicinity is hunted heavily when the McArthur River area and other areas do not have many moose. Some trapping takes place here.
Trading Bay and McArthur River	Upper McArthur River areas are used for moose hunting and furbearer trapping. McArthur Flats is used for waterfowl hunting and furbearer trapping.
	a. Middle River and lower area flats are used for moose hunting, trapping and waterfowl hunting.

Chakachatna River Noaukta Slough	Used for moose hunting, trapping, and waterfowl hunting.
Chuitkilnacha Creek and associated marsh areas	Used for duck hunting.
Granite Point to Chuitna River	The shoreline areas here are relied upon for subsistence and commercial salmon and herring fishing. This is the main fishing area for Tyonek residents.
Chuitna River and Chuit Creek Area	Both are used extensively in winter months for trapping and moose hunting.
	a. <u>Chuitbuna Lake</u> referred to as Chuit Lake) area is used for trapping and hunting especially in the winter. During the fall the area around this lake is used for berry picking. This area has a particular importance because of its proximity to Tyonek village.
	b. The areas west and north of Beluga village are used very heavily in fall for hunting moose and in winter for furbearer trapping. This is also an important berry picking area.
	c. <u>Old Tyonek Creek</u> and the lakes area around Congahbuna Lake are used for moose hunting and trapping.
Beluga Flats and Lower reaches of Beluga River	These locations are very important for hunting whale and waterfowl. Some seals are also taken here.

Susitna River	The mouth and lower reaches are used for beluga whale and seal hunting in the spring and fall.

Source: A Social, Economic and Environmental Analysis of a State Oil and Gas Lease Sale in Upper Cook Inlet; Governor's Agency Advisory Committee on Leasing, 1981.

Table 6.19. Kenai-Cook Inlet Division Area Nonagricultural Employment and Payroll Industry Series - Alaska. 3rd Quarter 1980.

Industry	Average No. of Employees	Average Monthly Wage ($)
Mining	793	3,085
Construction	902	3,531
Manufacturing	2022	1,581
Transportation, Communication and Utilities	671	3,142
Wholesale Trade	272	2,515
Retail Trade	1048	1,021
Finance, Insurance and Real Estate	203	1,259
Services	1023	1,366
Agriculture, Forestry and Fisheries	51	2,387
Government	1169	1,981
Unclassifiable	1131	1,158
Totals	8185	2,055

Source: Statistical Quarterly - 3rd Quarter, 1980. Department of Labor, State of Alaska.

Table 6.20. Anchorage Division Area Nonagricultural Employment and Payroll Industry Series - Alaska. 3rd Quarter 1980.

Industry	Average No. of Employees	Average Monthly Wage ($)
Mining	2,915	3,286
Construction	7,190	3,252
Manufacturing	2,532	2,636
Transportation, Communication and Utilities	8,318	2,264
Wholesale Trade	4,230	2,150
Retail Trade	13,324	1,171
Finance, Insurance and Real Estate	4,900	1,649
Services	17,182	1,125
Agriculture, Forestry and Fisheries	197	1,019
Government	20,356	2,061
Unclassifiable	607	1,522
TOTALS	81,751	1,958

Source: Statistical Quarterly - 3rd Quarter, 1980. Department of Labor, State of Alaska.

Table 6.21. Historic Trails.

Trail Name	Quandrangle & Number	Location	Source	Description
Susitna - Tyonek	Q70 - #2	T.11, 12, 13, 14, 15, 16, 17N. R.7, 8, 9, 10, 11W. SM	ARC Annual Report 1930 Part II, Page 61. & Fifty Years of Highways - AK Dept. Public Works, Div. of Highways 1960, pg. 29-30.	Trail begins at town of Susitna T.17N. R.7W. and runs in a SW direction for 46 miles to town of Tyonek T.11N.R11W.
Winter Trail	Q70 - #3	T.11N.R.12, 13W, SM	USGS Tyonek Quad	Trail runs from Trading Bay to cabins on Nikolai Creek.

Source: State of Alaska. Department of Highways. Alaska Existing Trail System. 1973.

Table 6.22. Airport facility characteristics.

Name	Owner	Class	Length	Surface	Comments
Tyonek	Pvt.	Utility	3350' x 100' 1427' x 100'	Gravel	
Beluga	Pvt.	Non CAB Non CAB	3500' x 110' 5000" x 110'	Gravel Gravel	Lighted Lighted
Nikolai Creek	Pvt.	Non CAB	4100' x 75'	Gravel	
Trading Bay	Pvt.	Non CAB	4500' x 100'	Gravel-dirt	Lighted
West Foreland (Unit No. 2)	Pvt.	Utility	1975'	Dirt	
Drift River	Pvt.	Non CAB	4300' x 150' 40'	Gravel Gravel	Lighted

Table 6.23. 1982 data collection program for recording gages at Chakachatna and McArthur Rivers.

Site	Description	Measuring Devices	Period of Record 1982	Recording Interval
C	Streamflow stage and temperatures of Chakachatna River at lake outlet.	Datapod Model DP211SG dual channel recorder	11 Aug. - 13 Oct. 13 Oct. - Cont.	6 Hours[a]
13.5	Streamflow stage and temperatures of upper McArthur River at rapids.	Datapod Model DP211SG dual channel recorder	11 Aug. - 17 Aug. 17 Aug. - 16 Oct. b,c 16 Oct. - Cont. c	6 Hours[a] 1 Hour 6 Hours[a]
	Streamflow temperatures of upper McArthur River at rapids.	Peabody-Ryan Model J-90 thermograph	21 Aug. - 24 Sept.	Continuous
15	Streamflow temperatures of upper McArthur River at Powerhouse	Peabody-Ryan Model J-90 thermograph	21 Aug. - 18 Sept.	Continuous

[a]Average of six measurements at 1 hour intervals.

[b]Approximate one-week data gap in September due to a storm which dislodged the gage.

[c]Data after approximately 7 October, represent water temperature in dunes of sand that buried the gage.

Table 6.24. Summary of 1982 staff gage data base.

Site ID	Number of Channels with Gages	Period of Record	Approximate Frequency	Reference Elevation[a] (ft)
1	1	15 Aug. - 16 Oct.	weekly	92.25
3	1	15 Aug. - 15 Oct.	bi-daily	93.66
4	1	16 Aug. - 15 Oct.	daily	85.32; 87.39[b]
6	1	15 Aug. - 14 Oct.	daily	95.78
8	1	15 Aug. - 15 Oct.	weekly	84.46
10	1	13 Aug. - 16 Oct.	weekly	90.39; 93.26[c]
11	1	16 Aug. - 20 Aug.	daily	92.90
12	1	13 Aug. - 19 Oct.	weekly	84.80
13	1	13 Aug. - 19 Oct.	weekly	86.24
15	1	13 Aug. - 19 Oct.	weekly	85.59
16	2	14 Aug. - 17 Oct.	bi-weekly	78.07; 87.07[b]
16A	1	15 Aug. - 17 Oct.	weekly	74.43
17	2	14 Aug. - 17 Oct.	weekly	88.98; 85.37[b]
17D	1	14 Aug. - 19 Oct.	bi-weekly	91.47; 88.94[c]
18	1	16 Aug. - 18 Oct.	weekly	95.12
19	1	16 Aug. - 17 Aug.	daily	77.12
22	1	14 Aug. - 17 Oct.	bi-weekly	88.78

[a] Reference elevation is the elevation corresponding to a gage reading of 0.0 ft., referenced to the temporary bench mark elevation.

[b] Two reference elevations represent two staff gages; the first elevation is for gage A and the second is gage B.

[c] Two reference elevations represent two staff gages; the first elevation is for the high flow gage and the second is for the low water gage.

Table 6.25. Measured discharges at selected sites in the study area during the 1982 studies, and comparable discharges measured during the 1981 reconnaissance.

Site Number	Description	1982 Date	1982 Discharge (cfs)	1981 Date	1981 Discharge (cfs)
1	Lower Chakachatna at McArthur	10 Oct	370	26 Sept.	480
3	Lower Chakachatna below Middle	8 Oct.	350	26 Sept.	430
4	Middle below split with Chakachatna	9 Oct.	34	26 Sept.	80
6	Lower Chakachatna above Middle[a]	8 Oct.	380	22 Sept.	680
13.5	Upper McArthur at Rapids	12 Oct.	270	26 Sept.	300
15	Upper McArthur at Powerhouse[b]				
	Transect 1	12 Oct.	24	-	-
	Transect 2	12 Oct.	150	24 Sept.	12
	Transect 3	12 Oct.	93	24 Sept.	41
16	Upper Noaukta Slough below Split	10 Oct.	3400	22 Sept.	1300[c]
17d	Chakachatna below Bridge	15 Oct.	3100	-	-
18	Lower Straight Creek	15 Oct.	270	21 Sept.	50
22	Chakachatna below Canyon[a]	14 Oct.	3000	21 Sept.	5800
C	Chakachatna at Lake Outlet	10 Oct.	2900	-	-

[a] 1982 and 1981 measurements significant distance apart, but have no major tributaries entering in between.

[b] Measurements at Powerhouse location are miscellaneous measurements that are not additive; they do not represent the total McArthur River discharge at that location.

[c] Partial measurement, not all of the channels were measured.

Table 6.26. Mean daily discharges (cfs) in 1982 at three locations in the study area[a].

Date	August			September				October			
	C	13.5	6	C	13.5		6	C	13.5		6
									b	c	
1				4010	1140		690	3590	320	820	570
2				3960	1050		680	3480	310	810	550
3				3900	990		660	3410	290	780	530
4				3820	950		640	3330	270	760	510
5				3760	1550		620	3260	280	770	490
6				3840	1820		640	3170	260	730	470
7				3890	1490		660	3080	240	710	450
8				3890	1270		660	3020	230	700	430
9				3830	1150		640	2970	230	700	420
10				3780	1140		630	2900	220	690	400
11				3720	1040		610	2850	220	690	390
12	4510	1240	840	3610	940		580	2810	230	700	380
13	4530	1230	840	3540	1210		560		210	680	
14	4510	1320	840	3470	1230		540		210	670	
15	4560	1340	850	3490	2200		550		200	660	
16	4620	1250	870	3980	-		680		190	650	
17	4560	1190	850	4310	-		780				
18	4480	1180	830	4530	-		840				
19	4430	1210	810	4670	-		890				
20	4360	1230	790	4670	-		890				
21	4320	1260	780	4680	-		890				
22	4290	1220	770	4700	-		900				
23	4260	1230	760	4570	-		860				
					b	c					
24	4240	1240	760	4430	470	970	810				
25	4230	1210	750	4280	410	900	770				
26	4190	1190	740	4140	470	970	730				
27	4140	1210	730	4020	380	860	690				
28	4100	1130	710	3890	370	870	660				
29	4090	1370	710	3790	360	840	630				
30	4090	1340	710	3700	340	860	600				
31	4060	1240	700								

[a] Precision presented is for informational purposes of denoting trends and does not represent the accuracy of the data.

[b] Data computed using full cross section.

[c] Data computed using sedimented cross section.

Table 6.27. Summary of 1982 streamflow characteristics in comparison with U.S.G.S. records.

Site Number	Description	Year	Average Discharges for Period Indicated: 12 Aug.-12 Oct. Q (cfs)	12 Aug.-12 Oct. % of Avg.	12 Aug.-18 Aug. Q (cfs)	12 Aug.-18 Aug. % of Avg.	15 Sept.-21 Sept. Q (cfs)	15 Sept.-21 Sept. % of Avg.	6 Oct.-12 Oct. Q (cfs)	6 Oct.-12 Oct. % of Avg.
15294500	Chakachatna at Lake[a]	1959	7182	100	9633	76	4171	74	2514	80
		1960	5621	78	11014	87	4040	71	2044	65
		1961	7415	103	11243	89	8947	158	3099	99
		1962	7007	97	10443	82	5086	90	2060	66
		1963	8265	115	11109	87	6300	111	3194	102
		1964	7177	100	11843	93	4859	86	2410	77
		1965	10000	139	13571	107	13029	230	4950	158
		1966	7599	106	10629	84	6923	122	5359	171
		1967	9443	131	18642	147	3493	62	6357	203
		1968	6180	86	13686	108	3700	65	1796	57
		1969	4278	60	8874	70	3150	56	2867	91
		1970	5542	77	9030	71	5049	89	2576	82
		1971[d]	7748	108	25143	198	3771	67	1517	48
		1972	-	-	12971	102	6717	119	-	-
		Avg.	7189	100	12702	100	5660	100	3134	100
		Std. Dev.	1564		4359		2672		1491	
C	Chakachatna at Lake	1982	3949 -2.07[c]	55	4537 -1.87[c]	36	4333 -0.50[c]	77	2973 -0.11[c]	95
13.5	McArthur at Rapids	1982	1066[d] 892[e]	15[d] 12[e]	1250[d]	10[d]	-	-	704[d] 231[e]	22[d] 7[e]
6	Chakachatna above Middle	1982	681	9	846	7	788	14	421	13

[a]Data from U.S.G.S. records for the period 1959 to 1972.

[b]Data for 1971 is of poor quality due to a 470,000 cfs flood on 11 August which damaged the U.S.G.S. gage.

[c]Number of standard deviations of the average 1982 data from the average value for the period of record.

[d]Data computed using full cross section for entire period.

[e]Data computed using full cross section up to the flood on 15 September and sedimented cross section from 24 September to 16 October.

Table 6.28. Summary of 1982 streamflow temperature records in °C from the recording gage on the Chakachatna River at the lake outlet.

	August			September			October		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
1				8.4	8.0	8.5	7.0	7.0	7.0
2				7.9	7.5	8.0	6.9	6.5	7.0
3				8.1	7.5	8.5	6.8	6.5	7.0
4				8.0	8.0	8.0	6.5	6.5	6.5
5				6.4	5.5	7.5	6.5	6.5	6.5
6				5.6	5.5	6.0	6.0	6.0	6.0
7				8.4	8.0	8.5	6.0	6.0	6.0
8				8.5	8.5	8.5	6.1	6.0	6.5
9				7.9	7.5	8.0	6.0	6.0	6.0
10				7.0	7.0	7.0	6.0	6.0	6.0
11				7.6	7.0	8.0	6.0	6.0	6.0
12	8.1	7.5	8.5	8.0	8.0	8.0	5.9	5.5	6.0
13	8.1	8.0	8.5	6.7[a]	6.0	7.5	5.5	5.5	5.5
14	8.0	7.5	8.5	5.8	5.5	6.0			
15	8.5	8.5	8.5	6.5	6.0	7.0			
16	8.4	8.0	8.5	6.5	6.5	6.5			
17	8.5	8.5	8.5	6.5	6.5	6.5			
18	8.4	8.0	8.5	6.5	6.5	6.5			
19	8.1	8.0	8.5	6.5	6.5	6.5			
20	8.3	8.0	8.5	6.9	6.5	7.0			
21	8.0	7.5	8.5	6.6	6.5	7.0			
22	7.6	7.5	8.0	6.6	6.5	7.0			
23	7.1	7.0	7.5	7.0	7.0	7.0			
24	6.8	6.5	7.0	6.9	6.5	7.0			
25	7.5	6.5	8.0	7.0	7.0	7.0			
26	8.5	8.0	9.0	7.0	7.0	7.0			
27	8.9	8.5	9.0	7.0	7.0	7.0			
28	7.9	7.0	8.5	7.0	7.0	7.0			
29	6.1	6.0	6.5	7.0	7.0	7.0			
30	7.6	7.0	8.0	7.0	7.0	7.0			
31	8.5	8.5	8.5						

[a]Data based upon three of four readings; no data for the period 12:00-18:00.

Table 6.29. Summary of 1982 streamflow temperature records in °C from the recording gage on the McArthur River at the rapids.

	August			September			October		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
1				5.2	3.0	9.5	3.8	3.5	4.5
2				4.5	2.5	7.0	3.8	3.5	4.0
3				4.9	3.5	7.5	3.6	3.5	4.0
4				4.3	3.5	6.0	3.3	3.0	3.5
5				4.5	4.0	5.5	3.0	2.5	3.0
6				4.1	3.0	4.5	1.6	0.5	2.5
7				4.0	3.0	6.5	2.5	2.0	2.5
8				4.0	2.5	5.5	2.5	2.5	2.5
9				3.9	3.5	4.5	2.5	2.5	2.5
10				4.0	3.5	5.0	2.5	2.5	2.5
11				3.0	2.0	4.0	2.2	2.0	2.5
12				4.2	3.0	5.0	2.1	2.0	2.5
13				4.4	4.0	5.0	2.1	2.0	2.5
14				5.4[b]	4.5	7.5	2.0	1.5	2.0
15				4.2[c]	3.5	4.9	1.7	1.5	2.0
16				4.6[c]	4.1	5.2	1.9	1.5	2.0
17	5.9[a]	4.0	7.5	5.7[c]	4.7	7.4			
18	5.8	3.0	10.0	4.1[c]	3.2	5.2			
19	5.7	3.0	10.0	3.6[c]	3.3	3.9			
20	5.8	3.0	10.0	3.8[c]	3.5	4.2			
21	5.6	3.0	9.5	4.0[c]	3.6	4.6			
22	4.9	3.0	7.5	4.7[c]	3.7	5.9			
23	5.3	4.0	7.0	4.5[c]	3.7	5.2			
24	4.6	4.0	5.5	4.0[d]	3.5	4.5			
25	4.8	3.5	7.0	3.1	3.0	3.5			
26	5.2	3.0	9.5	3.9	3.0	4.5			
27	5.4	3.0	9.5	3.7	3.0	4.5			
28	4.3	3.5	5.5	3.6	3.5	4.0			
29	5.0	4.0	6.5	3.6	3.5	4.0			
30	4.2	3.5	6.0	4.0	3.5	4.5			
31	4.9	2.5	8.5						

[a]Incomplete record for the day.

[b]Recording gage dislodged by rainstorm flood.

[c]Peabody-Ryan thermograph data.

[d]Recording gage reinstalled.

Table 6.30. Summary of 1982 streamflow temperature records in °C from the recording gage on the McArthur River at the powerhouse location (Station 15).

	August			September			October		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
1				3.2	2.4	4.7			
2				3.1	1.9	4.8			
3				3.0	2.4	4.2			
4				3.1	2.4	4.5			
5				2.8	2.3	3.7			
6				2.5	2.2	2.8			
7				1.9	1.5	2.4			
8				2.2	1.2	3.8			
9				2.6	1.9	4.0			
10				2.3	1.8	2.9			
11				2.4	1.8	3.8			
12				1.8	0.5	4.1			
13				1.7	1.0	2.3			
14				2.4	2.2	2.7			
15				2.5	2.1	4.2			
16				3.5	2.5	4.9			
17									
18									
19									
20									
21	3.5	2.1	7.3						
22	3.4	2.1	5.9						
23	3.5	3.0	4.7						
24	3.4	2.9	4.2						
25	2.9	2.4	3.7						
26	2.9	1.8	4.9						
27	3.5	2.1	5.8						
28	3.4	2.4	5.7						
29	3.2	3.0	3.6						
30	2.8	2.3	4.0						
31	2.7	1.8	4.2						

Table 6.31. General substrate and sediment transport characteristics of the Chakachatna and McArthur River systems in 1982.

Reach	Representative Main Channel Substrate	Sediment Transport Characteristics
Chakachatna River in Chakachatna Canyon	Cobble/Boulder	Silts and sands are carried in suspension; gravel/cobble sizes are likely moved as bed load.
Chakachatna River from Canyon Outlet to Noaukta Slough Split	Gravel/Cobble	Silts and sands are carried in suspension; gravels are likely moved as bed load.
Upper McArthur River near Powerhouse	Sand with some gravel.	Silts and fine sands are moved in suspension; sand and small gravel may move as bed load.
Upper McArthur River at Rapids	Cobble/Boulder	Silts and sands are moved in suspension; gravel and cobbles likely moved as bed load.
McArthur River near Blockade Glacier	Sand with some areas of gravel/cobble.	Silts and fine sands are moved in suspension; course sands and small gravels are likely moved as bed load.
McArthur River below Blockade Glacier, Noaukta Slough, Lower Chakachatna River, and Middle River	Silty sand with limited areas of gravel.	Silts are carried in suspension; Sands are moved as bed load in large dune forms.

Table 6.32 Stream life of salmon from various sources

SPECIES	LITERATURE	DATA SOURCE: CARCASS[1] (Chakachatna Data by stream/station)	DATA SOURCE: TAGS (Chakachatna Data by stream/station)
Sockeye	12 days[2] 11.83 - 26.5 (weighted average = 13.8)[8]	∿12 days (17) <13 days (Chilligan) ∿5 days (12.4) ∿7 days (13x)	12 days (17) <13 days (Chilligan) 6 days (12.1) 5-7 days (13x)
Chinooks	13.1 - 7.7 days (early-late)[7]		∿10-14 days (19)
Pinks		∿6 days (13u) ∿6 days (12.1) ∿6 days (19)	∿7 days (19) ∿7 days (17) <7 days (12.1)
Chums	10 days[2]	∿8 days (C1)	10 days (C1)
	17.31 ±7.19[4] (n = 65)	<16 days (17)	9-11 days (17)
	5-9 days[5]		
	11 - 18 days[6]		
Coho	11 days † [3] 10 days	∿8 days (C1) ∿9 days (17)	9-12 days (17) <12 days (Chakachamna River Canyon) <11 days (Straight Creek Mouth

1 For areas where good counts were obtained only.

2 Bell and Atkinson (1982)

3 Wydowski and Whitney (1979)

4 Bruya (1981) - artificial spawning channels in Washington, reduced predation situation.

5 Hale, S. (1981) stream life.

6 Hale, S. (1981) freshwater life.

7 Neilsen and Green (1981) - early and late arriving spawners.

8 Barrett (1972) - stream life.

Table 6.33 Fyke Net deployment schedule for 1982

	Station[1]					
	1D	3	4	6	9	11
Date Set	Sept. 23	Sept. 19	Sept.10	Aug. 6	Sept. 26	Aug. 6
Date Pulled	Oct. 16	Oct. 17	Oct. 17	Aug. 26	Oct. 17	Aug. 7
Date Set				Sept. 10		Aug. 9
Date Pulled				Oct. 16		Aug. 26
Date Set						Sept. 14
Date Pulled						Sept. 15[2]
Date Set						Oct. 1
Date Pulled						Oct. 17

[1] See figure 6.30 for station location

[2] Net Lost

Table 6.34 Lake Chakachamna water temperatures and dissolved oxygen levels (March 22, 1982) Site 1.

Depth[1] m	Depth[1] ft	Water Temperature (°C)	Dissolved Oxygen Level (mg/l)
0	0	0.0	13.3
1.5	5	0.5	13.3
3.0	10	1.0	12.4
4.6	15	1.0	12.3
6.1	20	1.25	12.4
7.6	25	1.25	12.0
9.1	30	1.50	11.4
10.7	35	1.50	11.4
12.2	40	1.50	11.4
13.7	45	1.50	10.6
15.2	50	1.50	10.6
16.8	55	1.50	10.8
18.3	60	1.50	11.0
19.8	65	1.50	11.1
21.3	70	1.50	11.1
23.2	76	1.65	11.0
26.8	88	1.90	11.0
29.6	97	2.00	11.0
36.0	118	2.00	11.1
41.1	135	2.10	10.8

[1]Measured from water surface.

Table 6.35 Depth distribution of targets detected under the ice, density corrected percentages, 45° and 15° transducer deployments, Chakachamna Lake, March 1982.

Depth m	Depth ft	45° Deployment Site 1 % of targets	45° Deployment Site 2 % of targets	15° Deployment Site 1 % of targets	15° Deployment Site 2 % of targets
0 - 3.0	0 - 10	99.25	100.00	78.31	65.00
3.0 - 6.1	10 - 20	0.68	0.00	5.07	35.00
6.1 - 9.1	20 - 30	0.00	0.00	7.25	0.00
9.1 - 12.2	30 - 40	0.00	0.00	6.76	0.00
12.2 - 15.2	40 - 50	0.00	0.00	1.87	0.00
15.2 - 18.3	50 - 60	0.00	0.00	0.74	0.00
18.3 - 21.3	60 - 70	0.00	0.00	0.00	0.00
21.3 - 24.4	70 - 80	0.02	0.00	0.00	0.00
24.4 - 27.4	80 - 90	0.02	0.00	0.00	0.00
27.4 - 30.5	90 - 100	0.00	0.00	0.00	0.00
30.5 - 33.5	100 - 110	0.00	0.00		
33.5 - 36.6	110 - 120	0.00	0.00		
36.6 - 39.6	120 - 130	0.00	0.00		
39.6 - 42.7	130 - 140	0.00	0.00		
42.7 - 45.7	140 - 150	0.02	0.00		
45.7 - 48.8	150 - 160		0.00		
48.8 - 51.8	160 - 170		0.00		
51.8 - 54.9	170 - 180		0.00		
54.9 - 57.9	180 - 190		0.00		
57.9 - 61.0	190 - 200		0.00		
61.0 - 64.0	200 - 210		0.00		
64.0 - 67.1	210 - 220		0.00		
76.1 - 70.1	220 - 230		0.00		
70.1 - 73.2	230 - 240		0.00		
73.2 - 76.2	240 - 250		0.00		
76.2 - 79.2	250 - 260		0.00		

Table 6.36 Habitat data measured at Station 17 sloughs, March 1982.

	Station = Left Bank Slough				
	1	2	3	4	5
Distance from left bank (m)	0.3	2.4	5.2	8.5	10.6
Depth (m)	0.8	1.6	1.0	0.6	0.5
Velocity at .6 depth (m/s)	<0.01	<0.01	<0.01	<0.01	0.03
Water temperature (°C)	2.0	2.0	2.0	1.8	2.0
Dissolved Oxygen (mg/l)	12.8	12.9	13.1	13.2	13.2
	Station = Right Bank Slough				
Distance from left bank (m)	1.5	3.0	4.5		
Depth (m)	0.4	0.6	0.4		
Velocity (m/s)	0.30	0.36	0.30		

Table 6.37 Water quality data - McArthur River, winter 1982.

Station	Temperature (°C) Mean	(SD)[3]	Dissolved Oxygen (mg/l) Mean	(SD)[3]	Depth (m) Mean	(SD)[3]	Velocity (m/s) Mean	(SD)[3]
15	1.2	(0.3)	13.0	(0.1)	0.3	(0.2)	0.1	(0.0)
13	0.3	(0.1)[1]	11.1	(0.3)[1]	0.2	(0.1)	0.2	(0.1)[1]
	0.8	(0.3)[2]	11.5	(0.1)[2]			0.6	(0.3)[2]

[1]Pool
[2]Riffle
[3]Standard derivation

Table 6.38 Water quality data - Chakachatna River drainage, May 1982.

Station	Temperature (°C) Mean (SD)	Dissolved Oxygen (mg/l) Mean (SD)	Conductivity (μmho/cm) Mean (SD)	Turbidity (mg/l) Mean (SD)	pH Mean (SD)	Depth (m) Mean (SD)	Velocity (m/s) Mean (SD)
29	5.3 (0.2)	10.6 (0.2)	29.0 (0.0)	17.0 (0.0)	0.4 (0.2)	0.8 (0.4)	6.6 (0.1)
30	8.4 (0.3)	9.8 (0.4)	3.0 (0.0)	5.5 (2.1)	0.2 (0.0)	0.7 (0.2)	6.6 (0.1)
26	4.2 (0.0)	10.7 (0.0)	81.0 (0.0)	410.0 (57.0)	0.3 (-)	0.7 (-)	6.8 (0.0)
22	6.7	10.6	76.0	250.0	0.6	0.6	6.8
17d	4.6	10.7	66.0	55.0	0.6	0.8	6.8
17_{LB+2}	4.2 (0.6)	10.3 (1.1)	70.0 (7.0)	65.0 (7.1)	0.4 (0.1)	0.3 (0.3)	5.7 (0.4)
17_{LB+0}	2.3 (0.3)	9.8 (0.3)	83.0 (1.4)	23.5 (3.9)	0.4 (0.3)	0.1 (0.1)	6.0 (0.1)
5	8.4 (0.1)	8.2 (0.1)	73.7 (0.6)	36.7 (0.6)	0.2 (0.1)	0.3 (0.02)	6.4 (0.0)
10	4.7	10.4	55.0	84.0	0.5	0.2	6.7
18 Main channel	2.7	11.2	20.0	54.0	5.4	0.5	1.1
18 Side channel cove	2.7	11.1	20.0	49.0	5.0	0.2	0.6
18 Side channel riffle	2.7	11.1	20.0	53.0	5.2	0.3	0.3

Table 6.39 Water quality - McArthur drainage, May 1982.

Station	Temperature (°C) Mean (SD)	Dissolved Oxygen (mg/l) Mean (SD)	Conductivity (µmho/cm) Mean (SD)	Turbidity (mg/l) Mean (SD)	pH Mean (SD)	Depth (m) Mean (SD)	Velocity (m/s) Mean (SD)
15.5	1.1 (0.1)	11.0 (0.3)	16.3 (1.2)	86.7 (5.8)	6.5 (0.1)	0.5 (0.1)	0.3 (0.1)
15	3.5 (0.0)	10.5 (0.2)	60.0(77.3)	13.7 (1.2)	5.9 (0.1)	0.3 (0.7)	0.3 (0.1)
13	4.9 (0.0)	10.8 (0.4)	155.0 (7.1)	13.0 (0.0)	6.4 (0.1)	0.6 (0.3)	0.4 (0.1)
13u Mouth area	4.2 (0.3)	10.4 (0.1)	123.3(61.1)	10.3 (2.3)	6.5 (0.2)	0.4 (0.1)	0.2 (0.1)

1 SD = Standard Deviation

Table 6.40 Plankton net sampling for outmigrants - sample location, volume and fish densities (May 25-27, 1982).

Location (station number)	Volume sampled (m^3)	Total fish density #/100m^3	Species collected
Kenibuna Lake outlet (29)	353.08	0.0	
Chakachatna River (22)	336.03	0.55	Dolly Varden (parr), sculpin (juvenile)
McArthur River (15)	144.73	-[1]	
McArthur River tributary (13U)	132.37	0.0	
Noaukta Slough (10)	77.46	-[1]	
Chakachatna River (17D)	147.46	1.36	Dolly Varden(parr), coho salmon (parr)
Middle River (5)	-	-	
Straight Creek (18)	303.78	0.0	
Chakachatna River (17) - day	348.52	0.0	
Chakachatna River (17) - night	191.47	0.0	

[1]Net clogged.

Table 6.41 Water quality data - Chakachatna River drainage, June 8-11, 1982.

Station	Temperature (°C) Mean	(SD)	Dissolved Oxygen (mg/l) Mean	(SD)	Conductivity (µmho/cm) Mean	(SD)	Turbidity (mg/l) Mean	(SD)	pH Mean	(SD)	Depth (m) Mean	(SD)	Velocity (m/s) Mean	(SD)
31 pond	9.5		10.4		42.0		11.0		5.9		0.3	(0.1)	0.2	
31	10.4		10.3		28.0		31.0		5.8		0.6	(0.2)	0.5	(0.1)
32	7.0		11.1		14.0		4.0		6.3		0.2	(0.1)	0.4	(0.3)
33	7.2		10.8		7.0		9.0		6.1		0.8	(0.2)	0.5	(0.3)
30	4.5	(0.1)	11.8	(0.1)	16.0	(1.4)	3.5	(3.5)	5.8	(0.3)	0.5	(0.2)	0.6	(0.6)
27	4.0		11.7		21.0		16.0		5.8					
25	3.3		11.6		21.0		17.0		5.7					
24	3.2	(0.1)	12.4	(0.0)	21.5	(2.1)	71.5	(21.9)	6.5	(0.1)	0.4	(0.2)	0.5	(0.2)
22	3.8	(0.1)	12.3	(0.4)	31.7	(1.2)	336.0	(20.9)	6.2	(0.1)	0.5	(0.3)	0.4	(0.2)
20	5.3		12.4		36.0		270.0		6.6		2.1	(6.0)	0.0	(0.0)
17 main	5.1		11.9		39.0		130.0		6.3		0.2		0.4	
17 LB+2	5.8	(1.1)	11.5	(0.5)	59.7	(23.4)	60.7	(60.6)	6.1	(0.2)	0.2	(0.3)	0.2	(0.1)
1	8.5	(0.4)	10.7	(0.3)	53.0	(1.4)	113.0	(79.2)	5.9	(0.4)	0.4	(0.2)	0.4	(0.1)
5	7.7	(0.1)	10.3	(0.8)	38.5	(2.1)	52.0	(63.6)	6.0	(0.1)	0.4	(0.3)	0.2	(0.1)
16A	4.6		12.3		29.0		470.0		6.0		0.3	(0.2)	0.2	(0.3)
10	5.1		11.5		34.0		162.0		6.2		0.5	(0.2)	0.3	(0.3)
18	3.8	(0.1)	12.1	(0.2)	13.0	(0.0)	197.5	(24.7)	5.8	(0.0)	0.3	(0.1)	0.9	(0.7)

Table 6.42 Water quality data - McArthur River drainage, June 8-11, 1982.

Station	Temperature (°C) Mean (SD)	Dissolved Oxygen (mg/l) Mean (SD)	Conductivity (µmho/cm) Mean (SD)	Turbidity (mg/l) Mean (SD)	pH Mean (SD)	Depth (m) Mean (SD)	Velocity (m/s) Mean (SD)
15 upper	3.4	11.5	2.0	55.0	6.6	0.3 (0.1)	0.6 (0.1)
15 lower	3.8 (0.4)	10.9 (0.1)	3.0 (2.8)	38.0 (7.1)	6.5 (0.1)	0.3 (0.1)	0.8 (0.2)
13	4.3	11.6	9.0	126.0	6.8	0.4 (0.1)	0.3 (0.1)
12	4.6	11.6	10.0	141.0	6.1	0.6 (0.3)	0.3 (0.1)
11.5	5.7	10.8	42.0	105.0	6.3	0.7	0.4
11	5.9	11.2	42.0	105.0	6.7	0.3 (0.1)	0.4 (0.4)
1D	6.4	10.8	17.0	171.0	5.9	0.3 (0.1)	0.3 (0.1)

Table 6.43 Estimated escapement of chinook salmon, 1982.

Waterbody	Estimated Escapement 1	Estimated Escapement 2
Chakachatna Drainage		
Straight Creek - Clearwater Tributary (19)	1422	1099
McArthur Drainage		
Stream 13x	452	268
13u	1633	1186
12.2	-	22[3]
Totals		
Chakachatna Drainage	1422	1099
McArthur Drainage	2107	1476

[1]Based upon 12 day stream life.

[2]Based upon count of live and dead fish.

[3]Included in drainage estimate totals.

Table 6.44 Estimated escapement of sockeye salmon, 1982.

Waterbody	Estimated Escapement 1	2	3
Chakachatna Drainage			
Chilligan River	38,576		
Igitna River	2,781		
Chakachatna Canyon Sloughs	392		
Chakachatna Tributary (C1)	238		
Straight Creek Mouth	203		
Straight Creek - Clearwater Tributary (19)	254		
Chakachatna Bridge Sloughs	1,193		
McArthur Drainage			
McArthur Canyon	333	666	
Stream 13X	2,708	5,416	3,223
Stream 13U	606	1,213	
Stream 12.1	8,356	16,711	
Stream 12.2	3,042	6,085	
Stream 12.3	1,256	2,512	
Stream 12.4	1,164	2,328	
Stream 12.5	-	-	2[4]
TOTALS:			
Chakachatna Drainage	43,637		
McArthur Drainage	17,467	34,933	

[1]Based upon 12 day stream life.

[2]Based upon 6 day stream life.

[3]Based upon peak count.

[4]Included in drainage total estimates.

Table 6.45 Estimated escapement of pink salmon, 1982.

Waterbody	Estimated Escapement 1	2
Chakachatna Drainage		
Chakachatna Canyon Sloughs	279	
Chakachatna Tributary (C1)	0	
Straight Creek - Clearwater Tributary	7925	
Chakachatna Bridge Sloughs	59	
McArthur Drainage		
McArthur Canyon	56	60[3]
Stream 13x	4225	
13u	5402	
Stream 12.1	8499	
Stream 12.2	1566	
Stream 12.3		4[3]
Stream 12.4		18[3]
Stream 12.5		3[3]
Totals		
Chakachatna Drainage	8263	
McArthur Drainage	19777	

[1] Based upon 7 = day stream life.
[2] Based upon count of live and dead fish.
[3] Included in drainage estimate total.

Table 6.46 Estimated escapement of chum salmon, 1982.

Waterbody	Estimated Escapement 1	2
Chakachatna Drainage		
Chakachatna Canyon Sloughs	121	
Chakachatna Tributary (C1)	165	
Straight Creek Mouth	152	
Chakachatna Bridge Sloughs	1482	
McArthur Drainage		
McArthur Canyon		1[3]
Stream 13U	23	
Stream 12.1		4[3]
Stream 12.4		1[3]
Totals		
Chakachatna Drainage	1920	
McArthur Drainage	29	

[1] Based upon 10 day stream life.
[2] Based upon peak on total counts.
[3] Included in drainage estimate total.

Table 6.47. Estimated escapement of coho salmon, 1982.

Waterbody	Estimated Escapement 1	Estimated Escapement 2
Chakachatna Drainage		
Chakachatna Canyon Sloughs	608	
Chakachatna Tributary (C1)	183	
Straight Creek Mouth	76	
Straight Creek - Clearwater Tributary	172	
Chakchanta Bridge Sloughs	1560	
McArthur Drainage		
McArthur Canyon	1182	
Stream 13X	1378	
Stream 13U	32	
Stream 12.1	2000	
Stream 12.2	46	
Stream 12.3	89	
Stream 12.5		2[3]
Totals		
Chakachatna Drainage	2599	
McArthur Drainage	4729	

[1]Based upon 10 days stream life.

[2]Based upon peak count (live and dead fish).

[3]Included in drainage estimate total.

Table 6.48 Percent species composition of fish collected for all fyke net combined. - 1982

Species	Percent Composition			
	August	September	October	August-October
Dolly Varden	83.4	72.7	59.4	66.8
Coho salmon	2.9	8.6	15.8	12.4
Rainbow trout	1.6	11.8	14.6	11.84
Round whitefish	0.8	2.1	3.3	2.7
Pygmy whitefish	1.5	1.5	3.5	2.7
Bering cisco	0.0	1.2	0.9	0.9
Slimy sculpin	1.9	0.4	0.8	0.8
Three-spine stickleback	4.6	0.0	0.0	0.4
Chum salmon	0.0	1.1	0.1	0.4
Longfin smelt	0.0	0.0	0.6	0.3
Pink salmon	3.3	0.0	0.0	0.3
Eulachon	0.0	0.3	0.3	0.3
Chinook salmon	0.0	0.2	0.02	0.07
Sockeye salmon	0.0	0.1	0.02	0.07
Rainbow smelt	0.0	0.0	0.02	0.01

Table 6.49 Percentage species composition of fish collected in fyke net 6, Chakachatna River. - 1982[1]

Species	Percent Composition		
	August	September	October
Dolly Varden	89.57	77.57	55.43
Coho salmon	0.54	5.14	23.93
Rainbow trout	1.62	10.00	12.38

[1]only net set continuously during sampling

Table 6.50 Monthly catch per effort values for all lifestages of major species collected by fyke nets - 1982

Species	Catch Per Effort (All Nets)		
	August	September	October
Dolly Varden	33.50	78.87	155.8
Coho salmon	1.15	12.82	41.5
Rainbow trout	0.63	17.64	38.3

Species	Catch Per Effort (Net 6)[1]		
	August	September	October
Dolly Varden	24.90	15.10	67.2
Coho salmon	0.15	1.00	29.0
Rainbow trout	0.45	1.95	15.0

[1]only net set continuously during sampling

Table 6.51 Percentage of total fyke net catch per effort represented by sub-adults of all species - 1982.

	% of Total August	% of Total September	% of Total October
Chakachatna (Net 6)	43.5	57.6	79.9
Chakachatna (Net 3)	*	53.2	63.7
McArthur (Net 11)	79.5	+	71.5
McArthur (Net 1D)	*	85.6	65.26
Noaukta Slough (Net 9)	*	49.4	47.6
Middle River (Net 4)	*	59.0	66.6

* Not Sampled
\+ Net Lost

Table 6.52 Species composition by location Fyke Nets - 1982

Species	McArthur River Stations 1 & 11	Chakachatna River Stations 3 & 6	Middle River Station 4	Noaukta Slough Station 9
Dolly Varden	74.0	61.5	69.6	72.9
Coho salmon	9.4	16.2	7.3	7.7
Rainbow trout	4.5	13.2	19.8	9.5
Round whitefish	1.3	3.6	0.6	4.1
Pygmy whitefish	0.3	3.8	1.5	3.8
Bering cisco	4.4	0.0	0.0	0.0
Slimy sculpin	0.5	0.9	1.0	0.3
Threespine stickleback	1.8	0.04	0.0	0.0
Chum salmon	0.9	0.1	0.2	0.9
Longfin smelt	1.6	0.0	0.0	0.0
Pink salmon	0.1	0.5	0.0	0.0
Eulachon	1.2	0.0	0.0	0.3
Chinook salmon	0.0	0.03	0.1	0.5
Sockeye salmon	0.0	0.1	0.2	0.0
Rainbow smelt	0.1	0.0	0.0	0.0

Table 6.53 Percentage of species - specific catch per effort (c/f) represented by each lifestage for major species collected by fyke net 6 - 1982[1].

	Percent of c/f by Life Stage		
	August	September	October
Dolly Varden	c/f=24.9	c/f=15.1	c/f=67.2
Parr	1.8	1.4	0.2
Juvenile	40.6	59.6	85.0
Adult	56.2	39.0	14.9
Coho salmon	c/f= 0.2	c/f= 1.0	c/f=29.01
Parr	0.0	58.0	97.45
Juvenile	0.0	0.0	2.3
Adult	100.0	42.0	0.2
Rainbow trout	c/f= 0.5	c/f= 2.0	c/f=15.01
Parr	11.1	2.6	0.5
Juvenile	33.3	29.7	53.8
Adult	55.6	67.7	45.8

[1]only net set continuously throughout sampling

Table 6.54 Mean ($\bar{X}$) and standard error (SE) for catch per effort - values for all lifestages of major species collected by fyke net - 1982.

Species	McArthur River $\bar{X}$	McArthur River SE	Chakachatna River $\bar{X}$	Chakachatna River SE	Middle River $\bar{X}$	Middle River SE	Noaukta River $\bar{X}$	Noaukta River SE
Dolly Varden	17.6	7.2	28.4	10.1	23.2	9.0	19.7	10.1
Coho salmon	2.4	1.2	7.5	5.5	2.4	1.3	2.1	1.7
Rainbow trout	1.1	0.4	6.1	2.6	6.6	4.7	2.6	0.9

Table 6.55 Results of mark and recapture of Dolly Varden (DV) and rainbow trout (RT) on the McArthur-Chakachatna system. Fish tagged at fyke net stations - 1982

Recapture Station	Tagging Station 1	3	4	6	9	11
1	4 DV	1 RT 2 DV	1 RT 7 DV	3 DV		
2						
3	3 DV	4 RT 11 DV		3 RT 7 DV		2 DV
4		2 DV	9 RT 24 DV	1 RT 5 DV		
5			1 RT			
6	3 DV	4 RT 9 DV	9 RT 28 DV	2 RT 21 DV	1 RT	1 DV
9	2 DV				1 RT 2 DV	1 DV
11	2 DV	2 RT		1 RT 37 DV		3 DV
12.1			2 DV	1 DV		

Note: ___ indicates that fish were recaptured at same station as marked.

TABLE 6.56. CATCH PER EFFORT: MINNOW TRAP SAMPLES
AUGUST, 1982

STATION	DATE	SPECIES	LIFE STAGE	NUMBER OF REPLICATES	CATCH/ EFFORT	LENGTH (CM) MEAN	S.D.	N
0006	100882	DOLLY VARDEN	PARR	4	0.50	8.00	0.00	1
		SLIMY SCULPIN		4	0.50	0.00	0.00	0
	110882	DOLLY VARDEN	PARR	3	1.40	11.58	1.79	5
		DOLLY VARDEN	JUVENILE	3	0.33	13.70	0.00	1
		SLIMY SCULPIN	JUVENILE	3	0.67	7.70	0.42	2
0010	150882	DOLLY VARDEN	PARR	3	2.00	8.05	1.63	6
		SLIMY SCULPIN	JUVENILE	3	1.00	7.33	0.71	3
0011	110882	DOLLY VARDEN	PARR	4	2.00	11.76	1.80	8
		THREESPINE STICKLEBACK	ADULT	4	1.50	8.02	0.75	6
0013	170882	DOLLY VARDEN	PARR	4	1.50	8.88	2.14	6
		COHO SALMON	PARR	4	0.25	5.40	0.00	1
0016	160882	DOLLY VARDEN	PARR	5	2.00	9.03	0.95	10
		DOLLY VARDEN	JUVENILE	5	0.20	14.20	0.00	1
		SLIMY SCULPIN	JUVENILE	5	0.80	7.40	0.45	4
0019	130882	DOLLY VARDEN	PARR	10	5.60	9.22	2.06	54
		COHO SALMON	PARR	10	2.70	6.10	1.49	26
		CHINOOK SALMON	PARR	10	3.20	5.82	0.48	31
		CHINOOK SALMON	JUVENILE	10	0.10	14.00	0.00	1
		RAINBOW TROUT	PARR	10	0.40	7.60	1.01	4
		SLIMY SCULPIN	JUVENILE	10	0.50	8.00	0.61	5
		SLIMY SCULPIN	ADULT	10	0.20	12.60	4.10	2
0022	160882	DOLLY VARDEN	PARR	3	3.00	10.30	2.03	9
		SLIMY SCULPIN	JUVENILE	3	0.67	9.70	0.00	2
0023	140882	DOLLY VARDEN	PARR	3	2.67	10.00	2.07	8
		DOLLY VARDEN	JUVENILE	3	0.33	13.10	0.00	1
006A	240882	DOLLY VARDEN	JUVENILE	3	5.33	11.57	1.88	15
		DOLLY VARDEN	ADULT	3	1.33	14.75	0.59	4

TABLE 6.56. CATCH PER EFFORT: MINNOW TRAP SAMPLES
AUGUST, 1982

STATION	DATE	SPECIES	LIFE STAGE	NUMBER OF REPLICATES	CATCH/ EFFORT	LENGTH (CM) MEAN	S.D.	N
006A	240882	SLIMY SCULPIN	JUVENILE	3	0.67	8.80	1.70	2
		SLIMY SCULPIN	ADULT	3	0.33	9.00	0.00	1
016A	160882	DOLLY VARDEN	PARR	2	4.50	11.29	2.05	9

TABLE 6.57. CATCH PER EFFORT: MINNOW TRAP SAMPLES
SEPTEMBER,1982

STATION	DATE	SPECIES	LIFE STAGE	NUMBER OF REPLICATES	CATCH/ EFFORT	LENGTH (CM) MEAN	S.D.	N
0001	140982	DOLLY VARDEN	PARR	4	1.00	9.53	1.75	4
		COHO SALMON	PARR	4	0.25	6.80	0.00	1
0002	140982	DOLLY VARDEN	PARR	4	0.25	9.30	0.00	1
		COHO SALMON	PARR	4	1.25	6.50	1.57	5
		PYGMY WHITE FISH	PARR	4	0.25	6.10	0.00	1
		SLIMY SCULPIN	JUVENILE	4	0.25	7.20	0.00	1
		THREESPINE STICKLEBACK	ADULT	4	0.25	8.60	0.00	1
0003	140982	DOLLY VARDEN	PARR	4	0.50	9.55	1.34	2
		DOLLY VARDEN	JUVENILE	4	0.25	12.90	0.00	1
		COHO SALMON	PARR	4	0.75	7.03	1.11	3
0004	200982	DOLLY VARDEN	PARR	4	1.25	10.14	0.42	5
		DOLLY VARDEN	JUVENILE	4	0.25	14.10	0.00	1
		SLIMY SCULPIN	JUVENILE	4	0.25	8.20	0.00	1
		SLIMY SCULPIN	ADULT	4	0.50	9.80	1.13	2
0005	200982	SLIMY SCULPIN	ADULT	4	0.75	9.53	0.68	3
		THREESPINE STICKLEBACK	JUVENILE	4	0.25	5.70	0.00	1
		THREESPINE STICKLEBACK	ADULT	4	0.25	8.40	0.00	1
0006	200982	SLIMY SCULPIN	JUVENILE	2	2.50	6.46	1.74	5
0008	210982	DOLLY VARDEN	PARR	4	0.50	7.30	1.41	2
		DOLLY VARDEN	JUVENILE	4	0.25	14.10	0.00	1
		COHO SALMON	PARR	4	0.25	5.90	0.00	1
0009	230982	DOLLY VARDEN	PARR	4	1.50	11.20	1.65	6
		DOLLY VARDEN	JUVENILE	4	0.50	14.35	0.07	2
		PYGMY WHITE FISH	JUVENILE	4	0.25	10.00	0.00	1
		SLIMY SCULPIN	JUVENILE	4	0.25	4.90	0.00	1
0010	230982	PYGMY WHITE FISH	JUVENILE	4	0.75	9.33	0.23	3
		SLIMY SCULPIN	ADULT	4	0.50	9.90	1.41	2

TABLE 6.57. CATCH PER EFFORT: MINNOW TRAP SAMPLES
SEPTEMBER, 1982

STATION	DATE	SPECIES	LIFE STAGE	NUMBER OF REPLICATES	CATCH/ EFFORT	LENGTH (CM) MEAN	S.D.	N
0011	120982	COHO SALMON	PARR	4	4.00	7.24	2.28	16
		SLIMY SCULPIN	JUVENILE	4	0.25	3.60	0.00	1
		SLIMY SCULPIN	ADULT	4	0.25	10.30	0.00	1
		THREESPINE STICKLEBACK	JUVENILE	4	2.00	5.18	0.58	8
		THREESPINE STICKLEBACK	ADULT	4	0.25	7.80	0.00	1
0012	120982	DOLLY VARDEN	PARR	4	1.75	10.50	2.82	7
		SOCKEYE SALMON	PARR	4	1.00	7.18	1.40	4
		SLIMY SCULPIN	JUVENILE	4	0.25	7.20	0.00	1
		NINESPINE STICKLEBACK	ADULT	4	0.50	5.50	0.14	2
0013	120982	DOLLY VARDEN	PARR	4	4.50	7.60	1.95	18
		COHO SALMON	PARR	4	0.25	5.00	0.00	1
0014	120982	DOLLY VARDEN	PARR	4	4.50	8.76	1.74	18
0015	120982	DOLLY VARDEN	PARR	4	0.75	9.07	1.01	3
0016	210982	DOLLY VARDEN	PARR	3	0.33	9.10	0.00	1
0017	250982	DOLLY VARDEN	PARR	4	2.00	9.85	3.24	8
		SLIMY SCULPIN	JUVENILE	4	0.50	5.25	0.35	2
0018	250982	DOLLY VARDEN	PARR	3	5.33	9.08	2.54	10
		DOLLY VARDEN	JUVENILE	3	0.33	14.00	0.00	1
		COHO SALMON	PARR	3	4.67	6.66	0.81	13
		CHINOOK SALMON	PARR	3	0.33	6.80	0.00	1
0019	250982	DOLLY VARDEN	PARR	4	0.75	7.27	1.19	3
		DOLLY VARDEN	JUVENILE	4	0.25	13.80	0.00	1
		SLIMY SCULPIN	JUVENILE	4	0.25	7.30	0.00	1
0020	250982	DOLLY VARDEN	PARR	3	4.33	7.21	1.84	12
		DOLLY VARDEN	JUVENILE	3	0.67	12.60	1.98	2
		COHO SALMON	PARR	3	0.67	8.10	0.14	2

TABLE 6.57 . CATCH PER EFFORT: MINNOW TRAP SAMPLES
SEPTEMBER, 1982

STATION	DATE	SPECIES	LIFE STAGE	NUMBER OF REPLICATES	CATCH/ EFFORT	LENGTH (CM) MEAN	S.D.	N
0020	250982	SOCKEYE SALMON	PARR	3	0.33	8.00	0.00	1
0021	240982	DOLLY VARDEN	PARR	4	1.75	10.53	1.63	6
		DOLLY VARDEN	JUVENILE	4	0.25	13.20	0.00	1
0022	240982	DOLLY VARDEN	PARR	4	0.50	10.90	0.28	2
		DOLLY VARDEN	JUVENILE	4	0.50	14.25	0.07	2
0023	240982	DOLLY VARDEN	PARR	6	0.17	11.80	0.00	1
		DOLLY VARDEN	JUVENILE	6	0.83	13.66	1.67	5
0024	240982	DOLLY VARDEN	PARR	4	1.00	9.73	2.09	4
		DOLLY VARDEN	JUVENILE	4	0.25	12.80	0.00	1
		LAKE TROUT	PARR	4	0.50	7.80	0.14	2
006A	230982	DOLLY VARDEN	PARR	4	1.25	11.12	1.41	5
016A	210982	DOLLY VARDEN	PARR	8	5.50	11.67	2.16	44
		DOLLY VARDEN	JUVENILE	8	0.62	13.54	0.62	5
		COHO SALMON	PARR	8	1.13	7.28	1.13	9
		SOCKEYE SALMON	PARR	8	0.50	7.48	0.74	4
		SLIMY SCULPIN	JUVENILE	8	0.12	7.60	0.00	1
		SLIMY SCULPIN	ADULT	8	0.25	8.55	0.21	2
		NINESPINE STICKLEBACK	JUVENILE	8	0.50	5.68	0.33	4
		NINESPINE STICKLEBACK	ADULT	8	0.25	7.40	0.28	2
017D	220982	DOLLY VARDEN	PARR	4	1.50	9.48	0.99	6
		SLIMY SCULPIN	JUVENILE	4	0.25	7.70	0.00	1
		SLIMY SCULPIN	ADULT	4	0.25	10.80	0.00	1

TABLE 6.58. CATCH PER EFFORT: MINNOW TRAP SAMPLES
OCTOBER, 1982

STATION	DATE	SPECIES	LIFE STAGE	NUMBER OF REPLICATES	CATCH/ EFFORT	LENGTH (CM) MEAN	S.D.	N
0001	161082	DOLLY VARDEN	PARR	4	0.50	10.45	3.04	2
		COHO SALMON	PARR	4	6.00	8.02	2.01	24
		PYGMY WHITE FISH	PARR	4	0.25	5.40	0.00	1
		SOCKEYE SALMON	PARR	4	2.25	6.26	0.54	9
		SOCKEYE SALMON	JUVENILE	4	0.50	5.60	1.41	2
		SLIMY SCULPIN	JUVENILE	4	0.25	4.90	0.00	1
		NINESPINE STICKLEBACK		4	4.75	0.00	0.00	0
		NINESPINE STICKLEBACK	JUVENILE	4	28.75	5.33	0.65	35
		NINESPINE STICKLEBACK	ADULT	4	4.50	6.89	0.48	8
0002	151082	DOLLY VARDEN	PARR	3	0.33	6.10	0.00	1
		COHO SALMON	PARR	3	0.33	12.40	0.00	1
		PYGMY WHITE FISH	PARR	3	0.33	6.40	0.00	1
		SOCKEYE SALMON	PARR	3	0.33	6.10	0.00	1
		SLIMY SCULPIN	JUVENILE	3	2.00	5.13	0.79	6
		SLIMY SCULPIN	ADULT	3	0.33	10.90	0.00	1
		NINESPINE STICKLEBACK	JUVENILE	3	4.67	5.66	0.67	14
0003	151082	DOLLY VARDEN	PARR	4	1.00	8.85	1.31	4
		COHO SALMON	PARR	4	0.25	14.40	0.00	1
		SLIMY SCULPIN	JUVENILE	4	1.25	6.24	1.26	5
0004	151082	DOLLY VARDEN	PARR	4	0.50	10.25	2.33	2
		DOLLY VARDEN	JUVENILE	4	0.75	8.80	0.85	2
		COHO SALMON	PARR	4	0.25	6.10	0.00	1
		SOCKEYE SALMON	PARR	4	0.25	5.90	0.00	1
		SLIMY SCULPIN	JUVENILE	4	0.25	8.10	0.00	1
		SLIMY SCULPIN	ADULT	4	0.25	9.10	0.00	1
0005	151082	COHO SALMON	PARR	2	1.00	6.50	2.69	2
		COHO SALMON	JUVENILE	2	0.50	6.30	0.00	1
		SOCKEYE SALMON	PARR	2	1.00	6.50	0.42	2
		NINESPINE STICKLEBACK	JUVENILE	2	2.00	4.75	0.61	4
		NINESPINE STICKLEBACK	ADULT	2	0.50	7.70	0.00	1
0006	151082	DOLLY VARDEN	PARR	4	0.25	5.70	0.00	1
		DOLLY VARDEN	JUVENILE	4	0.25	14.30	0.00	1
		COHO SALMON	PARR	4	0.25	13.00	0.00	1
		PYGMY WHITE FISH	JUVENILE	4	0.25	9.20	0.00	1

TABLE 6.58. CATCH PER EFFORT: MINNOW TRAP SAMPLES
OCTOBER, 1982

STATION	DATE	SPECIES	LIFE STAGE	NUMBER OF REPLICATES	CATCH/ EFFORT	LENGTH (CM) MEAN	S.D.	N
0006	151082	SLIMY SCULPIN	JUVENILE	4	1.50	6.15	1.30	6
		SLIMY SCULPIN	ADULT	4	0.50	9.75	1.48	2
		NINESPINE STICKLEBACK	JUVENILE	4	0.25	5.40	0.00	1
0008	151082	DOLLY VARDEN	PARR	4	3.75	10.68	1.18	15
		DOLLY VARDEN	JUVENILE	4	0.50	13.60	0.42	2
		COHO SALMON	PARR	4	1.75	7.30	1.84	7
		SLIMY SCULPIN	JUVENILE	4	0.25	6.90	0.00	1
		NINESPINE STICKLEBACK	JUVENILE	4	0.75	5.50	0.69	3
0009	171082	DOLLY VARDEN	PARR	4	1.50	8.58	3.56	6
		DOLLY VARDEN	JUVENILE	4	0.25	16.30	0.00	1
		COHO SALMON	PARR	4	0.50	6.65	0.64	2
		PYGMY WHITE FISH	PARR	4	0.50	6.30	0.00	2
		PYGMY WHITE FISH	ADULT	4	0.25	10.30	0.00	1
		SOCKEYE SALMON	PARR	4	0.50	7.80	1.98	2
		SLIMY SCULPIN	JUVENILE	4	0.50	6.70	2.12	2
0010	161082	DOLLY VARDEN	PARR	4	1.50	10.98	1.83	6
		DOLLY VARDEN	JUVENILE	4	0.75	13.87	0.58	3
		COHO SALMON	PARR	4	0.50	9.95	2.76	2
		SLIMY SCULPIN	JUVENILE	4	0.50	7.00	0.28	2
		SLIMY SCULPIN	ADULT	4	1.00	9.75	0.72	4
0011	161082	COHO SALMON	PARR	4	0.75	7.63	0.76	3
		SOCKEYE SALMON	PARR	4	0.25	7.30	0.00	1
		NINESPINE STICKLEBACK	JUVENILE	4	0.25	4.70	0.00	1
0012	191082	DOLLY VARDEN	PARR	4	0.50	7.95	2.62	2
0013	191082	DOLLY VARDEN	PARR	4	0.50	8.70	2.26	2
		SLIMY SCULPIN	JUVENILE	4	0.25	8.70	0.00	1
0014	191082	DOLLY VARDEN	PARR	4	6.25	9.16	2.16	25
		COHO SALMON	PARR	4	2.75	6.90	0.66	11
		SLIMY SCULPIN	JUVENILE	4	0.75	7.77	0.49	3
		NINESPINE STICKLEBACK	JUVENILE	4	0.25	6.80	0.00	1

TABLE 6.58. CATCH PER EFFORT: MINNOW TRAP SAMPLES
OCTOBER, 1982

STATION	DATE	SPECIES	LIFE STAGE	NUMBER OF REPLICATES	CATCH/ EFFORT	LENGTH (CM) MEAN	S.D.	N
0015	191082	DOLLY VARDEN	PARR	4	5.75	8.05	2.07	23
		DOLLY VARDEN	JUVENILE	4	0.25	16.70	0.00	1
		COHO SALMON	PARR	4	0.25	7.80	0.00	1
0016	171082	DOLLY VARDEN	PARR	4	0.25	11.70	0.00	1
		DOLLY VARDEN	JUVENILE	4	1.25	14.80	0.99	5
		SLIMY SCULPIN	ADULT	4	0.25	10.10	0.00	1
0017	171082	DOLLY VARDEN	PARR	4	0.50	8.70	2.83	2
		SLIMY SCULPIN	JUVENILE	4	0.25	5.20	0.00	1
0018	181082	DOLLY VARDEN	PARR	4	0.25	8.40	0.00	1
		COHO SALMON	PARR	4	0.25	5.60	0.00	1
0019	181082	COHO SALMON	PARR	4	0.50	6.40	0.99	2
		CHINOOK SALMON	PARR	4	0.50	7.05	0.07	2
		NINESPINE STICKLEBACK	JUVENILE	4	0.25	5.30	0.00	1
0021	181082	DOLLY VARDEN	PARR	4	0.50	11.60	0.14	2
		DOLLY VARDEN	JUVENILE	4	0.75	14.43	1.17	3
		PYGMY WHITE FISH	ADULT	4	0.25	12.80	0.00	1
		SLIMY SCULPIN	ADULT	4	0.25	11.50	0.00	1
0022	181082	DOLLY VARDEN	PARR	4	0.50	13.10	0.14	2
		SLIMY SCULPIN	JUVENILE	4	0.25	5.20	0.00	1
006A	171082	DOLLY VARDEN	PARR	3	1.00	10.07	2.39	3
		PYGMY WHITE FISH	JUVENILE	3	0.33	10.00	0.00	1
016A	171082	DOLLY VARDEN	PARR	4	0.25	10.30	0.00	1
		COHO SALMON	PARR	4	3.50	8.00	2.16	14
		COHO SALMON	JUVENILE	4	0.25	6.30	0.00	1
		SLIMY SCULPIN	JUVENILE	4	2.00	6.96	0.56	8
		SLIMY SCULPIN	ADULT	4	0.25	7.60	0.00	1
		NINESPINE STICKLEBACK	JUVENILE	4	6.25	5.86	0.77	25
		NINESPINE STICKLEBACK	ADULT	4	2.75	7.27	0.36	11

TABLE 6.58. CATCH PER EFFORT: MINNOW TRAP SAMPLES
OCTOBER, 1982

STATION	DATE	SPECIES	LIFE STAGE	NUMBER OF REPLICATES	CATCH/ EFFORT	LENGTH (CM) MEAN	S.D.	N
017D	191082	DOLLY VARDEN	PARR	4	2.25	11.38	1.98	9
		COHO SALMON	PARR	4	0.25	12.70	0.00	1
		SLIMY SCULPIN	JUVENILE	4	1.75	5.91	1.04	7
		SLIMY SCULPIN	ADULT	4	0.50	9.25	0.07	2

Table 6.59 Dolly Varden parr catch per effort using minnow traps 1982.[1]

Station	August	September	October
1	-	1.00	0.50
2	-	0.25	0.33
3	-	1.25	1.00
4	-	1.25	0.50
5	-	0.00	0.00
6	2.83	0.00	0.25
6A	0.00	1.25	1.00
8	-	0.50	3.75
9	-	1.50	1.50
10	1.50	0.00	1.50
11	2.00	0.00	0.00
12	-	1.75	0.50
13	1.50	4.50	0.50
14	-	4.50	6.25
15	-	0.75	5.75
16	2.00	0.25	0.25
16A	4.50	5.50	0.25
17	-	2.00	0.50
17D	-	1.50	2.25
18	-	4.00	0.00
19	5.60	0.75	0.00
20	-	2.60	0.00
21	-	1.75	0.50
22	3.00	0.50	0.50
23	2.00	0.17	-
24	-	1.00	0.00

- not fished

[1]fish/trap/day

Table 6.60 Dolly Varden juveniles catch per effort using minnow traps 1982.

Station	August	September	October
1	-	0.00	0.00
2	-	0.00	0.00
3	-	0.25	0.00
4	-	0.25	0.75
5	-	0.00	0.00
6	0.50	0.00	0.25
6A	5.33	0.00	0.00
8	-	0.25	0.50
9	-	0.50	0.25
10	0.00	0.00	0.75
11	0.00	0.00	0.00
12	-	0.00	0.00
13	0.00	0.00	0.00
14	-	0.00	0.00
15	-	0.00	0.25
16	0.20	0.00	1.25
16A	0.00	0.62	0.00
17	-	0.00	0.00
17D	-	0.00	0.00
18	-	0.25	0.00
19	0.00	0.25	0.00
20	-	0.40	0.00
21	-	0.25	0.75
22	0.00	0.50	0.00
23	0.25	0.83	-
24	-	0.25	0.00

\- not fished

Table 6.61 Dolly Varden juvenile and parr catch per effort using minnow traps 1982.[1]

Station	August	September	October
1	-	1.00	0.50
2	-	0.25	0.33
3	-	1.50	1.00
4	-	1.50	1.25
5	-	0.00	0.00
6	3.33	0.00	0.50
6A	5.33	1.25	1.00
8	-	0.75	4.25
9	-	2.00	1.75
10	1.50	0.00	2.25
11	2.00	0.00	0.00
12	-	1.75	0.50
13	1.50	4.50	0.50
14	-	4.50	6.25
15	-	0.75	6.00
16	2.20	0.25	1.50
16A	4.50	6.12	0.50
17	-	2.00	0.25
17D	-	1.50	2.25
18	-	4.25	0.25
19	5.60	1.00	0.00
20	-	3.00	0.00
21	-	2.00	1.25
22	3.00	1.00	0.50
23	2.25	1.00	-
24	-	1.25	0.00

- not fished

[1]fish/trap/day

Table 6.62 Percentage incidence of juveniles of important salmonid species by month for all collection gear, sampling stations downstream of Chakachamna Lake - 1982.

Species	August	September	October
Dolly Varden	95.0	80.8	92.3
Coho salmon	60.0	46.2	61.5
Chinook salmon	15.0	11.5	11.5
Sockeye salmon	30.0	26.9	34.6
Rainbow trout	15.0	23.1	23.1
Pygmy whitefish	30.0	38.5	46.2

Table 6.63 Mean c/f for each reach by month for juvenile Dolly Varden and coho salmon - 1982.[1]

	Dolly Varden (parr 7 juveniles)			Coho Salmon (parr)		
	Aug	Sept	Oct	Aug	Sept	Oct
Upper Chakachatna River (Canyon)	2.63	1.08	0.25	0.00	0.00	0.00
Mid-Chakachatna River	-	2.13	1.00	-	0.10	0.06
Noaukta Slough	2.73	1.08	2.00	0.00	0.28	1.30
Lower Chakachatna River	3.05	0.63	0.68	0.00	0.52	0.31
Upper McArthur River	1.50	3.25	4.25	0.13	0.08	1.00
Lower McArthur River	2.00	1.42	0.33	0.00	1.42	2.25
Chakachatna Tributaries	5.60	2.63	0.13	2.70	1.75	0.38

Upper Chakachatna River (Canyon)	Stations 22, 23, 24
Mid-Chakachatna River	Stations 17, 17D, 20, 21
Noaukta Slough	Stations 8, 9, 10, 16, 16A
Lower Chakachatna River	Stations 1, 2, 3, 4, 5, 6, 6A
Upper McArthur River	Stations 13, 14, 15
Lower McArthur River	Stations 1D(1), 11, 12
Chakachatna Tributaries	Stations 18, 19

Table 6.64 Percentage of total catch of minnow trap captures based on catch/effort 1982.[1]

SPECIES	August	September	October
Dolly Varden	70.6	61.8	24.7
Coho salmon	6.6	17.3	14.2
Chinook salmon	7.3	0.4	0.4
Rainbow trout	0.9	0.0	0.0
Threespine stickleback	3.3	4.4	0.0
Slimy sculpin	12.0	9.0	11.8
Sockeye	0.0	2.5	3.6
Pygmy whitefish	0.0	1.8	1.7
Ninespine stickleback	0.0	1.8	42.9
Lake trout	0.0	0.7	0.0

[1]fish/trap/day

Table 6.65 Coho salmon parr catch per effort using minnow traps 1982.[1]

Station	August	September	October
1	-	0.25	6.00
2	-	1.25	0.33
3	-	0.75	0.25
4	-	0.00	0.25
5	-	0.00	0.50
6	0.00	0.00	0.25
6A	0.00	0.00	0.00
8	-	0.25	1.75
9	-	0.00	0.50
10	0.00	0.00	0.50
11	0.00	4.00	0.75
12	-	0.00	0.00
13	0.25	0.25	0.00
14	-	0.00	2.75
15	0.00	0.00	0.25
16	0.00	0.00	0.00
16A	0.00	1.13	3.50
17	-	0.00	0.00
17D	-	0.00	0.25
18	-	3.50	0.50
19	2.70	0.00	0.00
20	-	0.40	0.00
21	-	0.00	0.00
22	0.00	0.00	0.00
23	0.00	0.00	-
24	-	0.00	0.00

- not fished

[1] fish/trap/day

Table 6.66 Distribution of juveniles of important salmonid species August - 1982

Station	Dolly Varden	Coho	Chinook	Sockeye	Rainbow Trout	Pygmy Whitefish
1	+			+		+
3	+	+				+
4		+				
5	+	+				
6	+	+				+
6A	+					
8	+					
10	+					+
11	+	+	+	+		
12	+			+		
13	+	+			+	
15	+					
16	+	+				
16A	+	+				
17	+	+		+		
18	+	+	+			+
19	+	+	+		+	
20	+	+		+		+
22	+					
23	+			+		

Table 6.67 Distribution of juveniles of important salmonid species September - 1982

Station	Dolly Varden	Coho	Chinook	Sockeye	Rainbow Trout	Pygmy Whitefish
1	+	+		+	+	+
2	+	+				+
3	+	+			+	+
4	+	+		+	+	+
5						
6	+	+		+	+	+
6A	+	+				+
8	+	+				
9	+		+		+	+
10						+
11		+				
12	+			+		
13	+	+				+
14	+					
15	+					
16	+			+		
16A	+	+	+	+		+
17	+				+	
17D	+					
18	+	+	+			
19	+					
20	+	+		+		
21	+					
22	+					
23	+					
24	+					

Table 6.68 Distribution of juveniles of important salmonid species October - 1982

Station	Dolly Varden	Coho	Chinook	Sockeye	Rainbow Trout	Pygmy Whitefish
1	+	+		+	+	+
2	+	+		+		+
3	+	+	+		+	+
4	+	+		+	+	+
5	+	+		+		
6	+	+		+	+	+
6A	+					+
8	+	+				+
9	+	+		+	+	+
10	+	+				
11	+	+	+	+	+	
12	+					
13	+					
14	+	+				
15	+	+				
16	+					
16A	+	+				
17	+					+
17D	+	+				
18	+	+				+
19		+	+			
20				+		+
21	+					+
22	+					
23	+					
24	+			+		

Table 6.69 Distribution of juveniles of important salmonid species all collection gears - 1982

	Aug	Sept	Oct	Aug	Sept	Oct
	Dolly Varden			Coho		
Upper Chakachatna River (Canyon)	+	+	+			
Mid-Chakachatna River	+	+	+	+	+	+
Noaukta Slough	+	+	+	+	+	+
Lower Chakachatna River	+	+	+	+	+	+
Upper McArthur River	+	+	+	+	+	+
Lower McArthur River	+	+	+	+	+	+
Chakachatna Tributary Streams	+	+	+	+	+	+
	Chinook			Sockeye		
Upper Chakachatna River (Canyon)				+		+
Mid-Chakachatna River				+	+	+
Noaukta Slough		+			+	+
Lower Chakachatna River			+	+	+	+
Upper McArthur River						
Lower McArthur River	+		+	+	+	+
Chakachatna Tributary Streams	+	+	+			
	Rainbow Trout			Pygmy Whitefish		
Upper Chakachatna River (Canyon)						
Mid-Chakachatna River		+		+		+
Noaukta Slough		+	+	+	+	+
Lower Chakachatna River	+	+	+	+	+	+
Upper McArthur River	+			+	+	
Lower McArthur River		+	+	+	+	+
Chakachatna Tributary Streams	+			+		+

Upper Chakachatna River (Canyon)	Stations 22, 23, 24
Mid-Chakachatna River	Stations 17, 17D, 20, 21
Noaukta Slough	Stations 8, 9, 10, 16, 16A
Lower Chakachatna River	Stations 1, 2, 3, 4, 5, 6, 6A
Upper McArthur River	Stations 13, 14, 15
Lower McArthur River	Stations 1D(1), 11, 12
Chakachatna Tributaries	Stations 18, 19

Table 6.70 Chinook salmon juvenile and parr catch per effort using minnow traps 1982.

Station	August	September	October
1	-	0.00	0.00
2	-	0.00	0.00
3	-	0.00	0.00
4	-	0.00	0.00
5	-	0.00	0.00
6	0.00	0.00	0.00
6A	0.00	0.00	0.00
8	-	0.00	0.00
9	-	0.00	0.00
10	0.00	0.00	0.00
11	0.00	0.00	0.00
12	-	0.00	0.00
13	0.00	0.00	0.00
14	-	0.00	0.00
15	-	0.00	0.00
16	0.00	0.00	0.00
16A	0.00	0.00	0.00
17	-	0.00	0.00
17D	-	0.00	0.00
18	-	0.25	0.00
19	3.30	0.00	0.50
20	-	0.00	0.00
21	-	0.00	0.00
22	0.00	0.00	0.00
23	0.00	0.00	-
24	-	0.00	0.00

- not fished

Table 6.71 Sockeye salmon parr catch per effort using minnow traps 1982.

Station	August	September	October
1	-	0.00	0.25
2	-	0.00	0.33
3	-	0.00	0.00
4	-	0.00	0.25
5	-	0.00	0.50
6	0.00	0.00	0.00
6A	0.00	0.00	0.00
8	-	0.00	0.00
9	-	0.00	0.50
10	0.00	0.00	0.00
11	0.00	0.00	0.25
12	-	1.00	0.00
13	0.00	0.00	0.00
14	-	0.00	0.00
15	-	0.00	0.00
16	0.00	0.00	0.00
16A	0.00	0.50	0.00
17	-	0.00	0.00
17D	-	0.00	0.00
18	-	0.00	0.00
19	0.00	0.00	0.00
20	-	0.20	0.00
21	-	0.00	0.00
22	0.00	0.00	0.00
23	0.00	0.00	-
24	-	0.00	0.00

- not fished

Table 6.72 Pygmy whitefish catch per effort using minnow traps 1982.

Station	August	September	October
1	-	0.00	0.25
2	-	0.25	0.33
3	-	0.00	0.00
4	-	0.00	0.00
5	-	0.00	0.00
6	0.00	0.00	0.25
6A	0.00	0.00	0.33
8	-	0.00	0.00
9	-	0.25	0.75
10	0.00	0.75	0.00
11	0.00	0.00	0.00
12	-	0.00	0.00
13	0.00	0.00	0.00
14	-	0.00	0.00
15	-	0.00	0.00
16	0.00	0.00	0.00
16A	0.00	0.00	0.00
17	-	0.00	0.00
17D	-	0.00	0.00
18	-	0.00	0.00
19	0.00	0.00	0.00
20	-	0.00	0.00
21	-	0.00	0.25
22	0.00	0.00	0.00
23	0.00	0.00	-
24	-	0.00	0.00

- not fished

Table 6.73 Water quality profiles of Chukachamna Lake - August, 1982

Depth (meters)	Depth (feet)	Temperature (°C)	Dissolved Oxygen (mg/l)	Conductivity (umho/cm)	Turbidity (mg/l)
0.0	0.0	16.5	11.4	38	35
0.4	1.25	11.7	11.9	34	40
0.8	2.5	11.7	12.0	31	44
1.5	5.0	8.6	12.2	29	44
2.3	7.5	8.6	12.2	25	42
3.0	10.0	8.2	12.4	29	45
3.8	12.5	8.2	12.4	29	44
4.5	15.0	8.0	12.4	29	44
5.3	17.5	7.8	12.4	28	43
6.1	20.0	7.8	12.5	28	42
6.9	22.5	7.8	12.6	27	43
7.6	25.0	7.7	12.6	27	43
8.4	27.5	7.6	12.7	26	43
9.1	30.0	7.5	10.9	26	43
12.2	40.0	7.2	11.1	29	310
15.2	50.0	7.1	11.2	30	245
18.3	60.0	7.1	11.2	30	125
21.3	70.0	7.2	11.0	33	150
30.5	100.0	7.0	11.3	33	328
36.6	120.0	6.5	11.3	30	82
45.7	150.0	5.9	11.6	30	76
61.0	200.0	5.7	11.6	33	210
76.2	250.0	5.6	11.6	25	320
87.8	288.0	5.3	11.6	27	200

Table 6.74 Lake Chakachamna/Transect 1. Hydroacoustic Fish Density Estimates, 19 September, 1982 (1 is North shore area).

Depth 3.05m (10 ft) Strata	Sample Volume (m^3)	Number of Fish Per $m^3 \times 10^{-3}$ Distance from Start of Transect (180m Increments) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1	146																				0.0
2	441																				0.0
3	731																			1.37	1.37
4	1026		0.98																		0.98
5	1319																			0.76	0.76
6	1611																		1.24	0.62	1.86
7	1886	1.06																1.59	1.06	2.12	5.83
8	2198	0.46	0.46				0.46					0.46					0.46	1.82	0.91	4.09	9.15
9	2489															0.40	0.40	2.81	0.80	5.22	9.63
10	2785		0.36		0.36	0.36								1.08			1.08	3.59	0.72	4.67	12.22
11	3076								0.32		0.32			1.30				1.95	0.96	2.28	7.13
12	3370													0.30				1.48	0.59	0.59	2.96
13	3661													0.27					1.09		1.36
14	3956																		0.25		0.25
15	4248					0.23															0.23
16(49m)	4541																		0.22	0.22	0.44
	Total	1.52	1.80	0.0	0.36	0.59	0.46	0.0	0.32	0.0	0.32	0.46	0.0	2.95	0.0	0.40	1.94	13.24	7.84	21.94	
	Maximum Bottom Depth in meters	73	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	82	

Table 6.75 Lake Chakachamna -- Transect 2. Hydroacoustic Fish Density Estimates, 19 September, 1982 (1 is South shore area).

Depth 3.05 meters (10 ft) Strata	Sample Volume (m^3)	Number of Fish Per m^3 x 10^{-3} Distance from Start of Transect (180m Increments) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
1	146																		0.0
2	441															6.80	4.54		11.34
3	731															6.84	2.74		9.58
4	1026															9.75	2.92	0.97	13.64
5	1319															11.37	3.79		15.16
6	1611															3.10	3.10	1.86	8.06
7	1886	1.59		1.06					0.53	0.53			0.53	0.53		4.25	3.19		12.21
8	2198		0.91													1.82	1.82		4.55
9	2489	0.80					0.40	0.40							0.80	1.61	1.21	1.21	6.43
10	2785		0.36	0.36	0.36											0.72			1.80
11	3076		0.98	0.33						0.33			0.33				0.33	0.33	2.42
12	3370	0.30	0.59	0.30				0.30		0.30		0.30				0.30	0.59		2.98
13	3661		0.55	0.82				0.27								0.55	0.27		2.46
14	3956		0.25	0.25							0.25					0.51	0.25		1.51
15	4248																		0.0
16(49.m)	4541																		0.0
	Total	2.69	3.64	3.12	0.36	0.0	0.40	0.97	0.53	1.16	0.25	0.30	0.86	0.53	0.80	47.72	24.75	4.37	
Maximum Bottom Depth(m)		46	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	

Table 6.76 Lake Chakachamna -- Transect 3. Hydroacoustic Fish Density Estimates, 19 September, 1982 (1 is North Shore area).

Depth 3.05 meters (10 ft.) Strata	Sample Volume (m^3)	Number of Fish Per $m^3 \times 10^{-3}$ Distance from Start of Transect (180m Increments)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
1	146																	0.0
2	441										4.54							4.54
3	731									1.37								1.37
4	1026									1.95								1.95
5	1319									0.76	0.76					1.52		3.04
6	1611									1.24						0.62		1.86
7	1886				0.53					1.06		0.53			0.53	0.53		2.65
8	2198									1.36	1.36	0.45			0.45	0.45		4.07
9	2489								0.40	0.80	0.40	0.80		0.40	0.40	1.21		4.41
10	2785					0.36	0.36			0.36		0.36	0.36	0.36		1.08	0.72	3.96
11	3076									0.33	0.33		0.65			0.65	0.33	2.31
12	3370					0.30					0.30				0.30	0.89	0.30	2.09
13	3661															0.82	0.55	1.37
14	3956										0.25					1.01	0.25	1.51
15	4248																0.24	0.24
16(49m)	4541										0.22					0.22	0.66	1.10
	Total	0.0	0.0	0.0	0.53	0.66	0.36	0.0	0.40	9.23	8.16	2.14	1.01	0.76	1.68	8.78	3.08	
Maximum Bottom Depth (m)		3	29	55	78	90	91+	91+	91+	91+	91+	91+	91+	91+	91+	91+	56	

Table 6.77 Water Quality Profiles of Chakachamna Lake September, 1982

Depth (meters)	Depth (feet)	Temperature (°C)	Dissolved Oxygen (mg/l)	Conductivity (umho/cm)	Turbidity (mg/l)
0.0	0.0	5.9	11.9	23	54
0.8	2.5	6.0	10.8	23	58
1.5	5.0	6.0	12.5	23	58
2.1	7.0	5.9	12.5	23	57
3.0	10.0	5.9	12.4	27	58
4.6	15.0	5.9	11.9	27	61
6.1	20.0	5.9	12.1	23	63
7.6	25.0	5.9	11.6	24	64
9.1	30.0	5.9	11.9	28	64
15.2	50.0	6.2	[2]	28	66
22.9	75.0	6.3	[2]	24	70
30.5	100.0	6.2	[2]	25	62
45.7	150.0	6.3	[2]	23	54
61.0	200.0	6.3	[2]	23	53
76.2	250.0	6.3	[2]	22	58
91.4	300.0	6.5	[2]	23	80

1 - Data taken immediately follwing heavy rains and storm, waves 1.2 - 1.5 meters (4.5 - 5.0 ft).

2 - Samples taken with Van Dorn bottle showed signs of supersaturation - effervescence, dissolved oxygen could not be measured reliably.

Table 6.78 General substrate and cover characteristics by station. (1982)

Station no.	Substrate	Cover
1	sand-sand/silt	vegetation - limited
1D	sand/silt	none
2	sand/silt	vegetation/snags
3	sand/silt some small gravel	vegetation/snags - limited
4	sand/silt some small area of gravel	vegetation/snags - limited
5	sand/silt	vegetation
6	sand/silt some gravel	vegetation/snags
6A	sand/silt	vegetation/roots
8	sand/silt some small gravel	snags - limited
9	silt/mud	vegetation
10	silt/mud	snags
11	sand-sand/silt	snags - limited
11.5	sand/silt	snags - limited
12	sand-silt	snags - limited
13	gravel/cobble-sand	cobble/rubble
14	sand/silt	vegetation
15	gravel/sand	vegetation/boulders, rubble
16	cobble/gravel-armored in channel	snags/rubble
16A	sand/silt/gravel	snags/cobble
17	gravel/cobble/sand - main channel armored	cobble/vegetation few snags
17D	cobble/gravel - heavily armored	cobble/snags
18	sand/gravel	snags/vegetation
19	gravel/sand	snags/vegetation
20	small boulders/cobble/sand	boulders/cobble/snags
21	cobble/rubble/some gravel	cobble/snags
22	gravel/cobble-armored in channel	cobble/snags
23	rubble/cobble/sand-armored in channel	rubble
24	cobble/rubble/gravel - some sand-armored in channel	rubble/snags
25	sand	
26	sand	
27	sand/gravel some cobble	cobble
28	rubble, bedrock	rubble
29	cobble, gravel	cobble
30	gravel, cobble	cobble/vegetation, snags
31	sand/silt/little gravel	vegetation
32	gravel/sand	cobble
33	cobble/gravel	cobble/rubble

Table 6.79 Water quality data by station, July 1982.

Station	Water Temperature		Dissolved Oxygen		Conductivity		Turbidity		N
	Mean	S.D.[1]	Mean	S.D.	Mean	S.D.	Mean	S.D.	
15	4.5	0.0							1
17	10.3	0.4	13.0	0.4	51.0	1.4	12.0	4.2	2
13X	10.3	0.0	11.3	0.6	3.0	0.0	9.0	2.8	2
30	7.1	0.2	11.3	0.2	13.7	0.6	29.3	0.6	3
19	8.0	0.0							

[1]Standard Deviation

Table 6.80 Water quality data by station, August 1982.

Station	Water Temperature		Dissolved Oxygen		Conductivity		Turbidity		N
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	
1	10.5	-	10.1	-	42.0	-	53.0	-	1
1D	5.8	0.35	11.0	0.70	20.3	0.58	72.0	1.73	3
2	8.3	-	11.9	-	51.0	-	27.0	-	1
3	8.9	0.04	10.6	0.64	39.6	3.21	73.0	7.84	5
4	12.9	-	9.2	-	46.0	-	70.0	-	1
5	10.8	-	10.2	-	41.0	-	60.0	-	1
6	7.9	2.22	11.5	0.75	34.7	4.08	83.1	35.16	14
6A	8.8	0.05	10.6	0.34	33.8	0.45	72.8	6.83	5
8	9.3	0.16	11.4	0.55	33.3	1.50	166.1	42.60	9
10	8.2	0.44	11.7	0.33	42.8	23.62	218.1	28.65	8
11	11.3	1.37	10.5	1.08	43.0	9.30	61.9	31.40	20
12	3.7	0.47	12.7	0.61	7.4	1.19	228.1	82.46	8
12L	1.8	-	13.7	-	7.0	-	436.0	-	1
13	5.9	1.95	11.0	1.99	46.6	22.43	70.1	57.03	7
15	4.9	1.73	12.7	0.51	14.6	25.75	30.7	8.03	9
16	8.2	0.32	12.1	0.12	35.6	14.23	130.6	59.10	10
16A	9.5	0.24	10.8	0.86	36.3	4.92	114.0	20.99	4
17	9.2	0.36	10.0	1.67	36.2	2.17	91.2	7.16	5
$17_{LBO\&1}$	10.2	10.21	9.9	0.80	44.9	8.65	21.4	6.64	50
$17_{LBO\&2}$	11.6	1.12	11.5	0.80	61.9	17.34	4.5	7.30	13
18	5.0	0.82	12.1	0.70	51.8	3.63	272.1	15.00	9
19	9.0	2.47	10.8	1.18	20.8	10.10	14.0	9.06	21
19A	8.4	0.21	10.9	1.34	18.0	0	10.5	0.71	2
20	8.8	0.34	11.7	0.16	36.5	4.36	108.5	1.29	4
22	8.1	0.15	11.9	0.21	50.0	20.66	92.3	21.94	3
23	8.2	0.20	11.6	0.85	45.3	0.58	21.3	5.86	3
27	12.5	2.57	11.0	1.06	47.7	17.49	41.5	9.57	10
28	10.0	1.19	11.9	0.40	26.7	1.15	47.7	4.62	3
30	6.4	-	10.1	-	22.0	-	4.0	-	1

[1]standard deviation

Table 6.81 Water quality data by station, September 1982.

Station	Water Temperature		Dissolved Oxygen		Conductivity		Turbidity		N
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	
1	7.5	0.45	10.7	0.89	46.5	7.72	107.5	49.78	4
2	6.8	0.22	12.3	0.21	37.5	1.00	105.0	17.66	4
3	6.4	0.05	12.0	0.10	36.5	0.58	89.5	5.07	4
6A	6.9	0.18	12.0	0.13	33.0	0.82	129.5	9.98	4
8	7.1	0.10	11.5	0.56	26.8	2.36	335.3	72.72	4
9	6.6	0.19	12.3	0.26	31.5	1.00	286.3	275.90	4
10	5.5	0.13	12.5	0.51	29.8	1.50	108.3	18.95	4
11	7.4	0.36	10.2	1.26	40.5	2.38	178.8	48.87	4
12	3.0	0.78	13.2	0.71	12.0	6.24	594.3	419.23	3
13	5.0	0.46	11.4	0.70	62.5	13.18	19.8	14.45	4
14	2.9	0.31	13.8	0.31	9.5	1.73	23.0	1.83	4
15	2.6	0.34	13.8	1.27	10.2	13.20	13.7	10.63	9
16	6.3	0.19	12.3	0.52	25.3	1.26	455.0	23.09	4
16A	7.1	0.20	11.1	0.69	29.0	3.19	451.7	113.02	12
17LB &2	6.5	0.05	12.7	0.22	34.3	2.22	78.0	9.63	4
17D	6.4	0.13	10.7	0.10	30.3	0.50	201.8	21.11	4
19	3.8	0.13	13.1	0.15	14.0	0.0	67.3	17.84	4
20	5.8	-	12.4	-	34.0	-	75.0	-	1
21	6.8	0.08	12.8	0.85	31.0	0	87.3	11.93	4
22	6.6	0.08	11.5	0.35	31.0	0	84.3	10.24	4
23	6.6	0.23	12.0	0.46	38.7	8.43	86.8	89.28	6
24	6.3	0.10	12.4	0.50	22.5	1.00	88.5	30.49	4

[1]standard deviation

Table 6.82 Water quality data by station, October 1982.

Station	Water Temperature Mean	S.D.	Dissolved Oxygen Mean	S.D.	Conductivity Mean	S.D.	Turbidity Mean	S.D.	N
1	2.1	0.56	11.5	0.29	59.5	4.73	85.3	89.65	4
2	2.9	0.10	13.9	0.06	47.0	1.73	64.7	26.39	3
3	2.5	0.05	13.7	0.37	46.5	1.91	65.8	17.76	4
4	0.7	0.48	5.9	6.78	57.8	12.09	42.0	6.63	4
5	0.2	-	-	-	14.0	4.24	33.0	1.41	2
6	4.1	3.63	12.5	0.54	44.8	3.20	59.0	4.24	4
6A	3.8	0.61	11.7	0.20	53.3	11.85	43.0	12.77	3
8	0.5	0.40	13.4	0.23	21.8	6.95	9.0	2.83	4
9	3.6	0.05	12.0	0.26	47.8	2.87	70.3	16.76	4
10	3.8	0.05	11.0	0.31	50.5	11.03	59.5	3.00	4
11	3.6	0.10	10.3	0.62	52.0	12.11	74.8	37.03	4
12	0.1	0.06	12.8	0.59	17.0	-	38.5	2.52	4
13	0.5	0.22	12.5	0.47	24.8	3.50	60.3	19.64	4
14	0.7	0.18	11.9	0.75	13.6	2.07	6.2	1.64	5
15	1.2	0.26	12.7	0.21	15.8	5.19	2.3	0.50	4
16	4.2	0.15	11.7	0.19	53.0	4.24	74.3	16.38	4
16A	2.0	0.38	8.8	0.72	74.8	10.21	38.3	14.24	4
$17_{LB\&2}$	3.8	0.72	10.8	0.54	60.1	3.44	10.7	2.28	17
17D	4.6	0.13	12.2	0.57	51.3	2.99	65.0	7.44	4
18	1.7	0.24	12.0	0.18	35.0	1.15	81.0	59.94	4
19	1.5	0.10	11.1	0.71	15.5	2.65	65.3	40.01	4
20	2.3	0.17	11.9	0.06	43.3	1.26	186.5	85.78	4
21	4.6	0.05	11.7	0.24	49.8	0.96	148.3	59.13	4
22	4.5	0.18	11.3	0.42	47.3	0.50	68.8	10.53	4
23	4.2	0.06	10.8	0.12	57.0	8.66	64.7	0.58	3
24	4.8	0.28	10.9	0.28	22.3	7.70	73.0	7.35	8

[1]standard deviation

Table 6.83 Sources of Additional Inflow Identified at Sampling Stations 1982

Location	Station	Upwelling (slough) flow present	Clearwater tributary flow present	Other additional in flow present
Another River	33		+	
Igitna River	32	+	+	
Neacola River	31		+[1]	
Chilligan River	30	+	+	
Kenibuna Lake Outlet	29			
Chakachamna Lake	28			
Chakachamna Lake	27			
Nisishlamina River Delta	26			+
Chakachamna Lake	25			
Chakachatna River Canyon	24			
Chakachatna River Canyon	23			
Chakachatna River Canyon	22			
Chakachatna Canyon Sloughs	(22)	+	+	
Chakachatna River	21			
Tributary C1	(21)	+	+	
Buckwater Area	20			+[2]
Clearwater Tributary	19		+	
Straight Creek	18			
Straight Creek Mouth Area	(18)	+	+	
Chakachatna River Bridge Area	17	+		
Chakachatna River	17D			
Noaukta Slough	16			
Noaukta Slough	16A		+	
McArthur Canyon	15	+	+	
Lower McArthur Canyon	14			+[1]
Upper McArthur River	13	+		
McArthur River	12			
McArthur River	11			
Noaukta Slough	10			+[1,2]
Noaukta Slough	9			
Noaukta Slough	8		+	+[2]
Chakachatna River	6A			
Chakachatna River	6			
Middle River	5			+[1,2]
Middle River	4			
Lower Chakachatna River	3			
Chakachatna River	2			+[2]
Chakachatna River	1			
McArthur River	1D			
Tributary	13U		+	+[1]
Tributary	13X		+	+[2]
Tributary	12.1		+	+[2]
Tributary	12.2		+	+[2]
Tributary	12.3		+	+[2]
Tributary	12.4		+	+[2]
Tributary	12.5		+	+[2]

[1] Beaver Pond Seepage
[2] Run-off from land drainage

Table 6.84. Summary of estimated salmon escapement by waterbody and drainage for 1982.

	CHAKACHATNA RIVER DRAINAGE								
Species	Straight Creek Mouth	Chakachatna Bridge Side Channels and Sloughs	Chakachatna Canyon Sloughs	Chakachatna Tributary (C1)	Igitna River	Chilligan River	Straight Creek	Straight Creek Clearwater Tributary	Drainage Total
Sockeye Salmon	203	1,193	392	238	2,781	38,576	0	254	43,637
Chinook Salmon	0	0	0	0	0	0	0	1,422	1,422
Pink Salmon	0	59	279	0	0	0	0	7,925	8,263
Chum Salmon	152	1,482	121	165	0	0	0	0	1,920
Coho Salmon	76	1,560	608	183	0	0	0	172	2,599

	MCARTHUR RIVER DRAINAGE								
				Streams					
Species	McArthur Canyon	Stream 13X	Stream 13U	12.1	12.2	12.3	12.4	12.5	Drainage Total
Sockeye Salmon	666	5,416	1,213	16,711	6,085	2,512	2,328	0	34,933
Chinook Salmon	0	452	1,633	0	22	0	0	0	2,107
Pink Salmon	60	4,225	5,402	8,499	1,566	4	18	3	19,777
Chum Salmon	1	0	23	4	0	0	1	0	29
Coho Salmon	1,182	1,378	32	2,000	46	89	0	0	4,729

FIGURES

FIGURE 6.1

Approximate Boundary Of Chakachamna Lake Study Area 1981

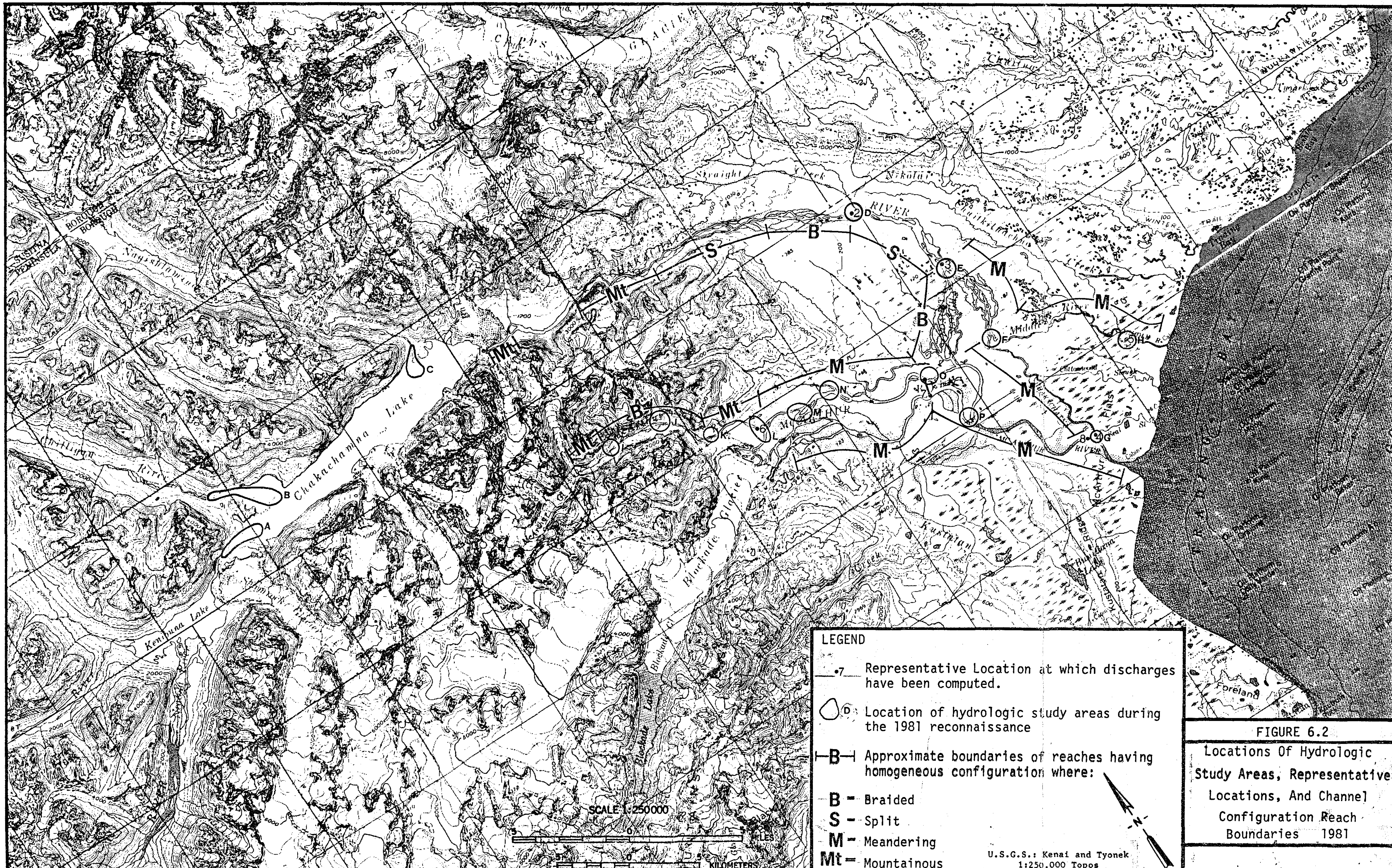
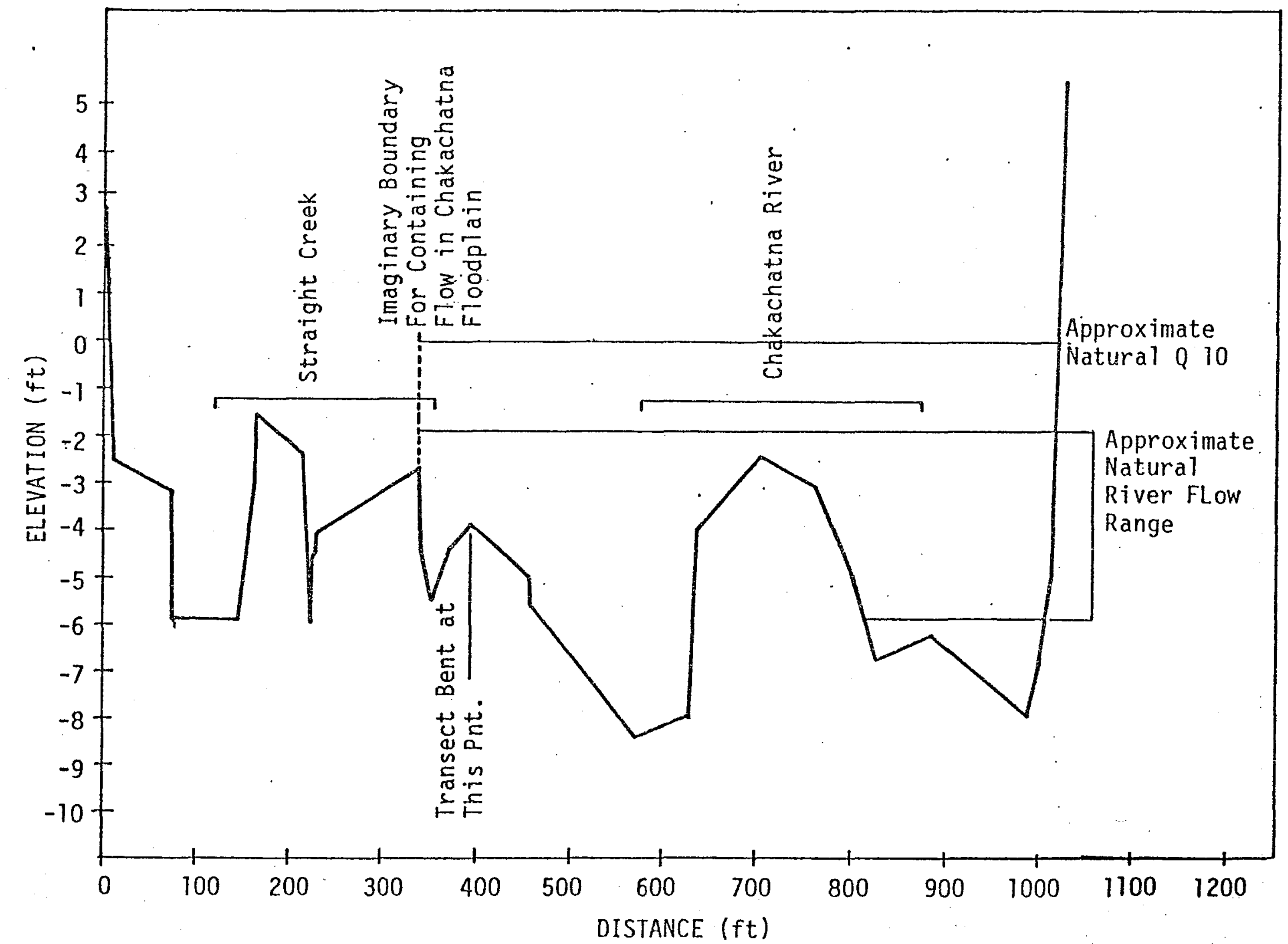


FIGURE 6.2

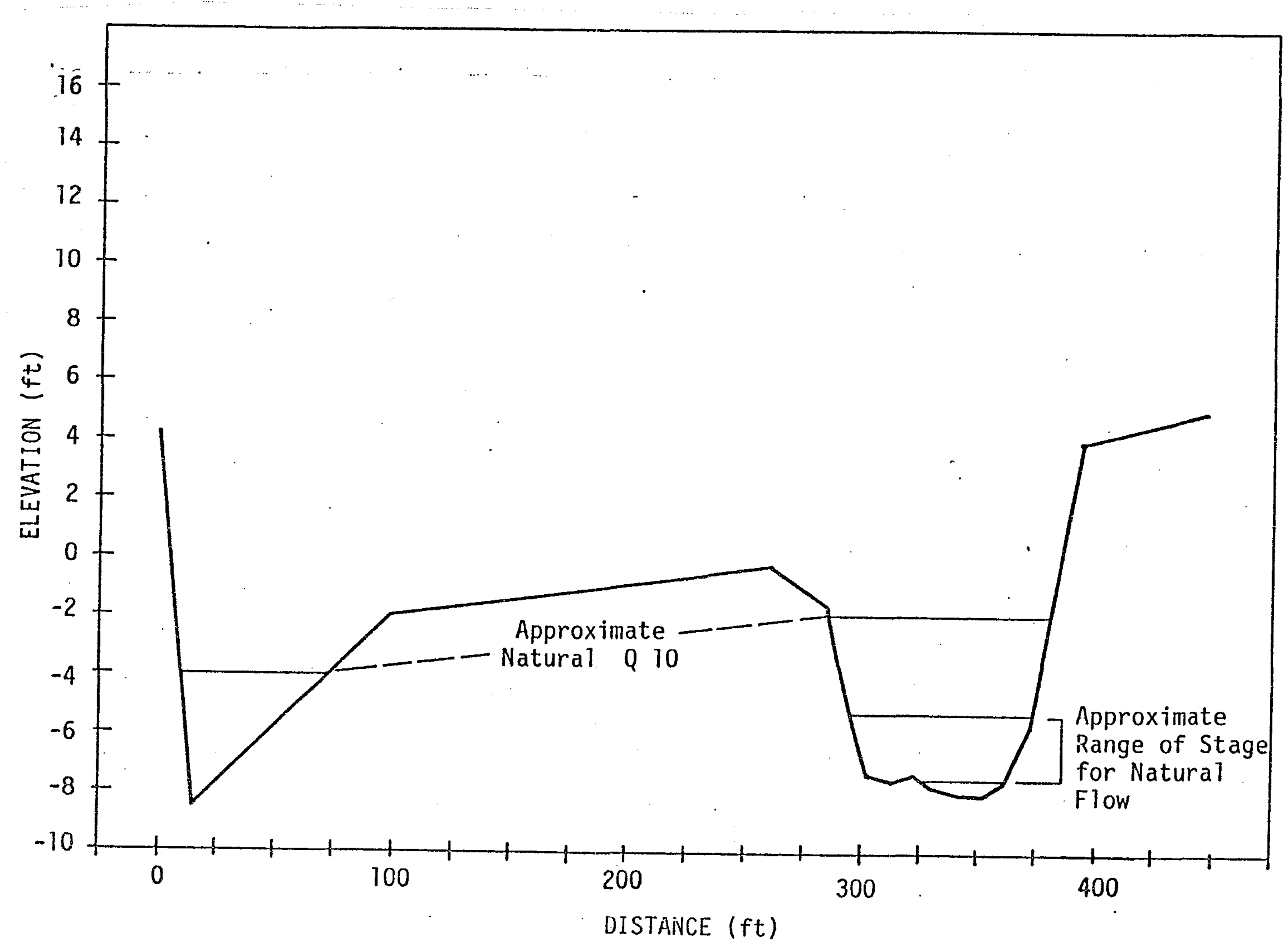
Locations Of Hydrologic Study Areas, Representative Locations, And Channel Configuration Reach Boundaries 1981



Note: Site is located upstream of confluence with Straight Creek in Study Area D. Transect as shown is looking in downstream direction.

Figure 6.3

Stream And Floodplain Transect on Chakachatna River Showing Approximate Range of Natural Stages 1981



Note: Site is located upstream of confluence with Upper Blockade Glacier Channel in Study Area L. Transect as shown is looking in downstream direction.

Figure 6.4

1981 Stream and Floodplain Transect on Upper McArthur River Showing Approximate Range of Natural Stages

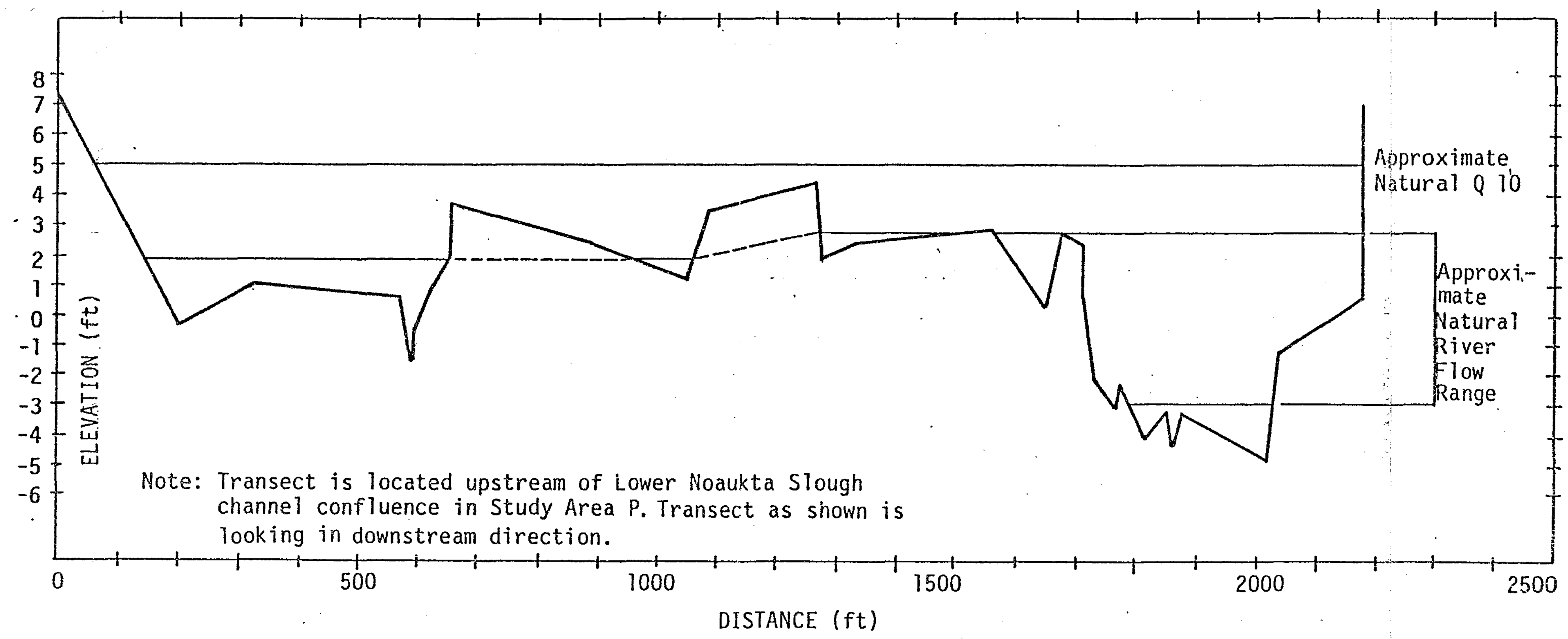
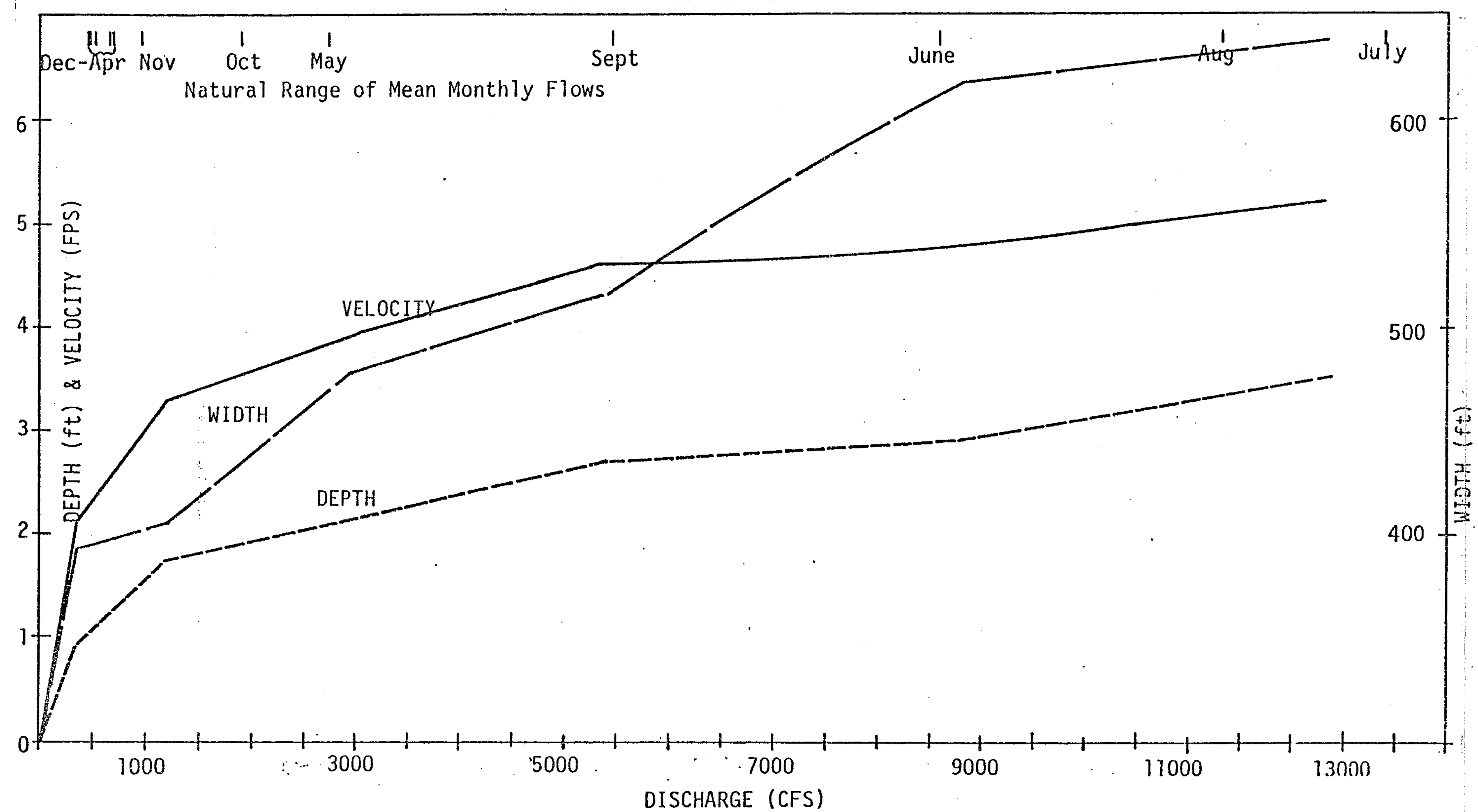


Figure 6.5

Stream and Floodplain Transect on McArthur River Showing Approximate Range of Natural Stages 1981

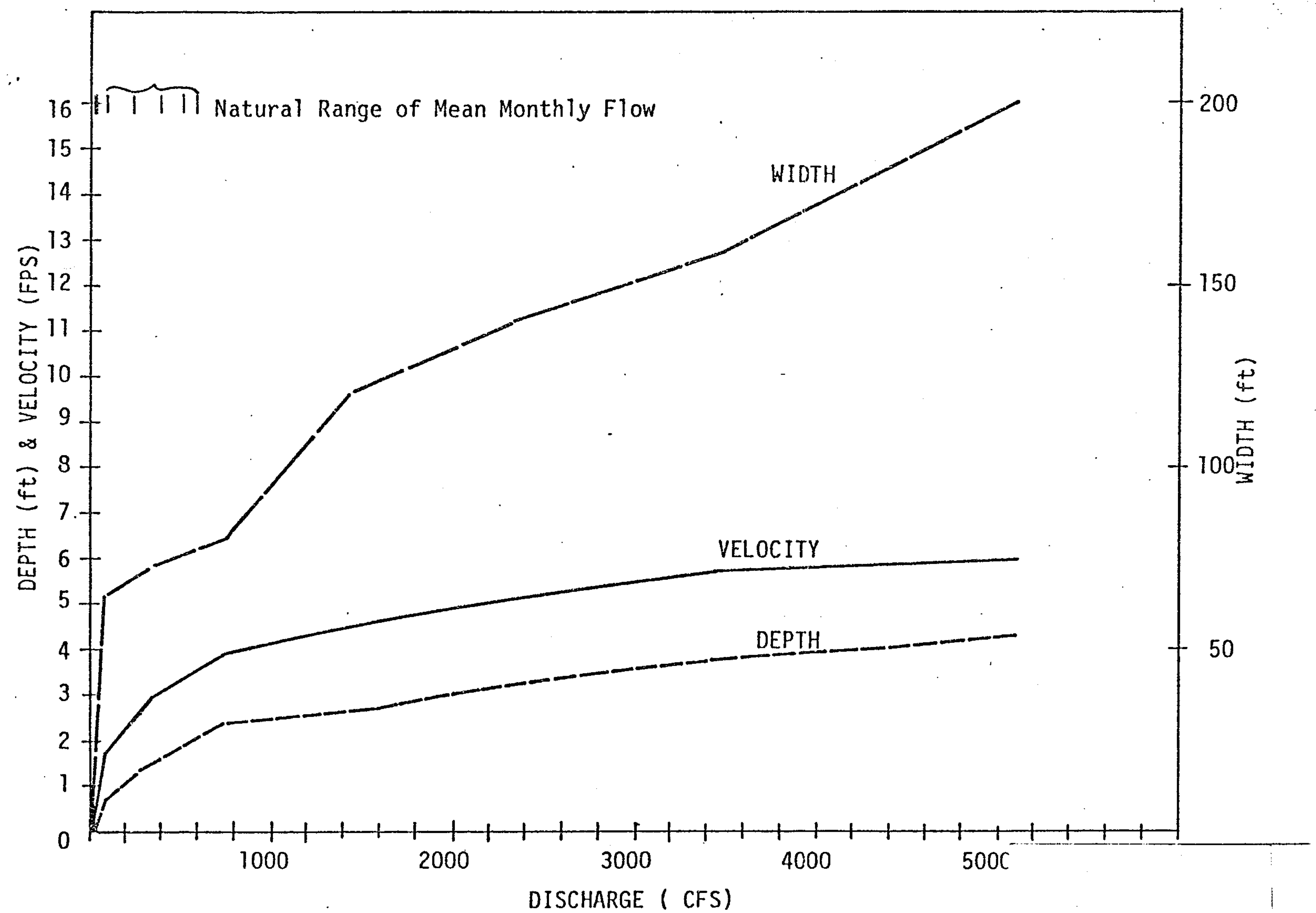


Note: Site is located upstream of confluence with Straight Creek in Study Area D. For transect, refer to Figure 6.3.

Figure 6.6

Hydraulic Geometry of Chakachatna River Showing Approximate Range of Natural Flow
1981

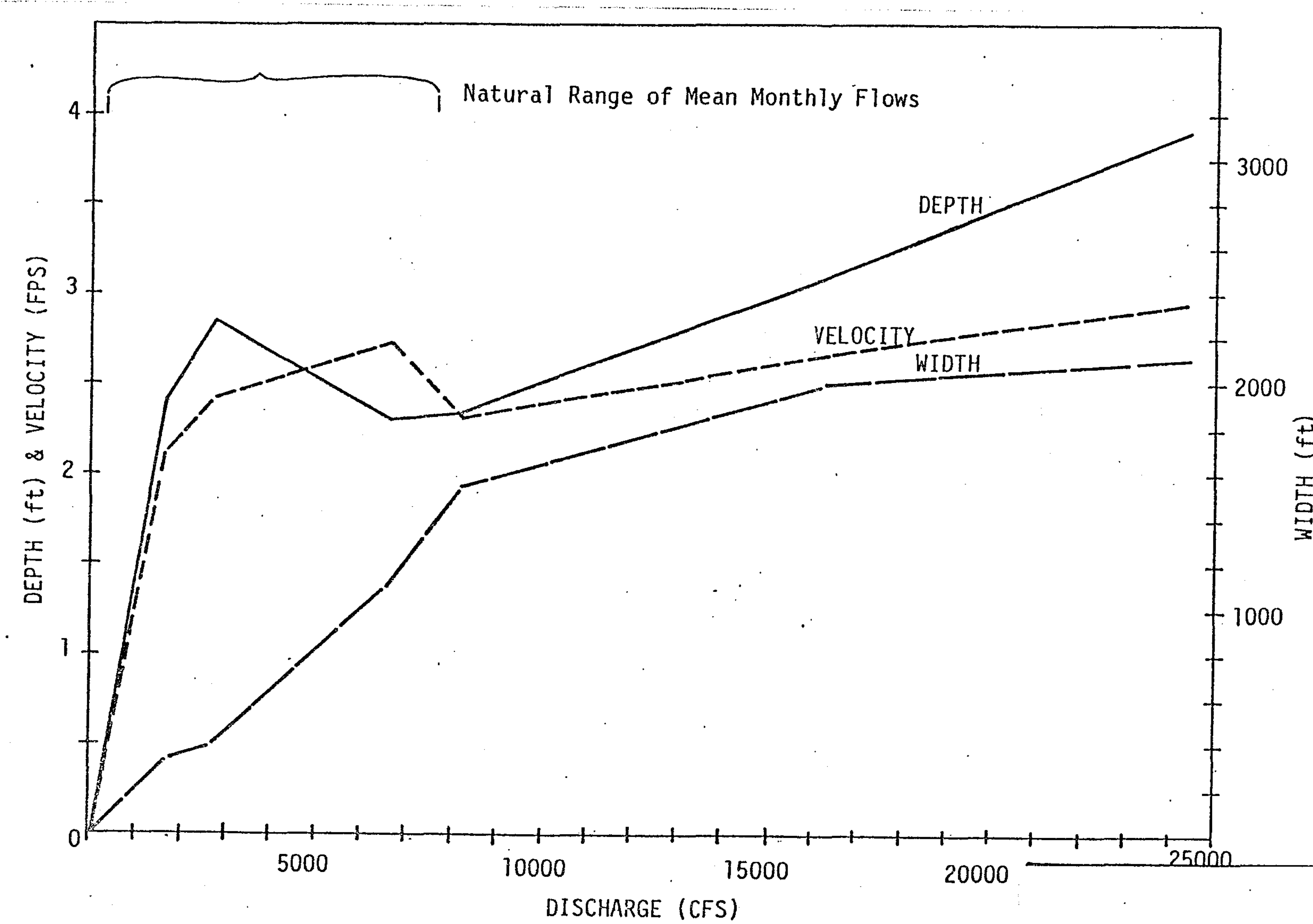
94052



Note: Site is located upstream of confluence with Upper Blockade Glacier Channel in Study Area L. For transect, refer to Figure 6.4.

Figure 6.7

Hydraulic Geometry of Upper McArthur River Showing Approximate Range of Natural Flow
1981



Note: Site is located upstream of confluence with Lower Noaukta Slough Channel in Study Area P. For transect, refer to Figure 6.5.

Figure 6.8

Hydraulic Geometry of McArthur River Showing Approximate Range of Natural Flow 1981

94052

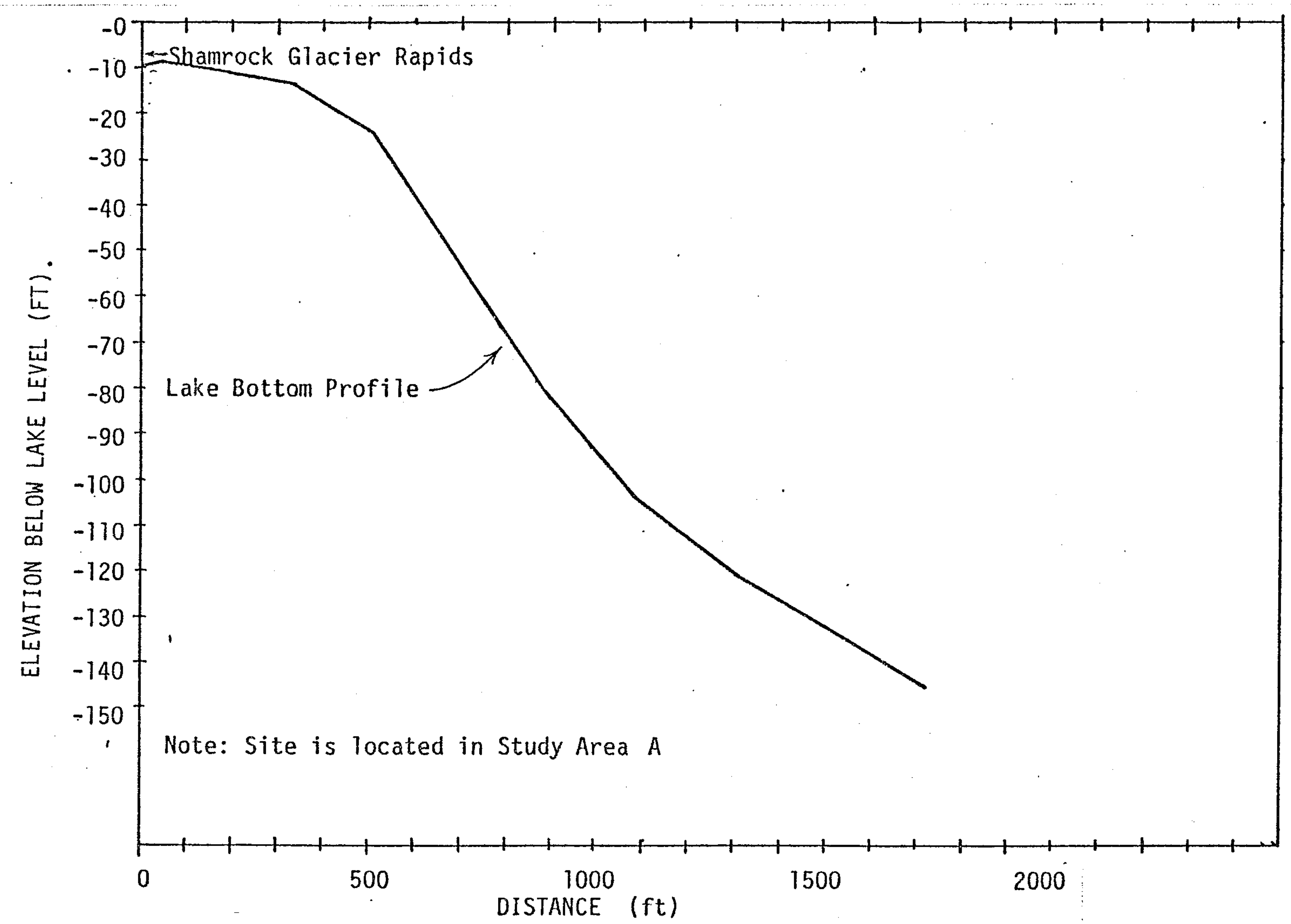
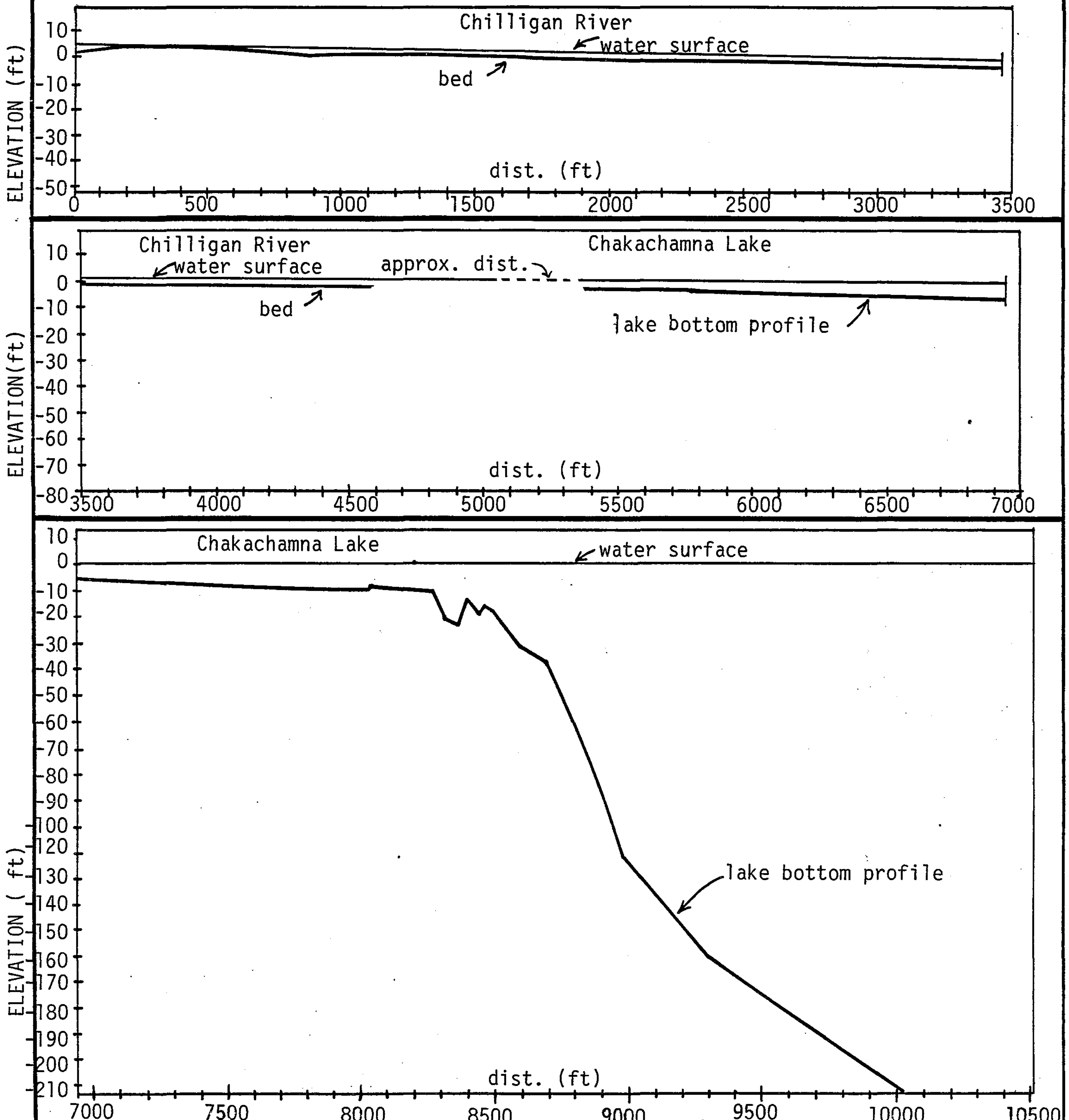


Figure 6.9

Chakachamna Lake Bottom Profile Offshore From Shamrock Glacier Rapids 1981

94052



Note: Site is located in Study Area B.

Figure 6.10

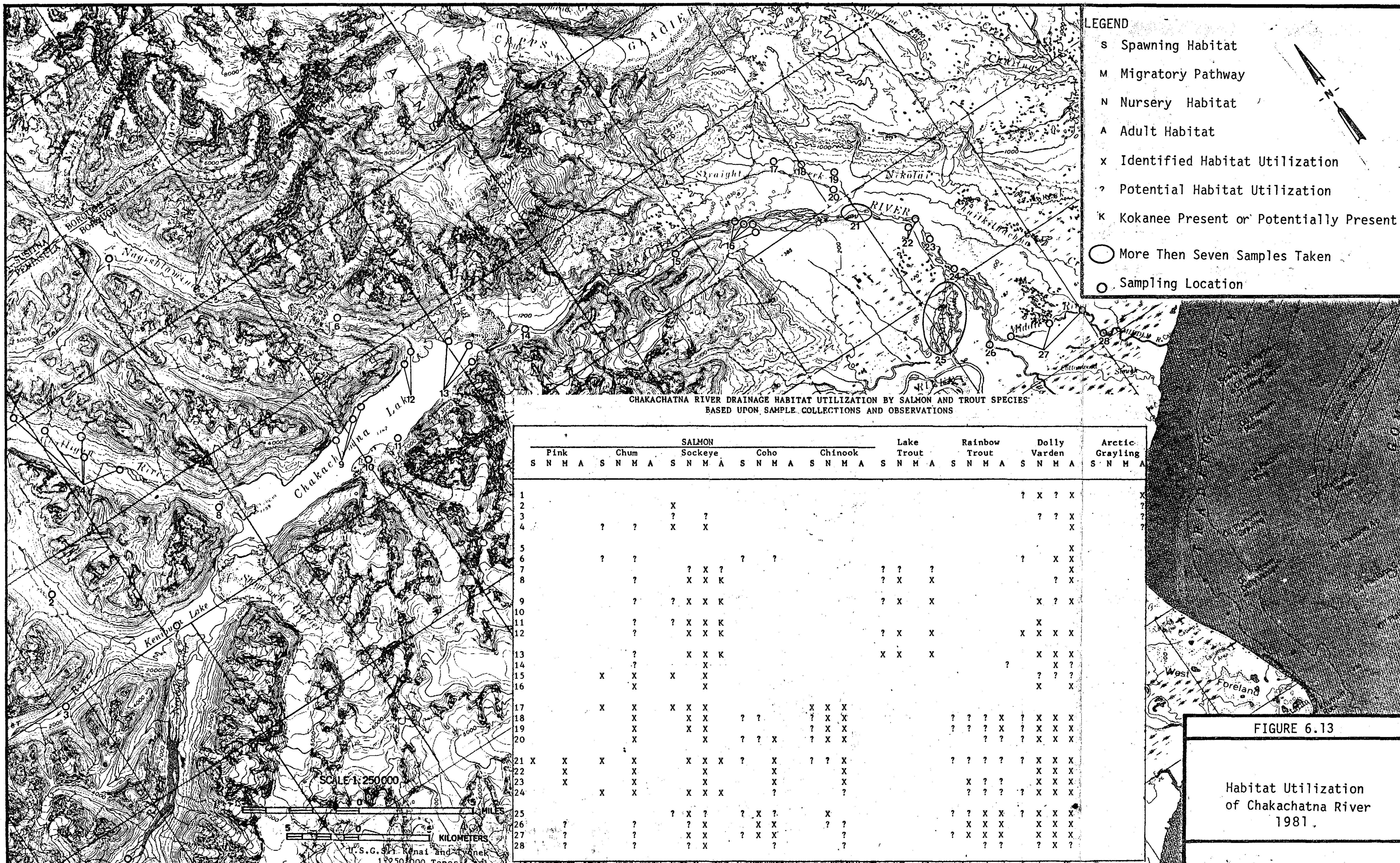
Chilligan River and Chakachamna Lake Bottom Profiles 1981

FIGURE 6.11

Electroshocking And Seine Sampling Locations 1981

FIGURE 6.12

Location Of Fixed Net Sets 1981



CHAKACHATNA RIVER DRAINAGE HABITAT UTILIZATION BY SALMON AND TROUT SPECIES BASED UPON SAMPLE COLLECTIONS AND OBSERVATIONS

	SALMON																				Lake Trout				Rainbow Trout				Dolly Varden				Arctic Grayling			
	Pink				Chum				Sockeye				Coho				Chinook																			
	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A
1																													?	X	?	X				X
2									X																											?
3									?		?																			?	?	X				?
4					?		?		X		X																					X				?
5																																X				
6					?		?						?		?														?		X	X				
7										?	X	?									?	?		?								X				
8							?			X	X	K									?	X		X							?	X				
9							?		?	X	X	K									?	X		X						X	?	X				
10																																				
11							?		?	X	X	K																		X						
12							?			X	X	K									?	X		X					X	X	X	X				
13							?			X	X	K									X	X		X						X	X	X				
14							?				X																	?			X	?				
15					X		X		X		X																			?	?	?				
16							X				X																			X		X				
17					X		X		X	X	X						X	X	X																	
18							X			X	X		?	?			?	X	X						?	?	?	X	?	X	X	X				
19							X			X	X						?	X	X						?	?	?	X	?	X	X	X				
20							X				X		?	?	X		?	X	X								?	?	?	X	X	X				
21	X		X		X		X			X	X	X	?		X		?	?	X						?	?	?	?	?	X	X	X				
22			X				X				X				X				X											X	X	X				
23			X				X				X				X				X							X	?	?		X	X	X				
24					X		X			X	X	X			?				?							?	?	?	?	X	X	X				
25									?	X	?		?	X	?			X							?	?	X	X	?	X	X	X				
26			?				?			?	X			X	X			?	?							X	X	X		X	X	X				
27			?				?			X	X		?	X	X				?						?	X	X	X		X	X	X				
28			?				?			?	X				?				?								?	?		?	X	?				

FIGURE 6.13

Habitat Utilization of Chakachatna River 1981.

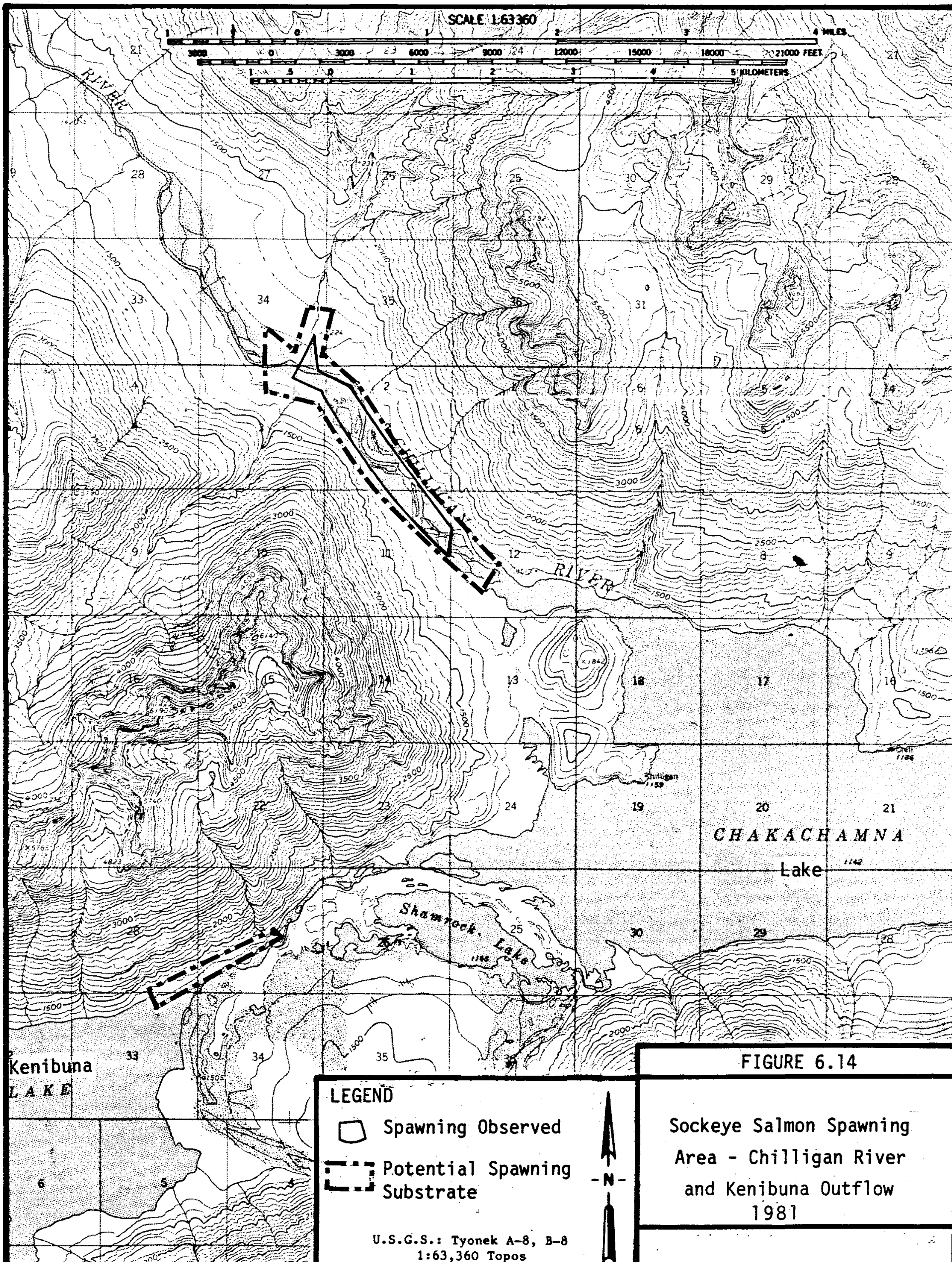


FIGURE 6.14

Sockeye Salmon Spawning Area - Chilligan River and Kenibuna Outflow 1981

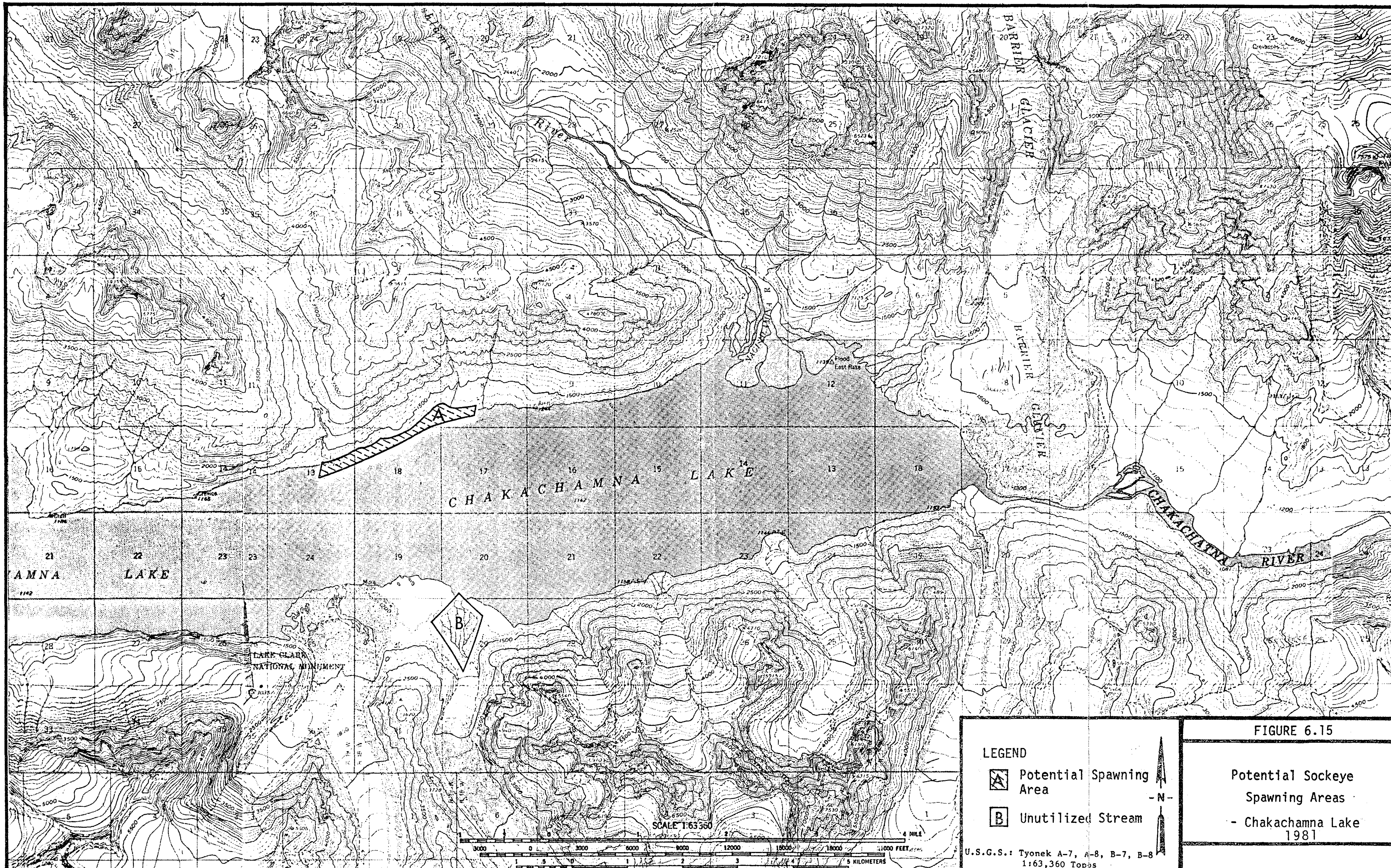


FIGURE 6.15

Potential Sockeye Spawning Areas - Chakachamna Lake 1981

FIGURE 6.16

1981
Chum and Sockeye Salmon
Spawning Areas,
Chakachatna River Canyon
and Straight Creek

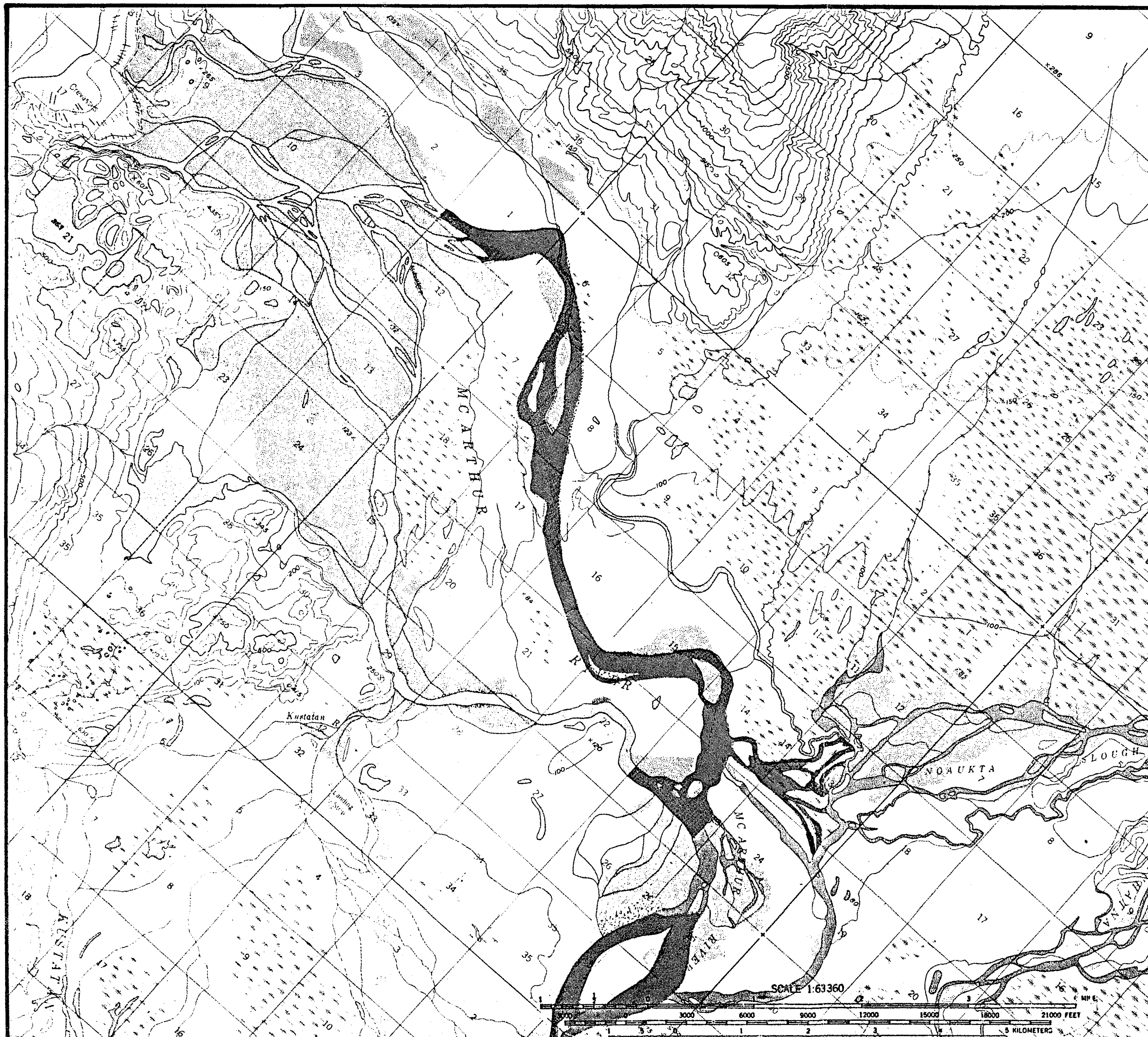


FIGURE 6.17

Chakachatna River Mainstem Sockeye, Chum and Pink Salmon Spawning Sites 1981

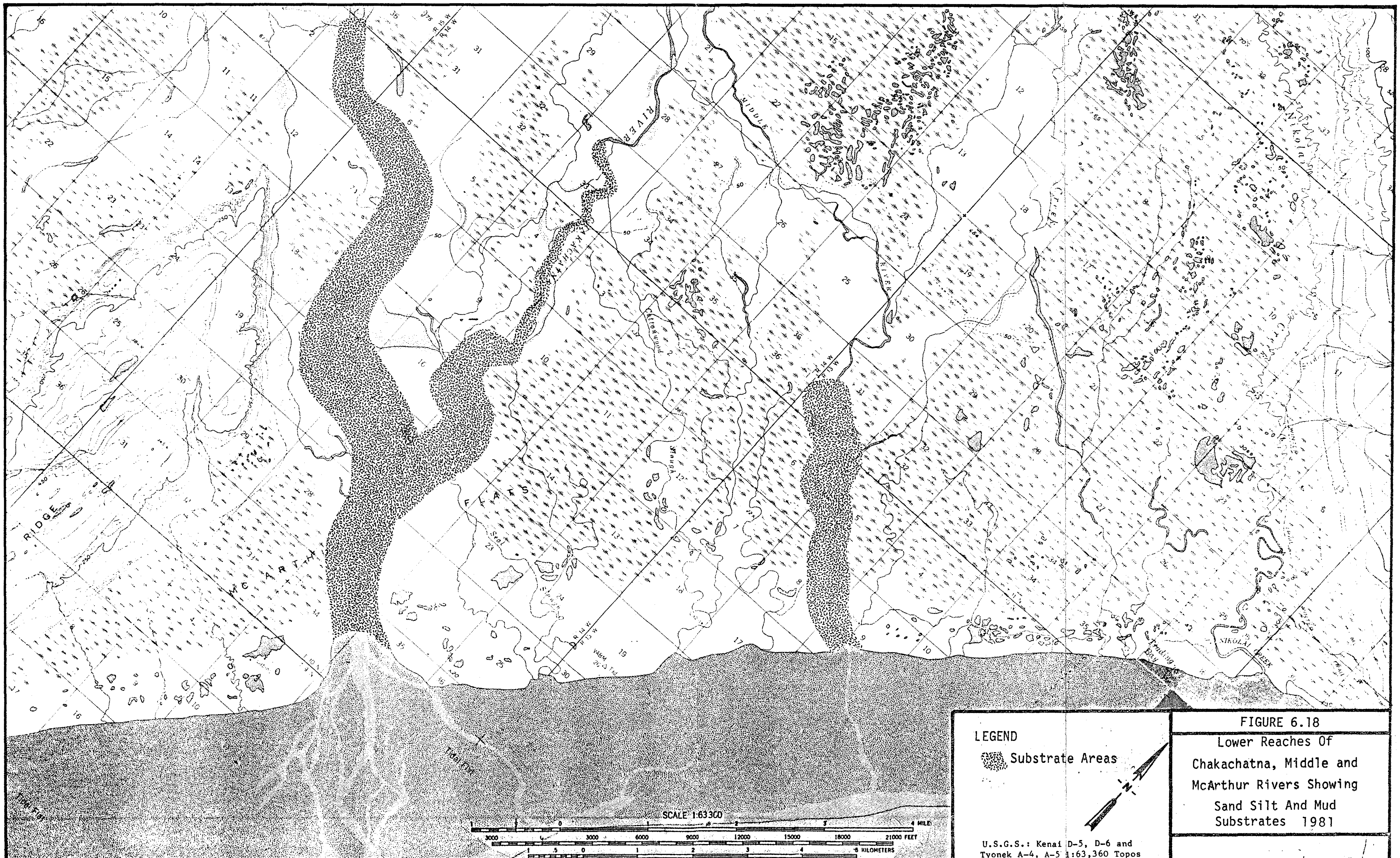
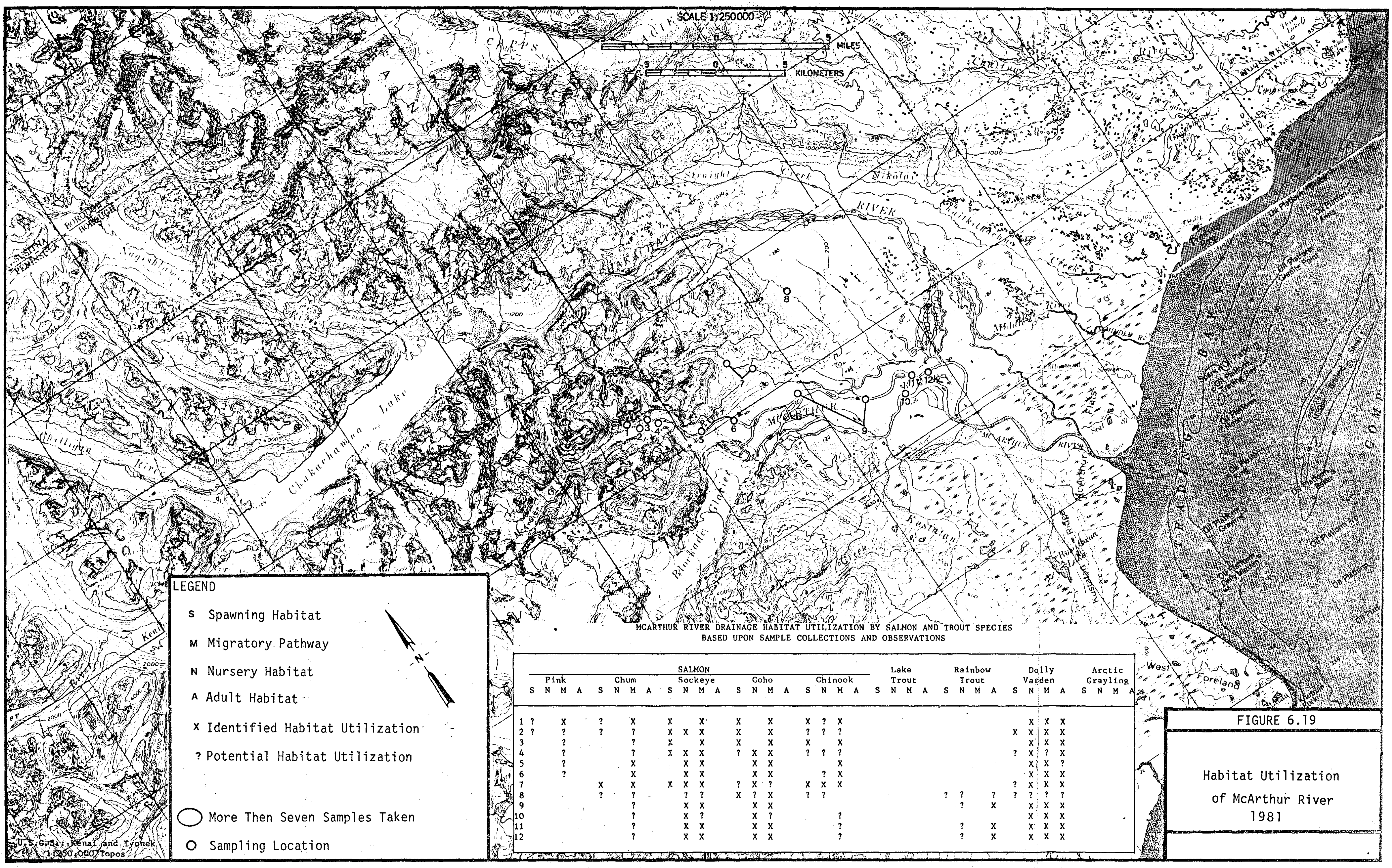


FIGURE 6.18

Lower Reaches Of Chakachatna, Middle and McArthur Rivers Showing Sand Silt And Mud Substrates 1981



MCARTHUR RIVER DRAINAGE HABITAT UTILIZATION BY SALMON AND TROUT SPECIES
BASED UPON SAMPLE COLLECTIONS AND OBSERVATIONS

	SALMON Pink				Chum				Sockeye				Coho				Chinook				Lake Trout				Rainbow Trout				Dolly Varden				Arctic Grayling			
	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A	S	N	M	A
1	?		X		?		X		X		X		X		X		X	?	X											X	X	X				
2	?		?		?		?		X	X	X		X		X		?	?	?										X	X	X	X				
3			?				?		X		X		X		X		X		X											X	X	X				
4			?				?		X	X	X		?	X	X		?	?	?										?	X	?	X				
5			?				X			X	X			X	X				X											X	X	?				
6			?				X			X	X			X	X			?	X											X	X	X				
7					X		X		X	X	X		?	X	?		X	X	X										?	X	X	X				
8					?		?			?	?		X	?	X		?	?							?	?		?	?	?	?	?				
9							?			X	X			X	X											?		X		X	X	X				
10							?			X	?			X	?				?											X	X	X				
11							?			X	X			X	X				?							?		X		X	X	X				
12							?			X	X			X	X				?							?		X		X	X	X				

FIGURE 6.19

Habitat Utilization
of McArthur River
1981

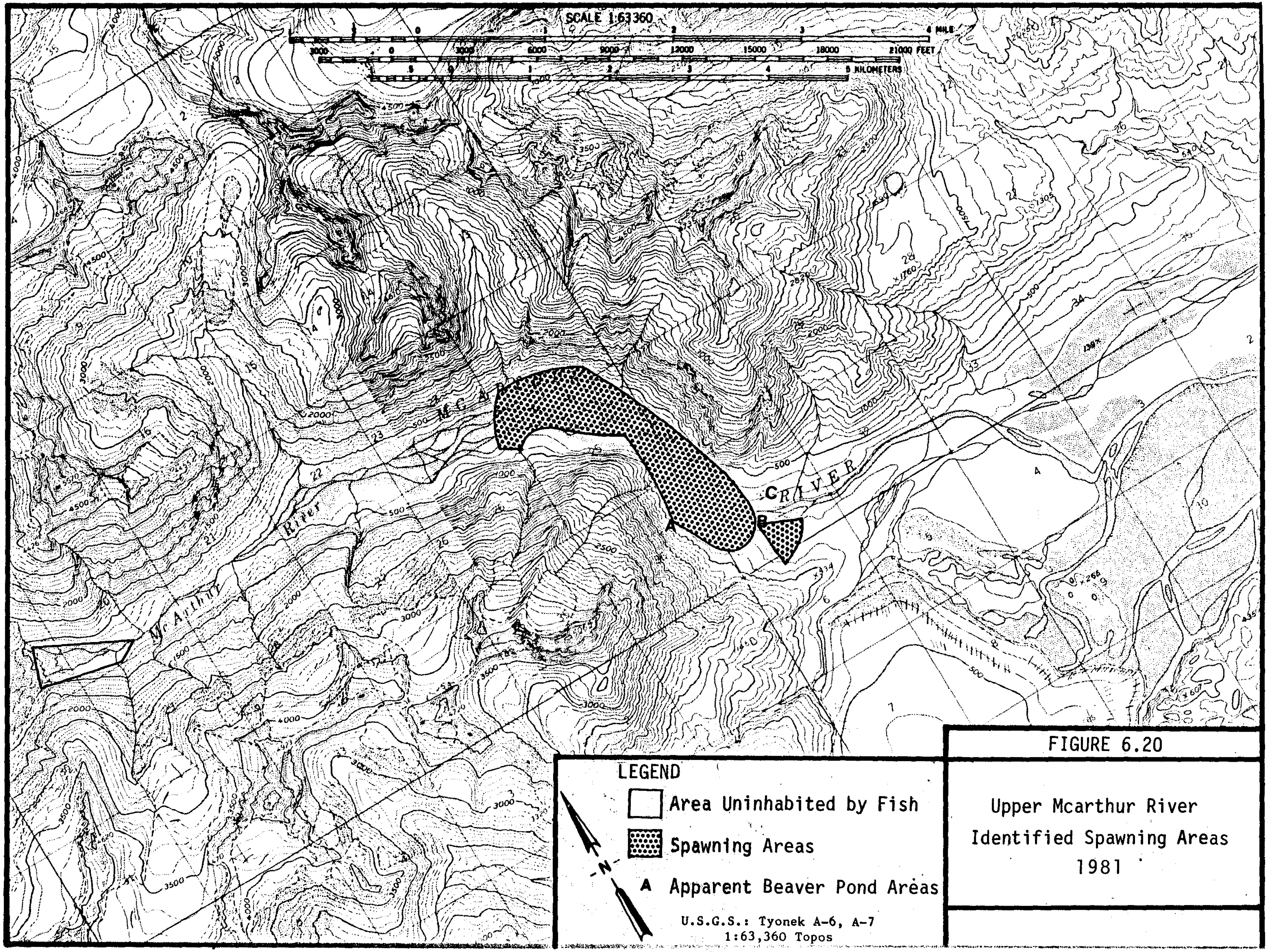


FIGURE 6.20

Upper Mcarthur River
Identified Spawning Areas
1981

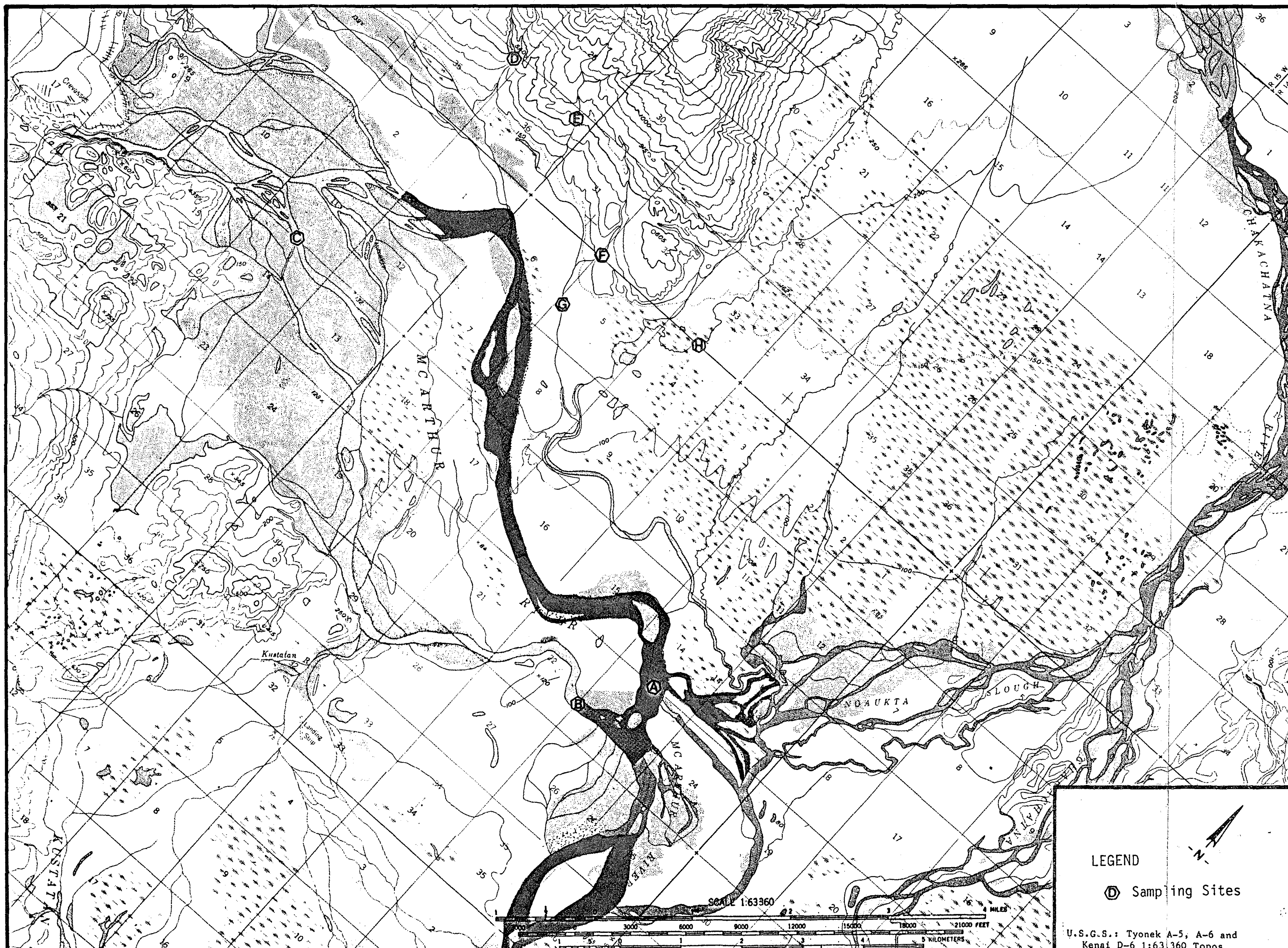


FIGURE 6.21

McArthur River Sampling Sites 1981

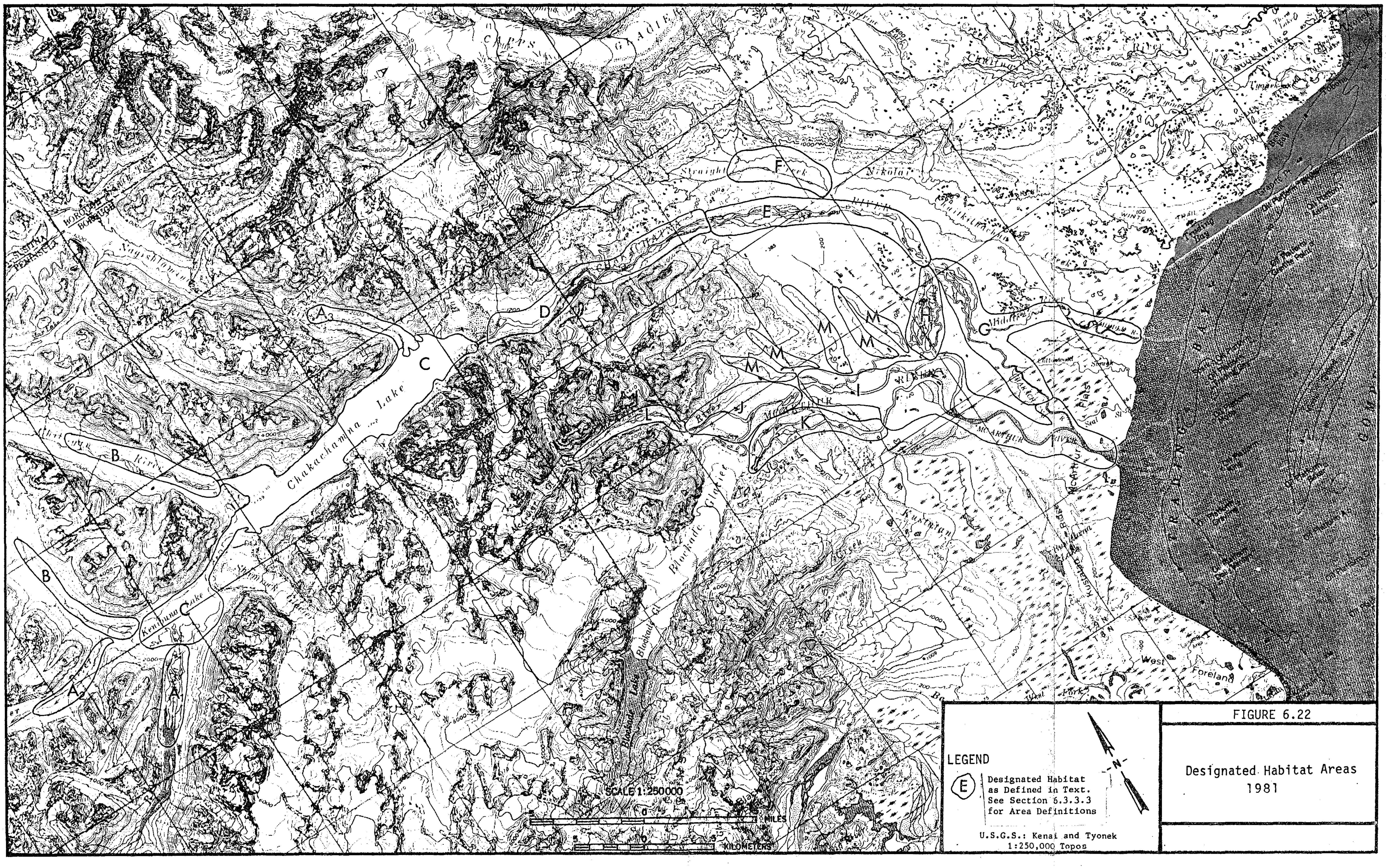


FIGURE 6.22

Designated Habitat Areas 1981

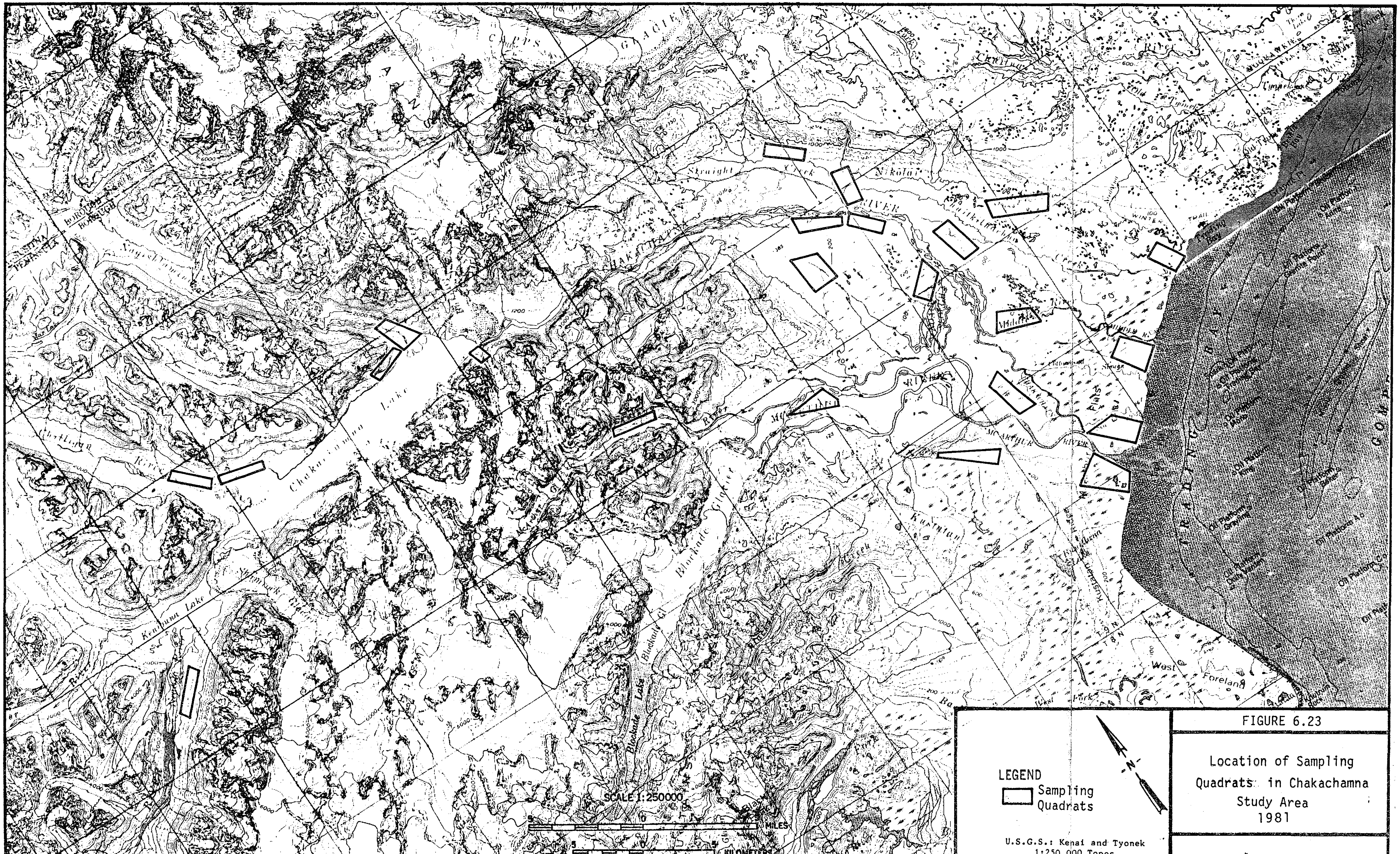


FIGURE 6.23

Location of Sampling Quadrats in Chakachamna Study Area 1981

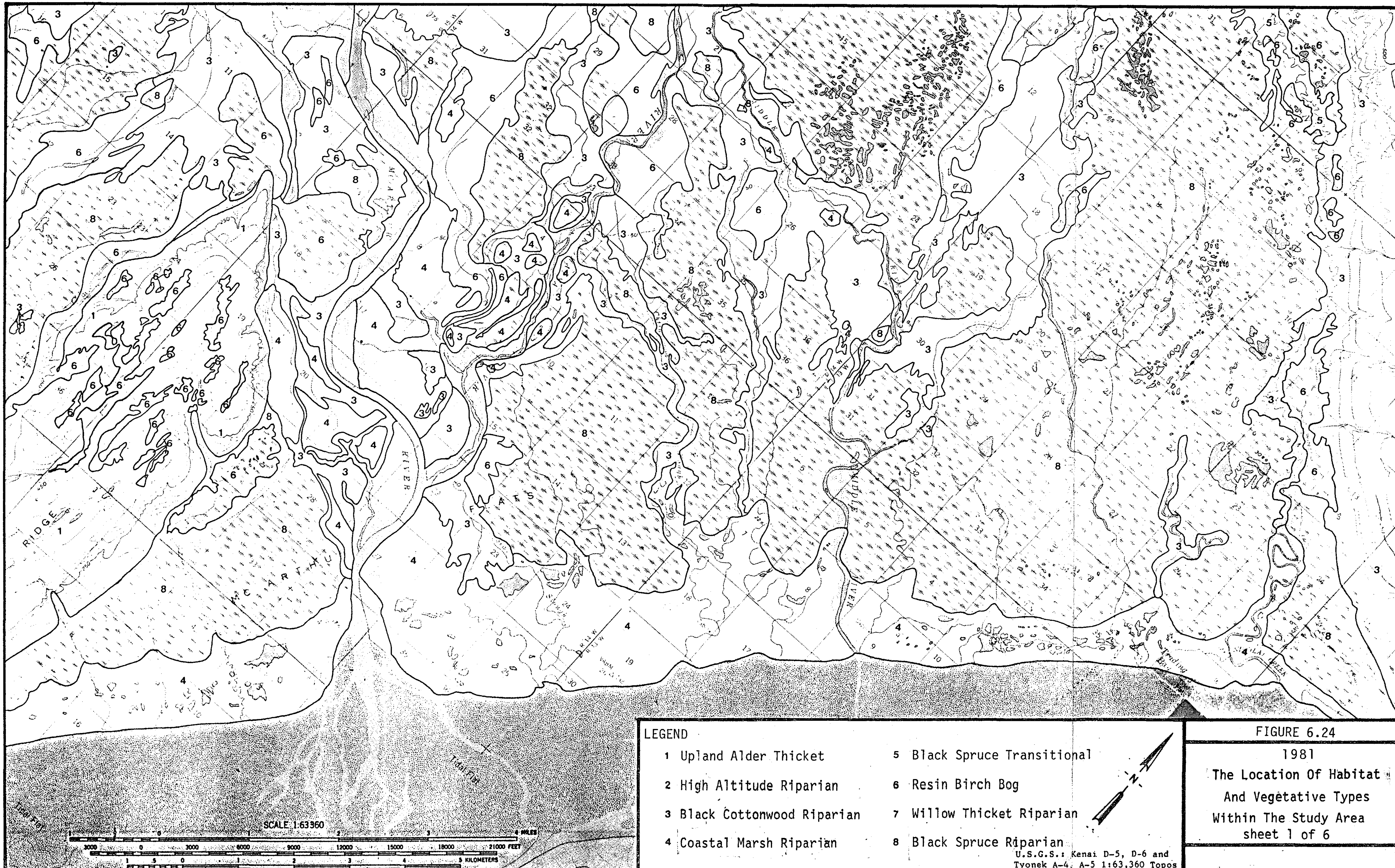


FIGURE 6.24

1981 The Location Of Habitat And Vegetative Types Within The Study Area sheet 1 of 6

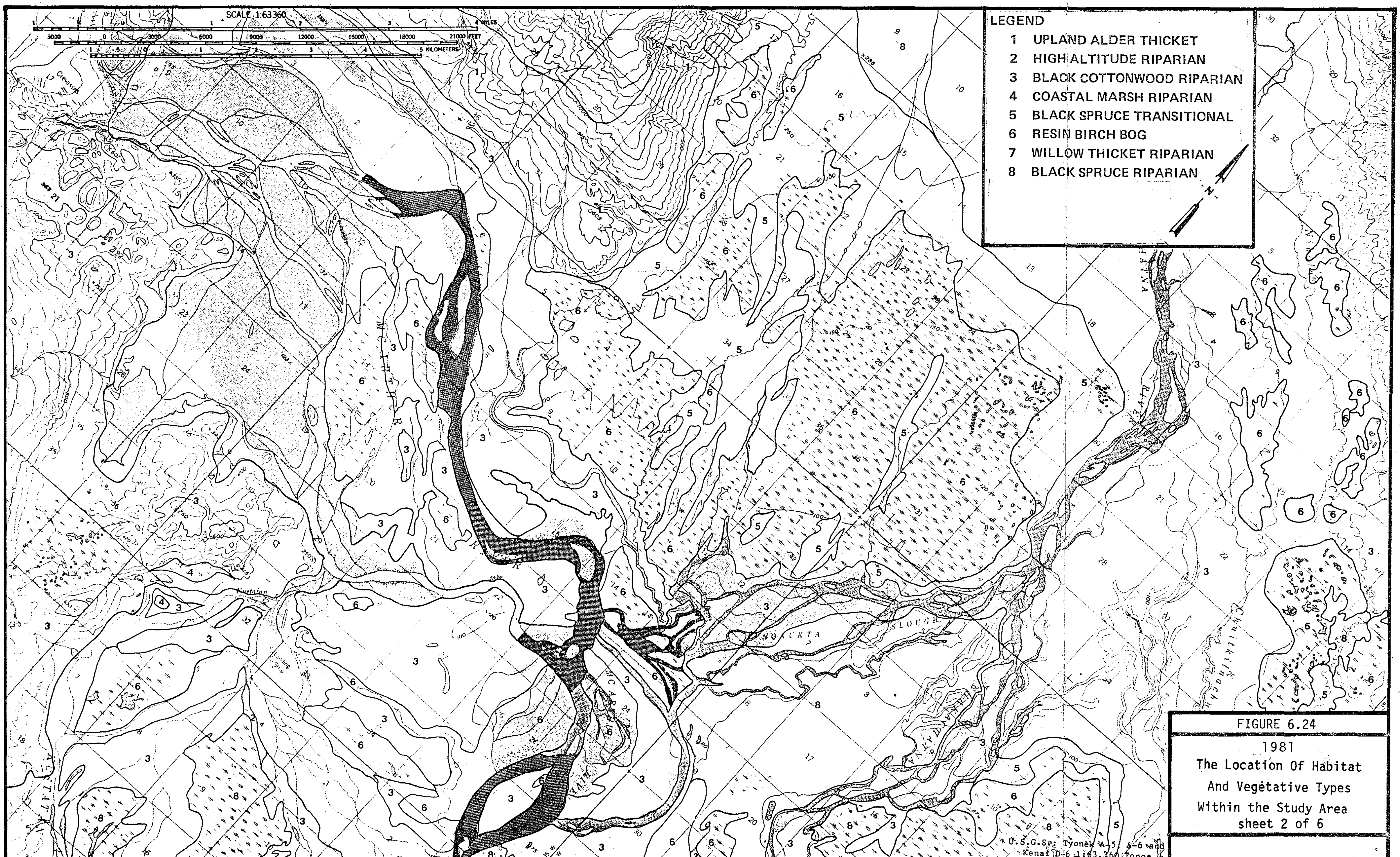


FIGURE 6.24

1981
The Location Of Habitat And Vegetative Types Within the Study Area
sheet 2 of 6

FIGURE 6.24

1981
The Location Of Habitat
And Vegetative Types
Within The Study Area
sheet 3 of 6

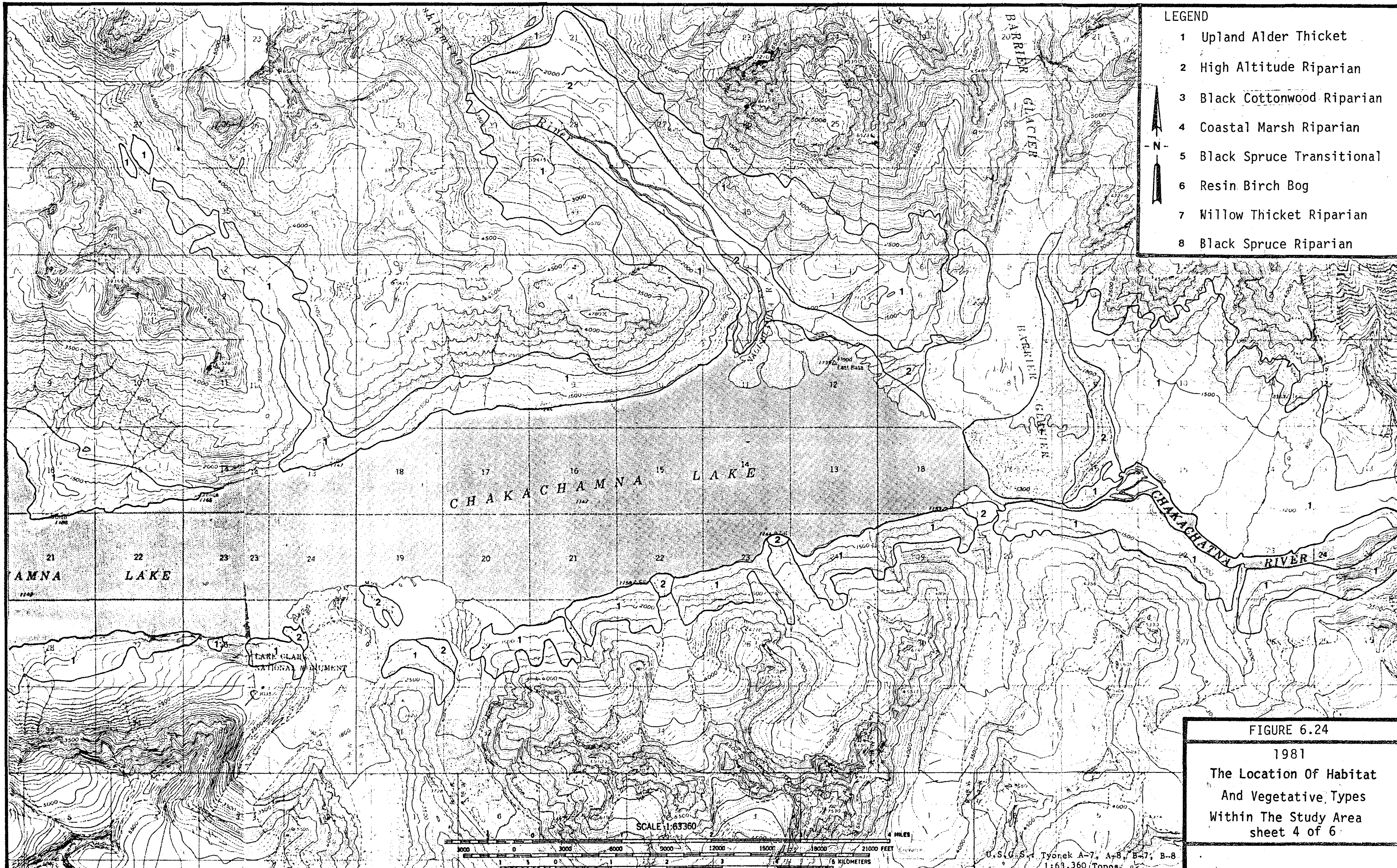


FIGURE 6.24

1981
The Location Of Habitat And Vegetative Types Within The Study Area
sheet 4 of 6

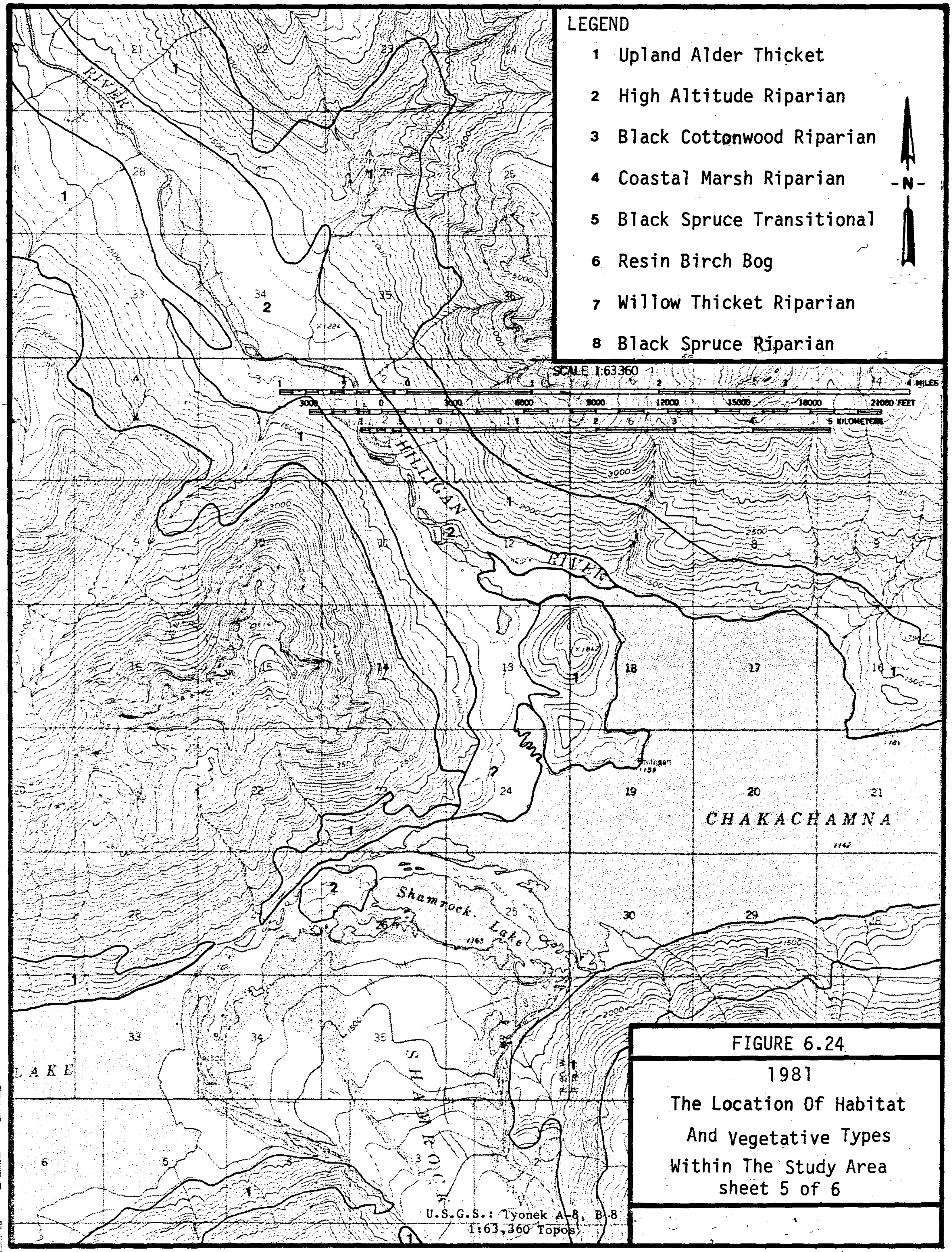


FIGURE 6.24

1981

The Location Of Habitat And Vegetative Types Within The Study Area sheet 5 of 6

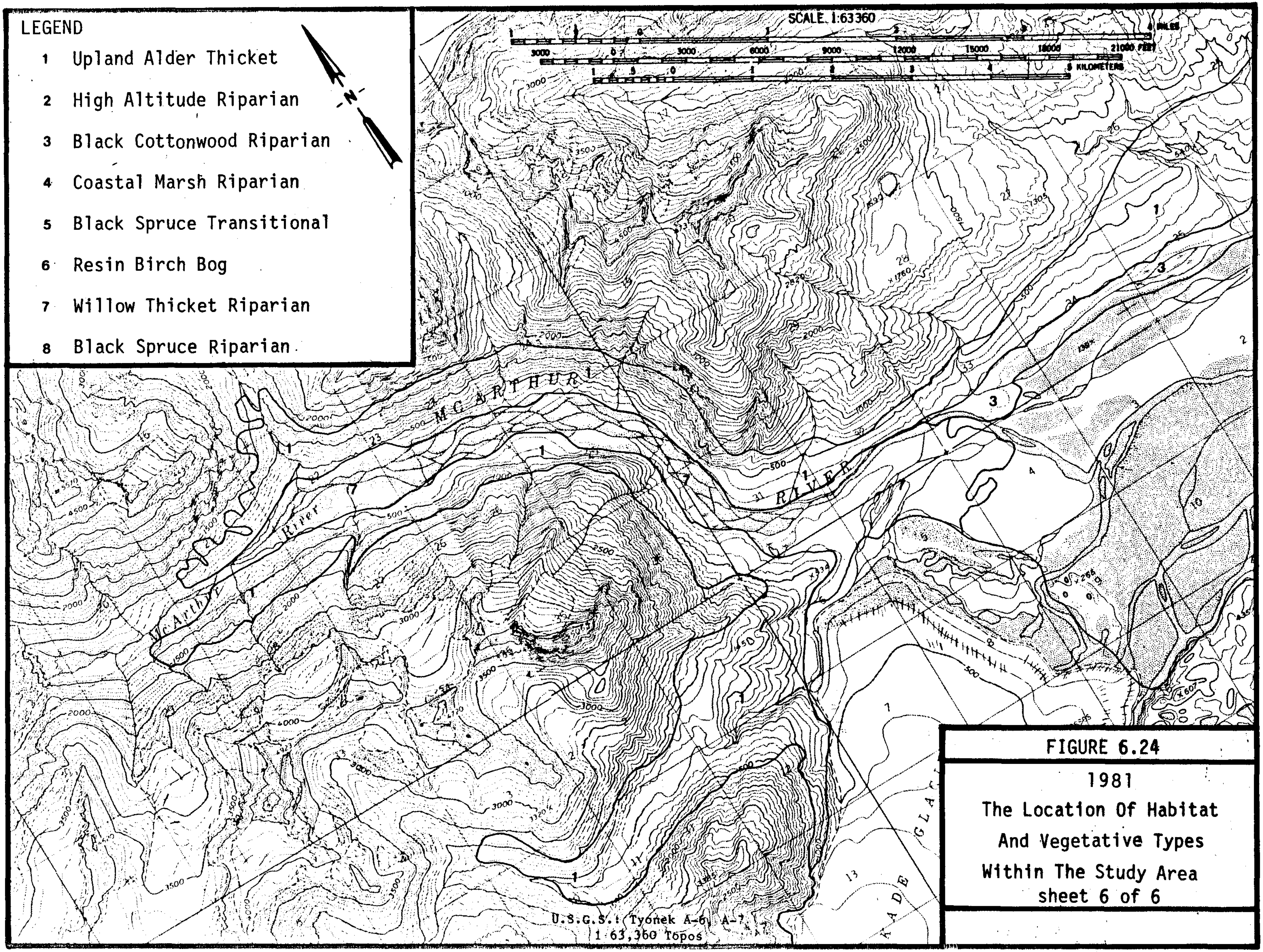


FIGURE 6.24

1981

The Location Of Habitat And Vegetative Types Within The Study Area

sheet 6 of 6

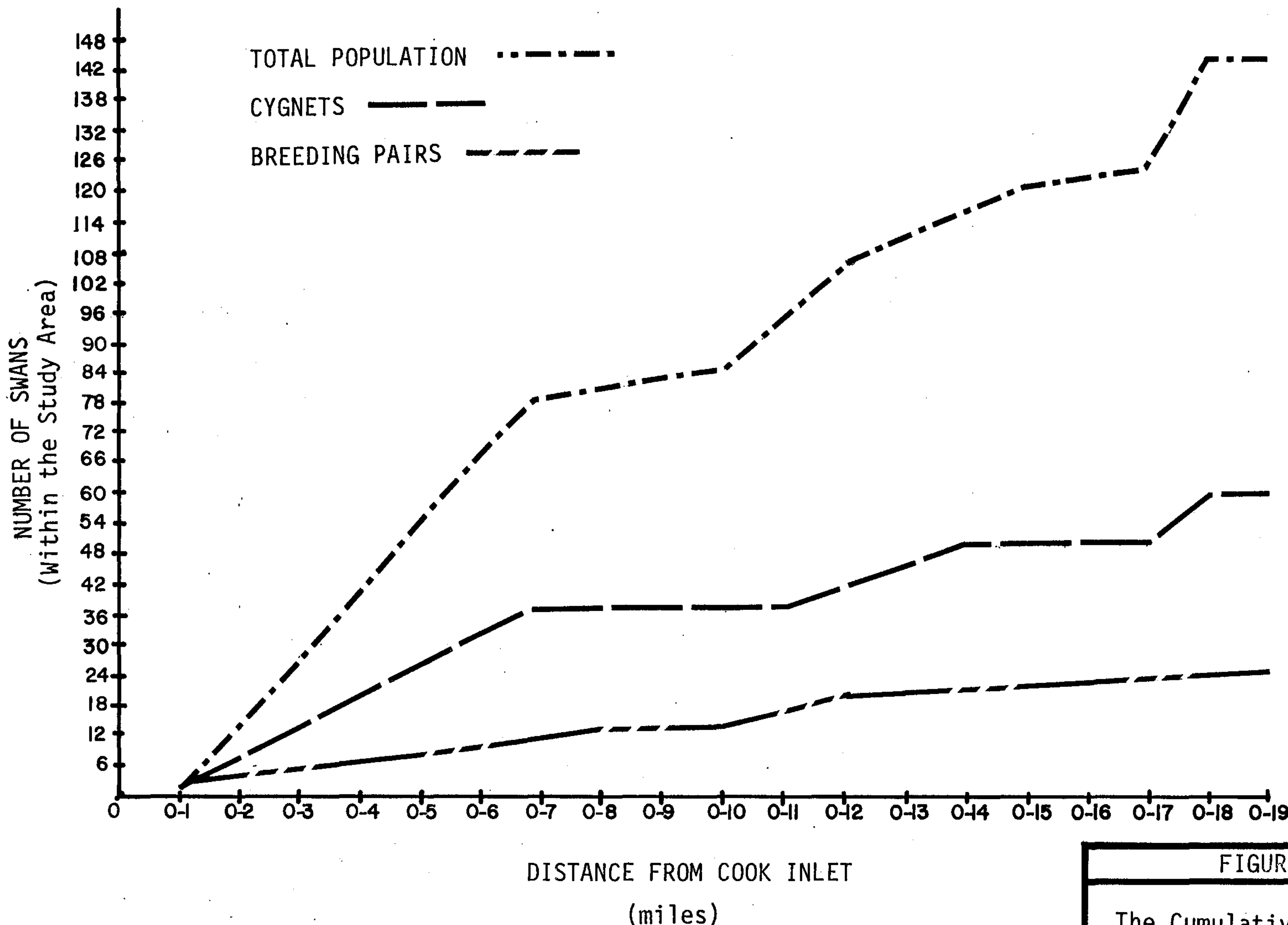


Figure is based on data obtained in a 1980
USFWS survey of the Cook Inlet waterfowl refuges.

FIGURE 6.25

The Cumulative Number of Breeding Pairs Within the Study Area 1981

FIGURE 6.26

Nesting Locations:
Bald Eagle Nests as of
May 1980
Trumpeter Swan Nests as
of August 1980

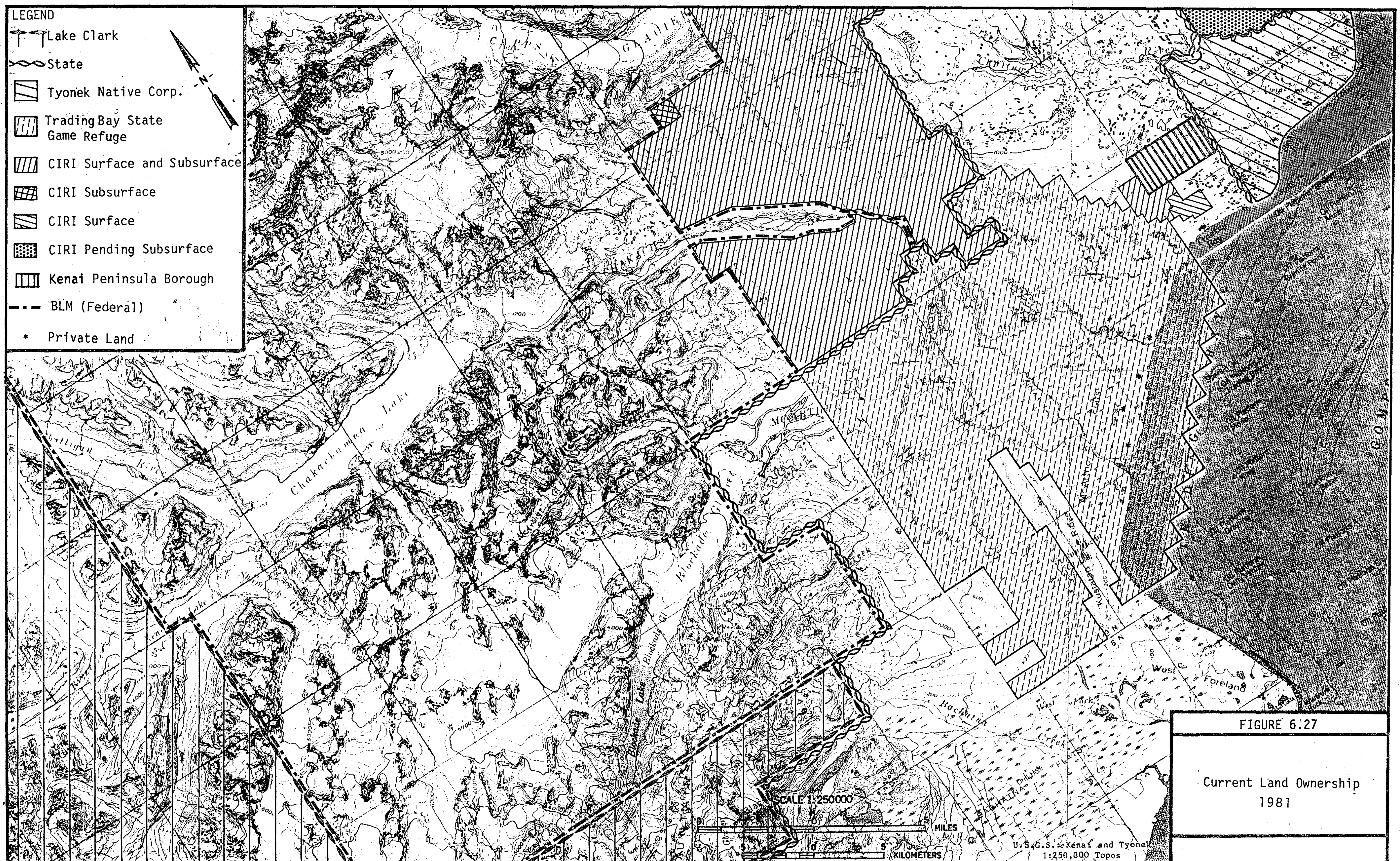


FIGURE 6.27

Current Land Ownership 1981

FIGURE 6.28

Existing and Potential Land Use 1981

FIGURE 6.29

Existing and Proposed Transportation Facilities 1981

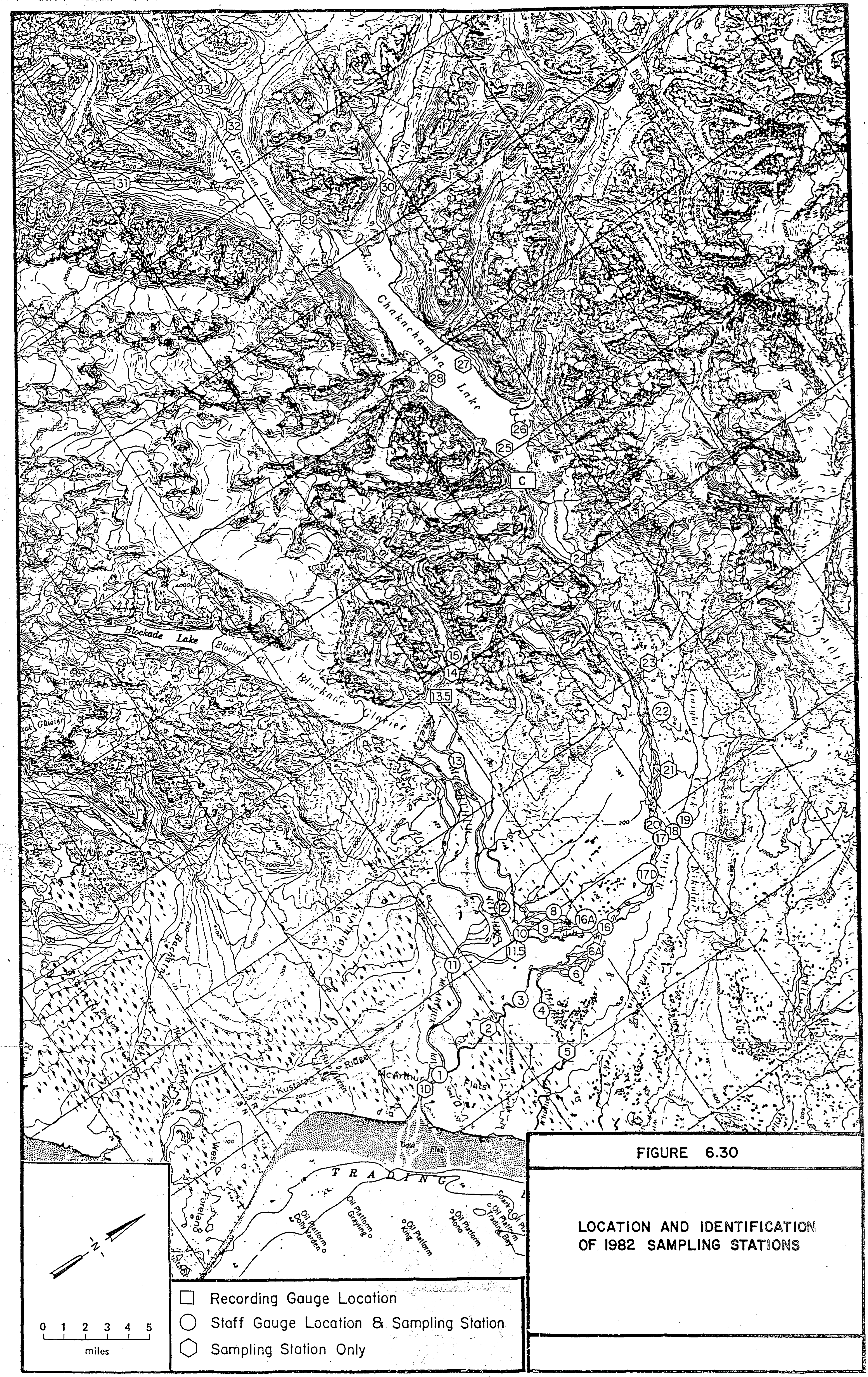


FIGURE 6.30

LOCATION AND IDENTIFICATION OF 1982 SAMPLING STATIONS

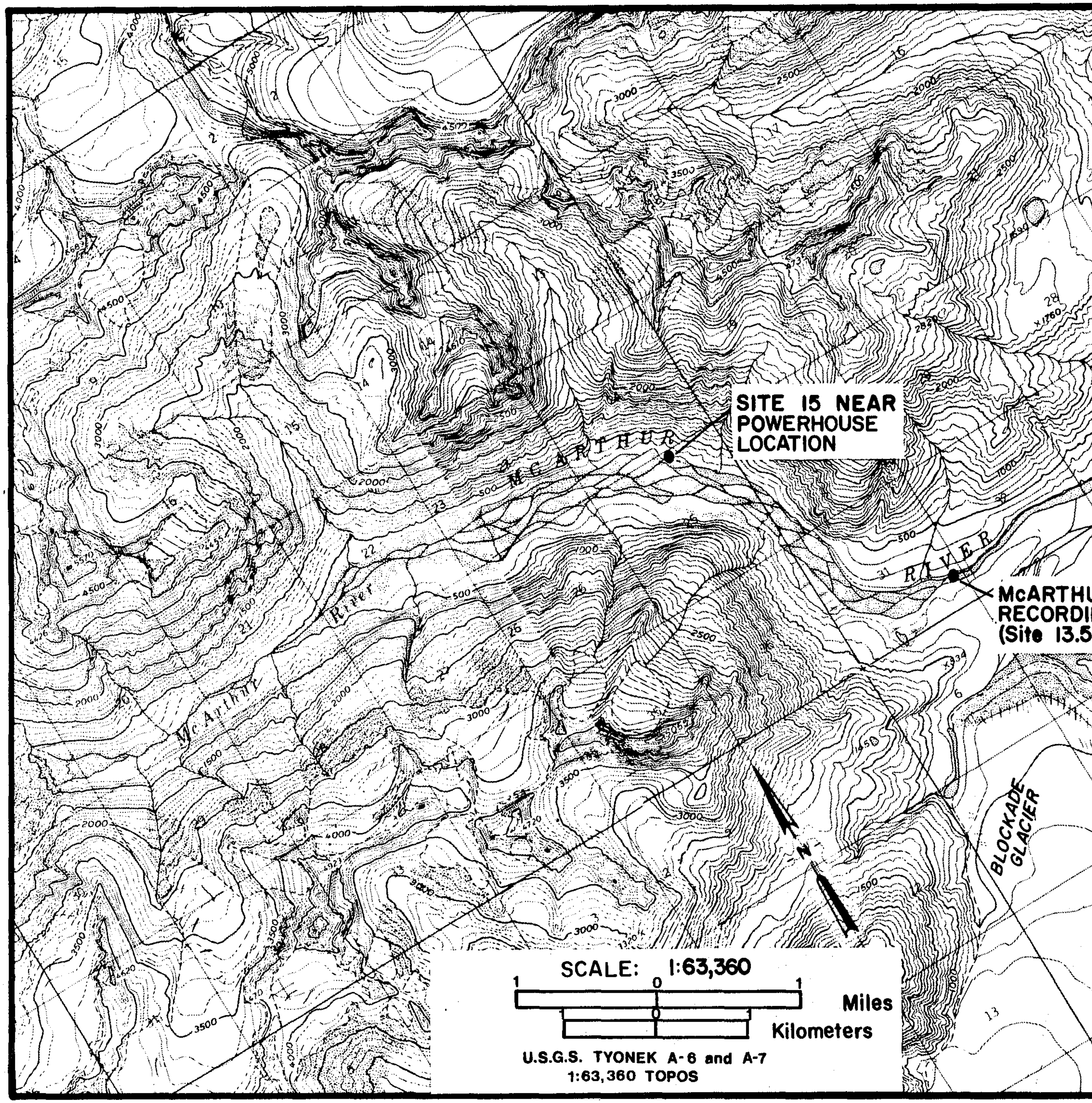


FIGURE 6.31

Map of Upper McArthur River Showing Location of the 1982 Recording Gage and Powerhouse Sites.

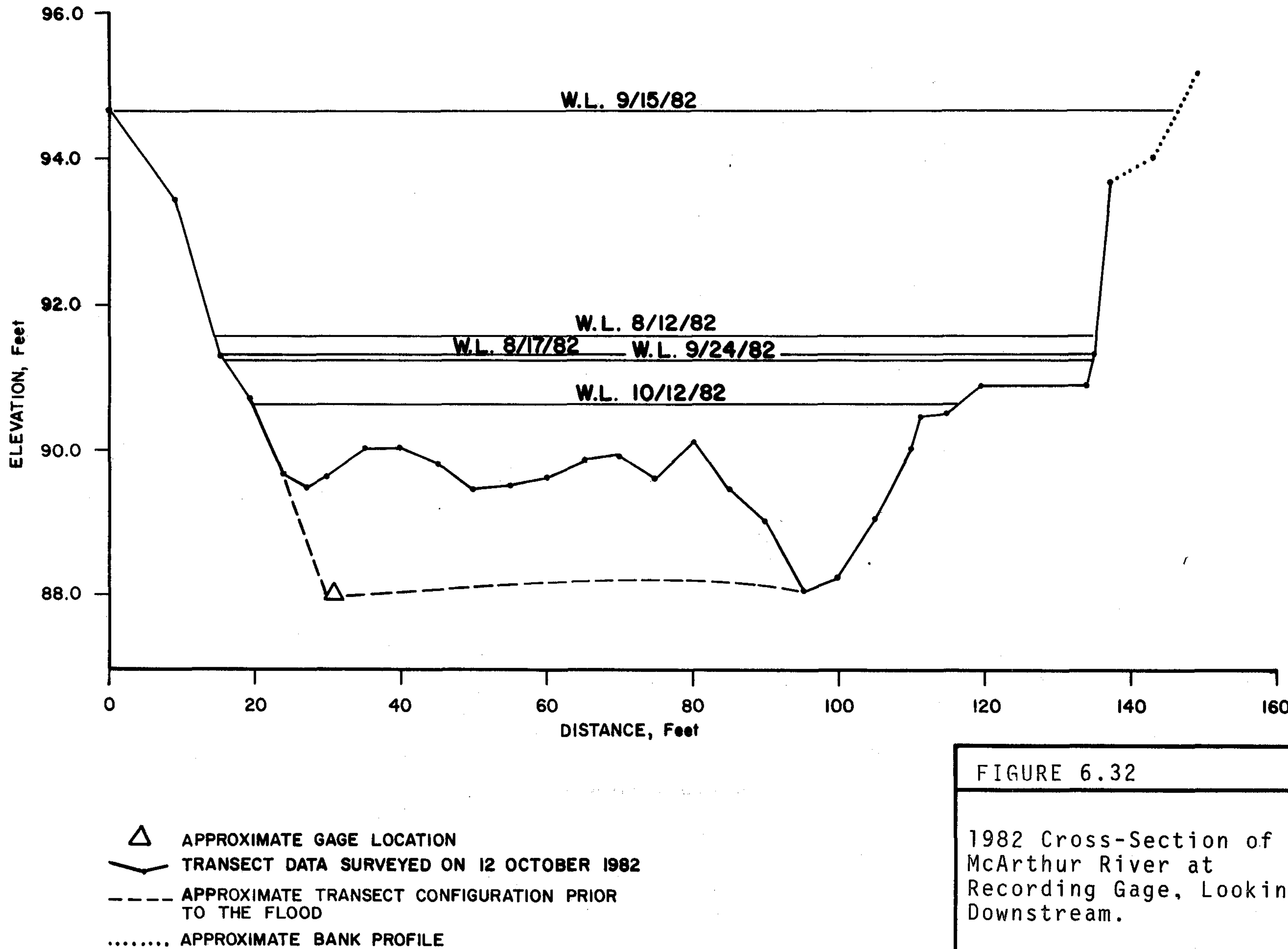


FIGURE 6.32

1982 Cross-Section of McArthur River at Recording Gage, Looking Downstream.

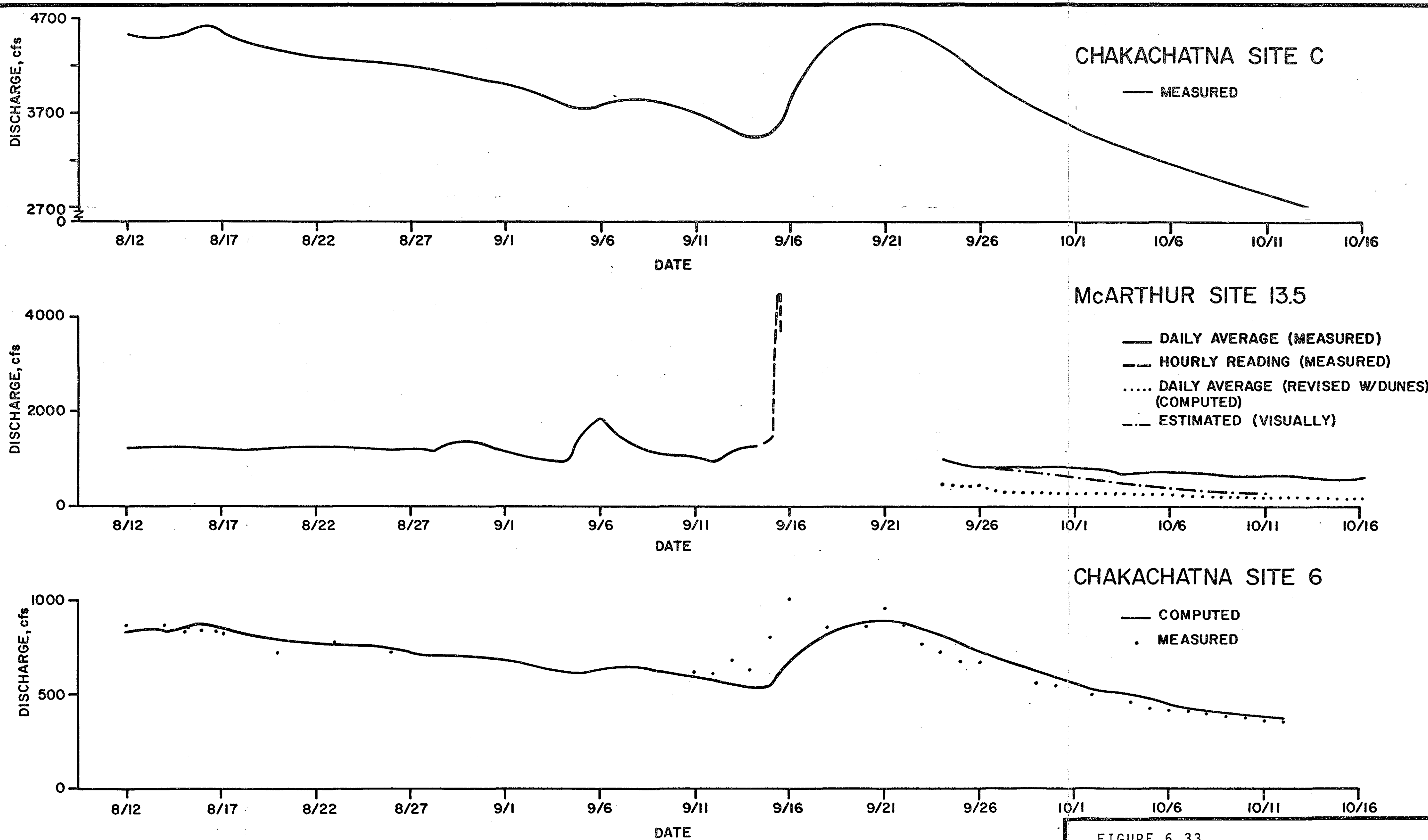


FIGURE 6.33

Hydrographs of 1982 Mean Daily Flows At Three Locations in the Study Area.

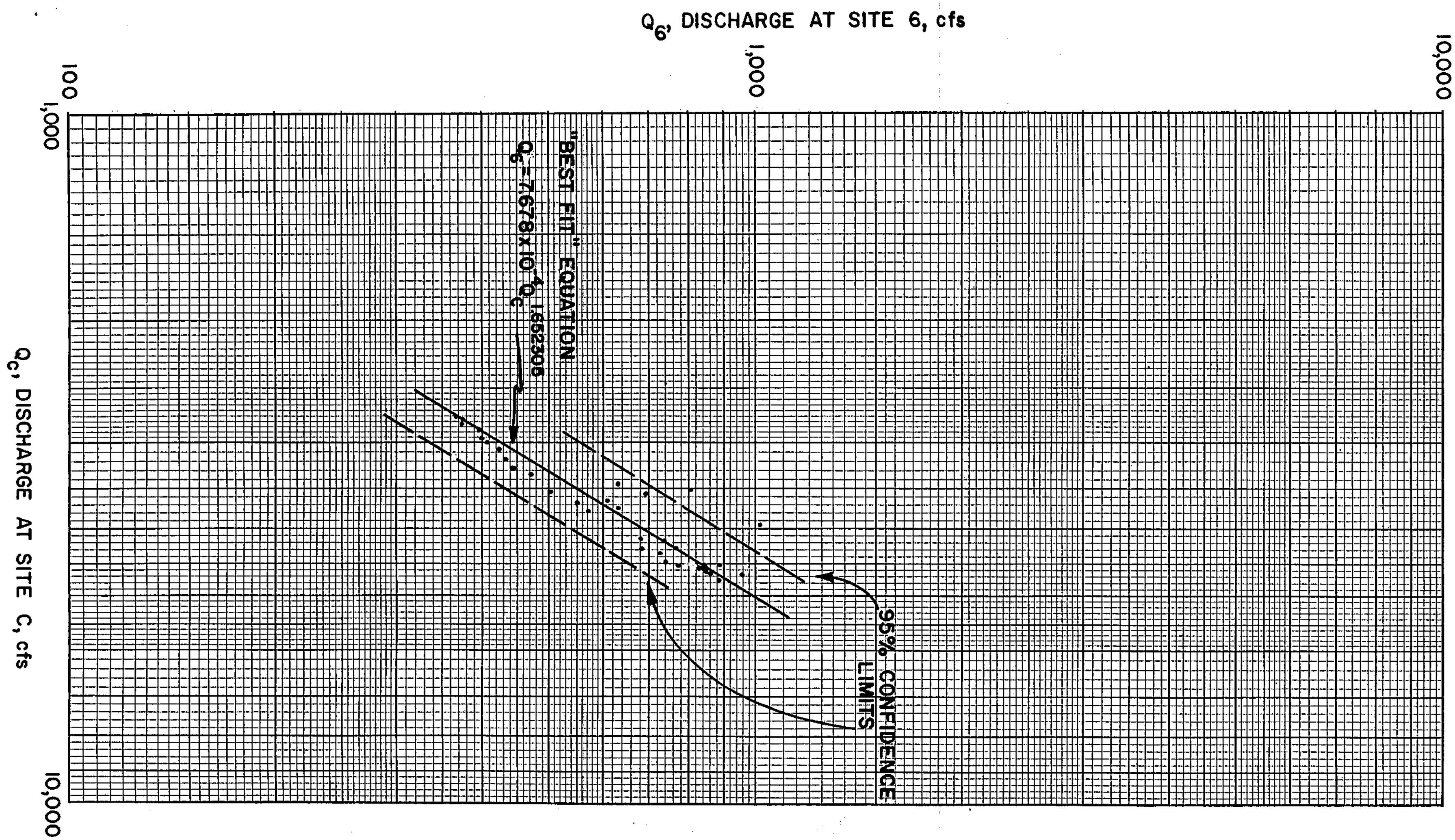


FIGURE 6.34

1982 Regression Relationship Between Discharges at Site 6 and Discharges at the Chakachatna Recording Gage.

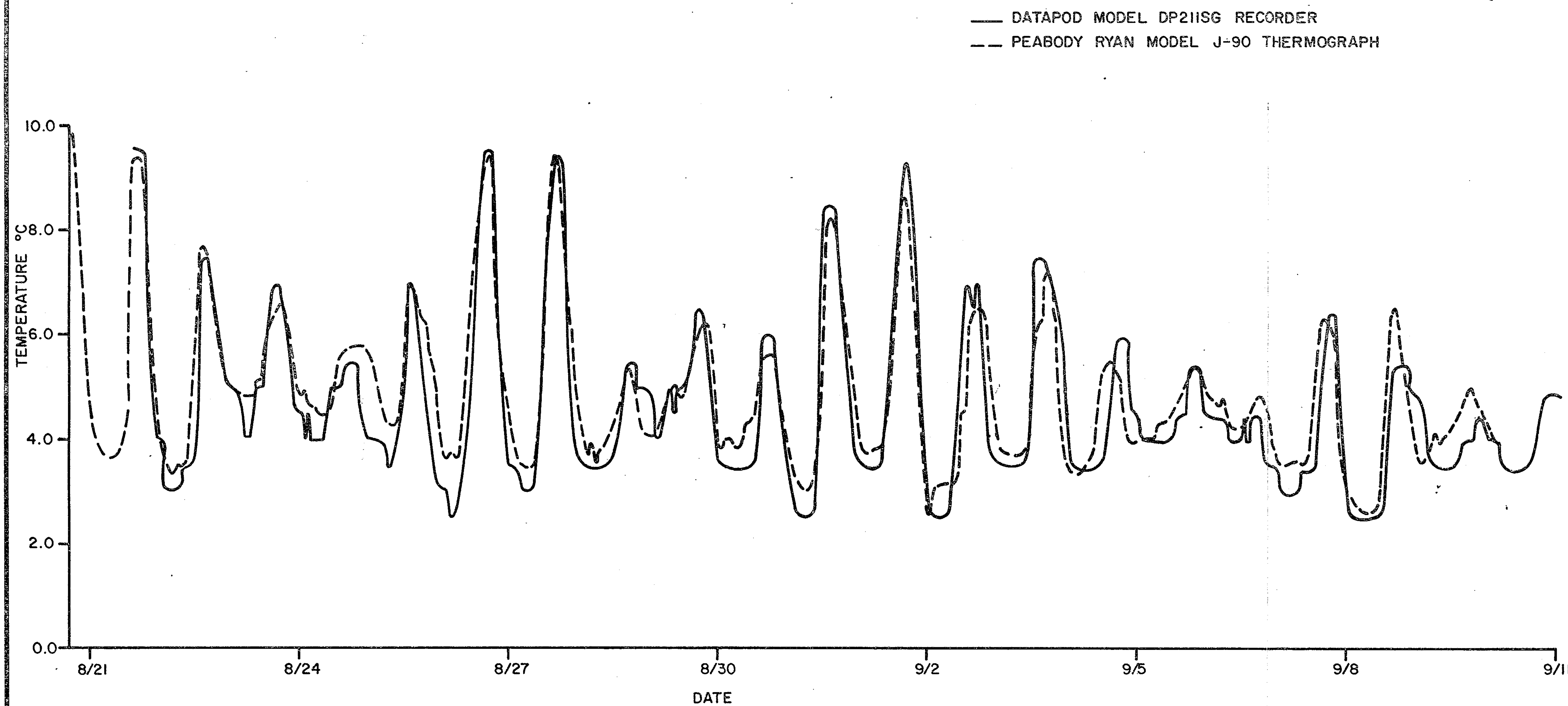


FIGURE 6.35

1982 Water Temperature Records at the McArthur River Recording Gage Site Showing Diurnal Variation.

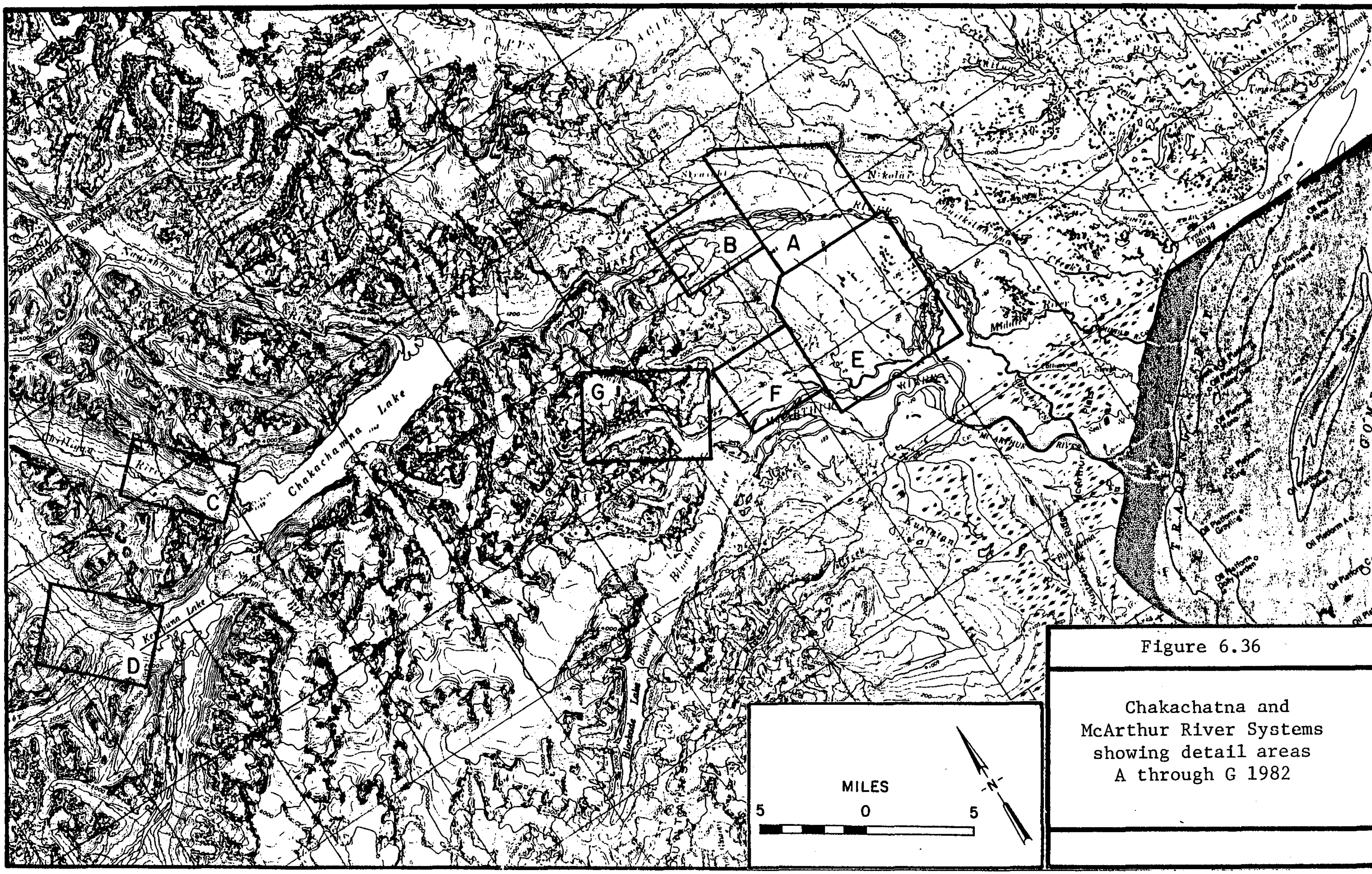


Figure 6.36

Chakachatna and McArthur River Systems showing detail areas A through G 1982

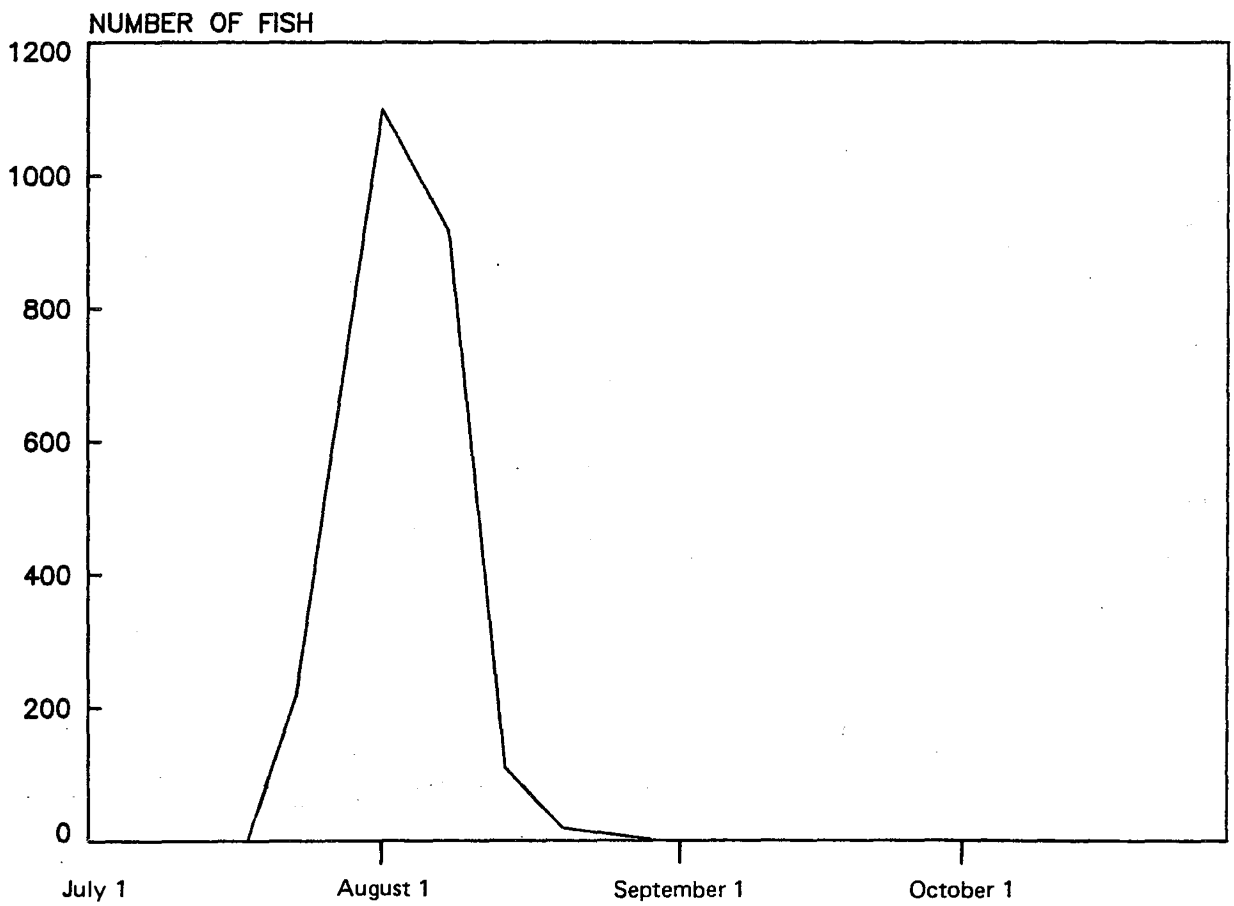


Figure 6.37

Chinook Salmon
Estimated Fish
Escapement For
Clearwater Tributary
to Straight Creek (19)

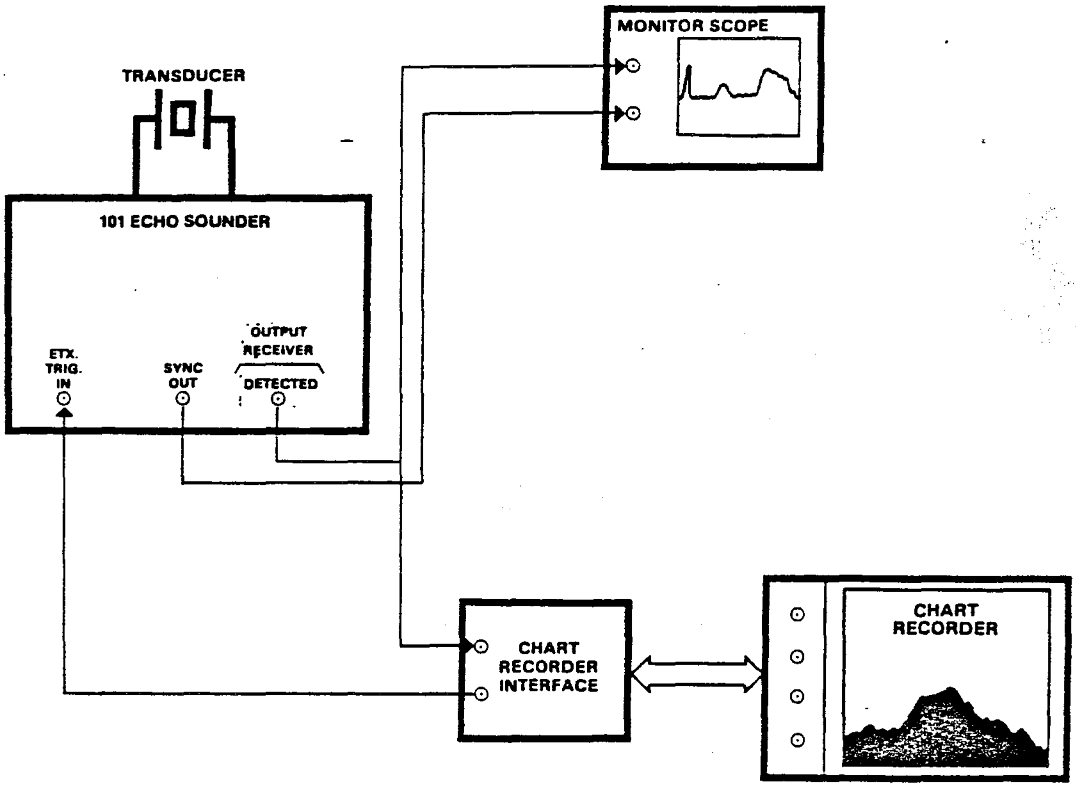


Figure 6.38

Hydroacoustic Survey
System Schematic

Winter 1982

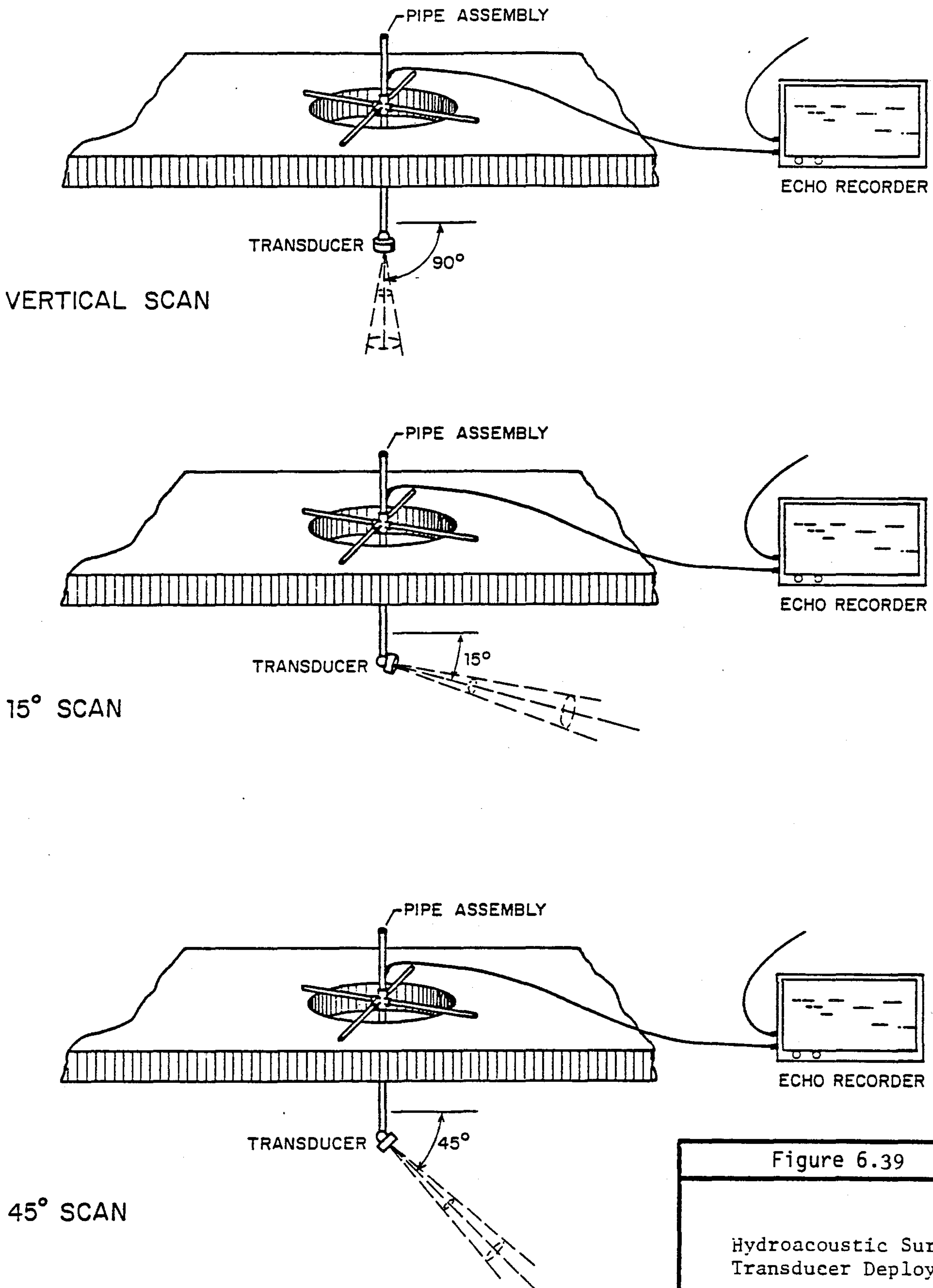


Figure 6.39

Hydroacoustic Survey
Transducer Deployment

Winter 1982

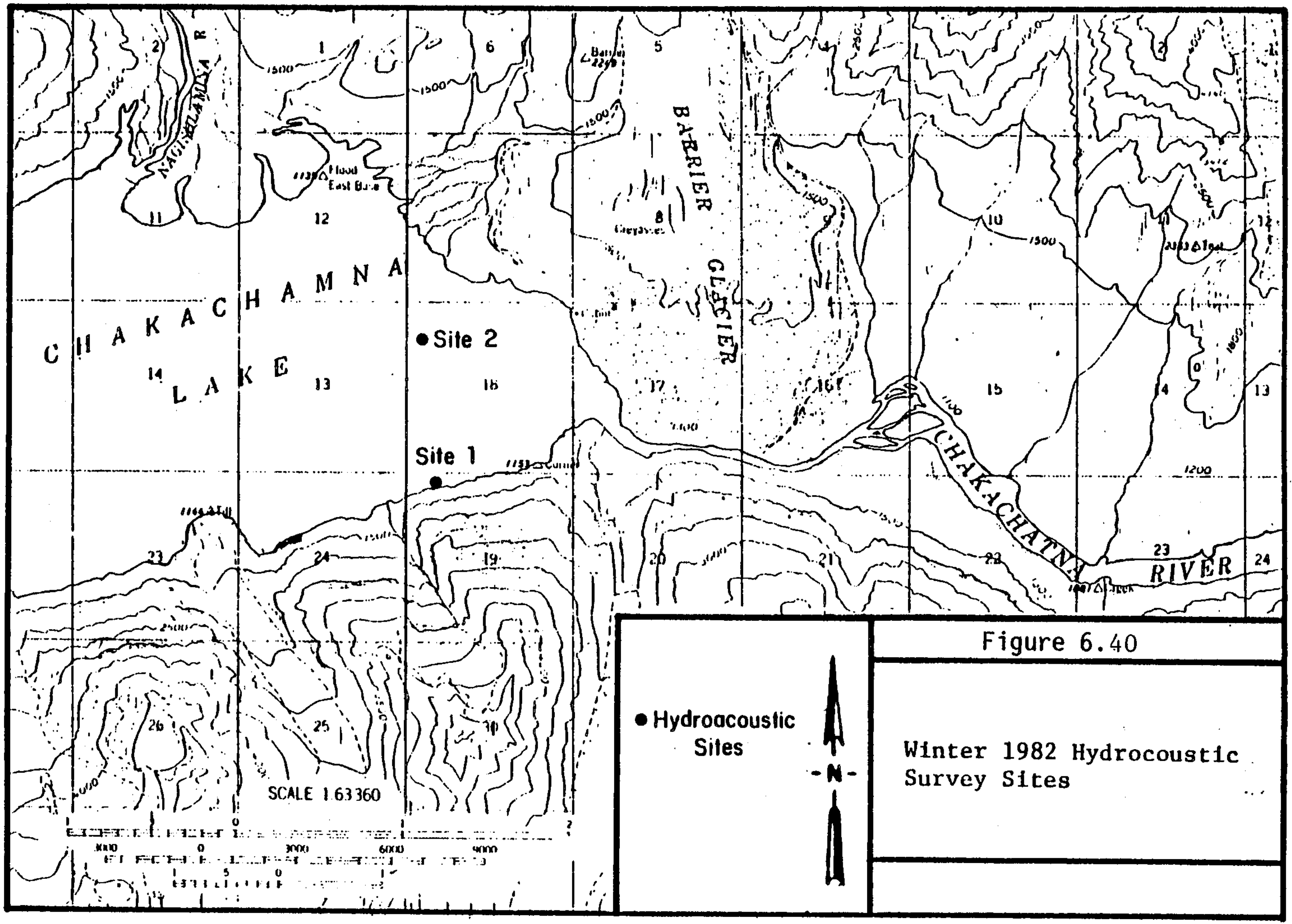


Figure 6.40

Winter 1982 Hydrocoustic Survey Sites

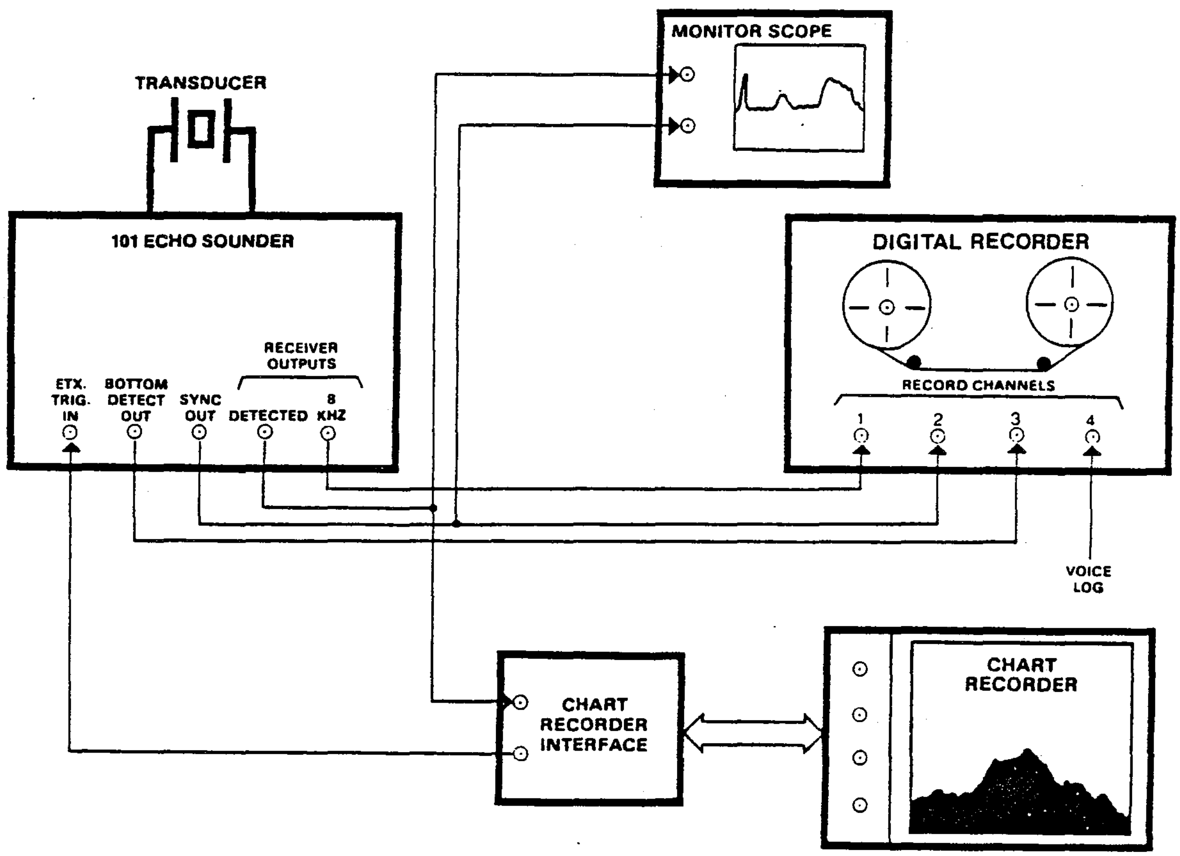


Figure 6.41

Hydroacoustic Survey
System Schematic

Summer-Fall 1982

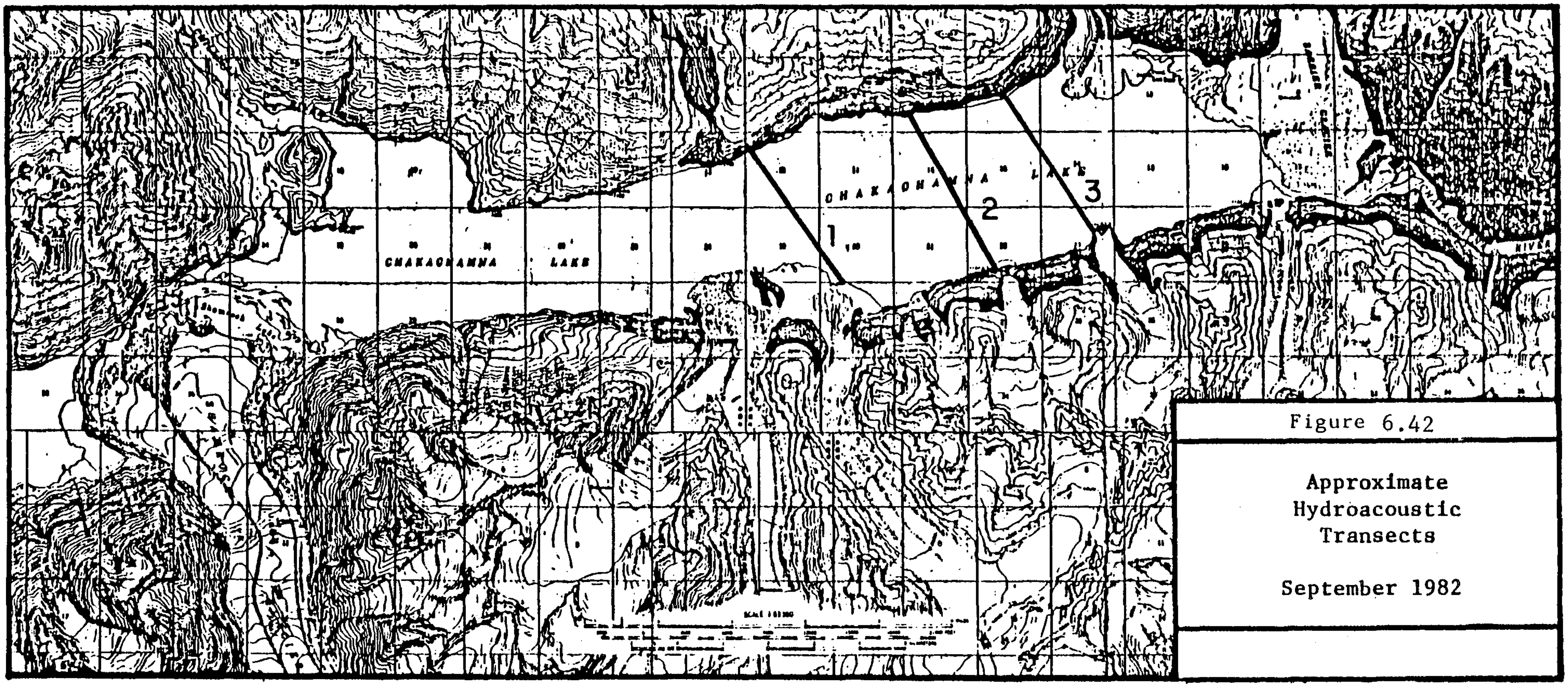


Figure 6.42

Approximate Hydroacoustic Transects

September 1982

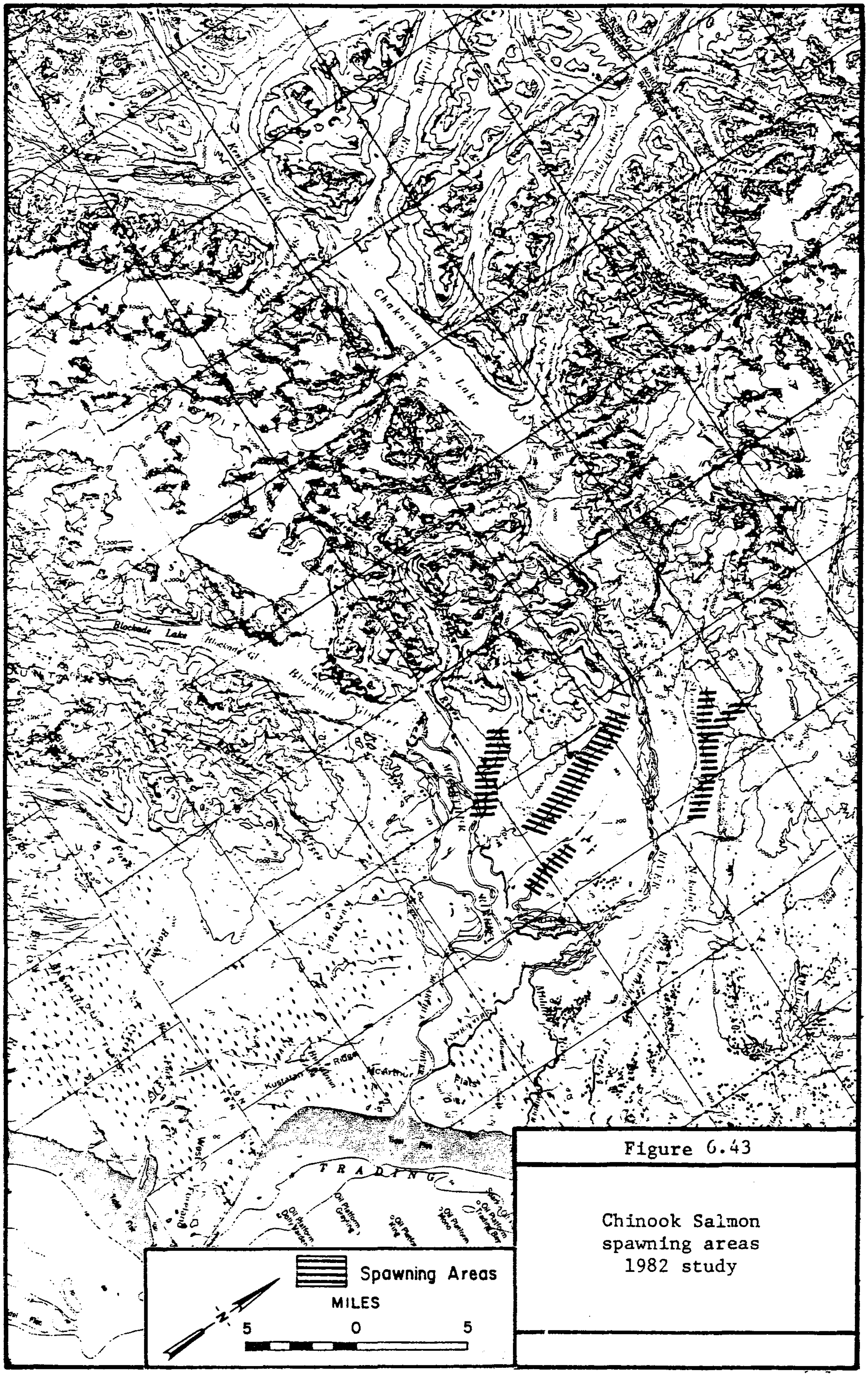


Figure 6.43

Chinook Salmon
spawning areas
1982 study

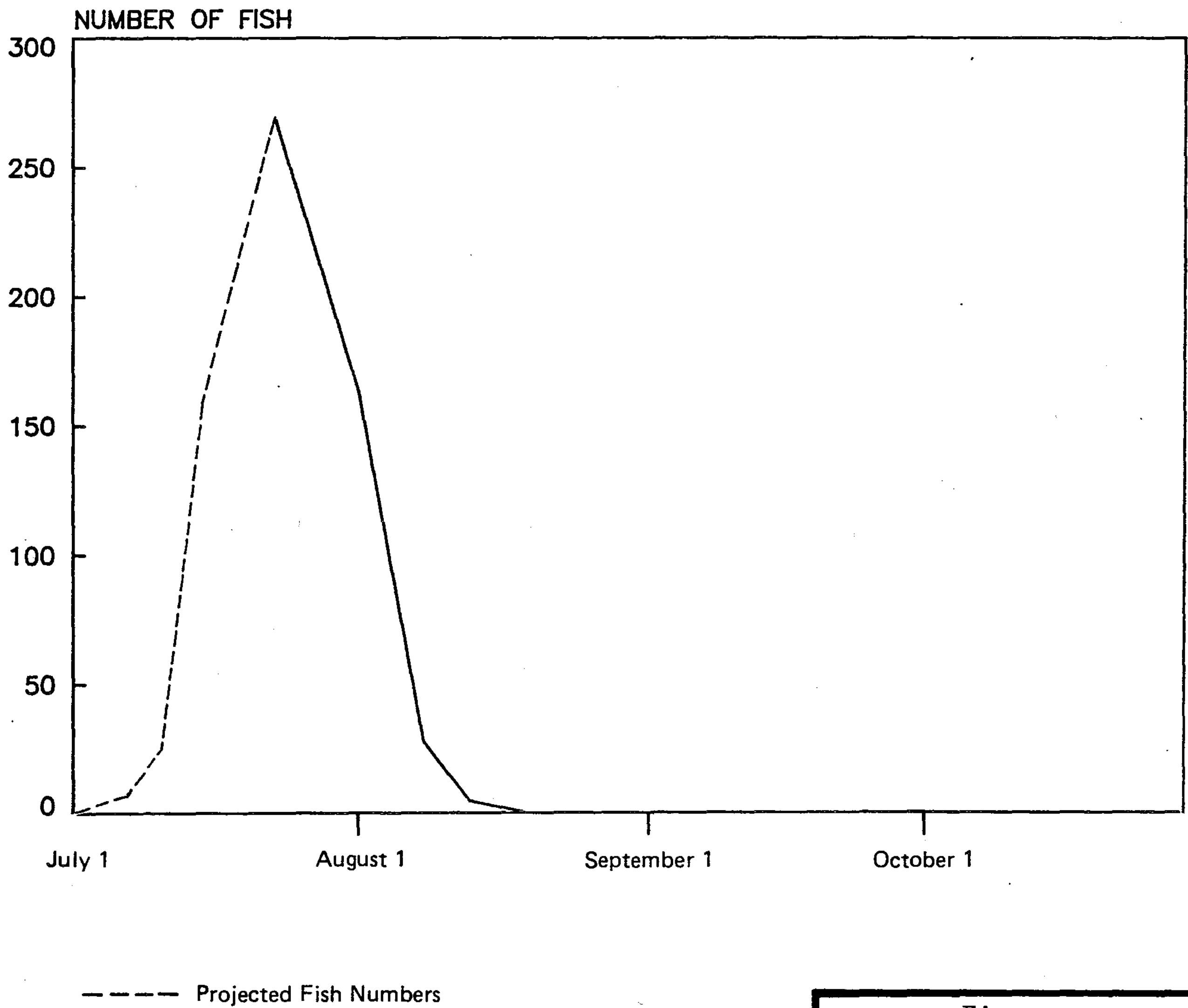


Figure 6.44

Chinook Salmon
Estimated Fish
Escapement For
McArthur River
Oxbow Creek (13X)

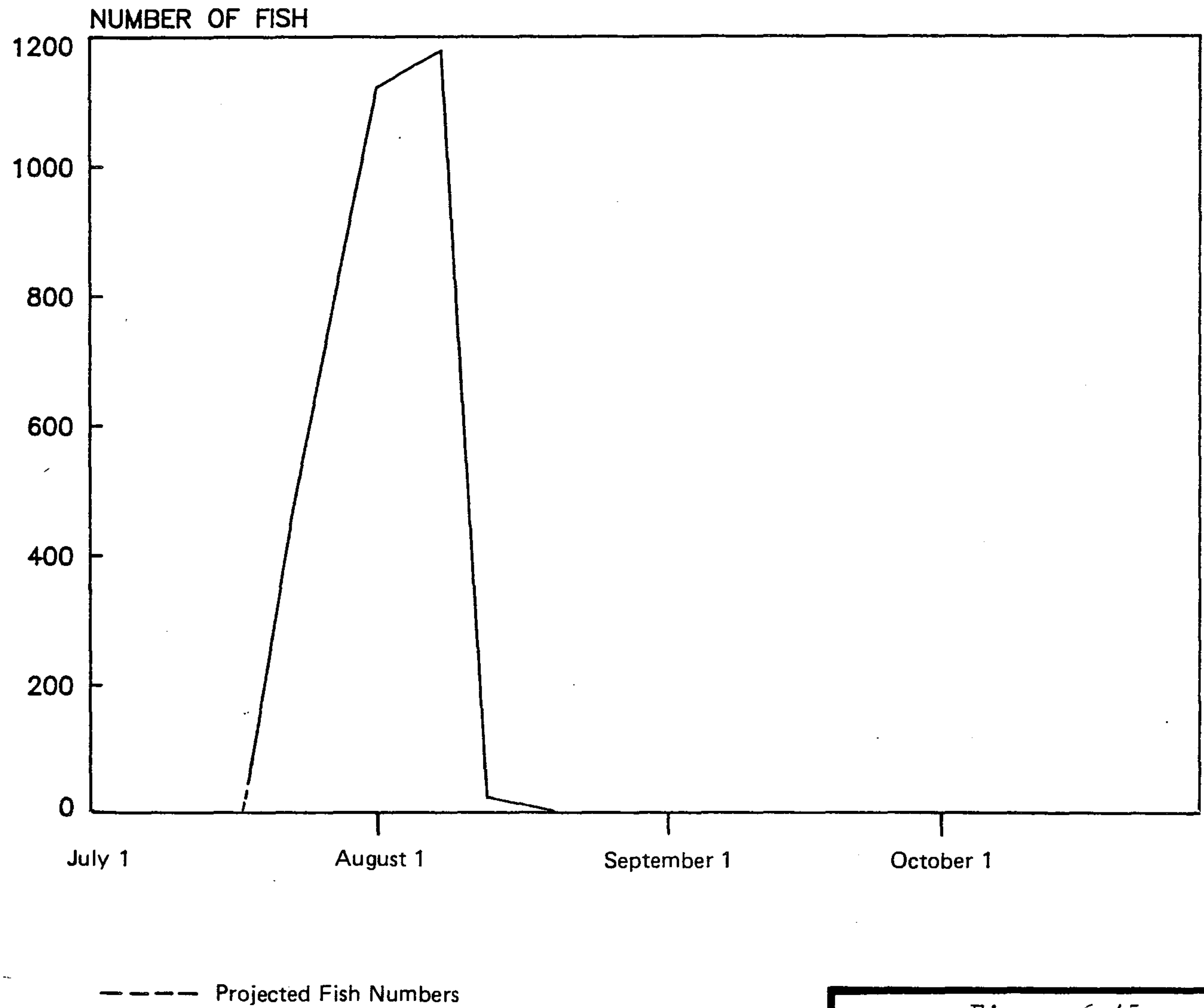


Figure 6.45

Chinook Salmon
Estimated Fish
Escapement For
McArthur River
Upper Tributary (13U)

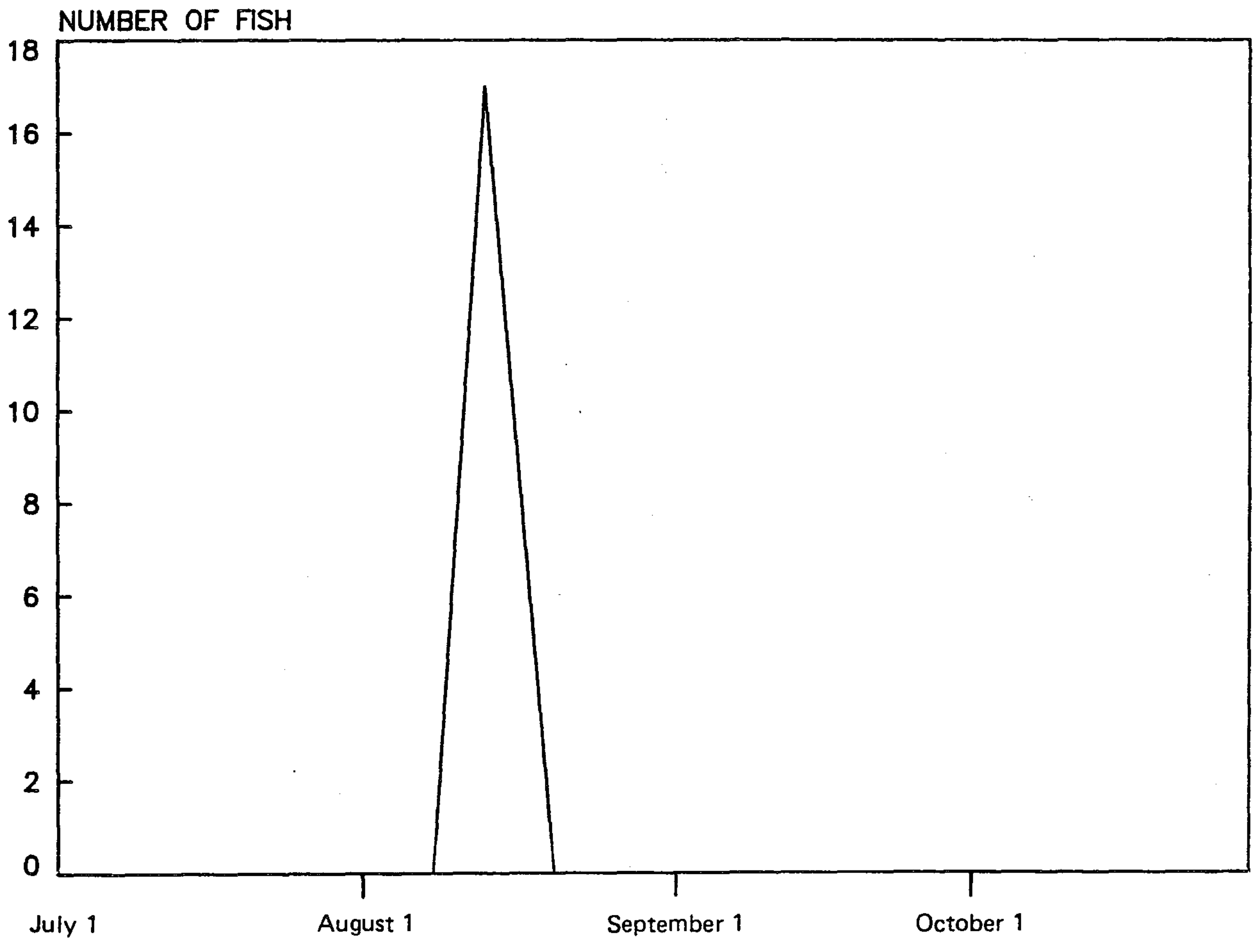
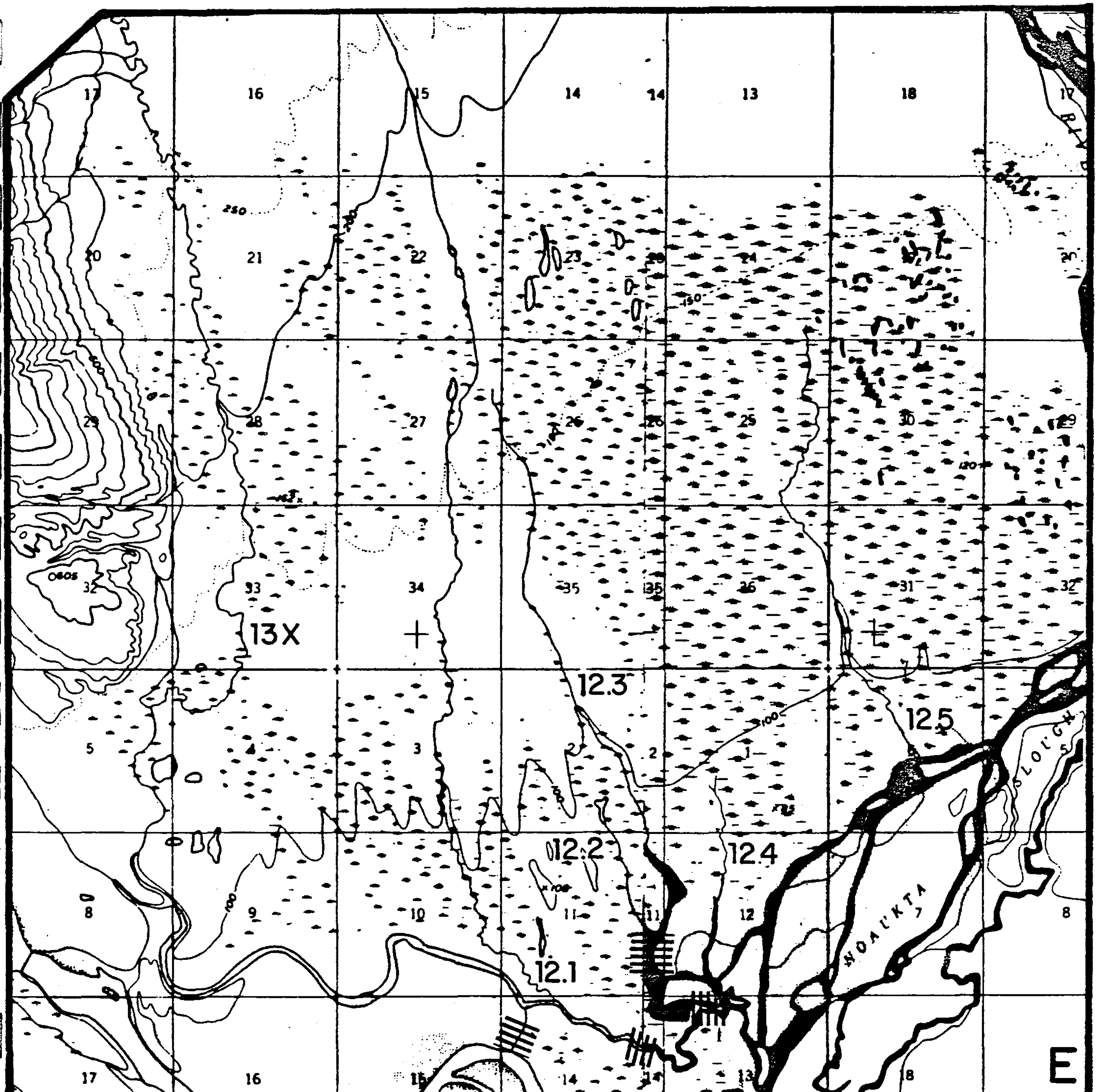


Figure 6.46

Chinook Salmon
Estimated Fish
Escapement For
Tributary 12.2



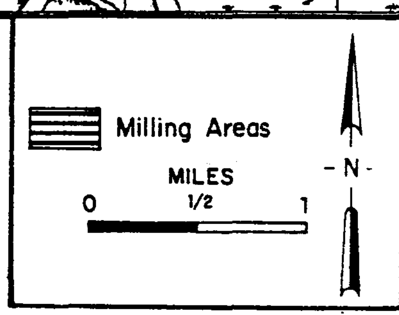


Figure 6.47

Sockeye Milling Areas
Streams 13X, 12.1,
12.2, 12.3
1982
Detail Area E

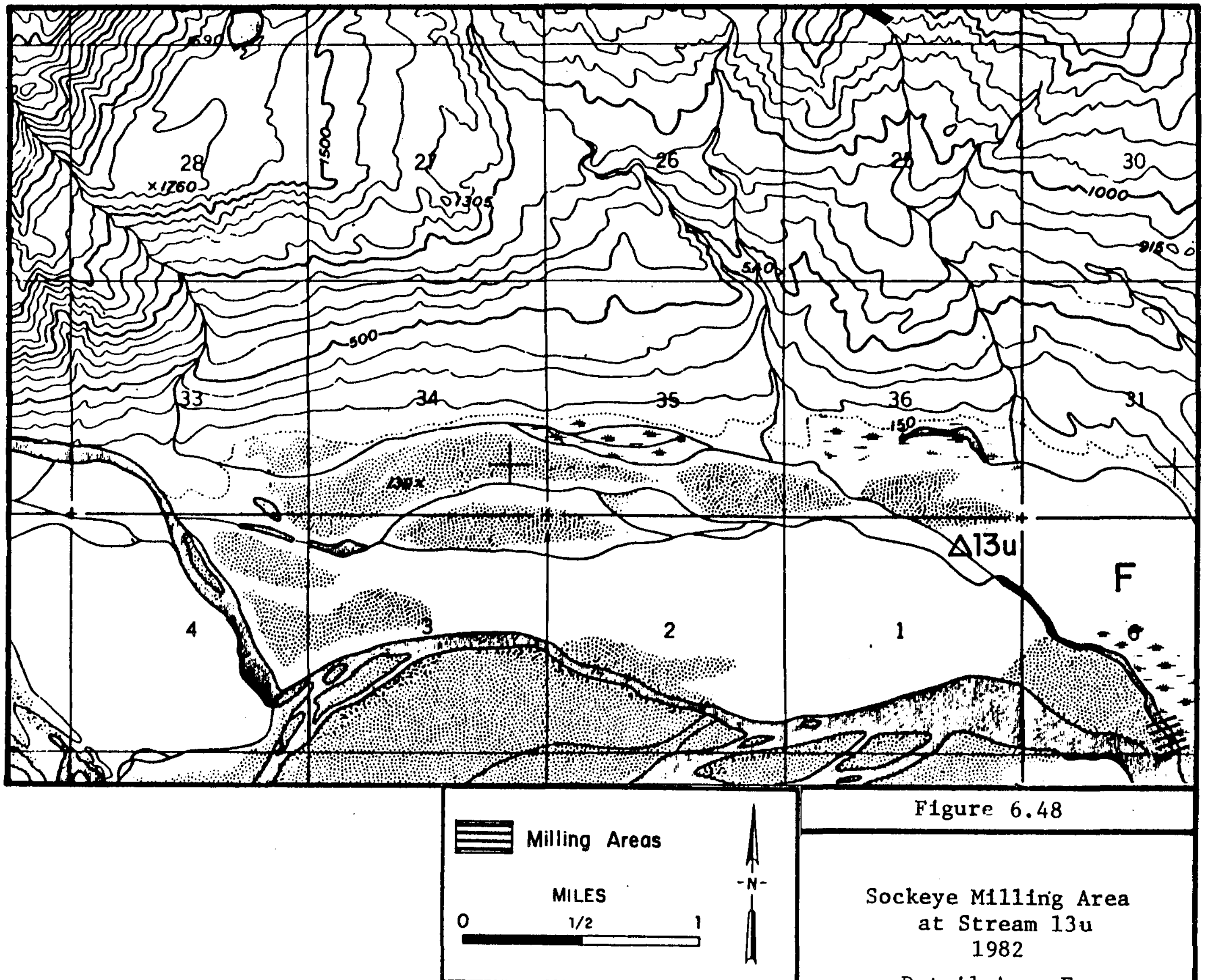


Figure 6.48

Sockeye Milling Area
at Stream 13u
1982

Detail Area F

Figure 6.49

Sockeye Salmon
Spawning Areas
1982

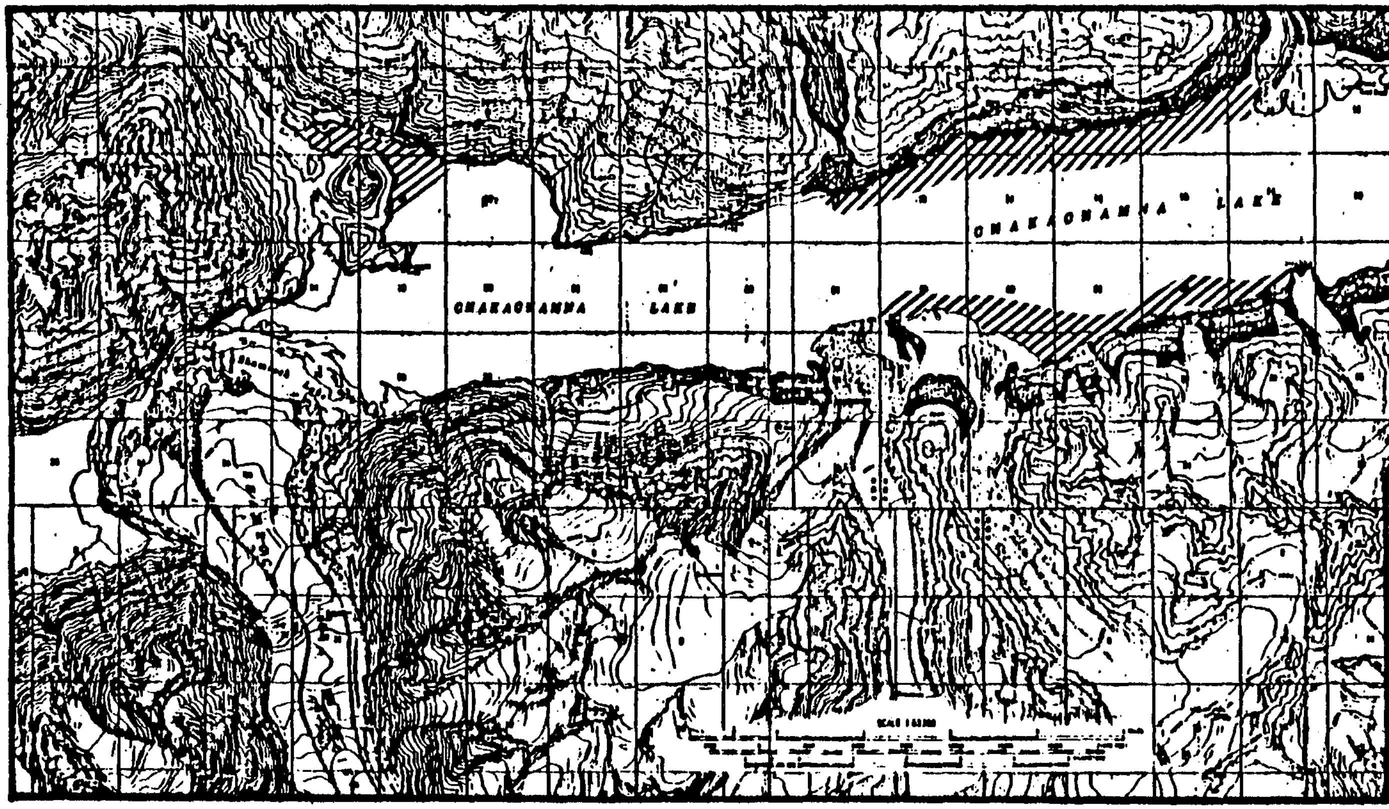


Figure 6.50

Chakachamna Lake Sockeye Milling Areas 1982

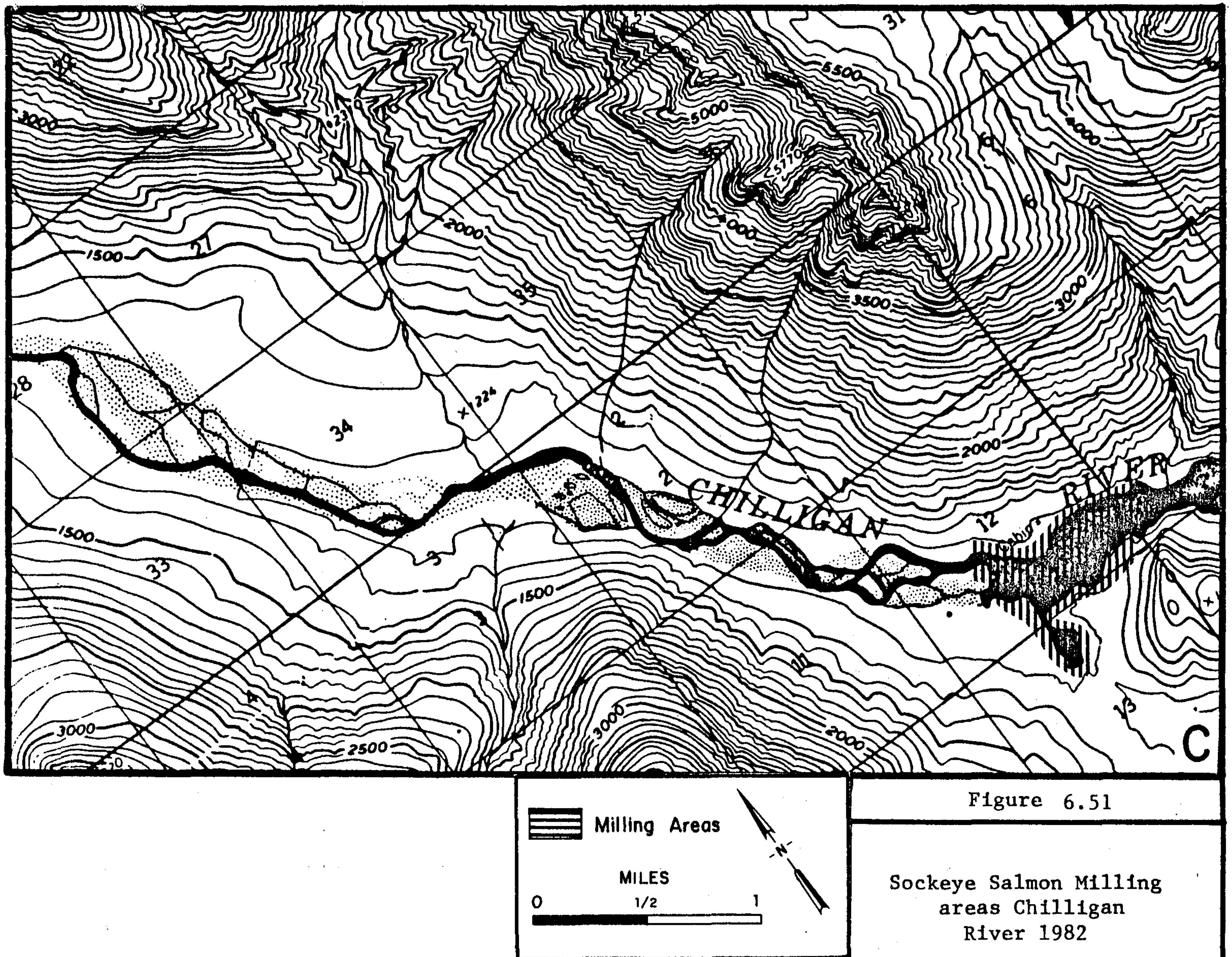


Figure 6.51

Sockeye Salmon Milling areas Chilligan River 1982

Detail Area C

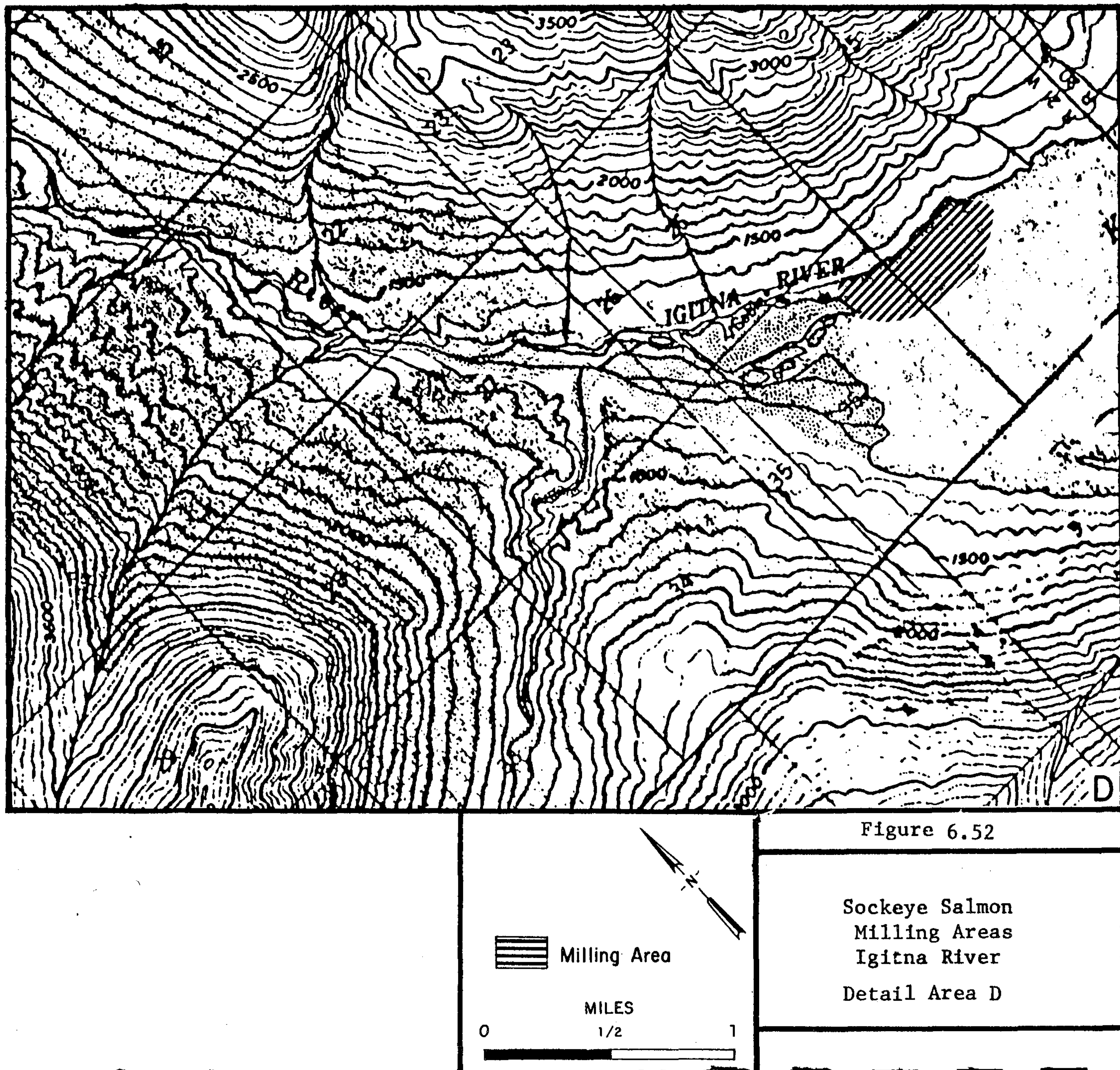


Figure 6.52

Sockeye Salmon
Milling Areas
Igitna River

Detail Area D

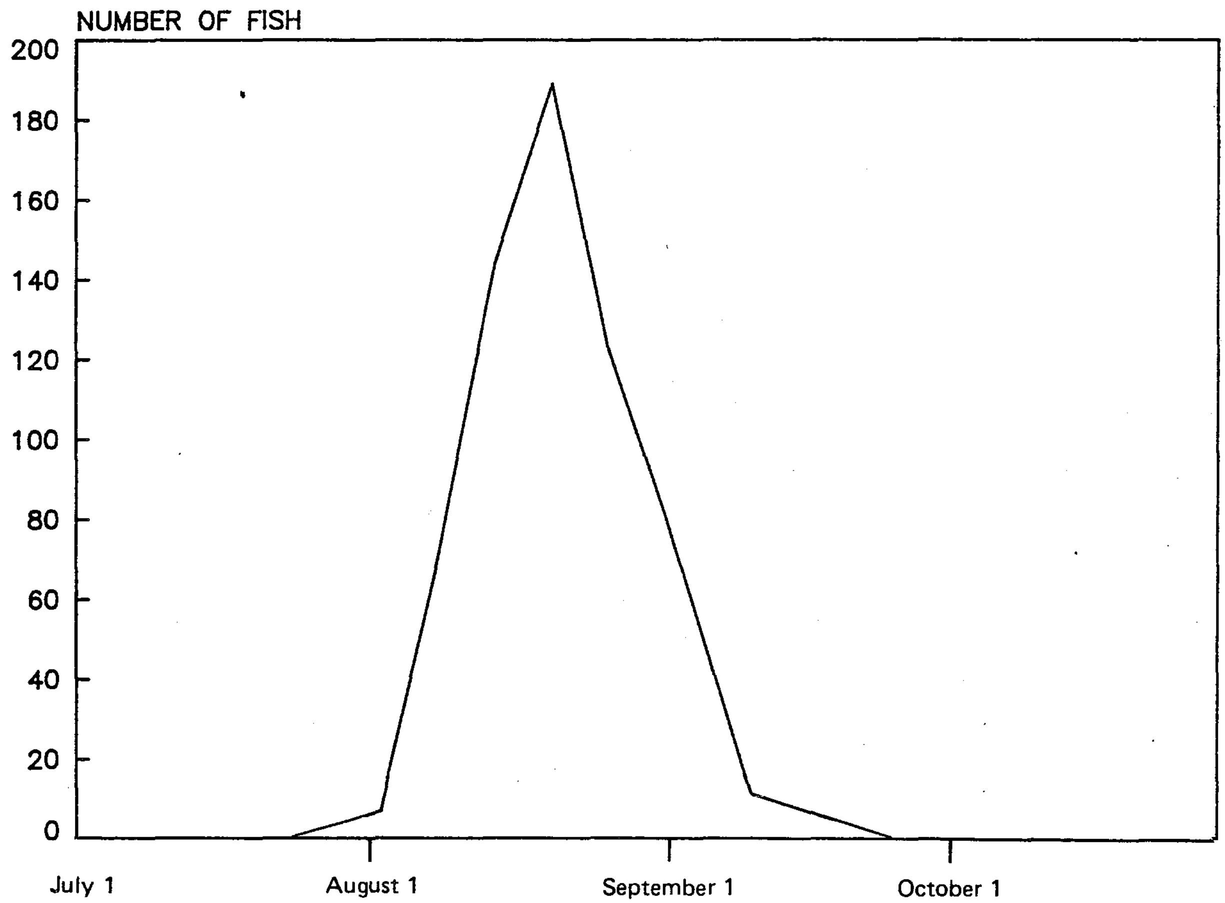


Figure 6.53

Sockeye Salmon
Estimated Fish
Escapement For
McArthur River
Canyon (stations 15 & 14)

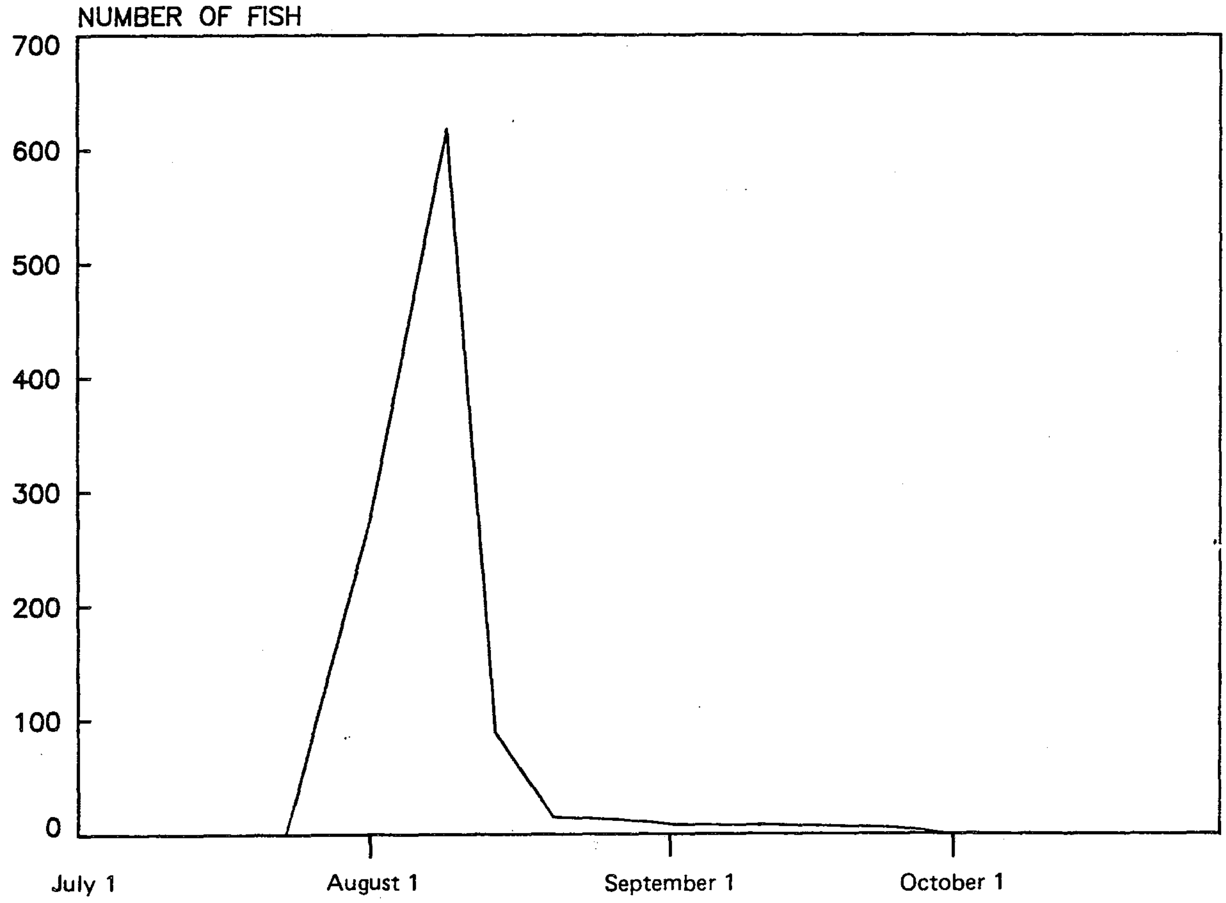


Figure 6.54

Sockeye Salmon
Estimated Fish
Escapement For
McArthur River Upper
Tributary (13U)

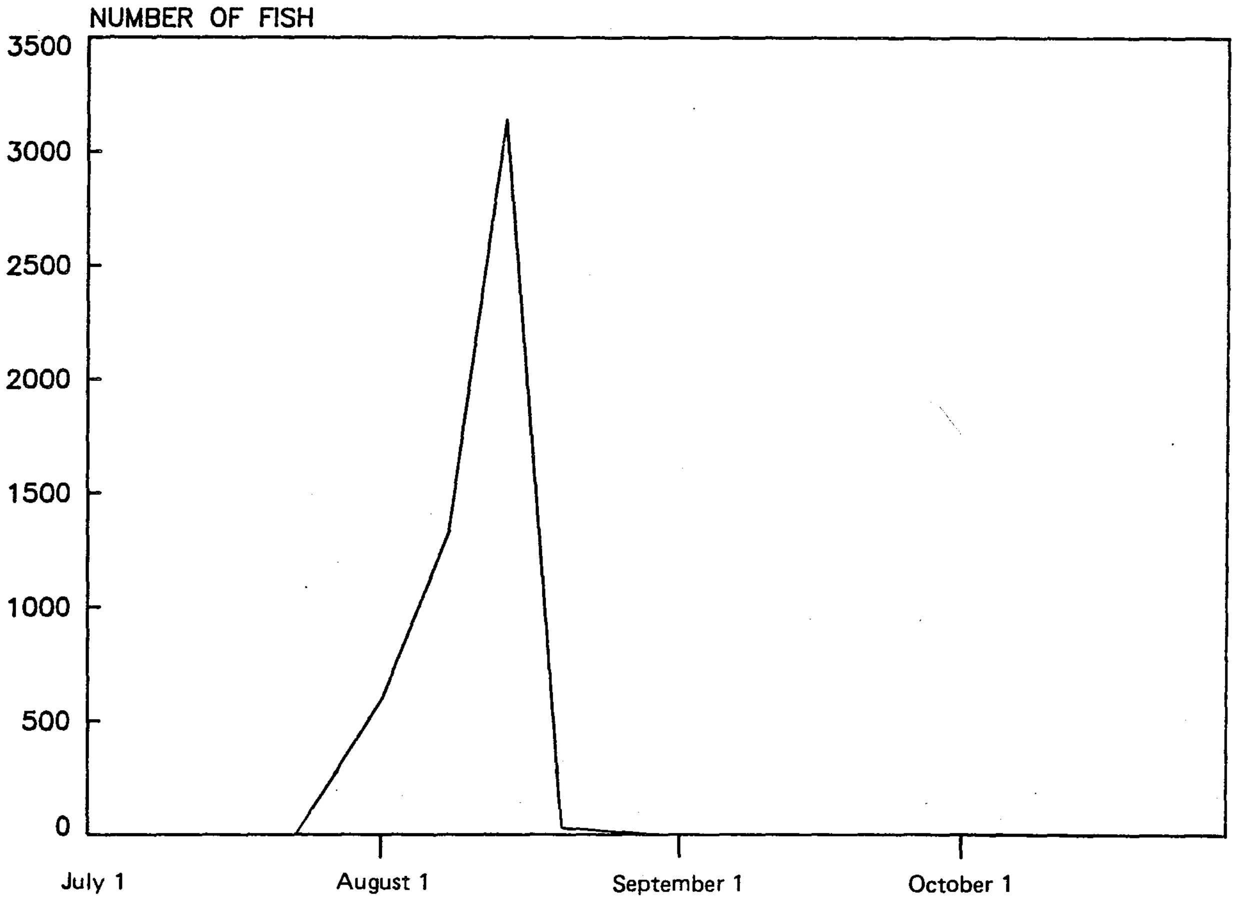


Figure 6.55

Sockeye Salmon
Estimated Fish
Escapement For
McArthur River
Oxbow Creek (13X)

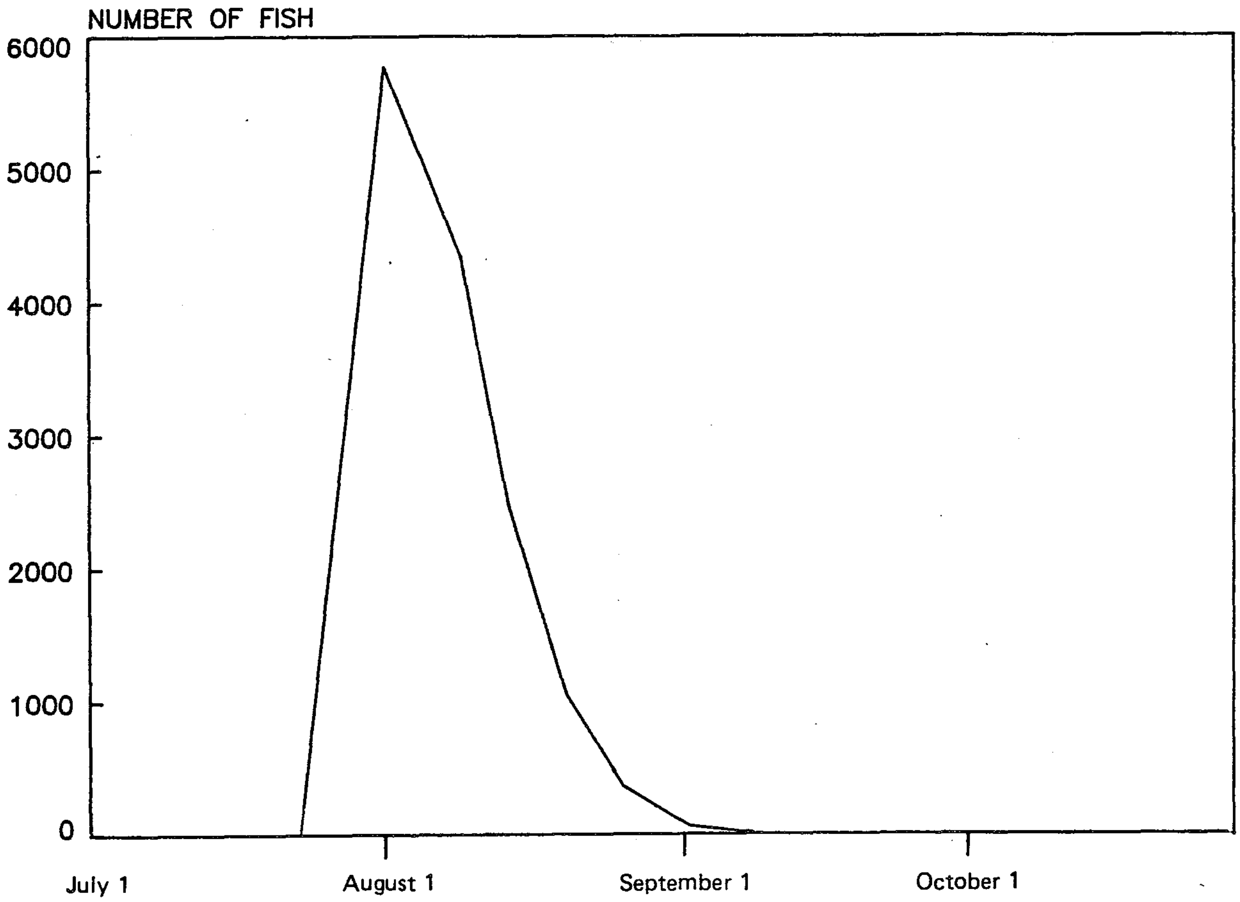


Figure 6.56

Sockeye Salmon
Estimated Fish
Escapement For
Tributary 12.1

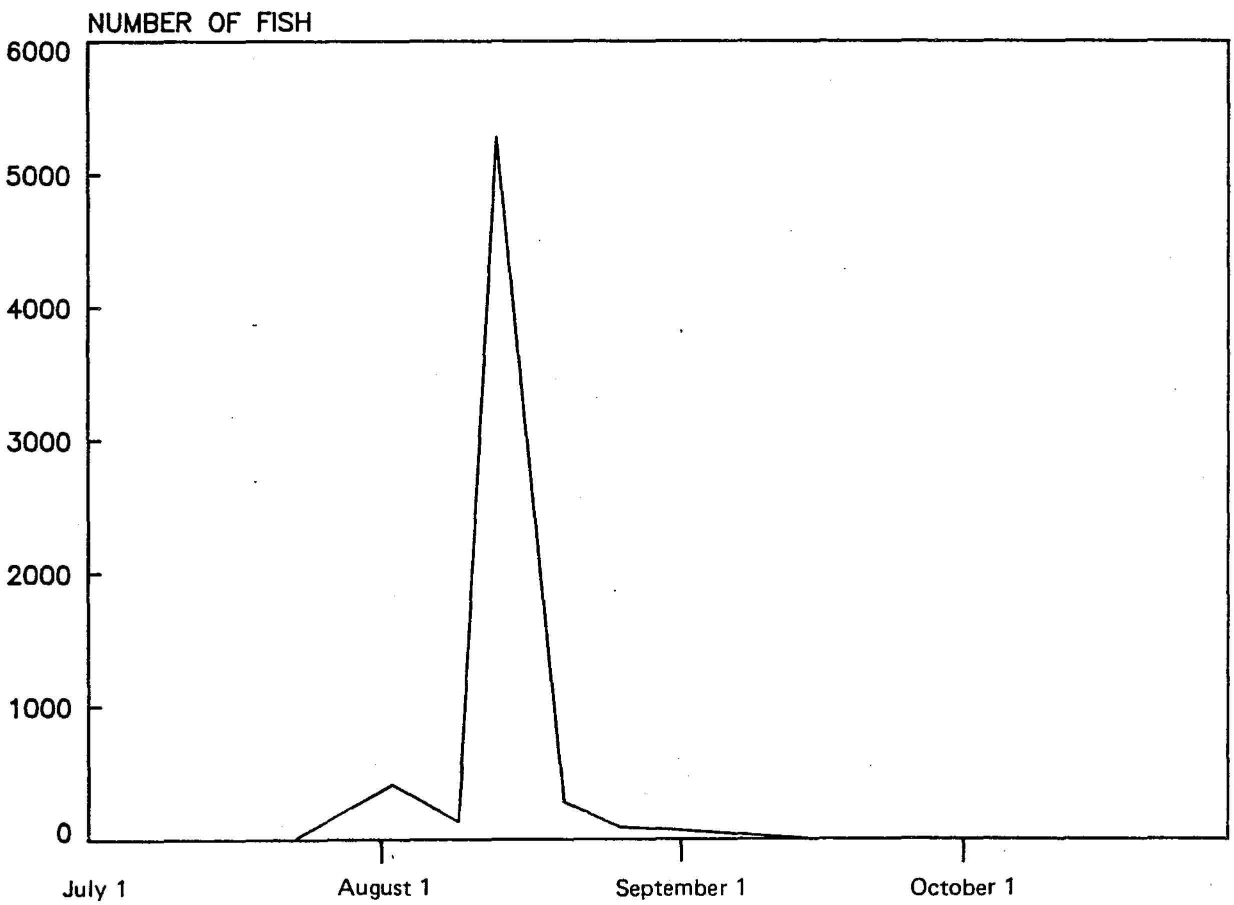


Figure 6.57

Sockeye Salmon
Estimated Fish
Escapement For
Tributary 12.2

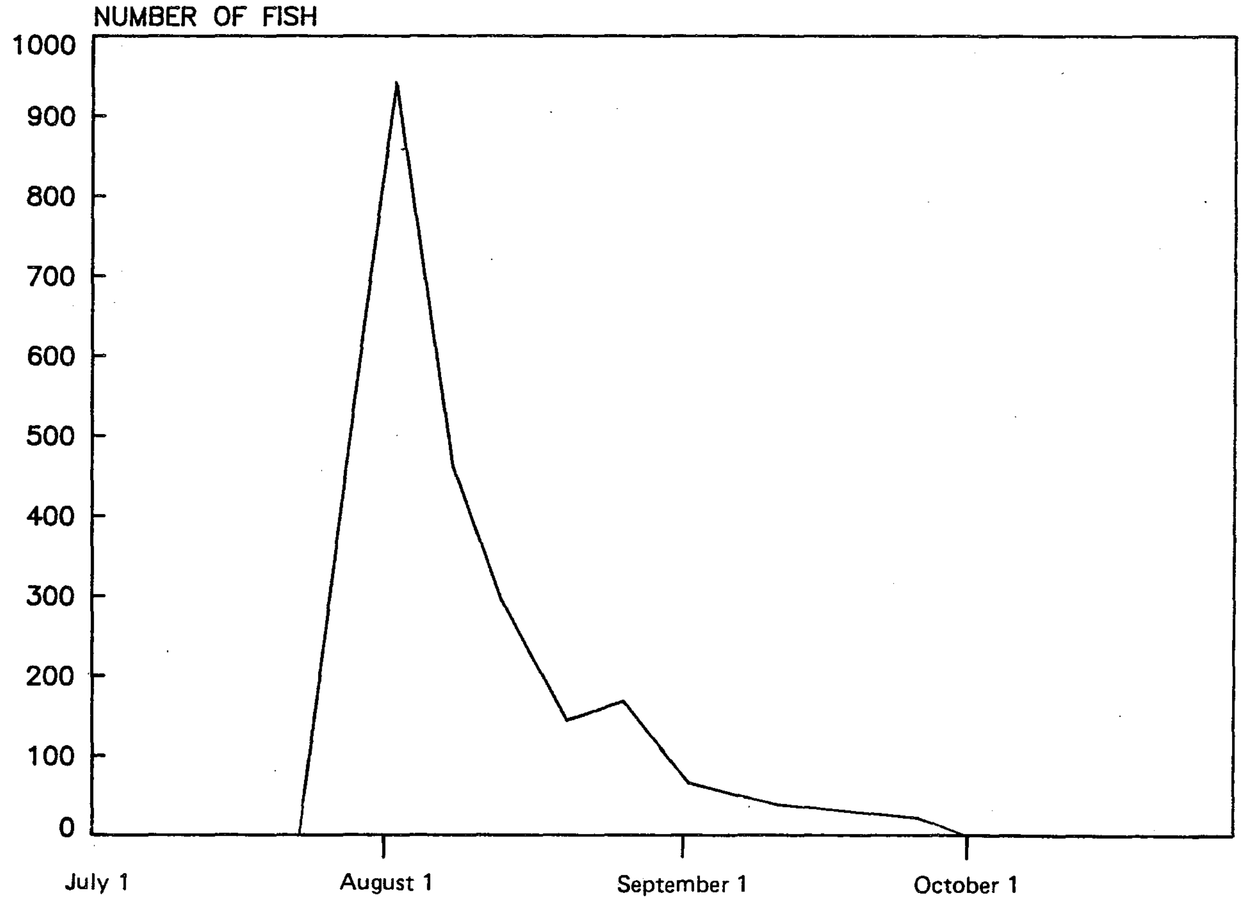


Figure 6.58

Sockeye Salmon
Estimated Fish
Escapement For
Tributary 12.3

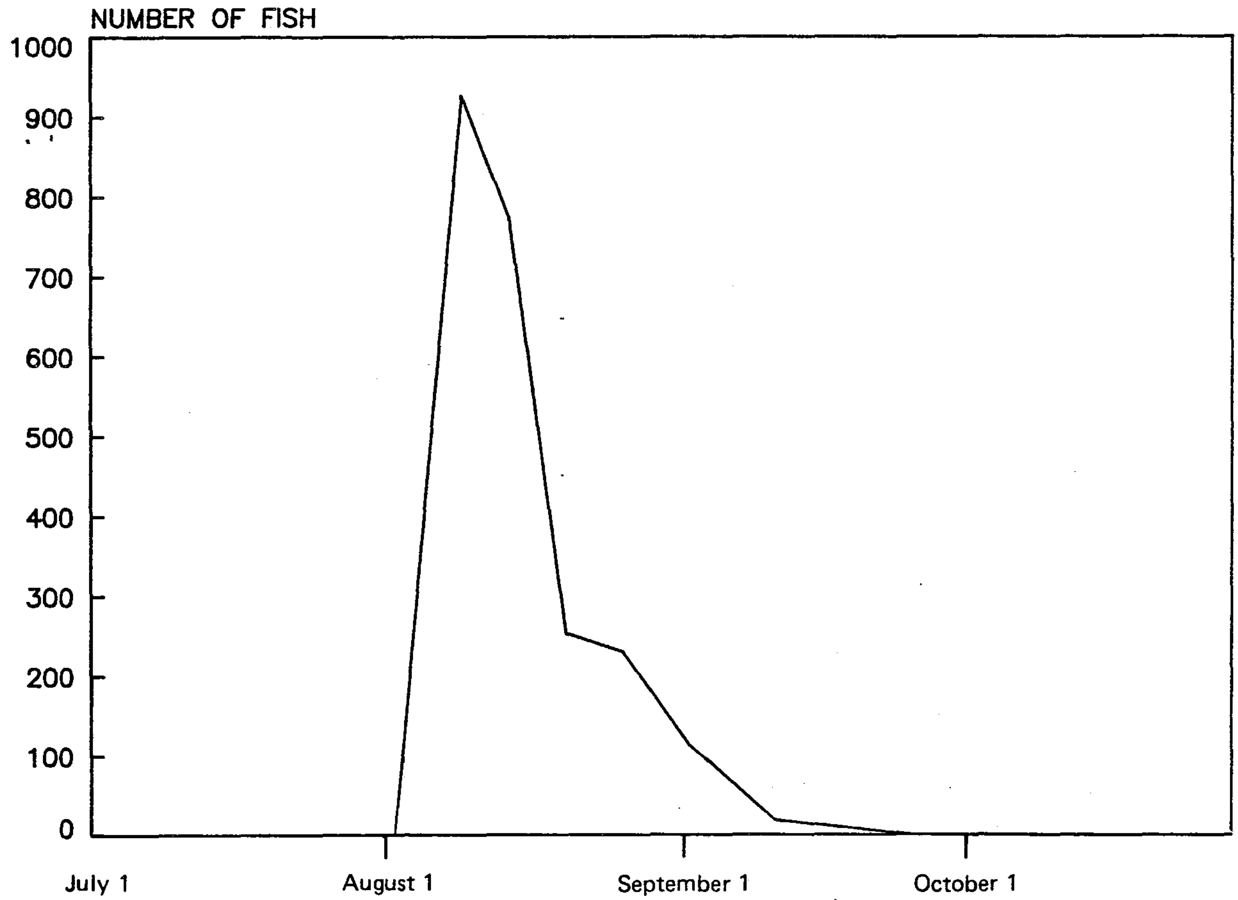


Figure 6.59

Sockeye Salmon
Estimated Fish
Escapement For
Tributary 12.4

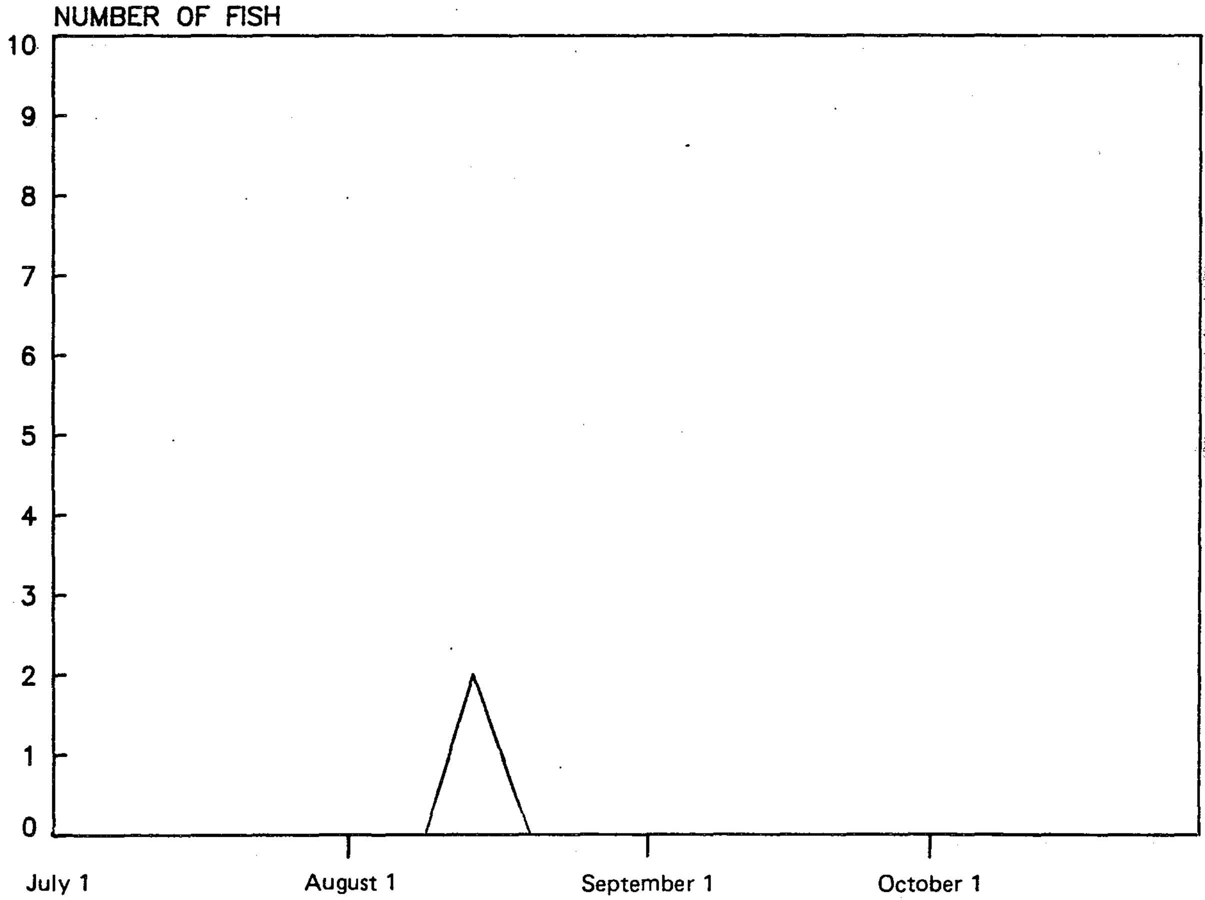


Figure 6.60

Sockeye Salmon
Estimated Fish
Escapement For
Tributary 12.5

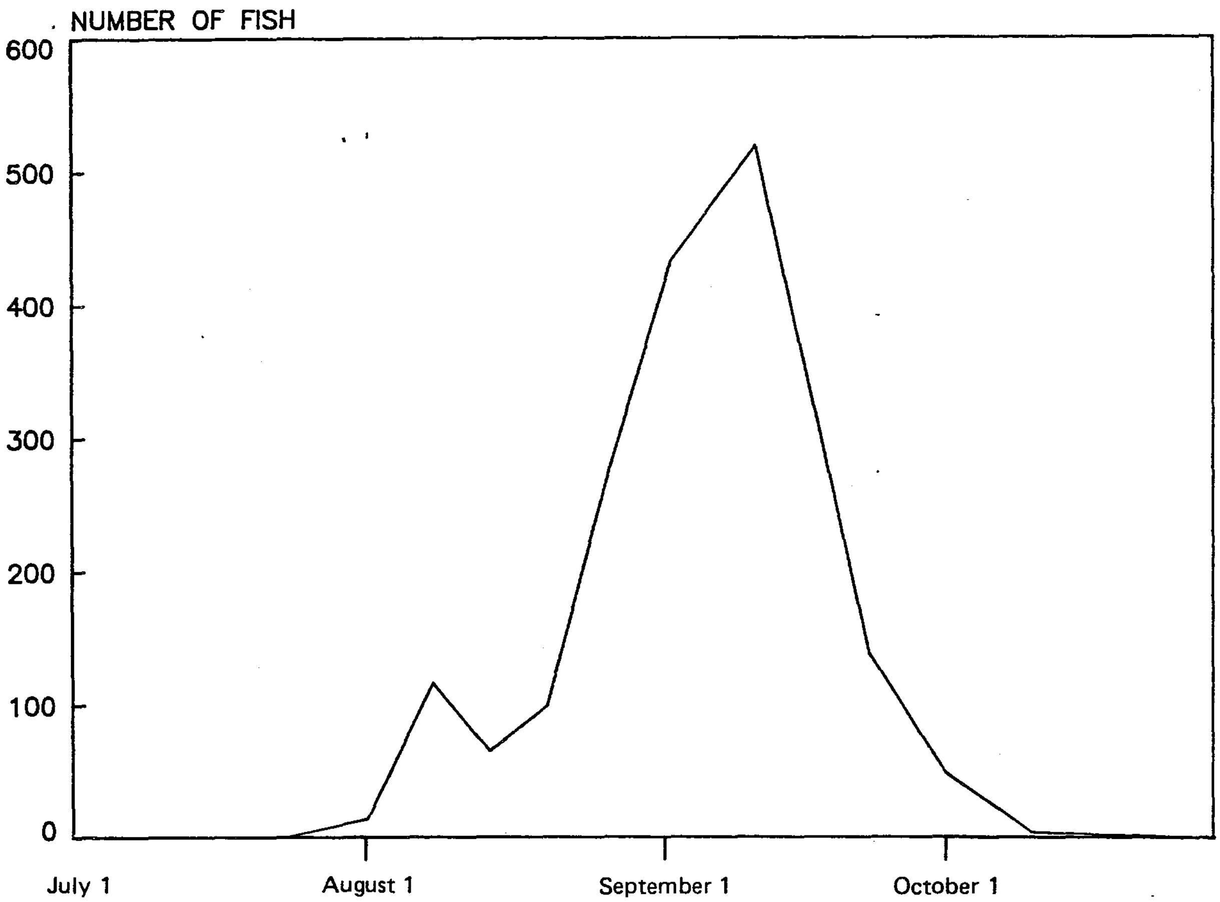


Figure 6.61

Sockeye Salmon
Estimated Fish
Escapement For
Bridge Area
Chakachatna River (17)

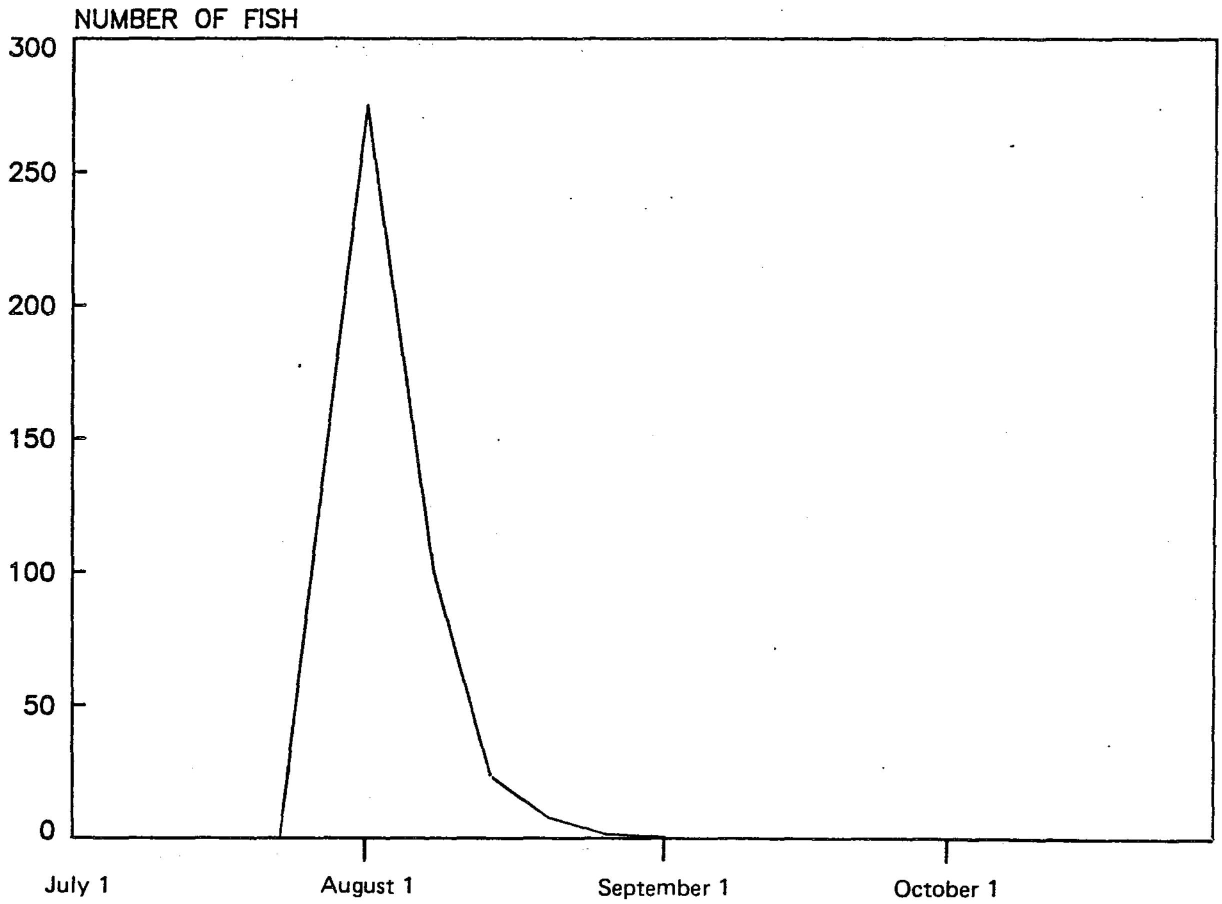


Figure 6.62

Coho Salmon
Estimated Fish
Escapement For
Clearwater Tributary to
Straight Creek (19)

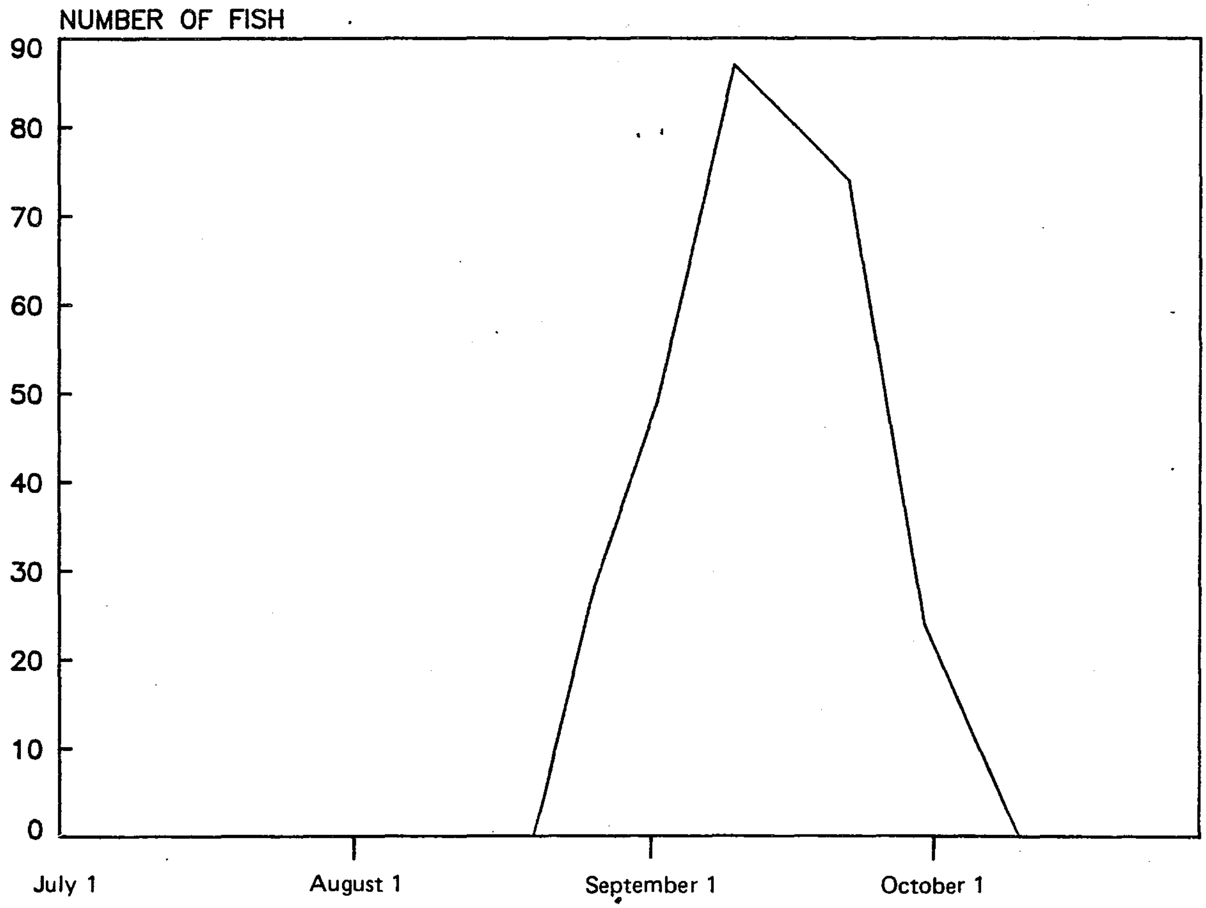


Figure 6.63

Sockeye Salmon
Estimated Fish
Escapement For
Clearwater Tributary
to Straight Creek (19)

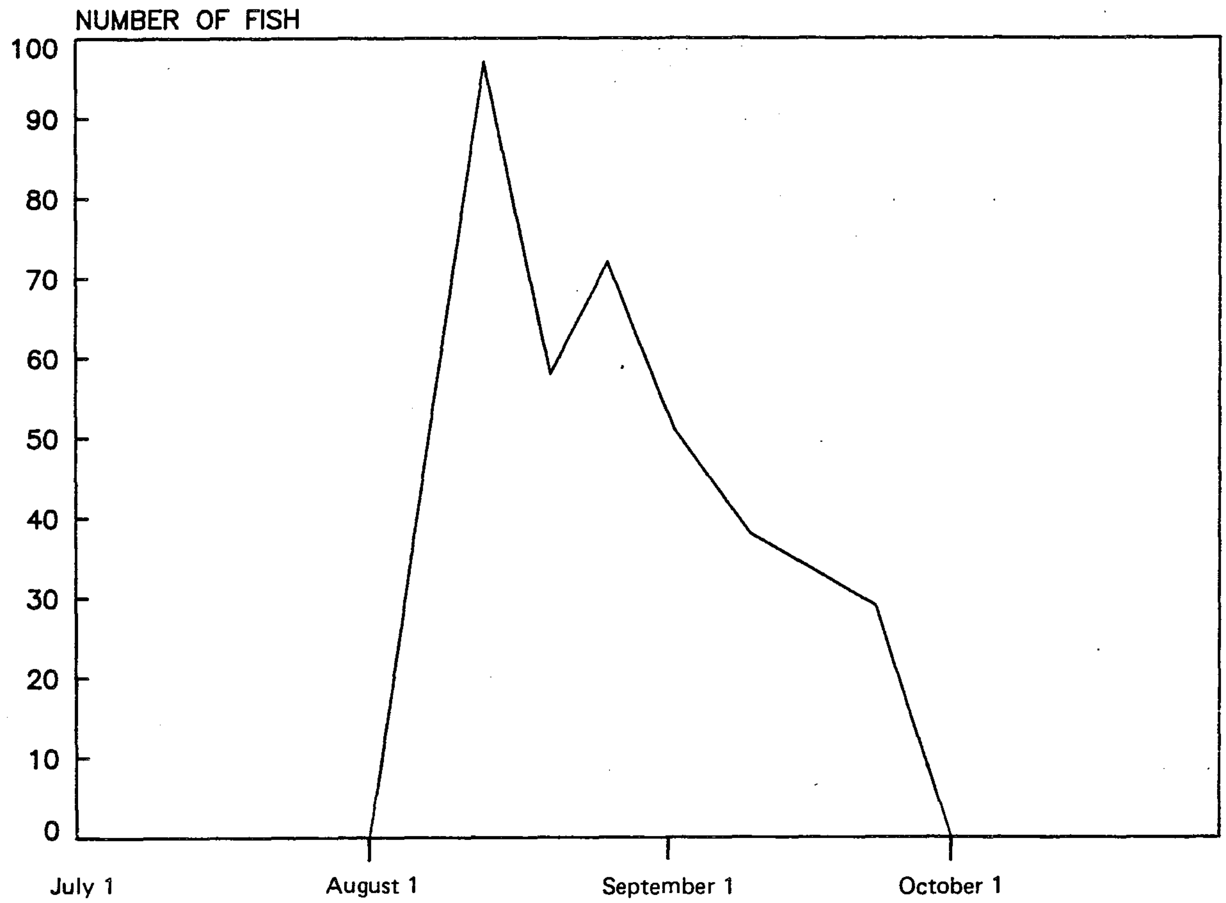


Figure 6.64

Sockeye Salmon Estimated Fish Escapement For Chakachatna River Tributary (C_1)

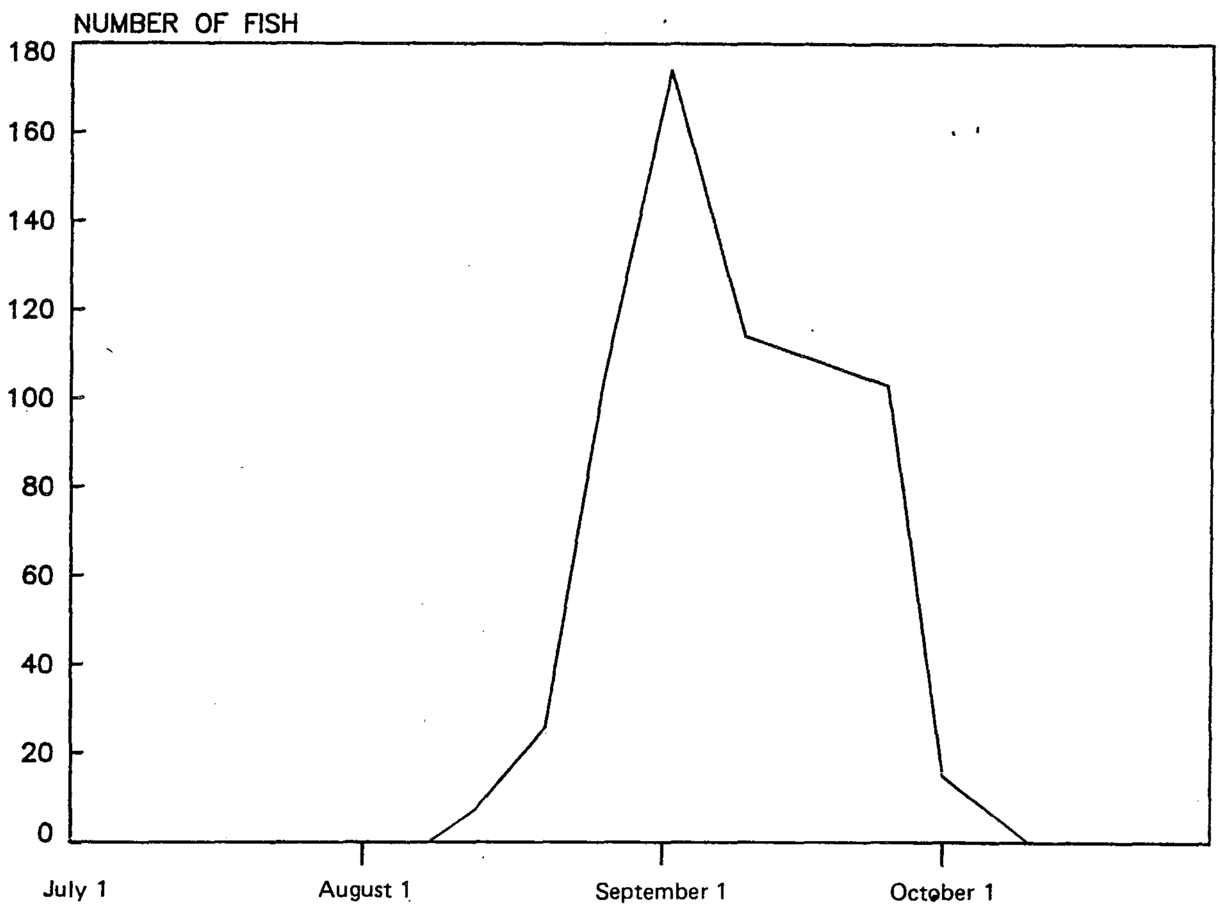


Figure 6.65

Sockeye Salmon
Estimated Fish
Escapement For
Chakachatna River
Canyon Sloughes

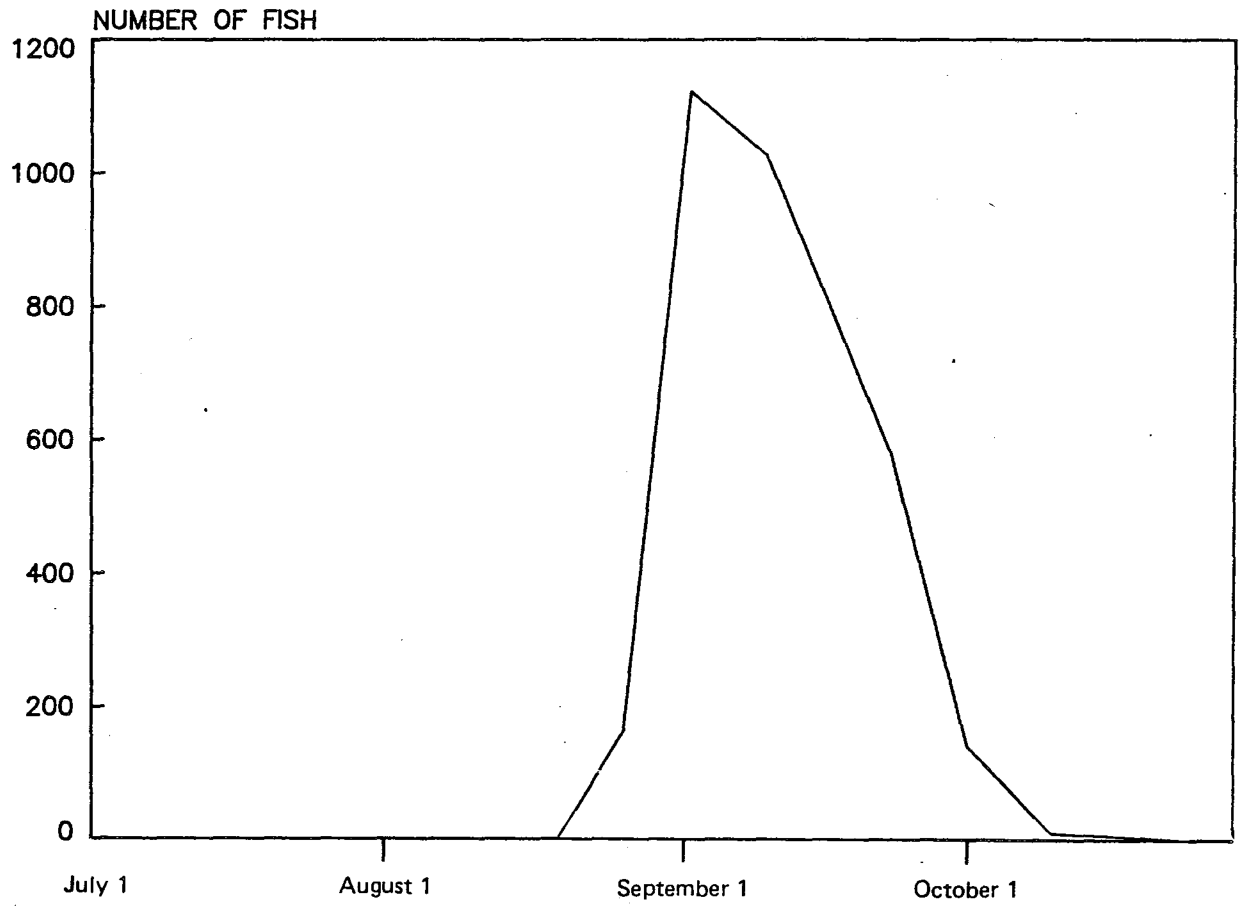


Figure 6.66

Sockeye Salmon
Estimated Fish
Escapement For
Igitna River

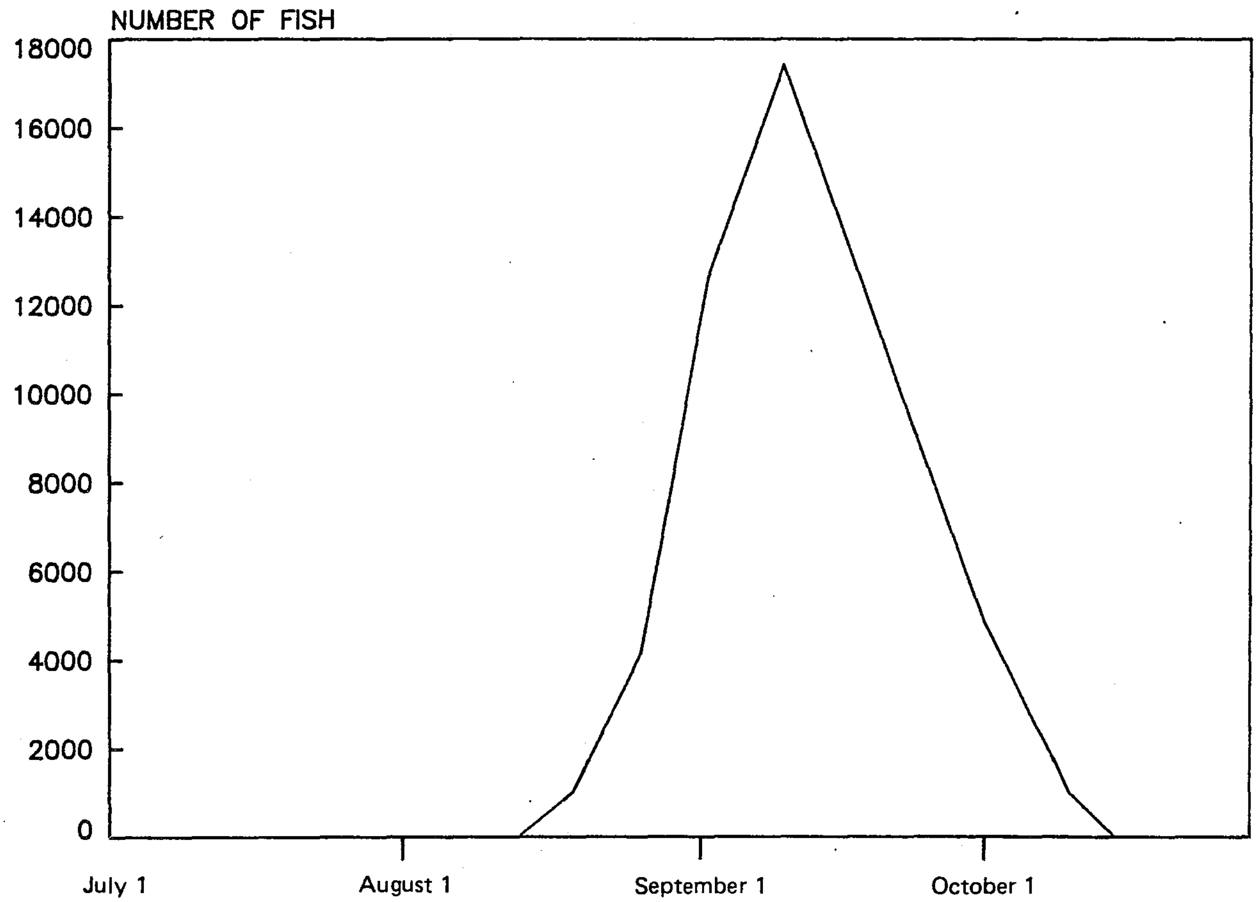


Figure 6.67

Sockeye Salmon
Estimated Fish
Escapement For
Chilligan River

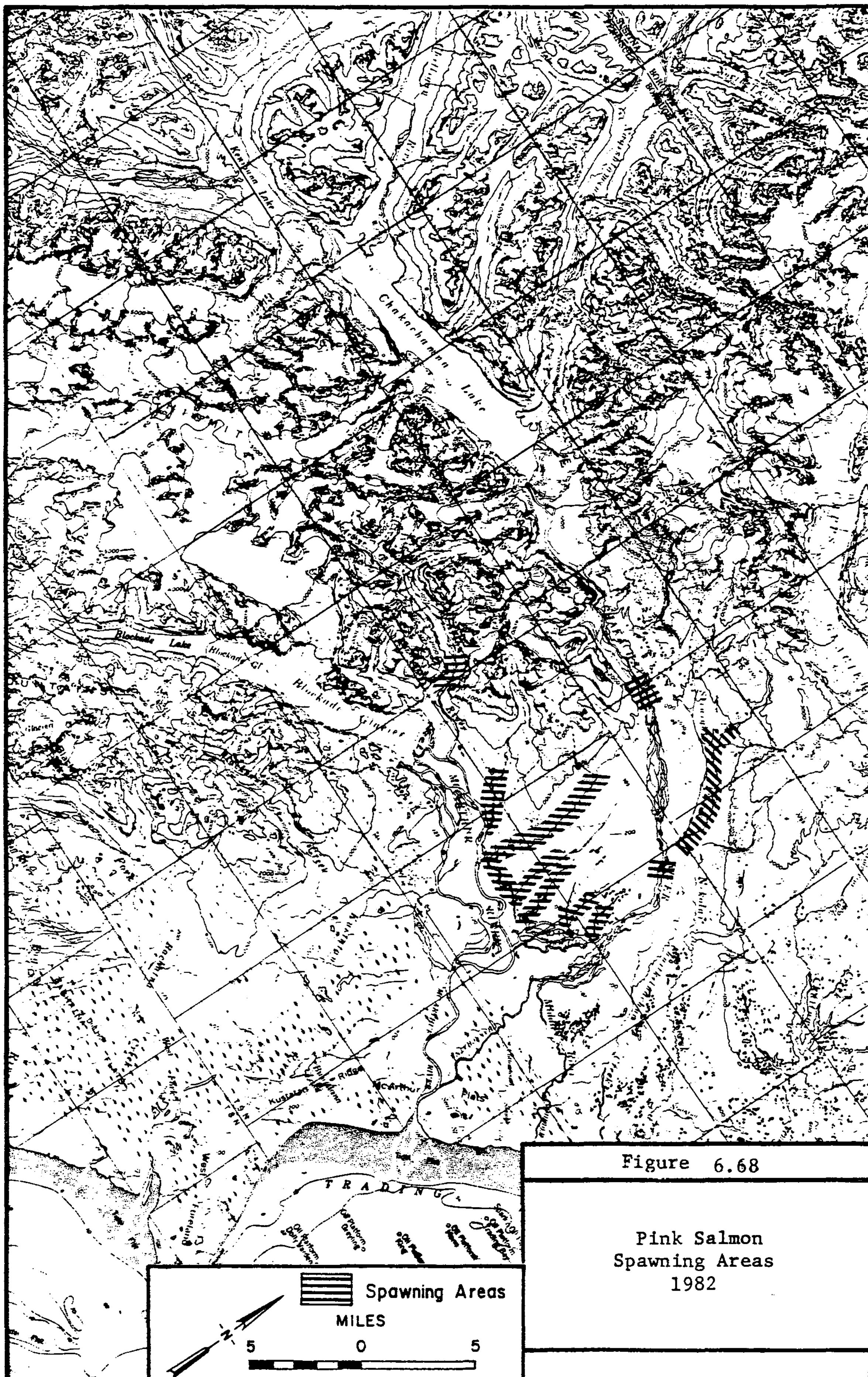


Figure 6.68

Pink Salmon
Spawning Areas
1982

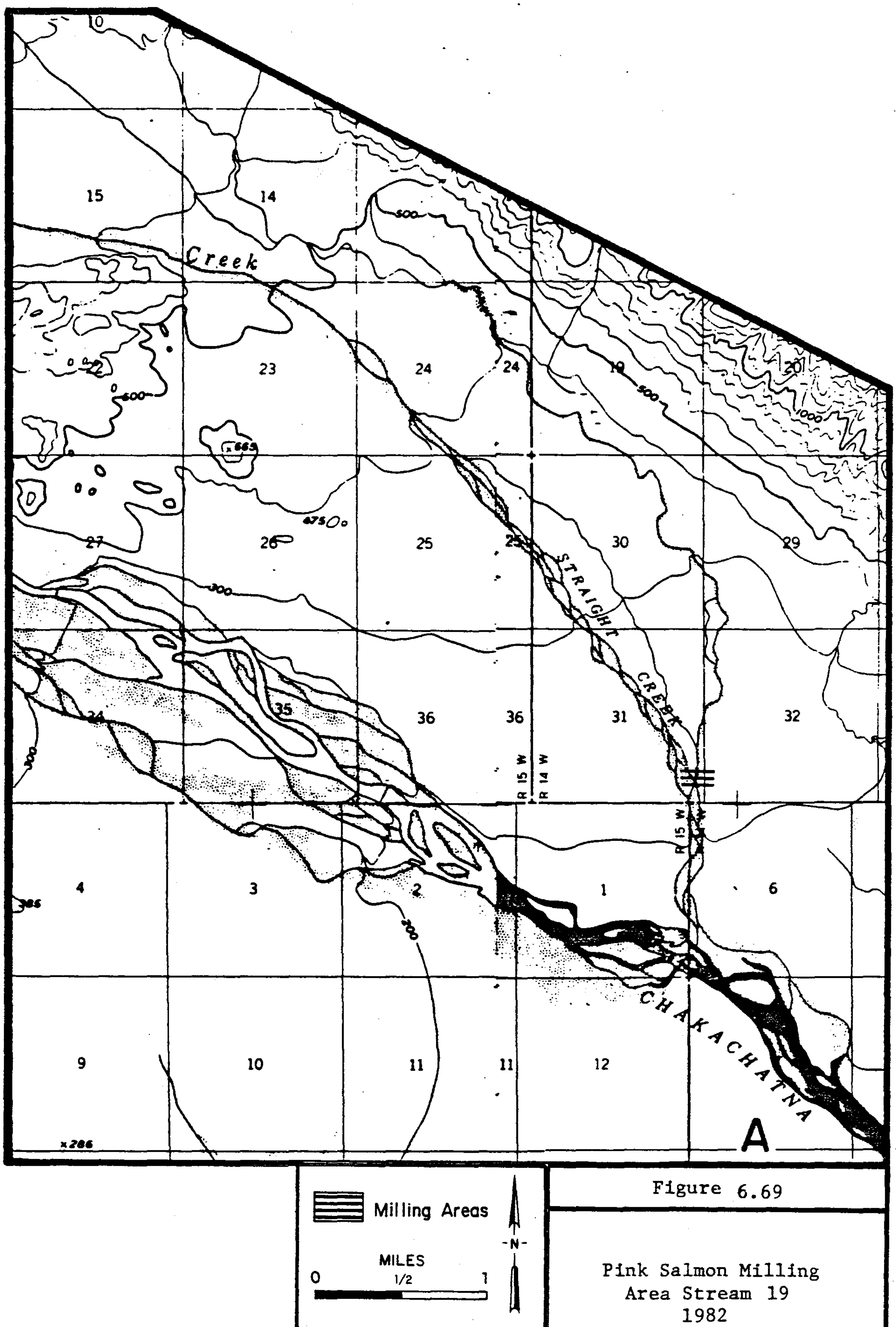
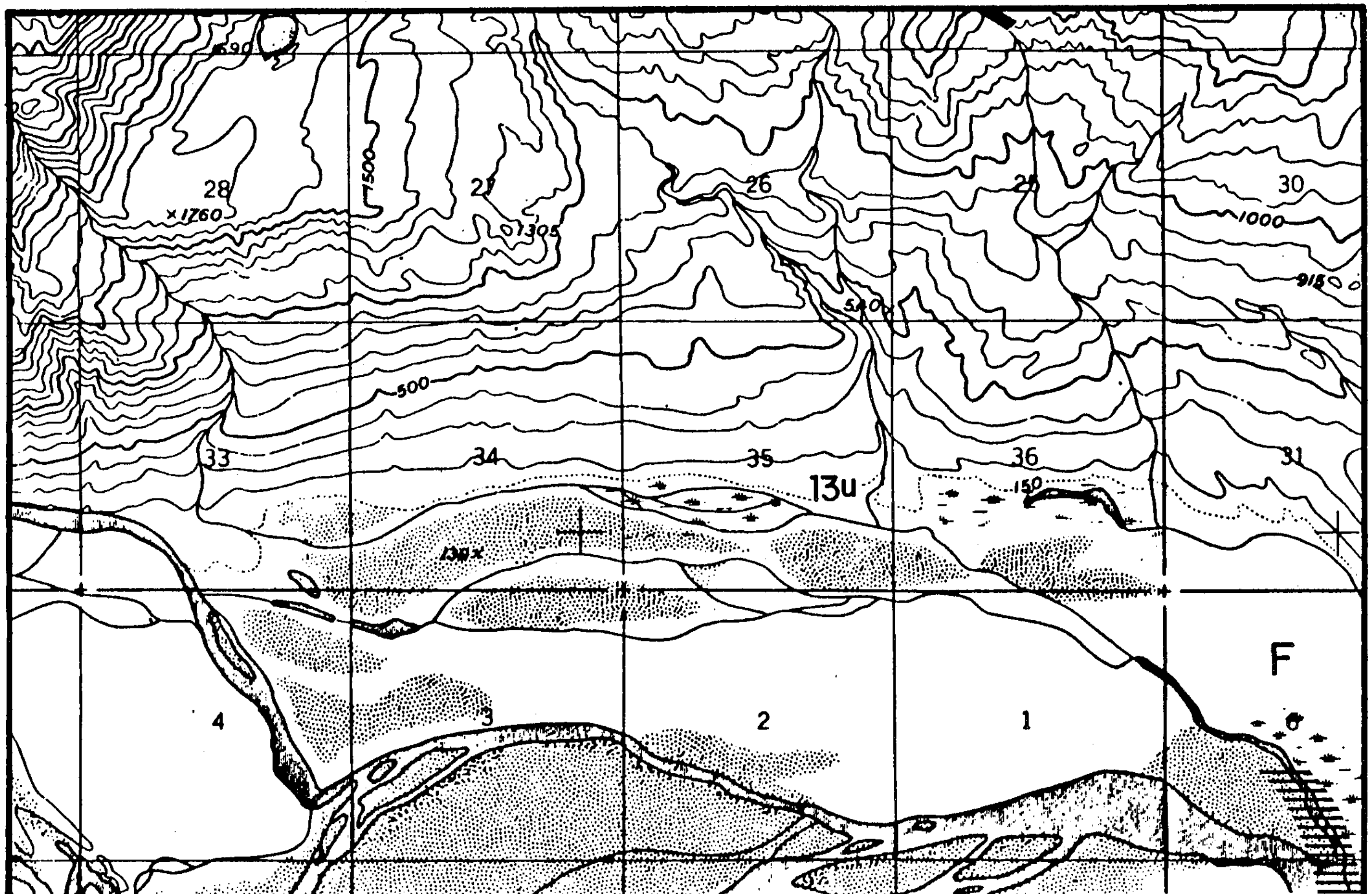


Figure 6.69

Pink Salmon Milling
Area Stream 19
1982



Milling Areas

MILES

0 1/2 1

N

Figure 6.70

Pink Salmon
Milling Area
Stream 13u
1982

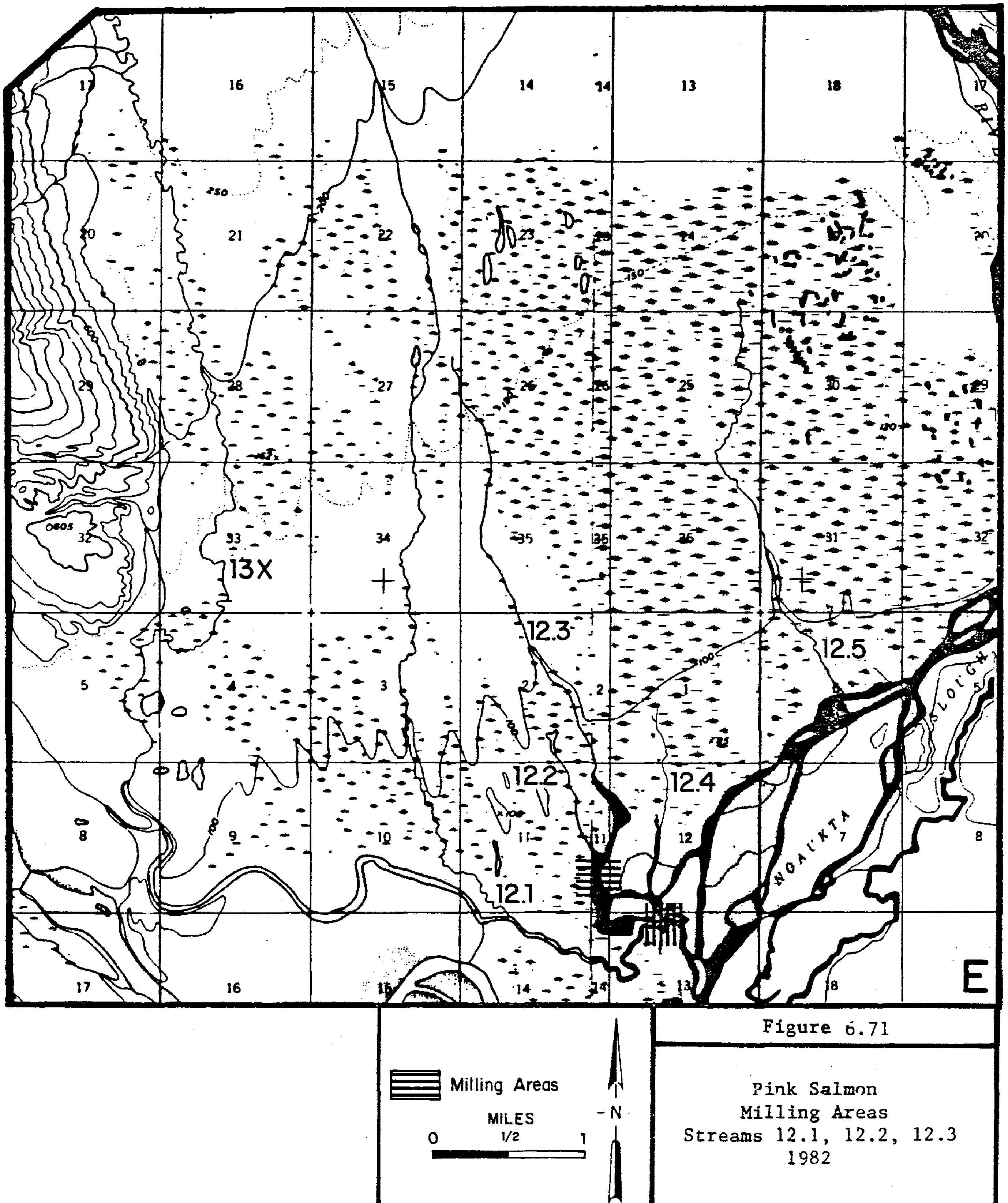
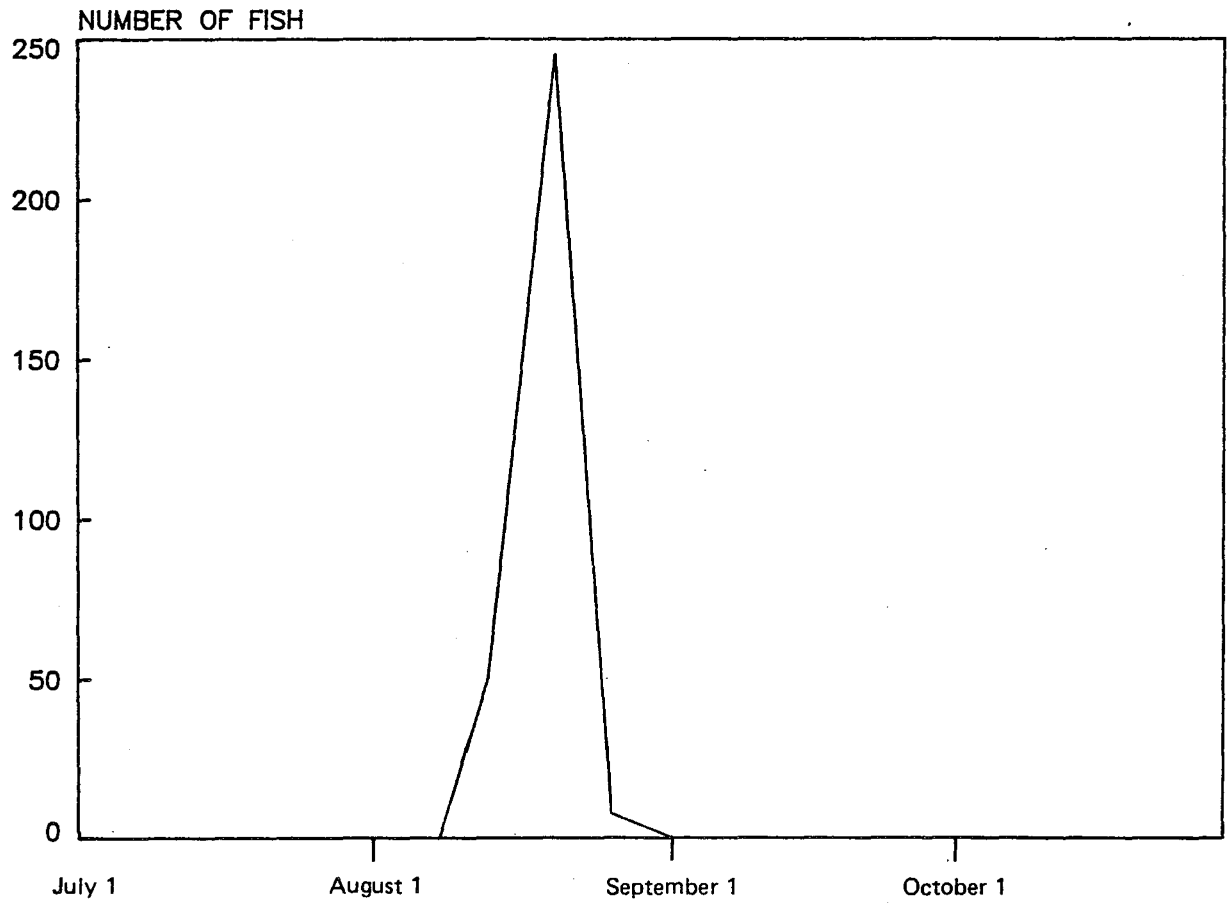


Figure 6.71

Pink Salmon
Milling Areas
Streams 12.1, 12.2, 12.3
1982



Figurc 6.72

Pink Salmon
Estimated Fish
Escapement For
Chakachatna River
Canyon Sloughes

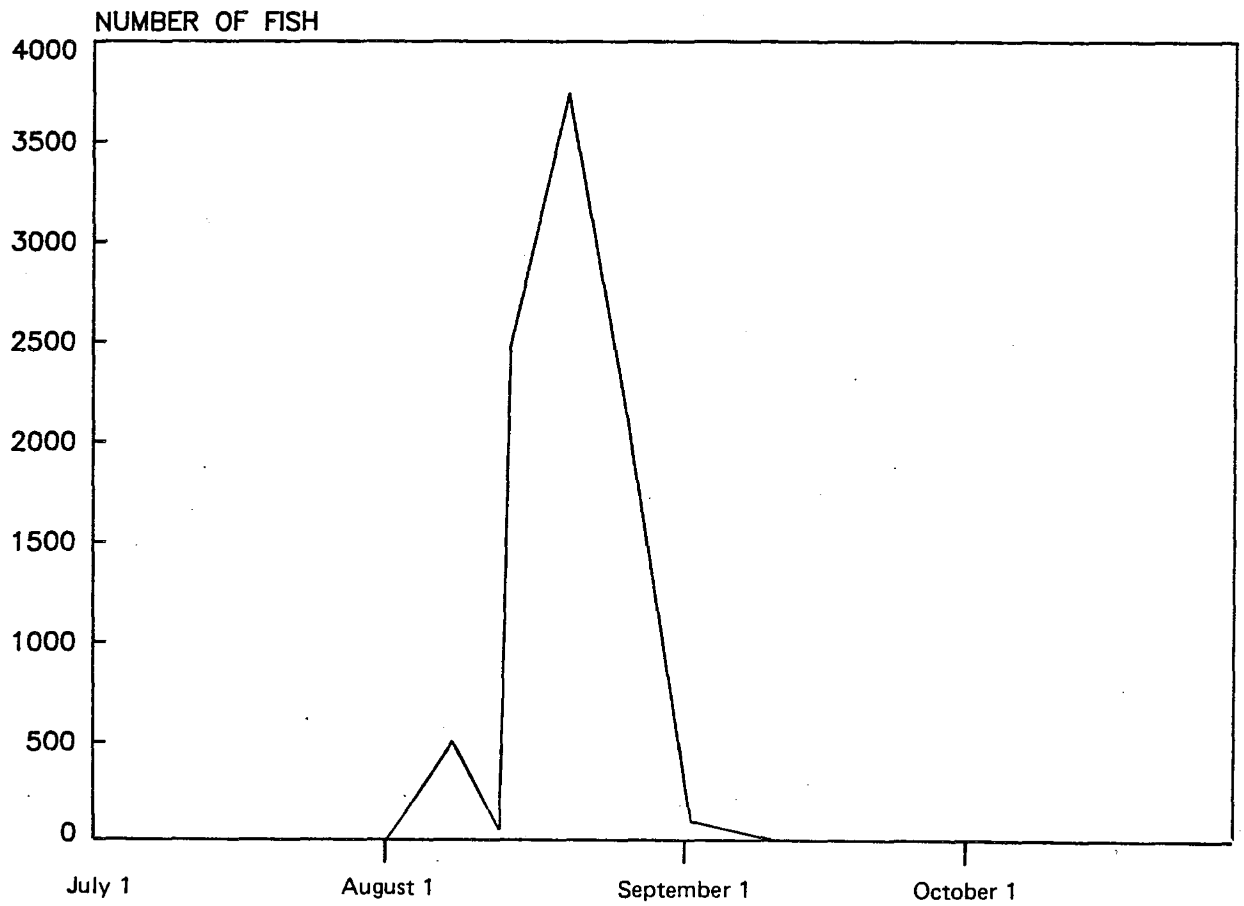


Figure 6.73

Pink Salmon
Estimated Fish
Escapement For
Cleanwater Tributary to
Straight Creek (19)

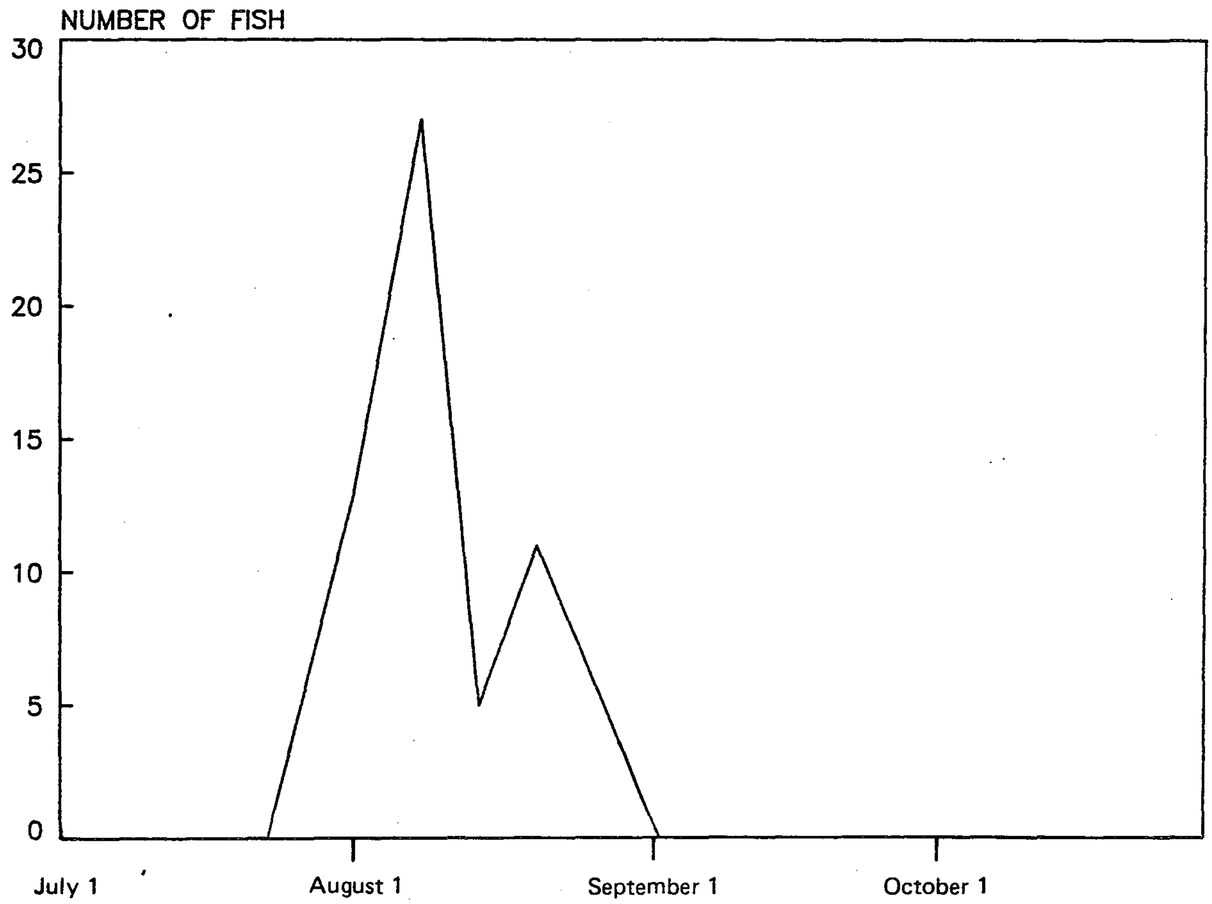


Figure 6.74

Pink Salmon
Estimated Fish
Escapement For
Bridge Area
Chakachatna River (17)

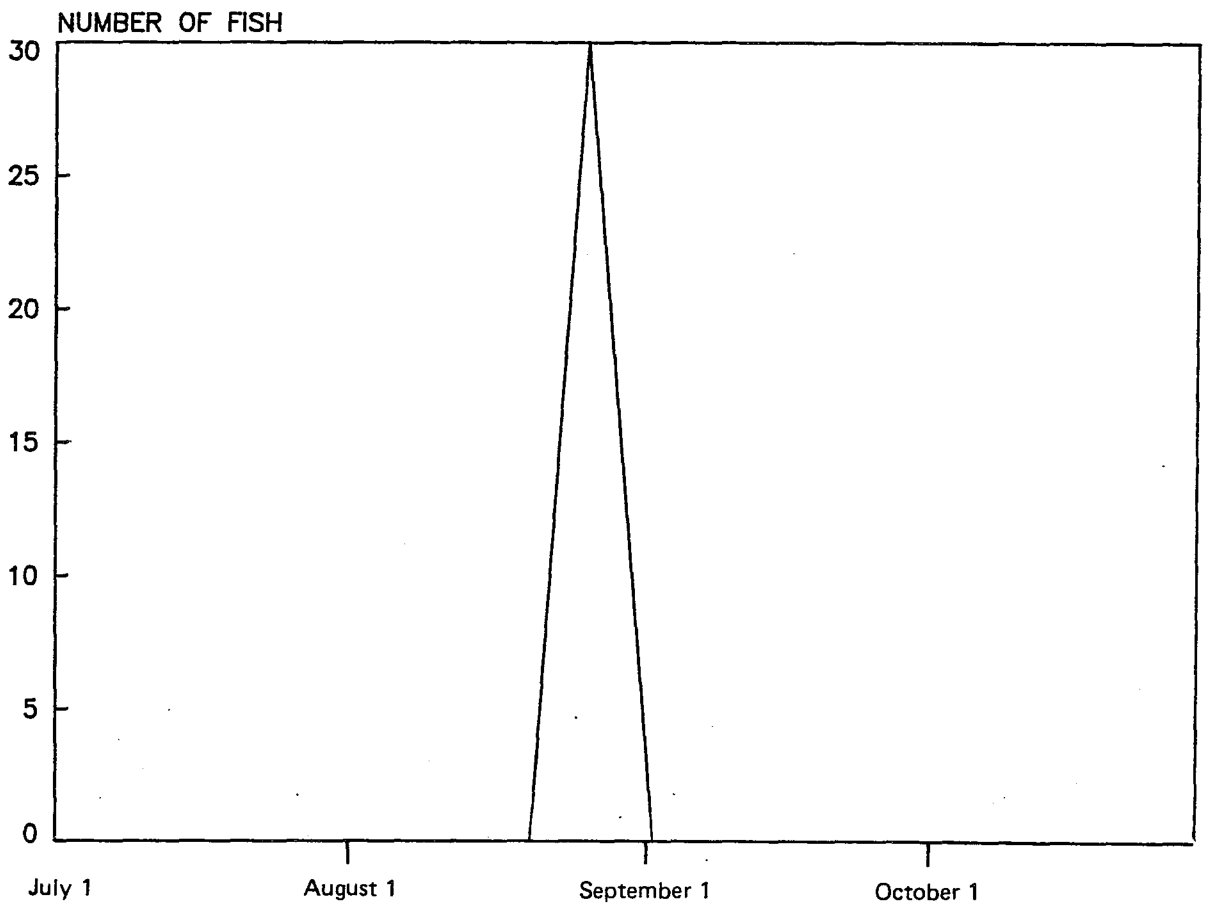


Figure 6.75

Pink Salmon
Estimated Fish
Escapement For
McArthur River
Canyon

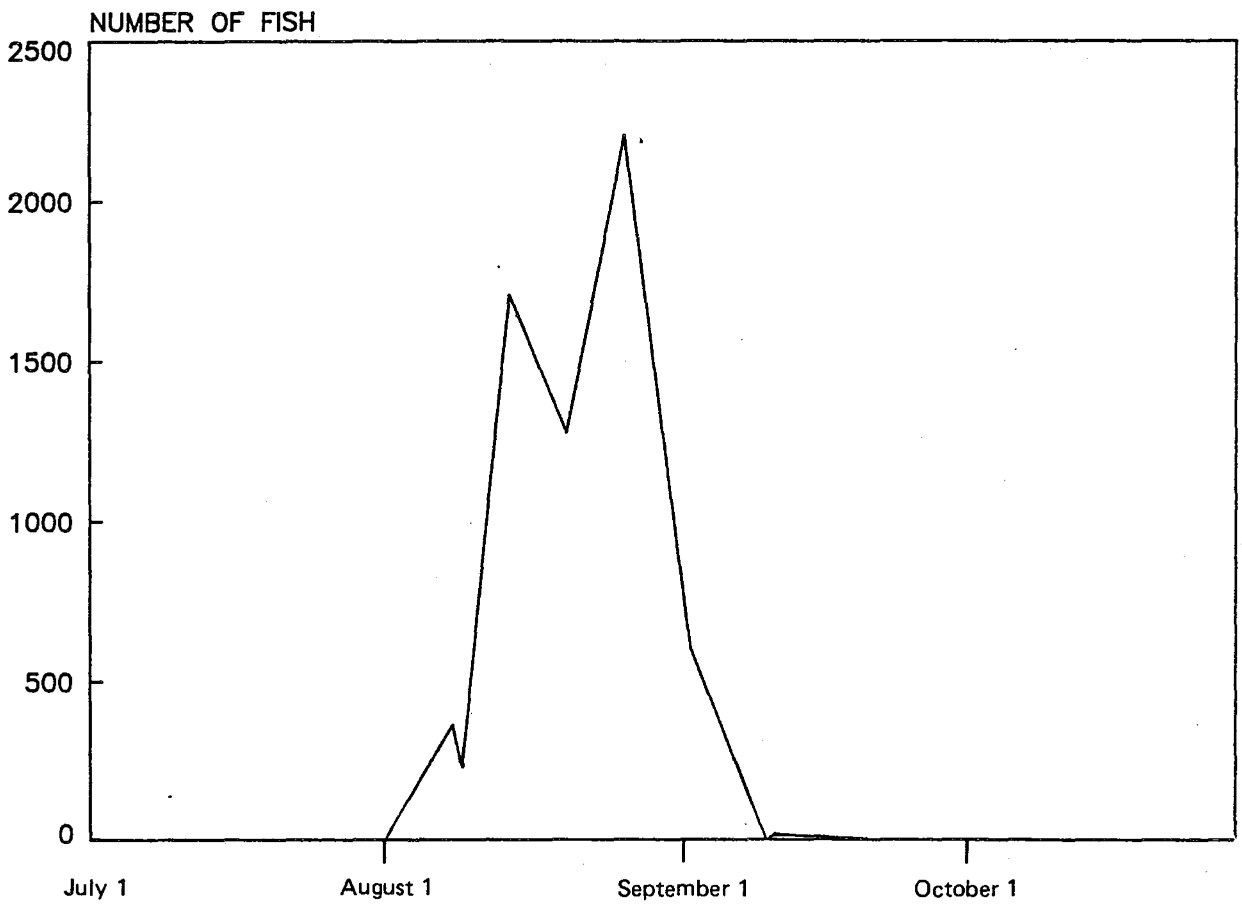


Figure 6.76

Pink Salmon
Estimated Fish
Escapement For
McArthur River
Upper Tributary (13U)

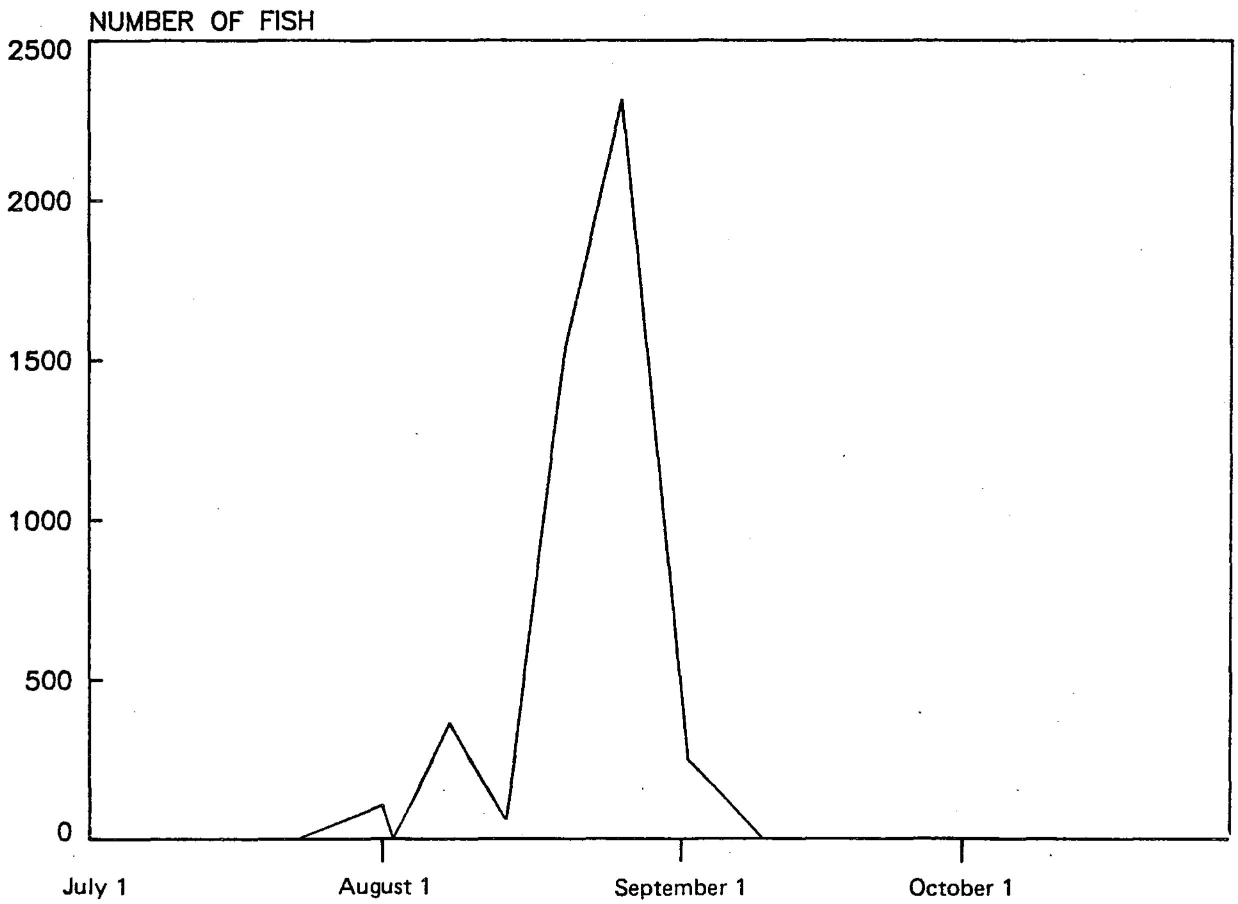


Figure 6.77

Pink Salmon
Estimated Fish
Escapement For
McArthur River
Oxbow Creek (13X)

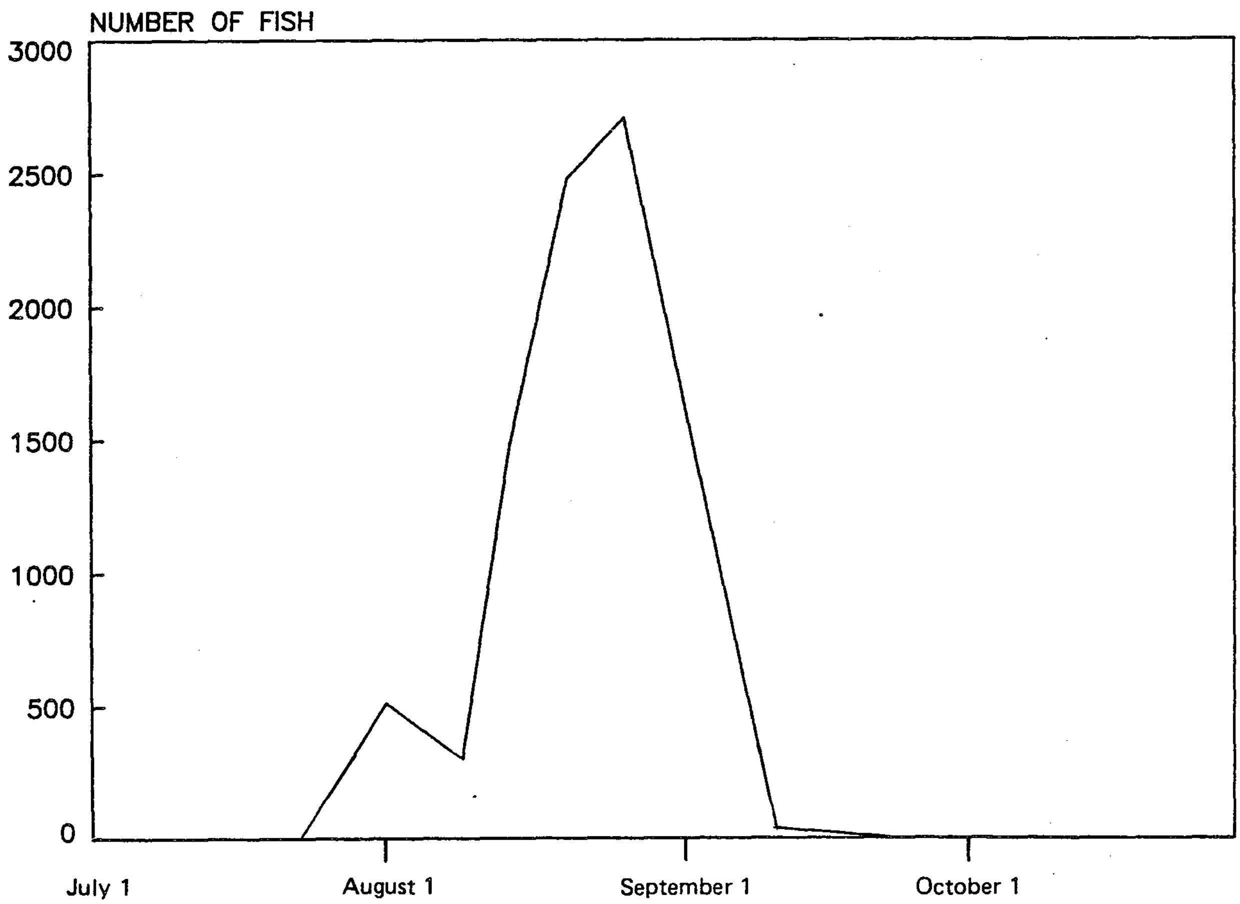


Figure 6.78

Pink Salmon
Estimated Fish
Escapement For
Tributary 12.1

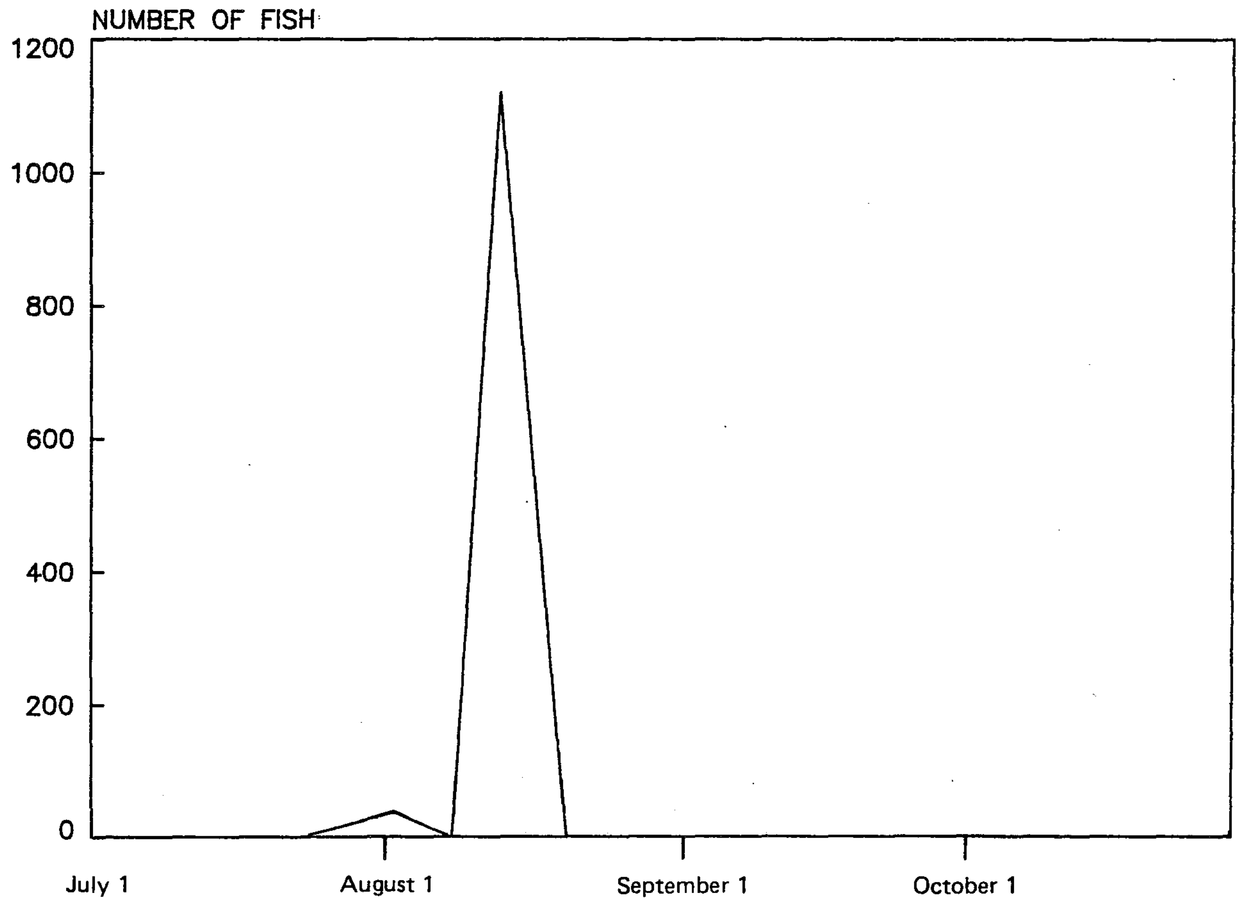


Figure 6.79

Pink Salmon
Estimated Fish
Escapement For
Tributary 12.2

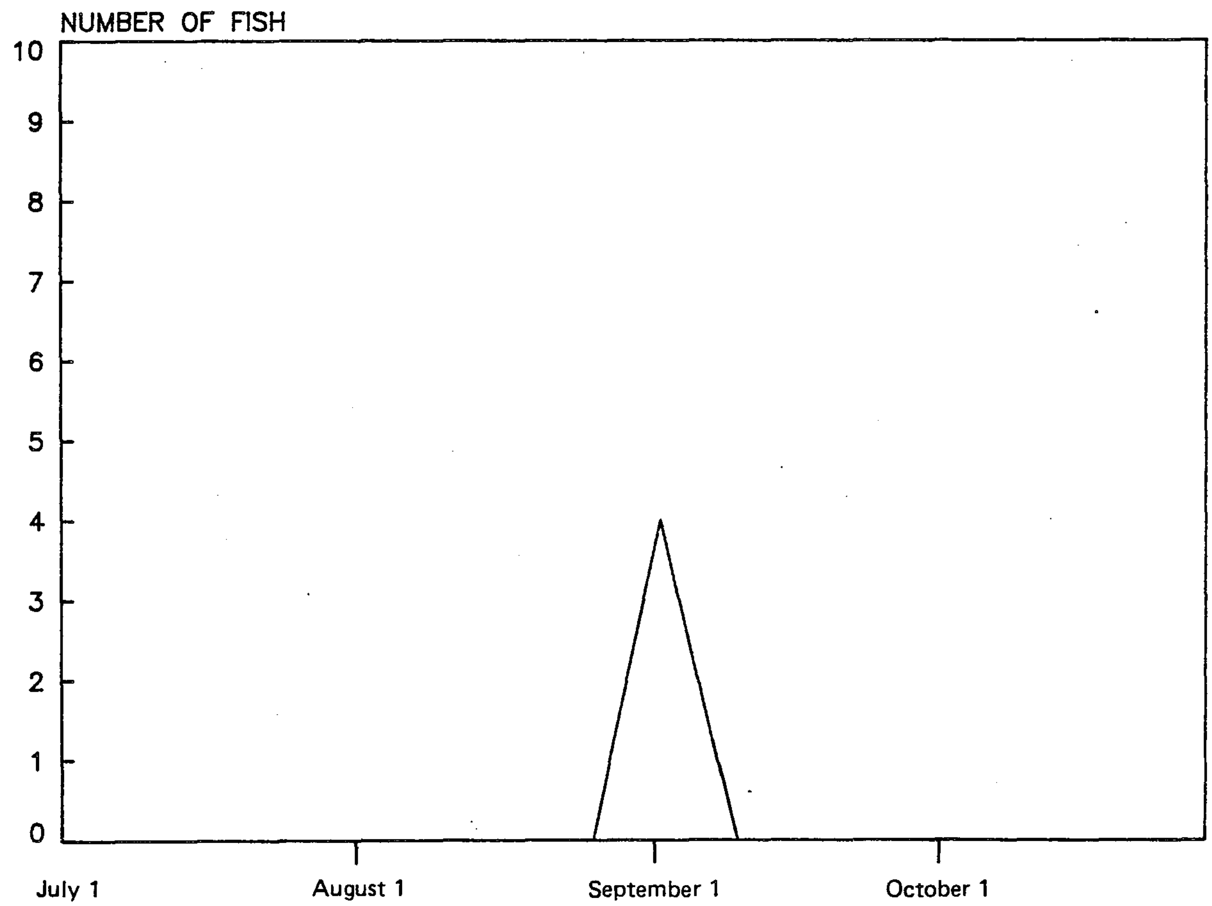


Figure 6.80

Pink Salmon
Estimated Fish
Escapement For
Tributary 12.3

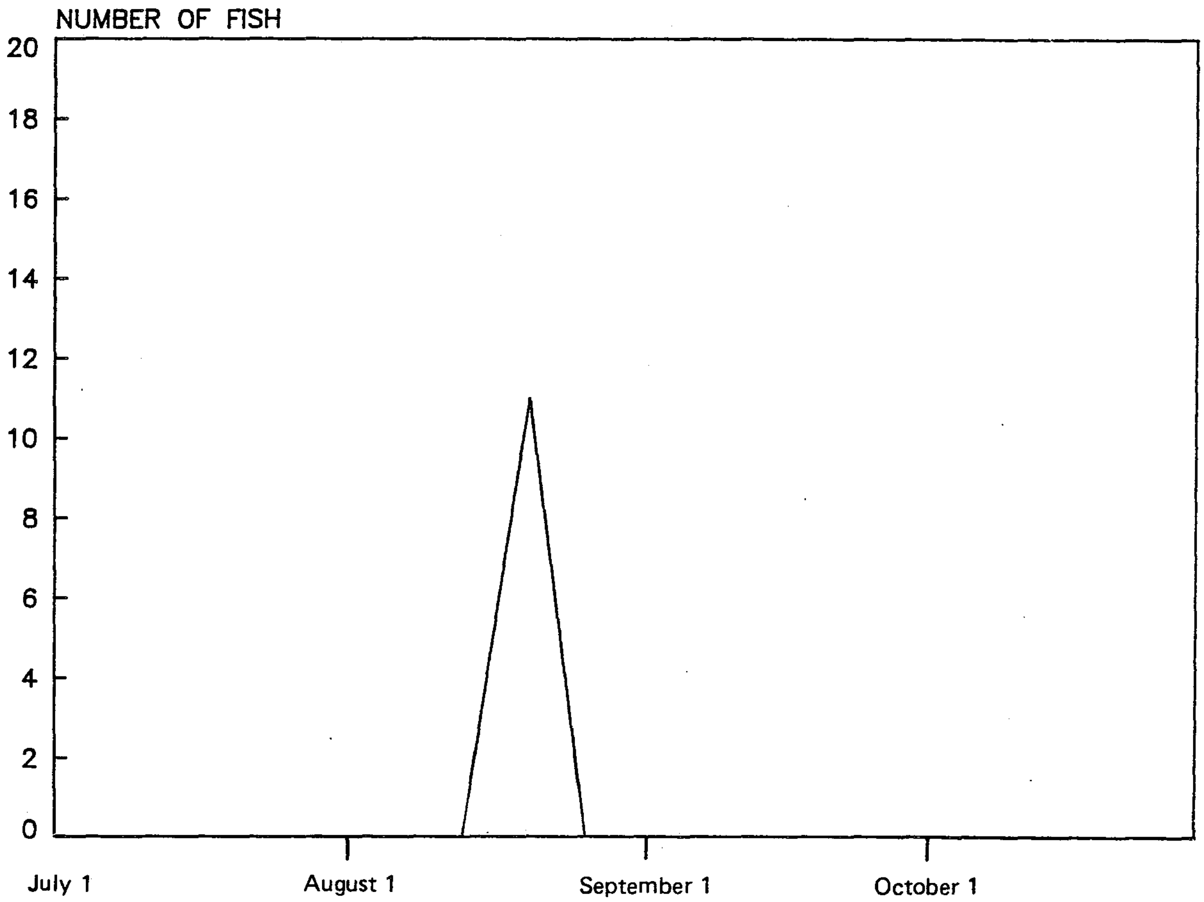


Figure 6.81

Pink Salmon
Estimated Fish
Escapement For
Tributary 12.4

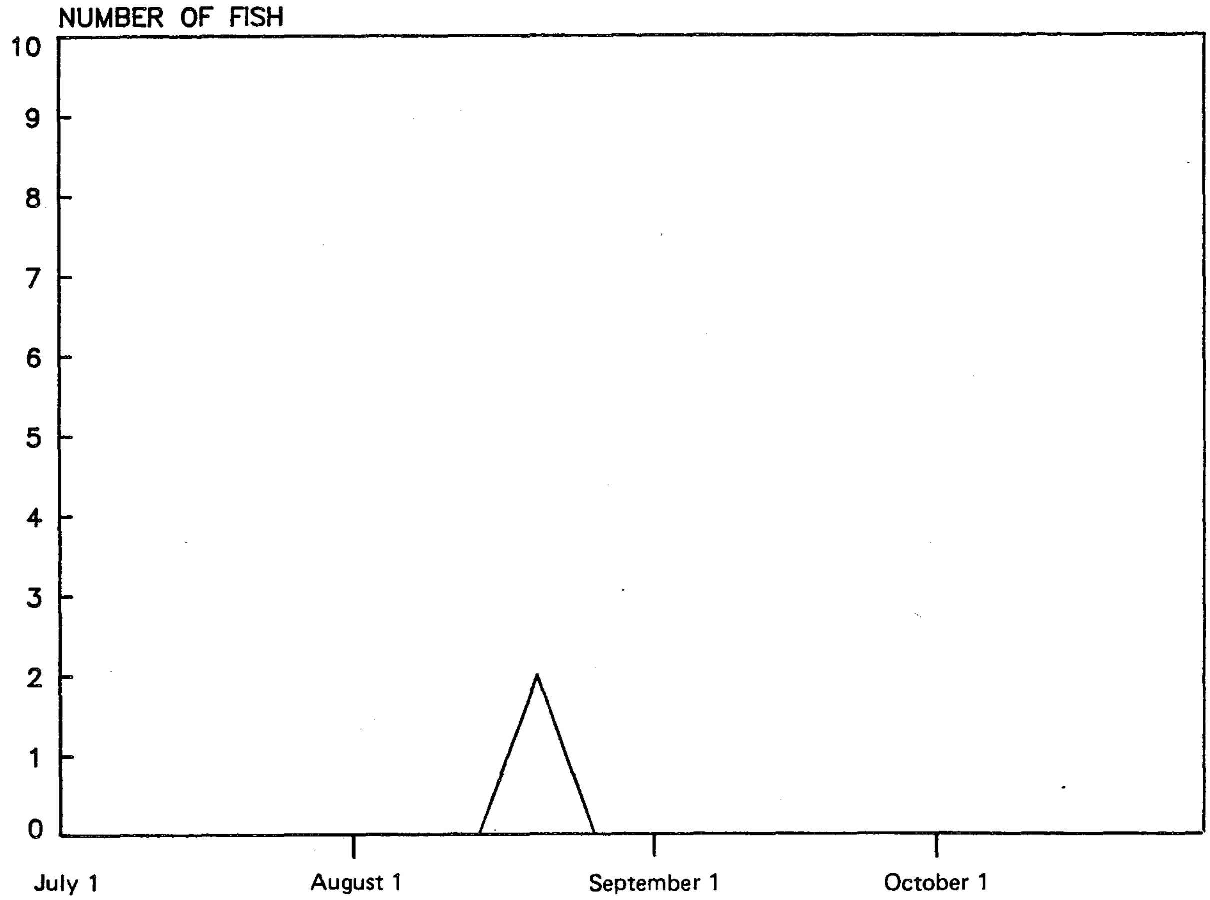


Figure 6.82

Pink Salmon
Estimated Fish
Escapement For
Tributary 12.5

Figure 6.83

Chum Salmon
Spawning Areas
1982

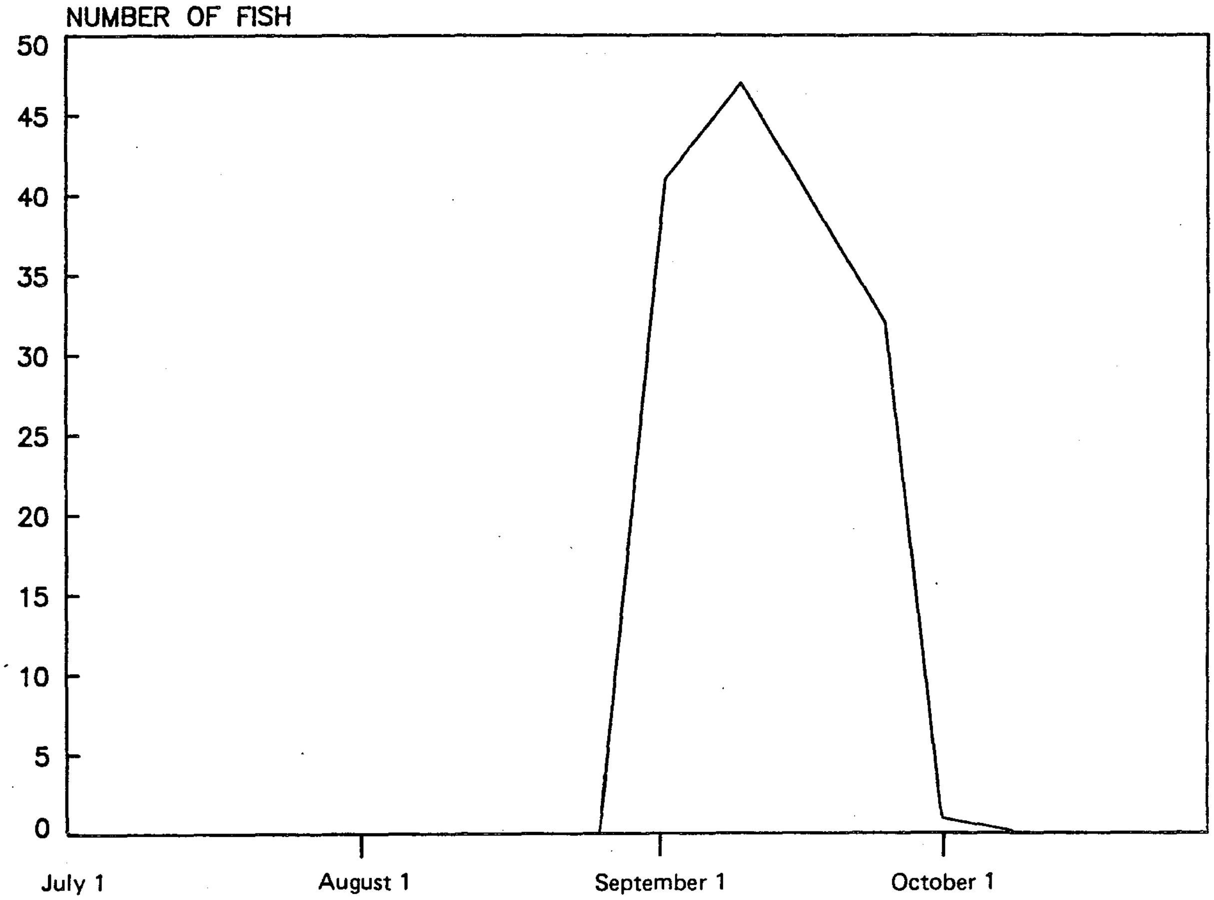


Figure 6.84

Chum Salmon
Estimated Fish
Escapement For
Chakachatna River
Canyon Sloughes

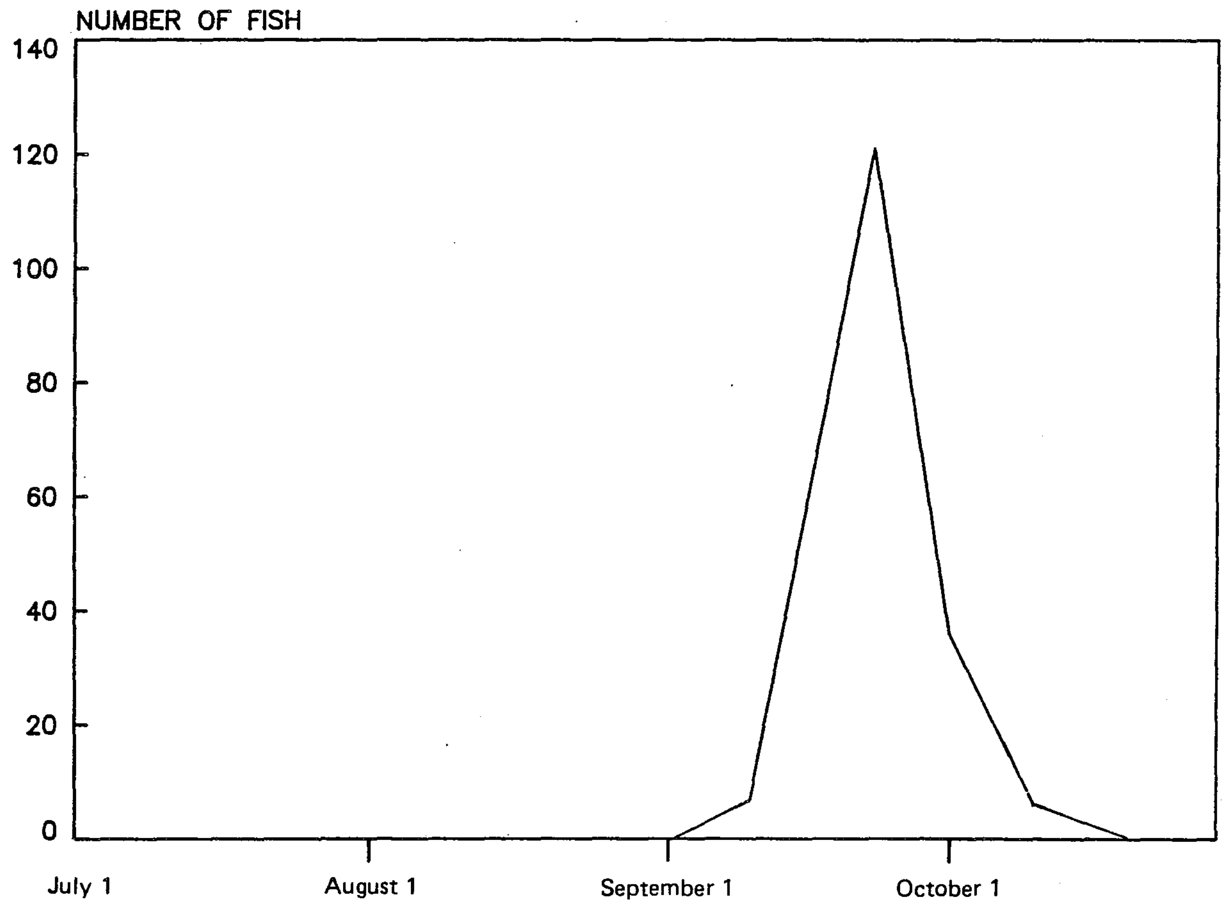


Figure 6.85

Chum Salmon
Estimated Fish
Escapement For
Chakachatna River
Tributary (C_1)

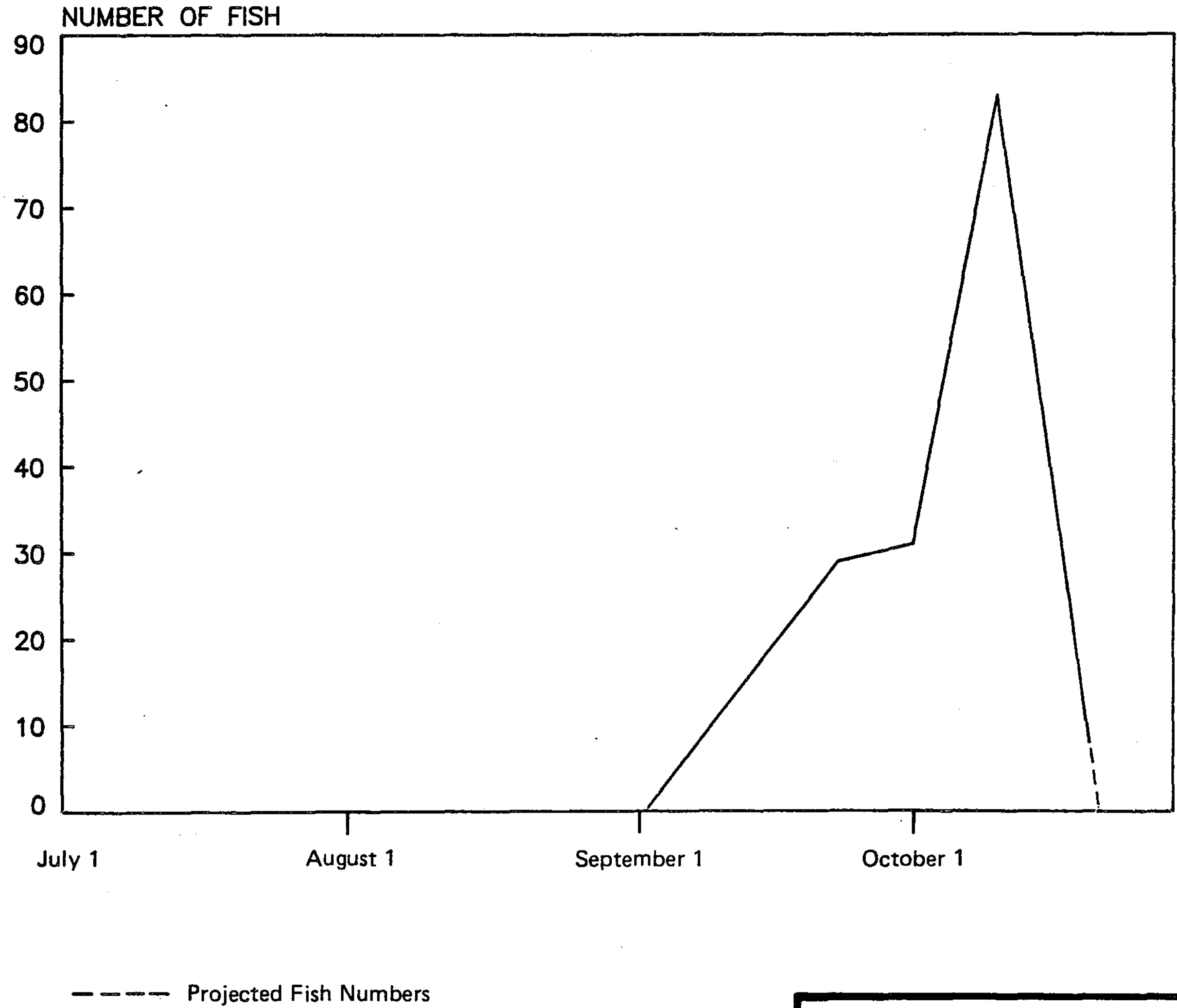


Figure 6.86

Chum Salmon
Estimated Fish
Escapement For
Straight Creek
Mouth Sloughes

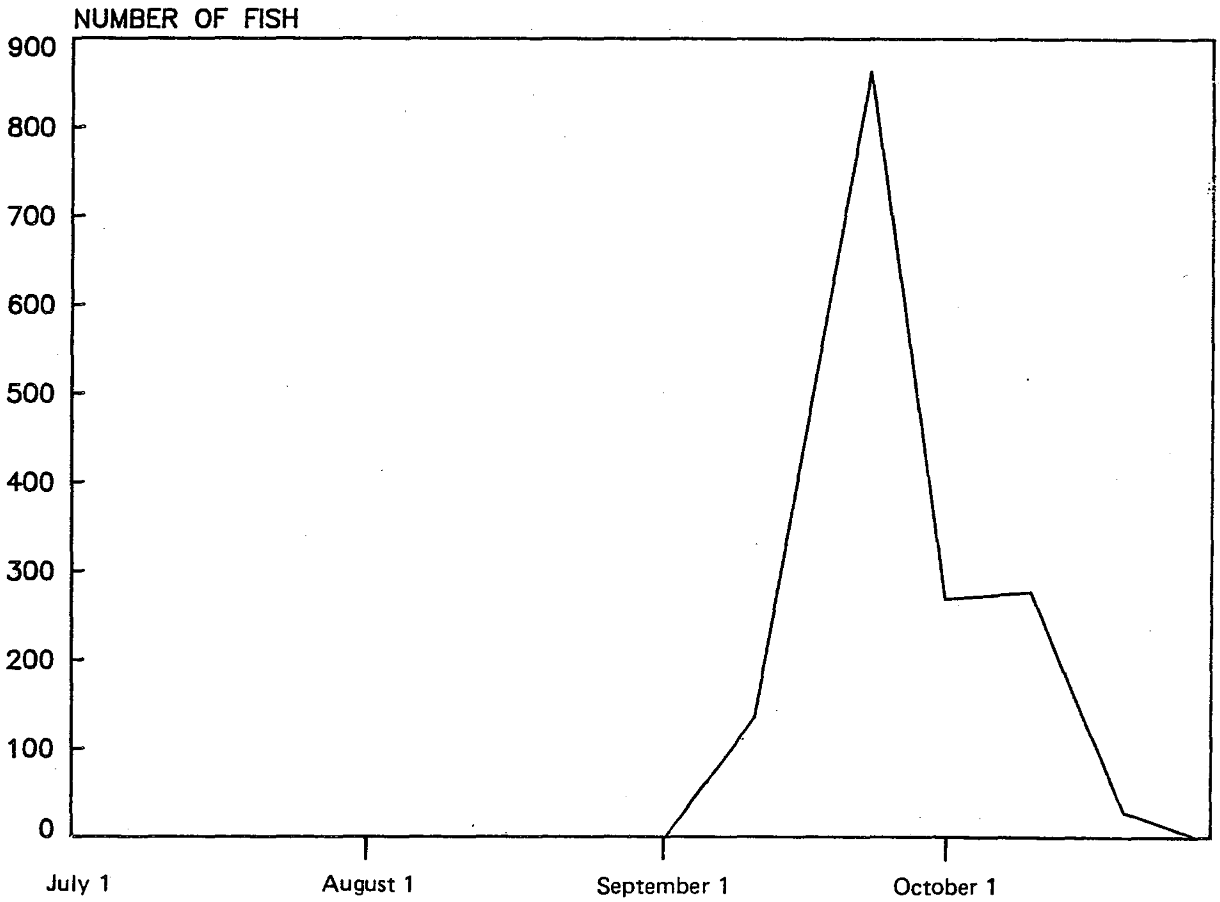


Figure 6.87

Chum Salmon
Estimated Fish
Escapement For
Bridge Area
Chakachatna River (17)

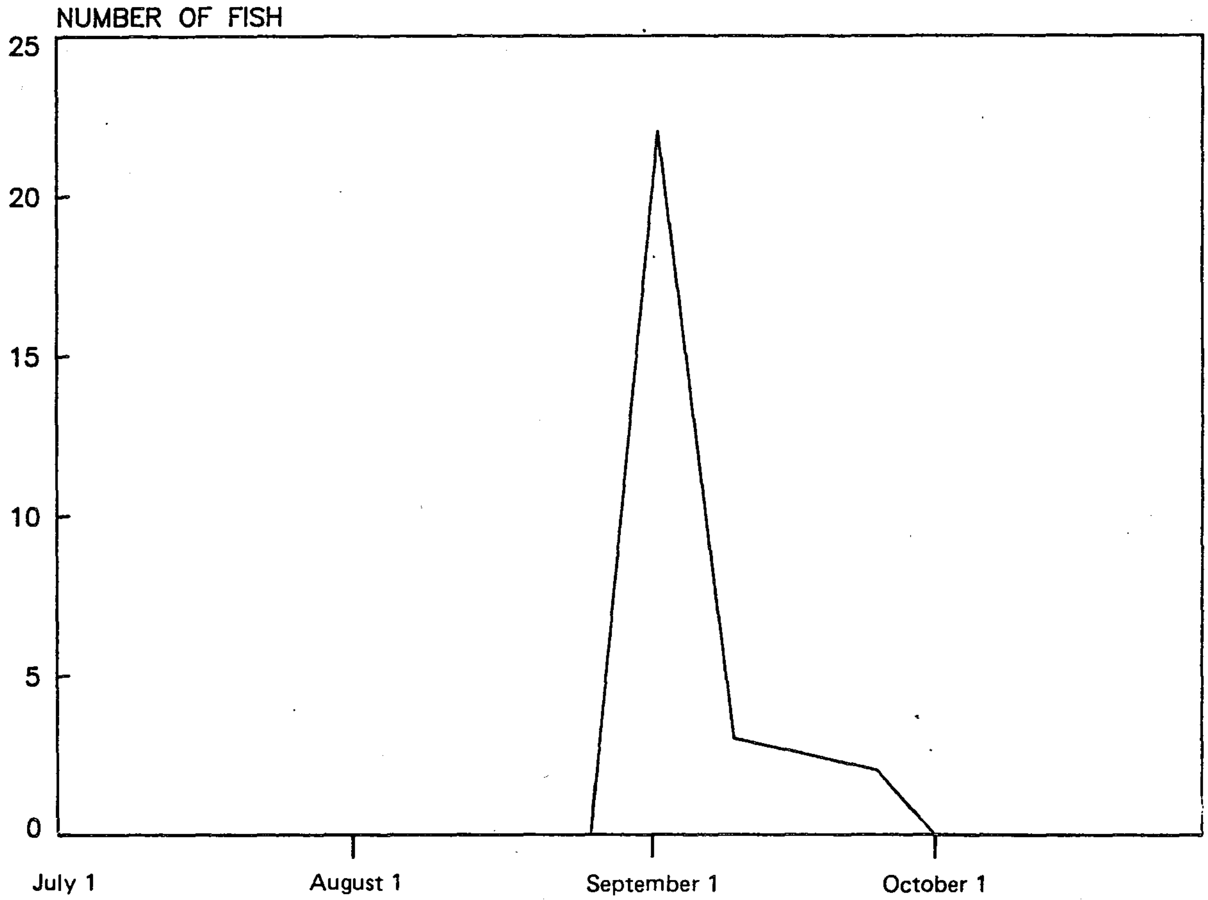


Figure 6.88

Chum Salmon
Estimated Fish
Escapement For
McArthur River
Upper Tributary (13u)

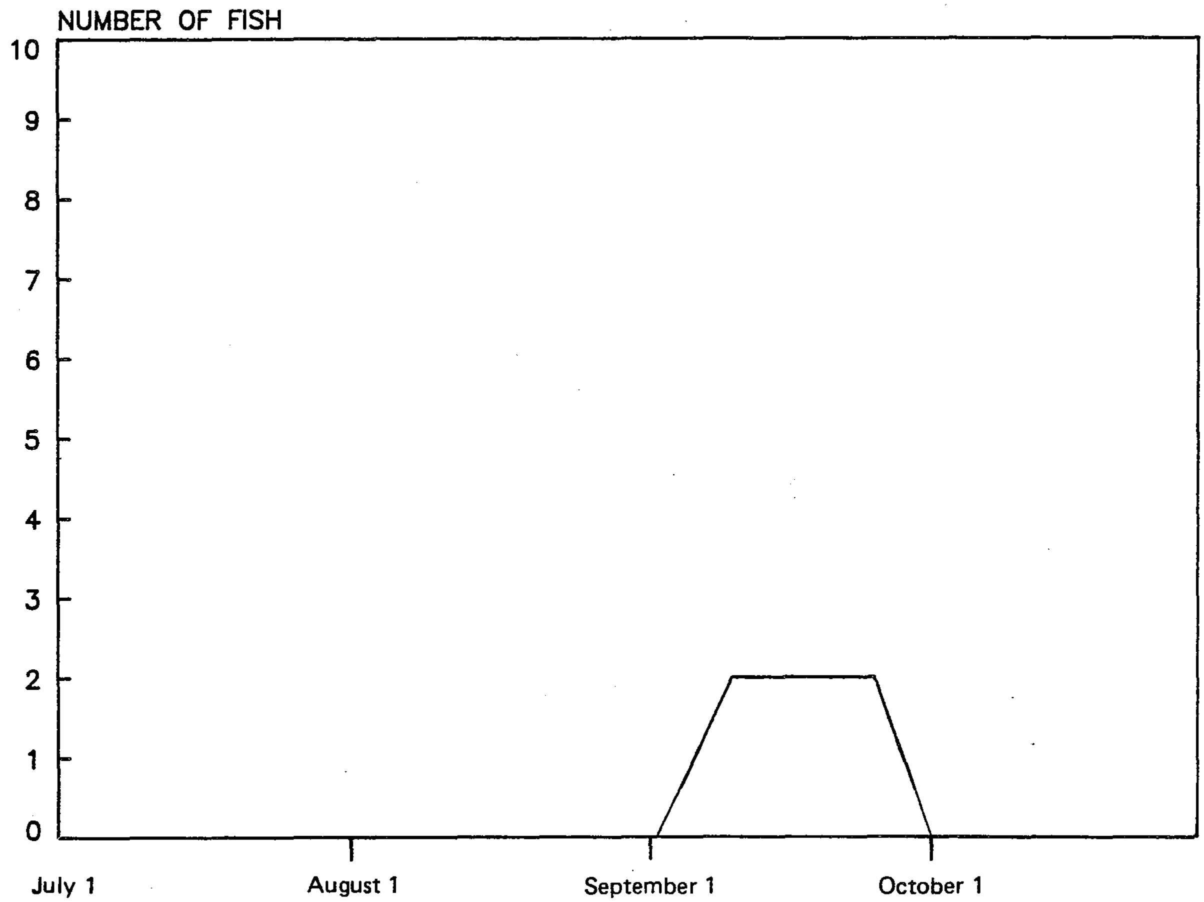


Figure 6.89

Chum Salmon
Estimated Fish
Escapement For
Tributary 12.1

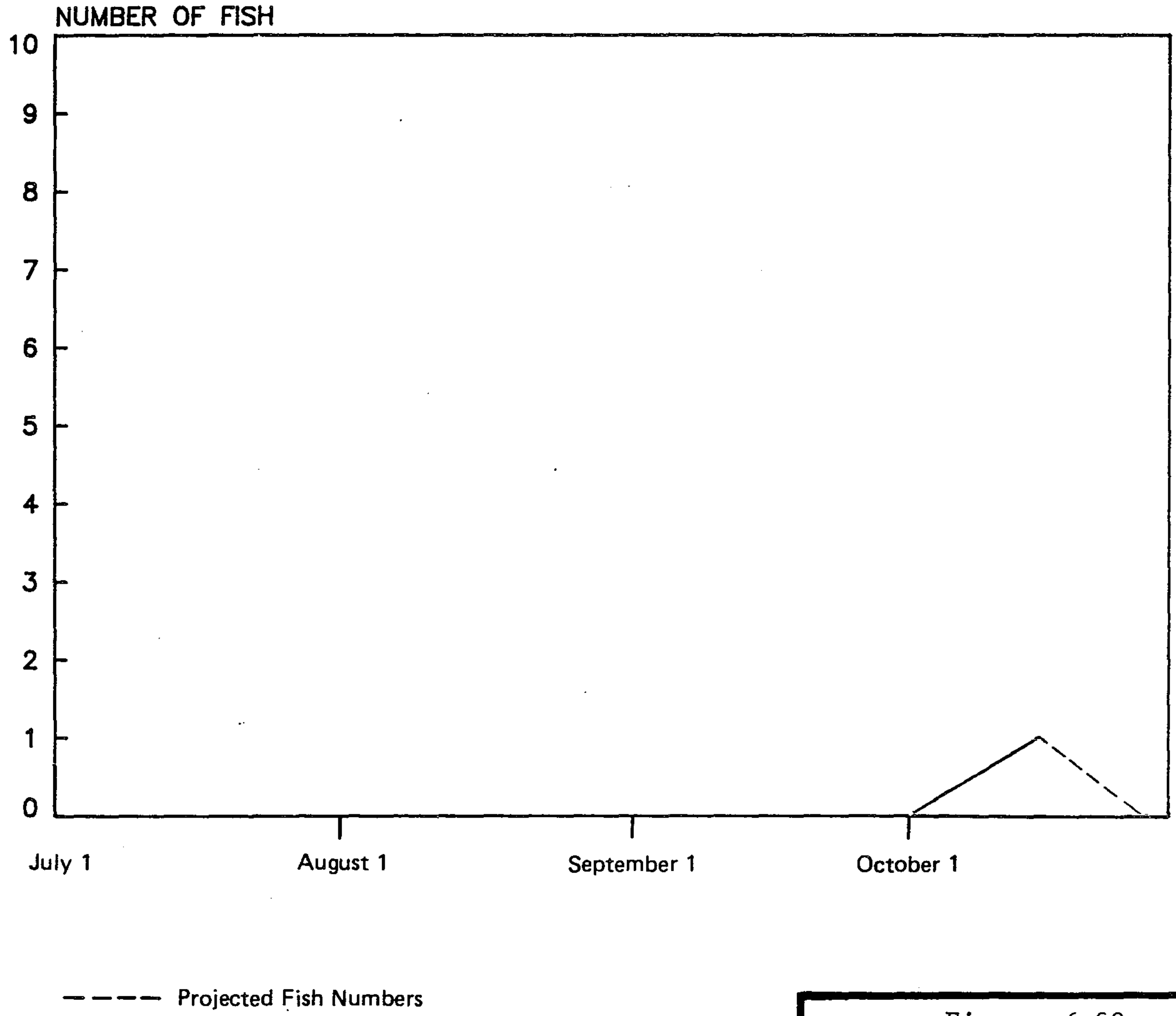


Figure 6.90

Chum Salmon
Estimated Fish
Escapement For
Tributary 12.4

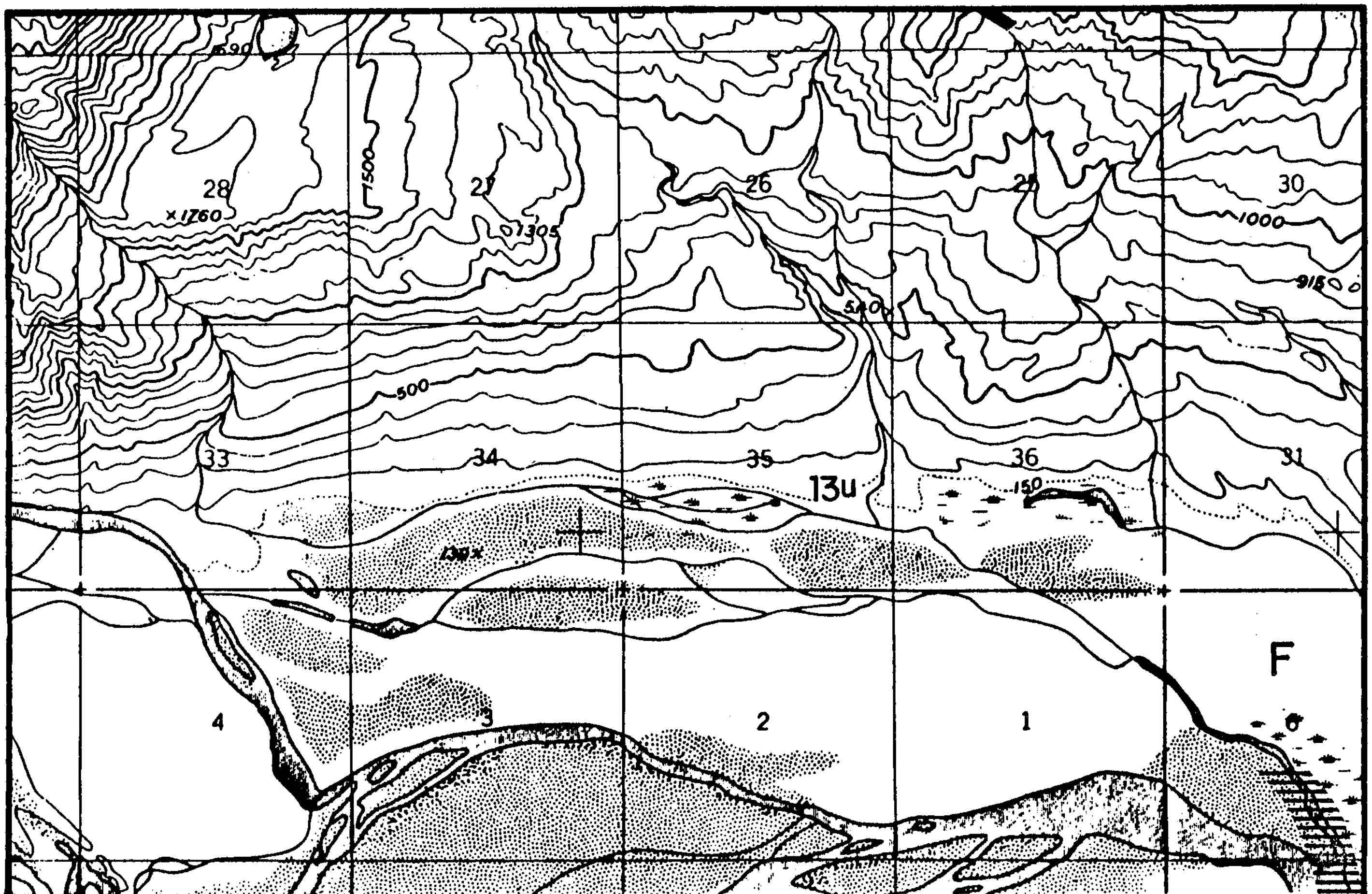


Figure 6.91

Coho Salmon
Milling Area
Stream 13 u
1982
Detail Area F

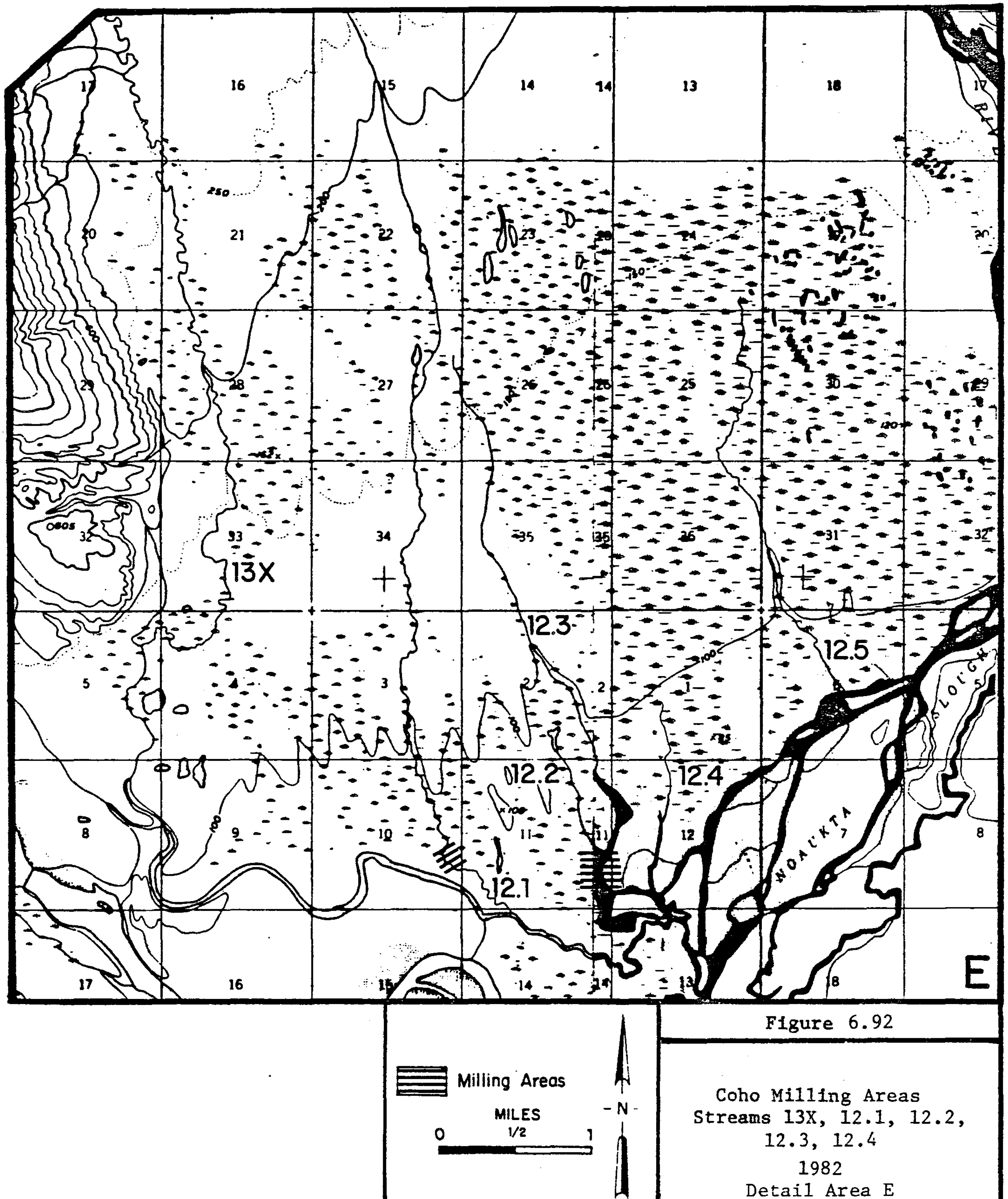


Figure 6.92

Coho Milling Areas
Streams 13X, 12.1, 12.2, 12.3, 12.4
1982
Detail Area E

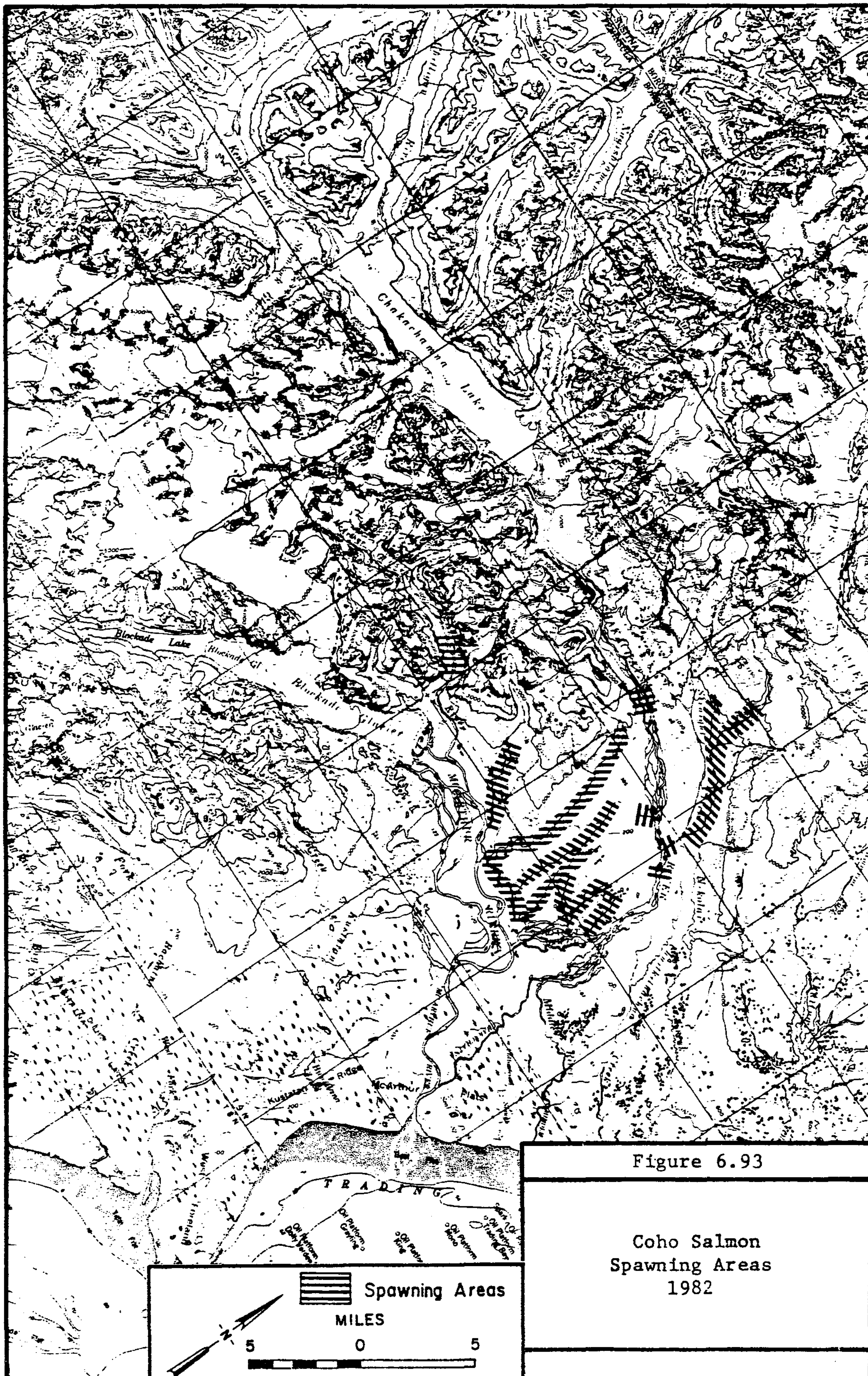


Figure 6.93

Coho Salmon
Spawning Areas
1982

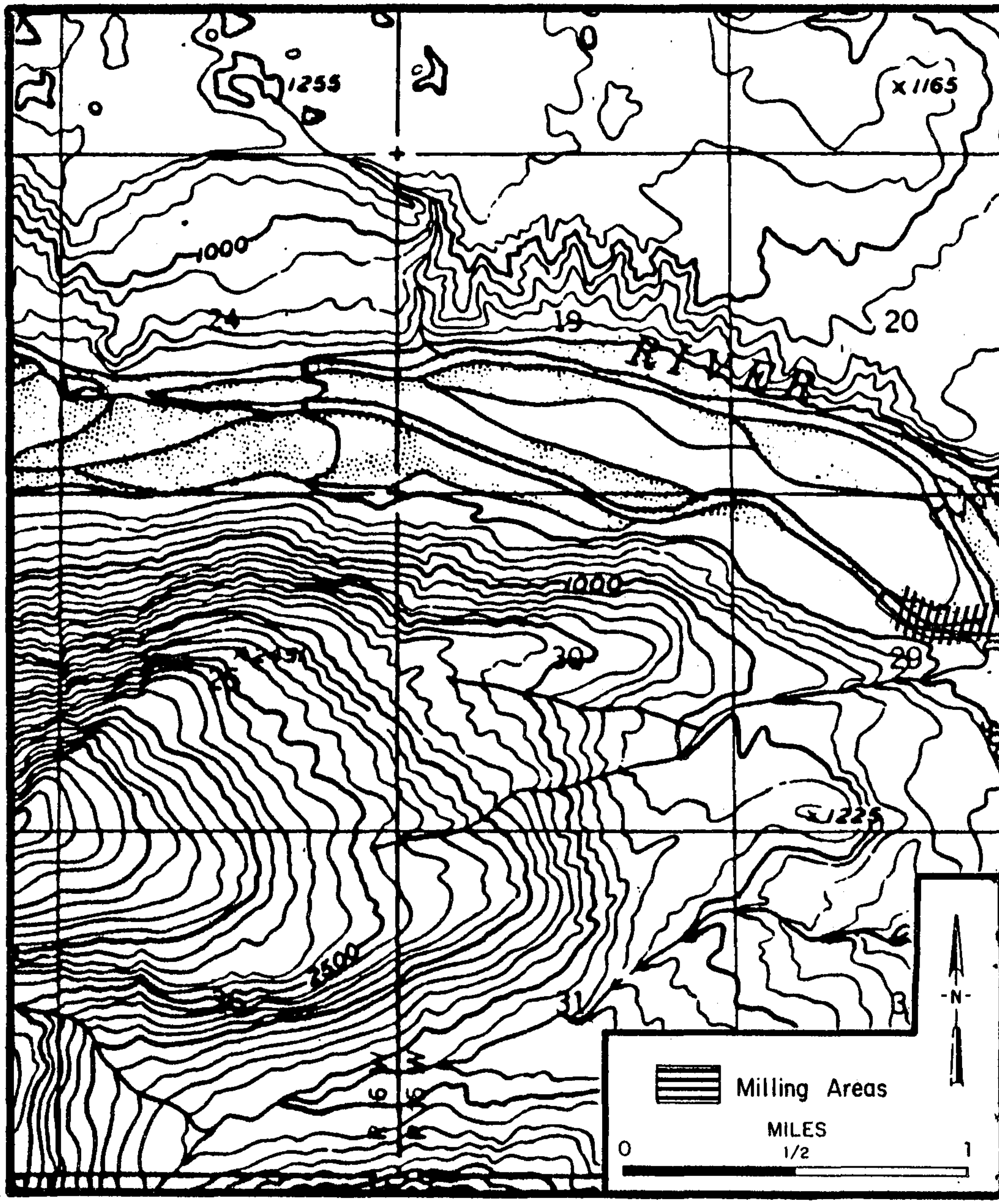


Figure 6.94

Coho Milling Areas
Chakachatna Canyon
1982

Detail Area B

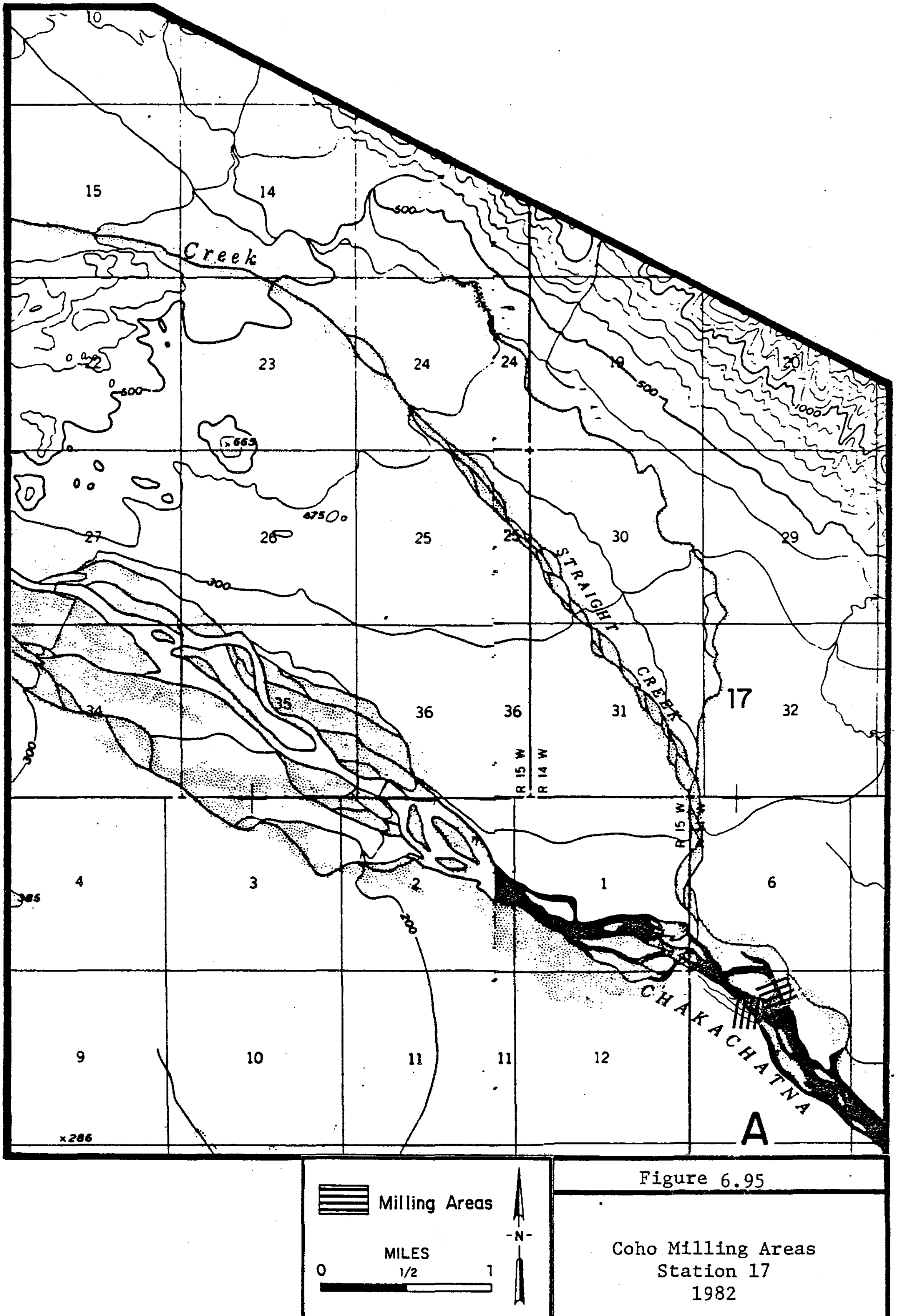


Figure 6.95

Coho Milling Areas
Station 17
1982
Detail Area A

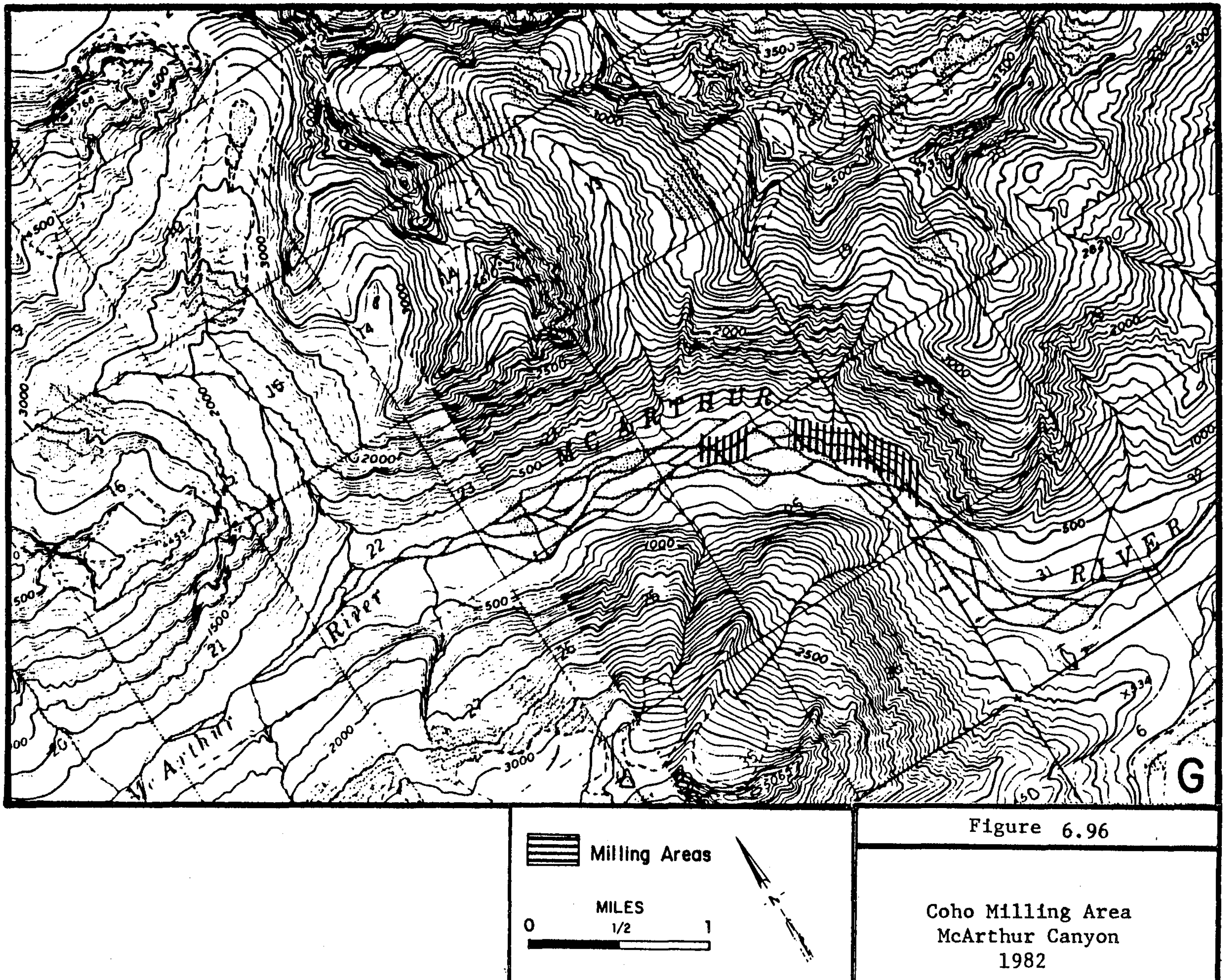


Figure 6.96

Coho Milling Area
McArthur Canyon
1982
Detail Area G

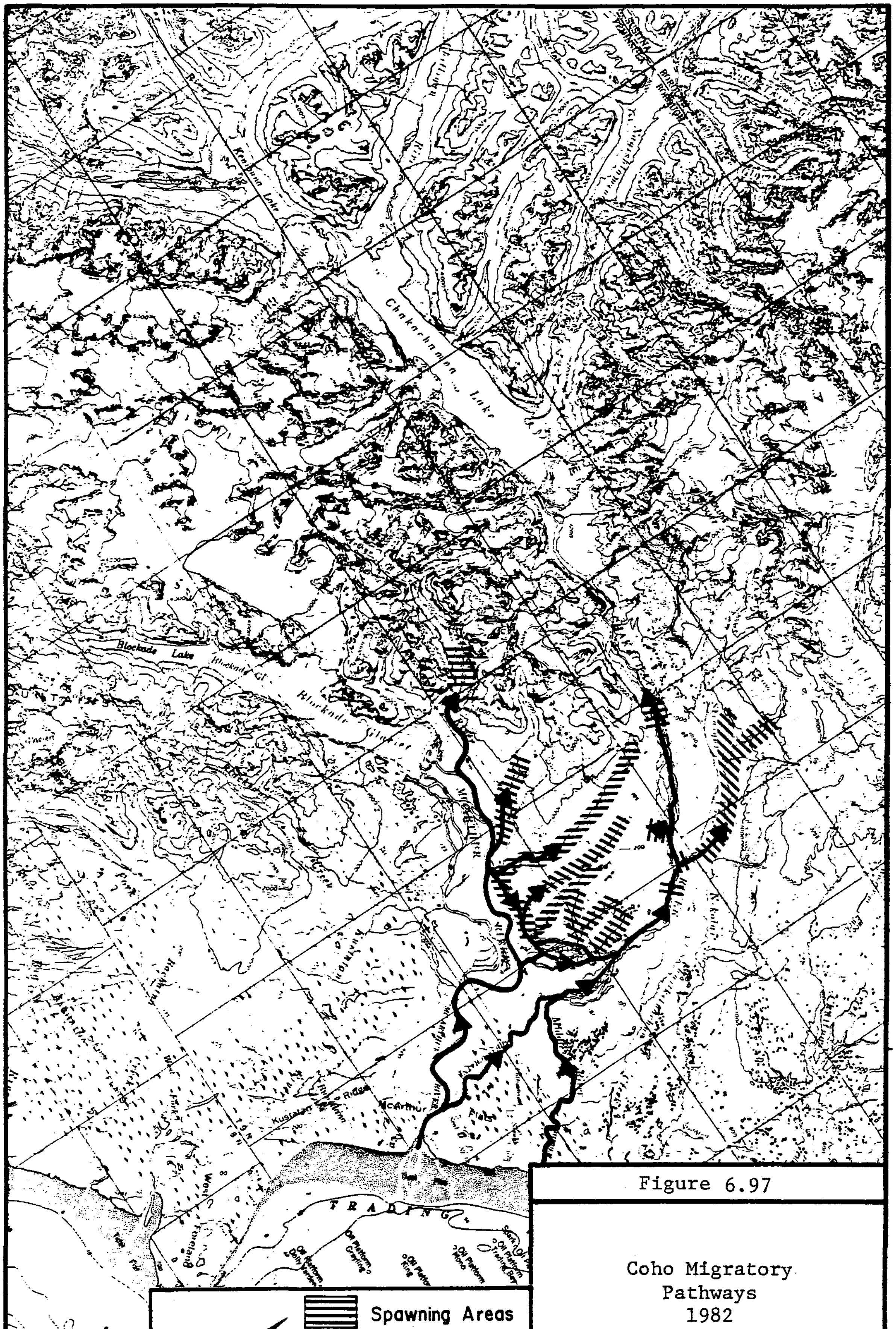


Figure 6.97

Coho Migratory Pathways 1982

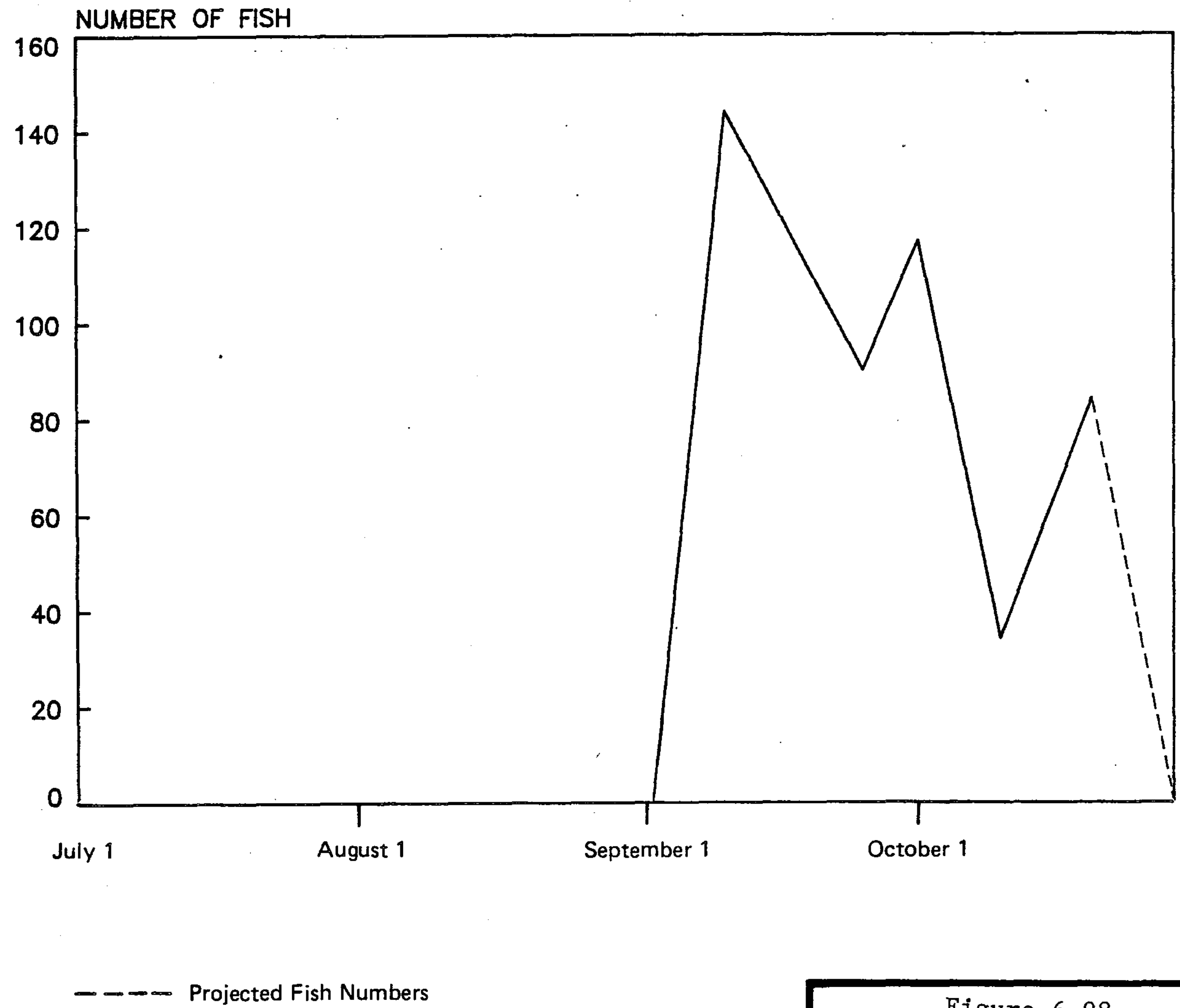


Figure 6.98

Coho Salmon
Estimated Fish
Escapement For
Chakachatna River
Canyon Sloughes

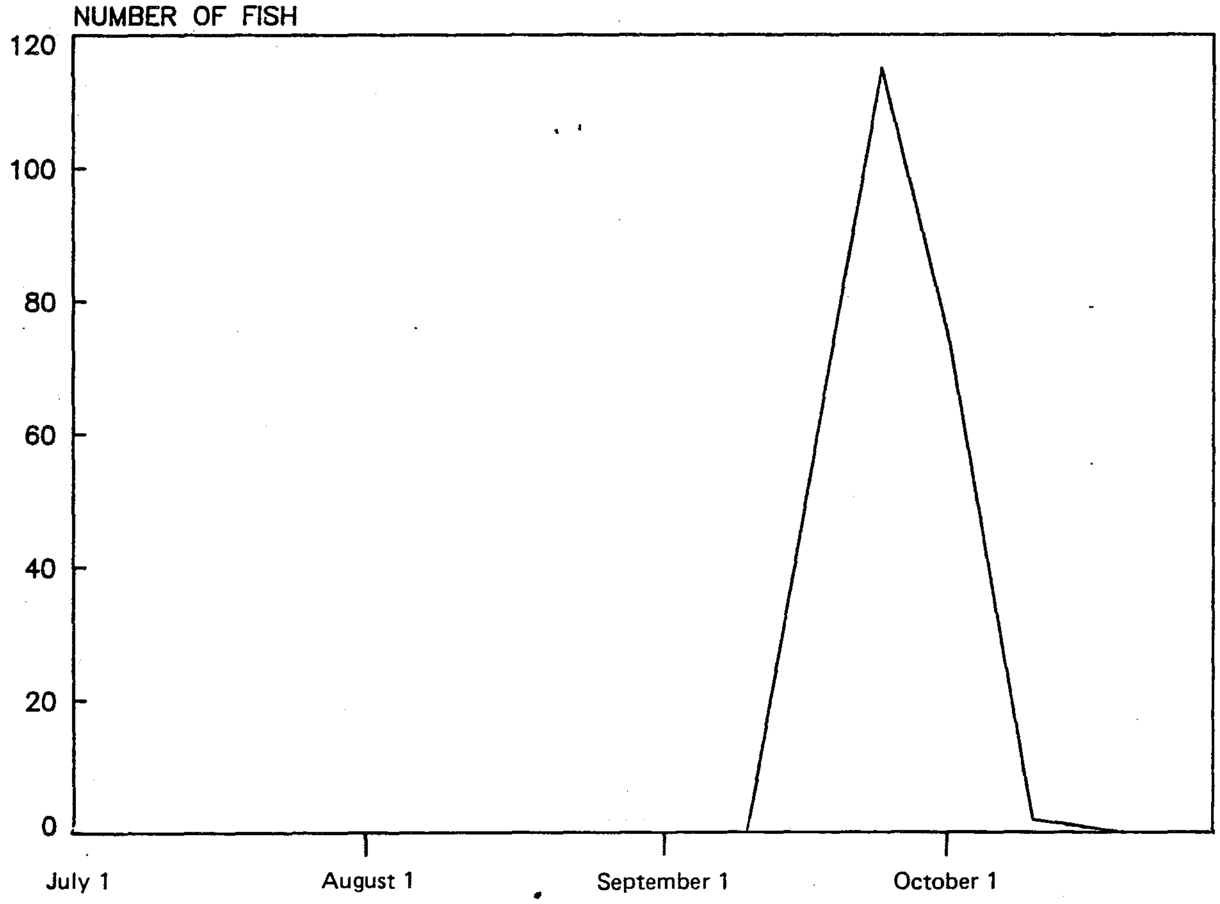


Figure 6.99

Coho Salmon
Estimated Fish
Escapement For
Chakachatna River
Tributary (C_1)

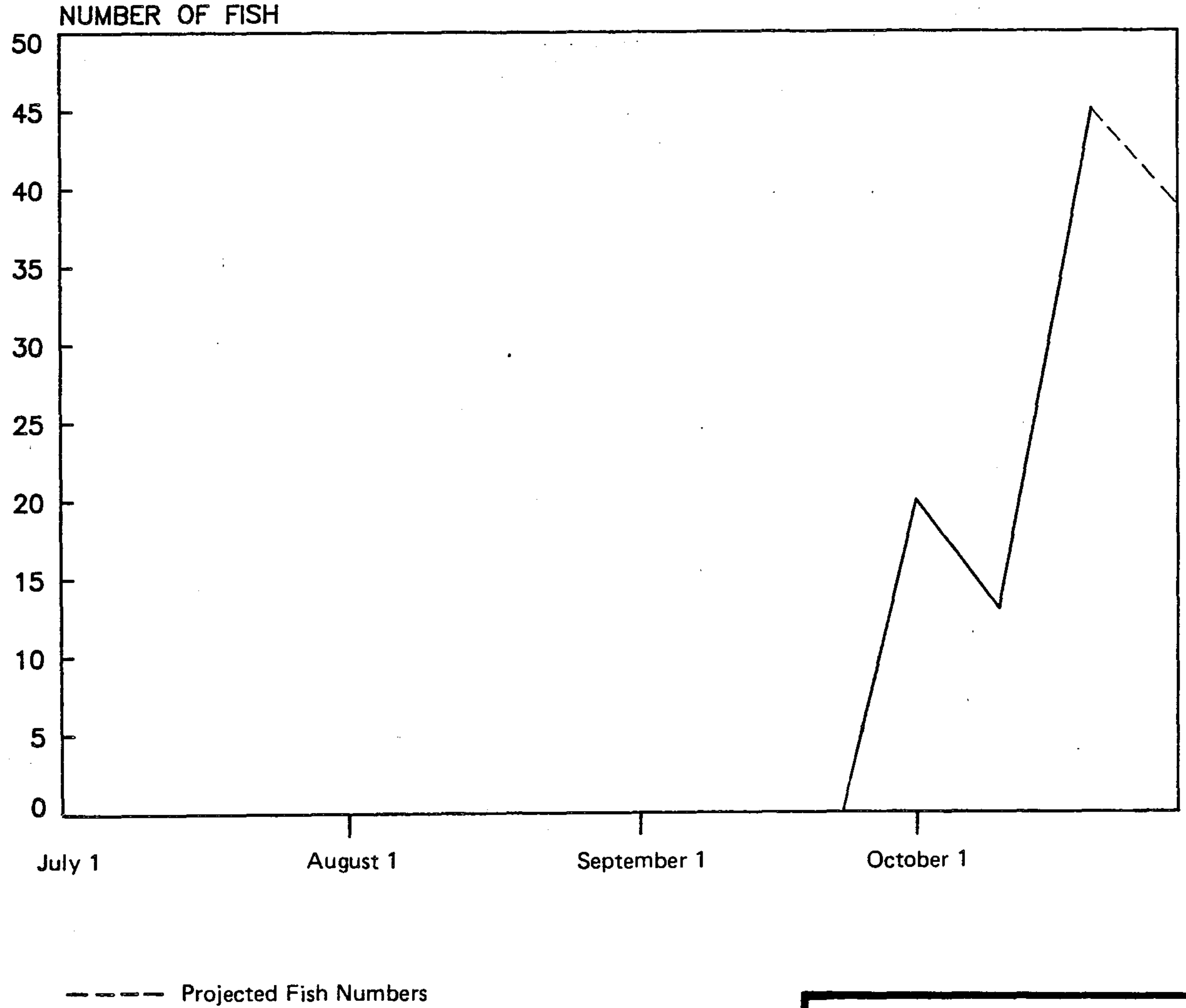


Figure 6.100

Coho Salmon
Estimated Fish
Escapement For
Straight Creek
Mouth Sloughes

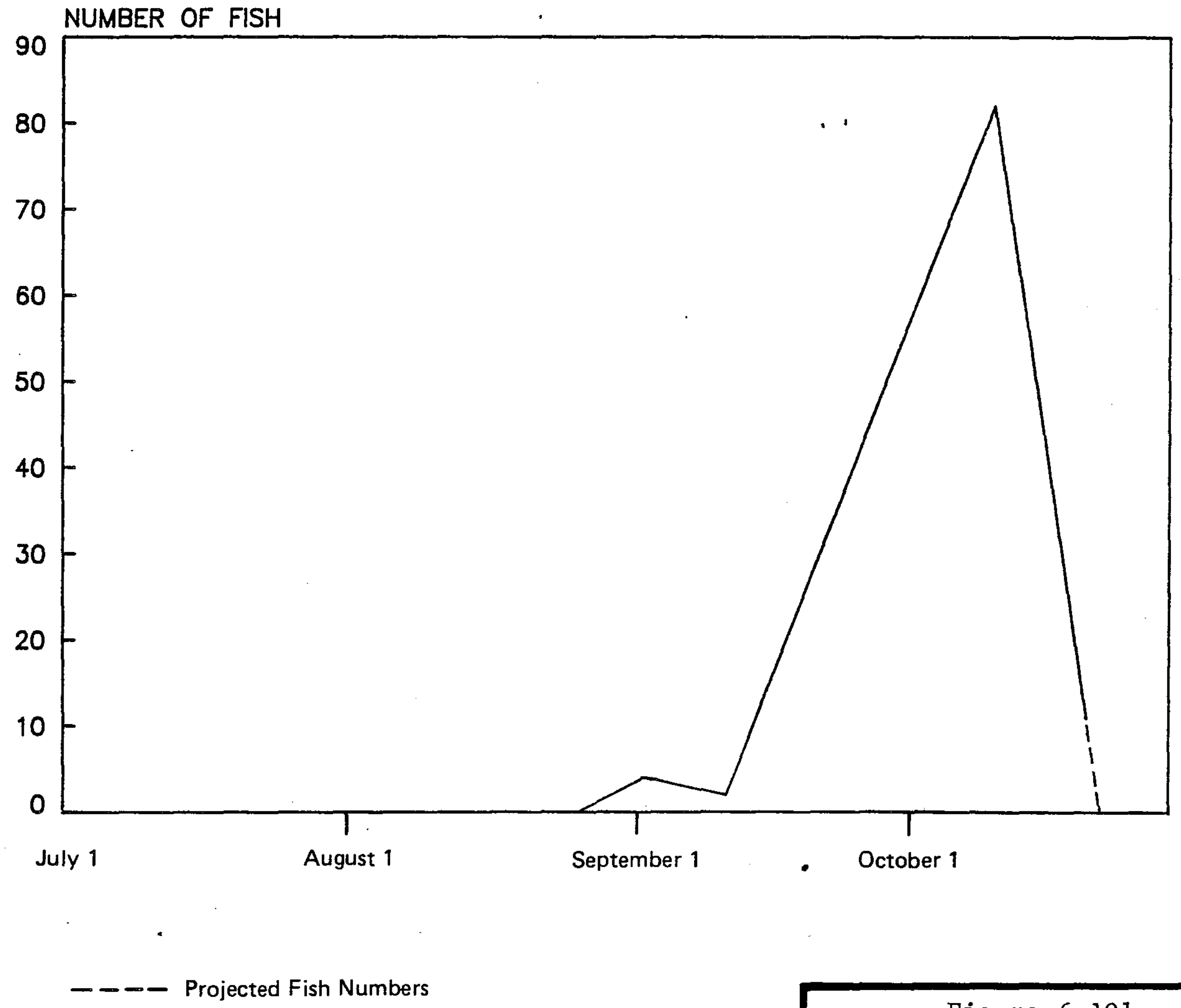


Figure 6.101

Coho Salmon
Estimated Fish
Escapement For
Clearwater Tributary
to Straight Creek (19)

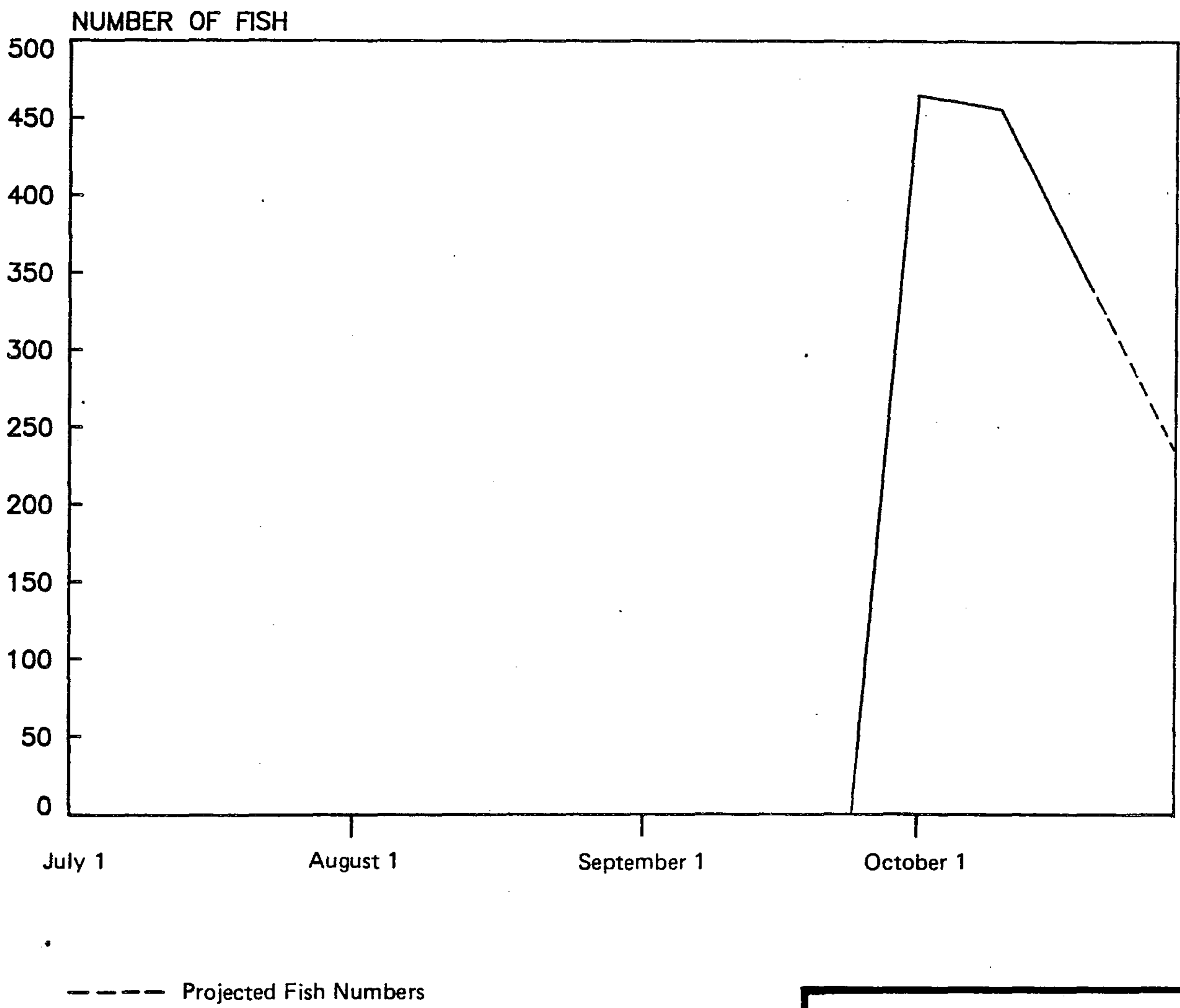


Figure 6.102

Coho Salmon
Estimated Fish
Escapement For
Bridge Area
Chakachatna River (17)

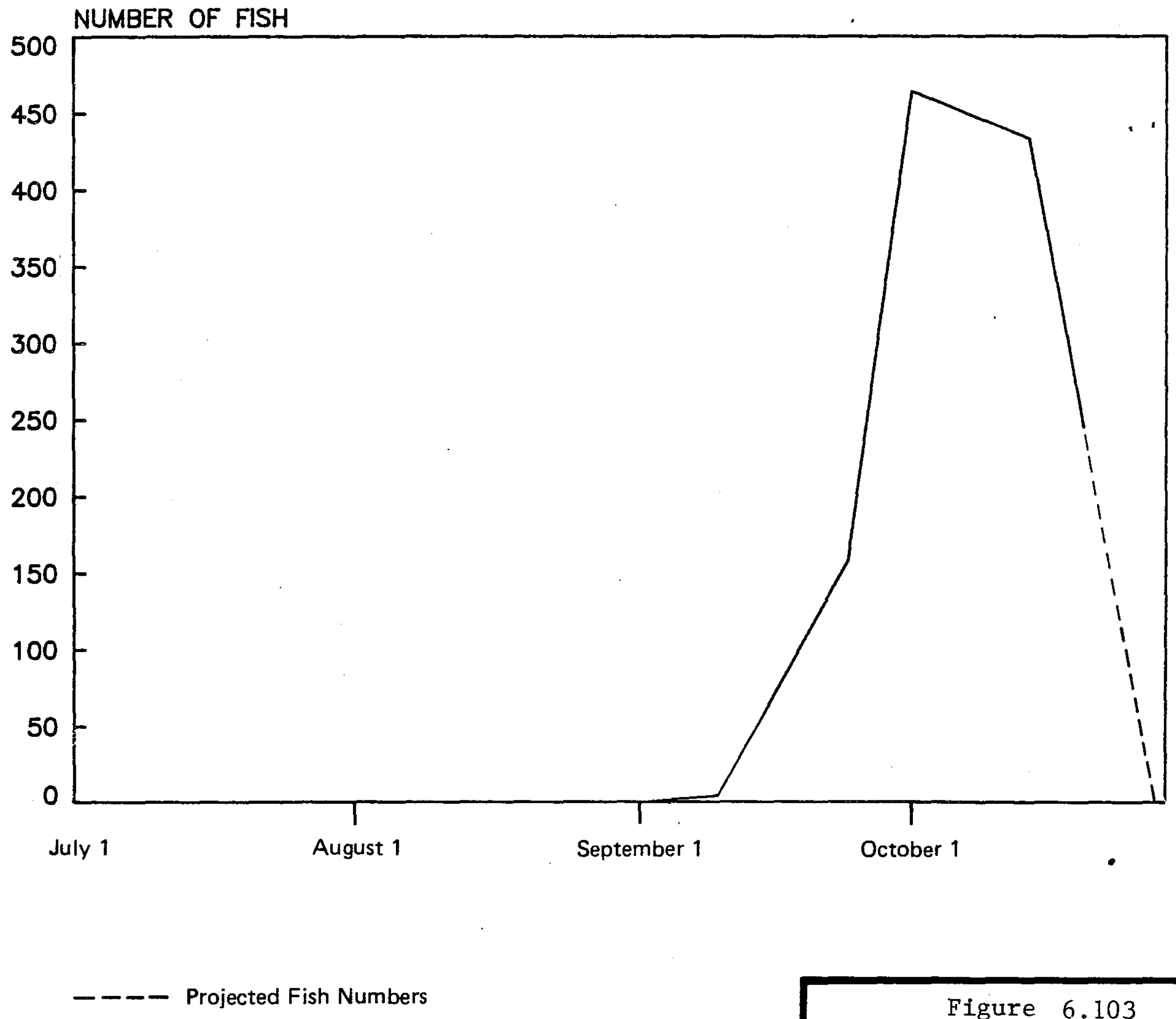


Figure 6.103

Coho Salmon
Estimated Fish
Escapement For
McArthur River
Canyon

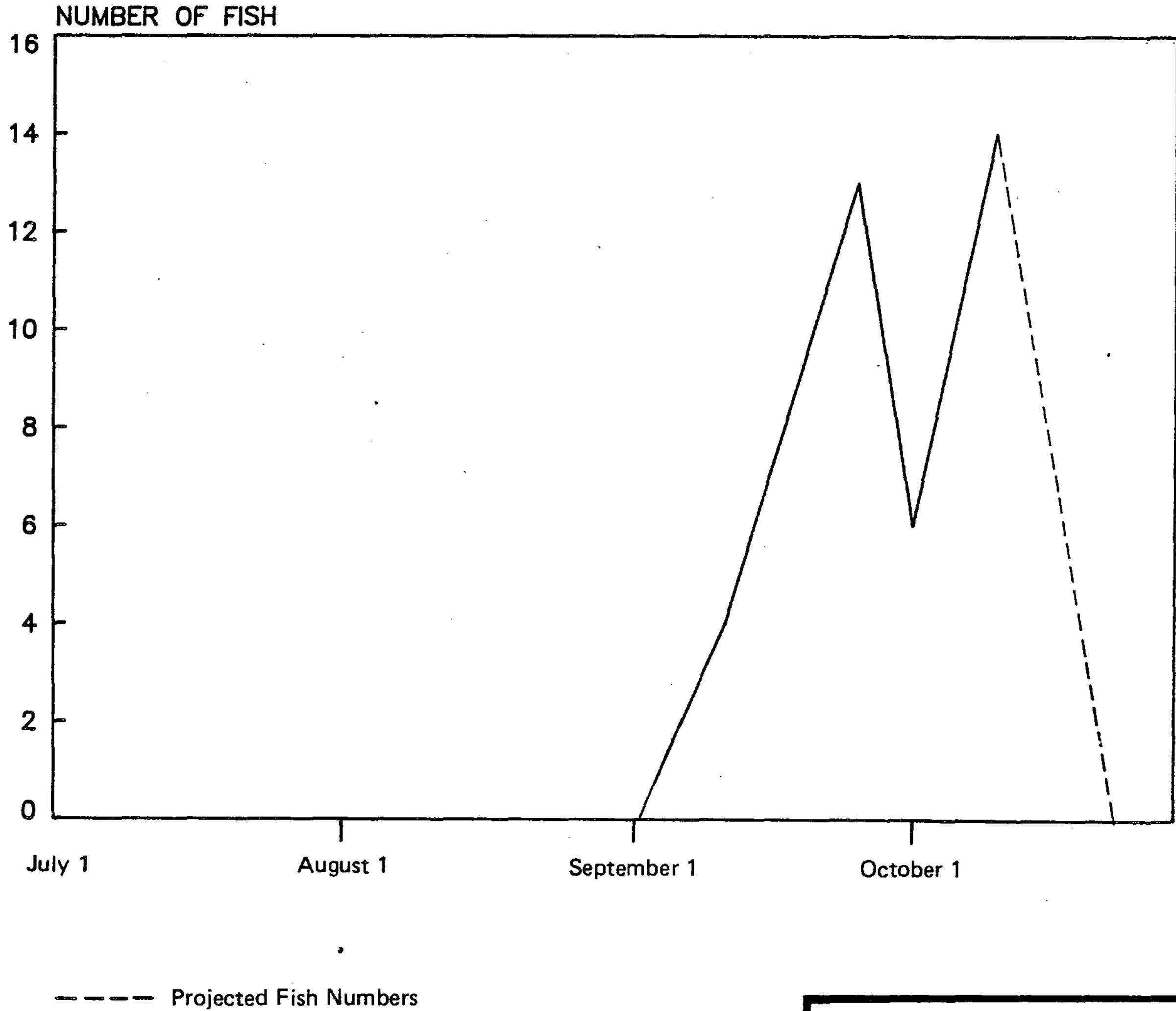


Figure 6.104

Coho Salmon
Estimated Fish
Escapement For
McArthur River
Upper Tributary (13u)

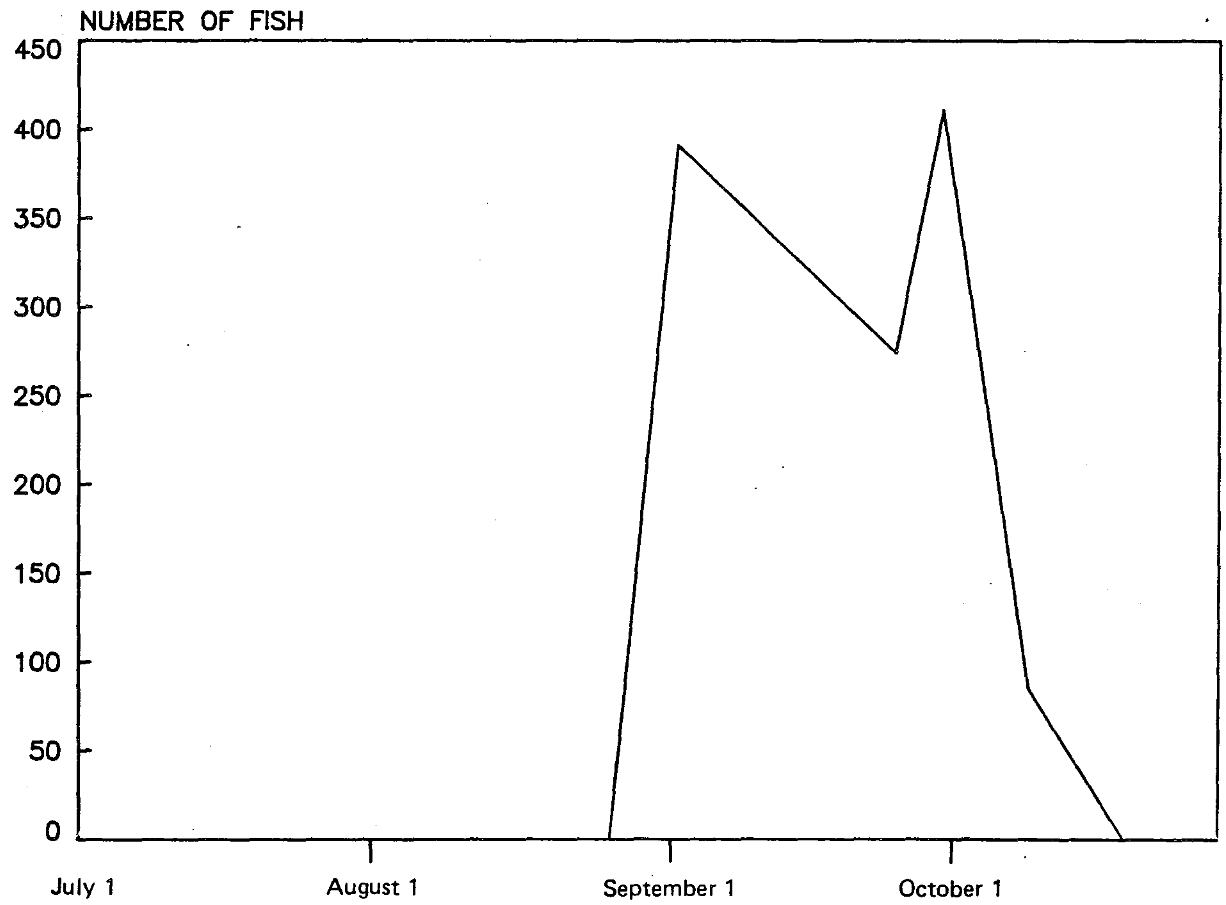


Figure 6.105

Coho Salmon
Estimated Fish
Escapement For
McArthur River
Oxbow Creek (13X)

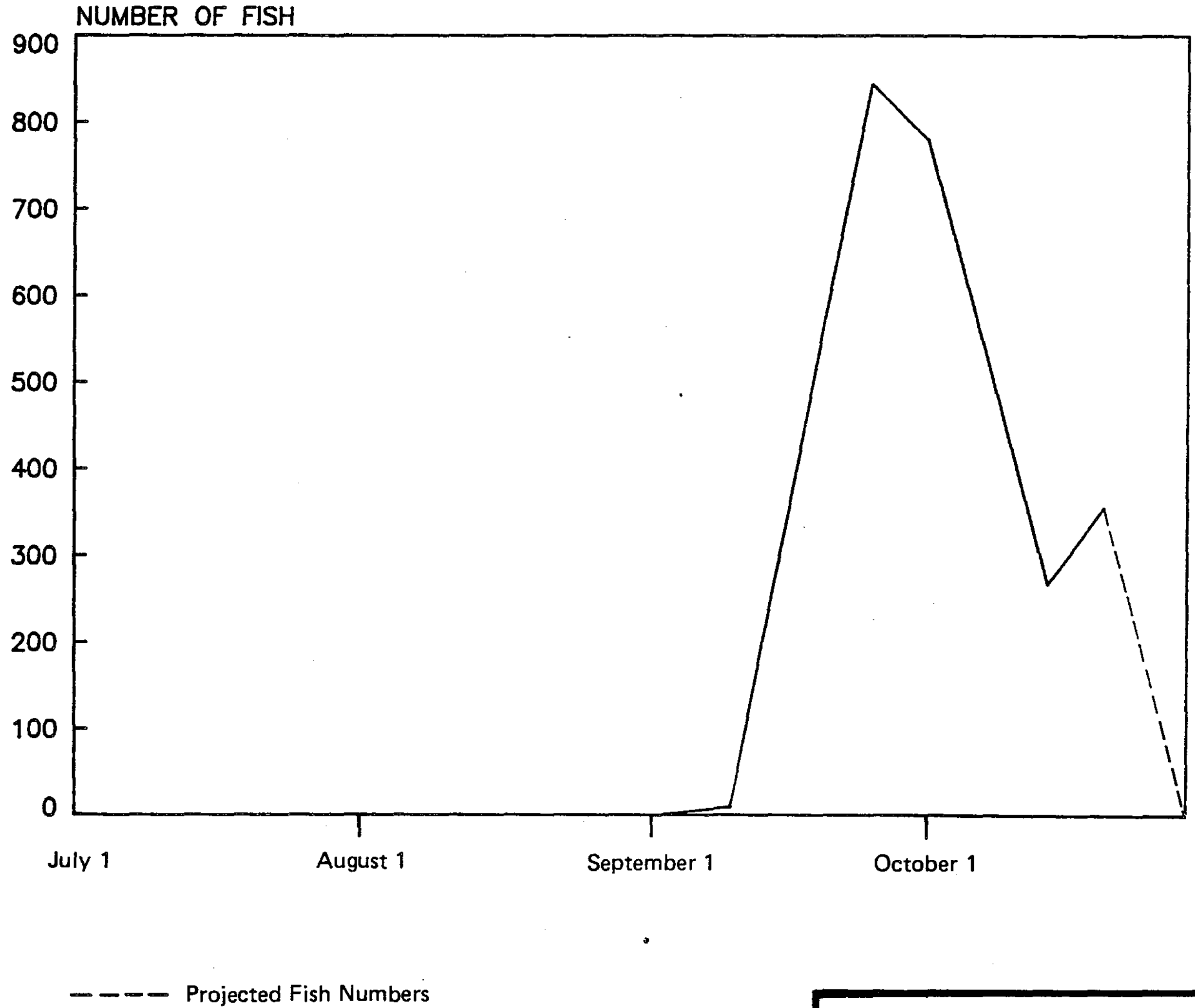


Figure 6.106

Coho Salmon
Estimated Fish
Escapement For
Tributary 12.1

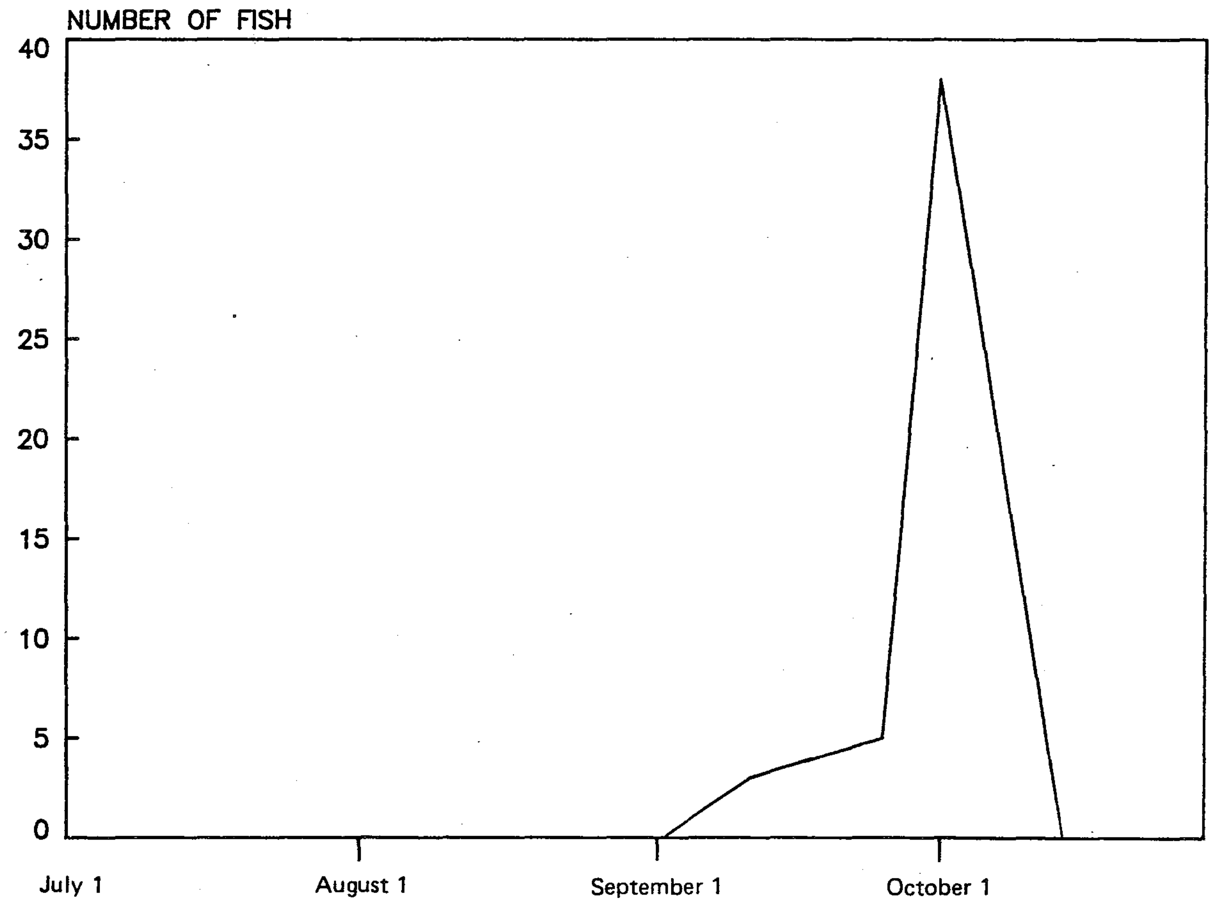


Figure 6.107

Coho Salmon
Estimated Fish
Escapement For
Tributary 12.2

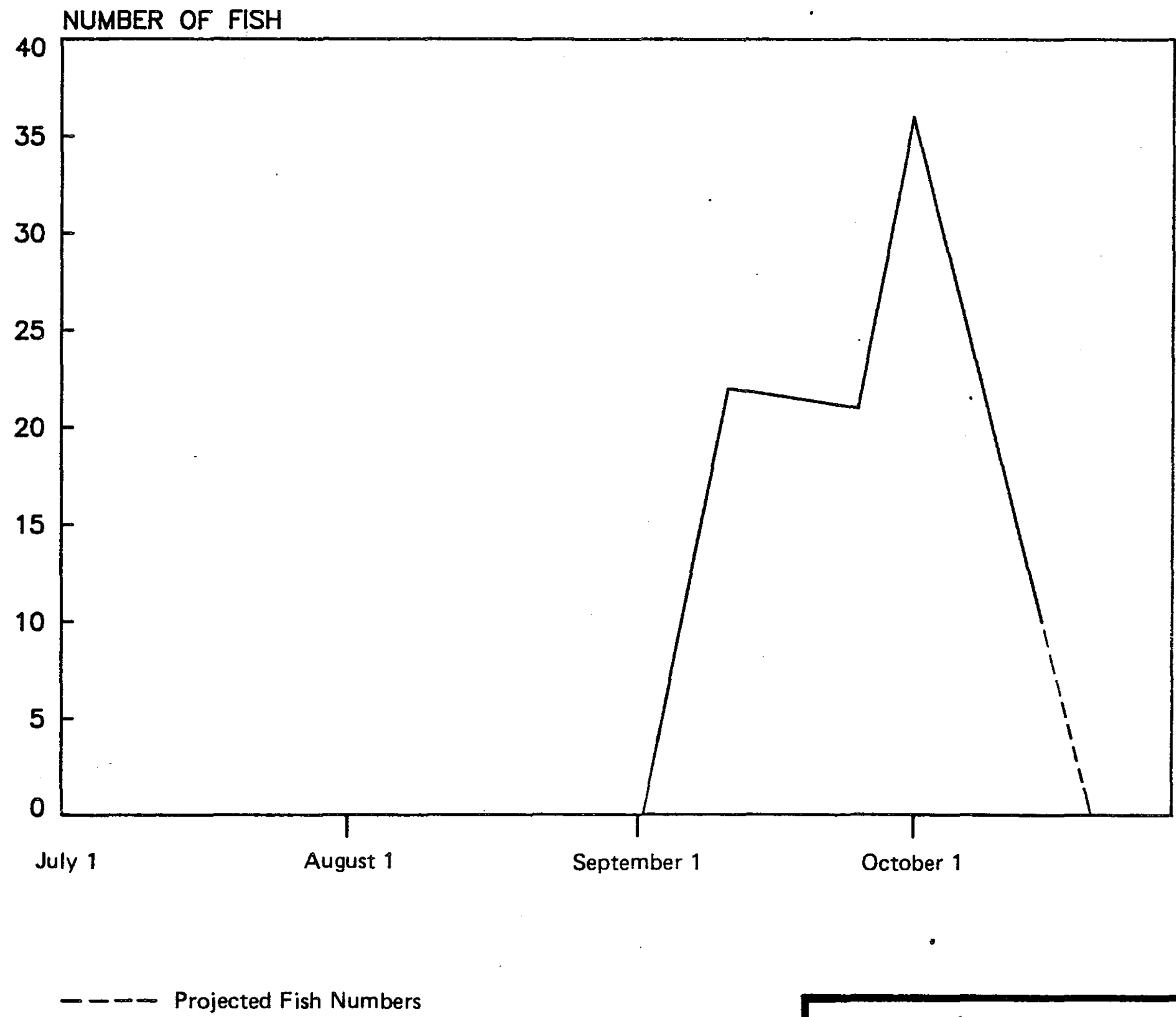


Figure 6.108

Coho Salmon
Estimated Fish
Escapement For
Tributary 12.3

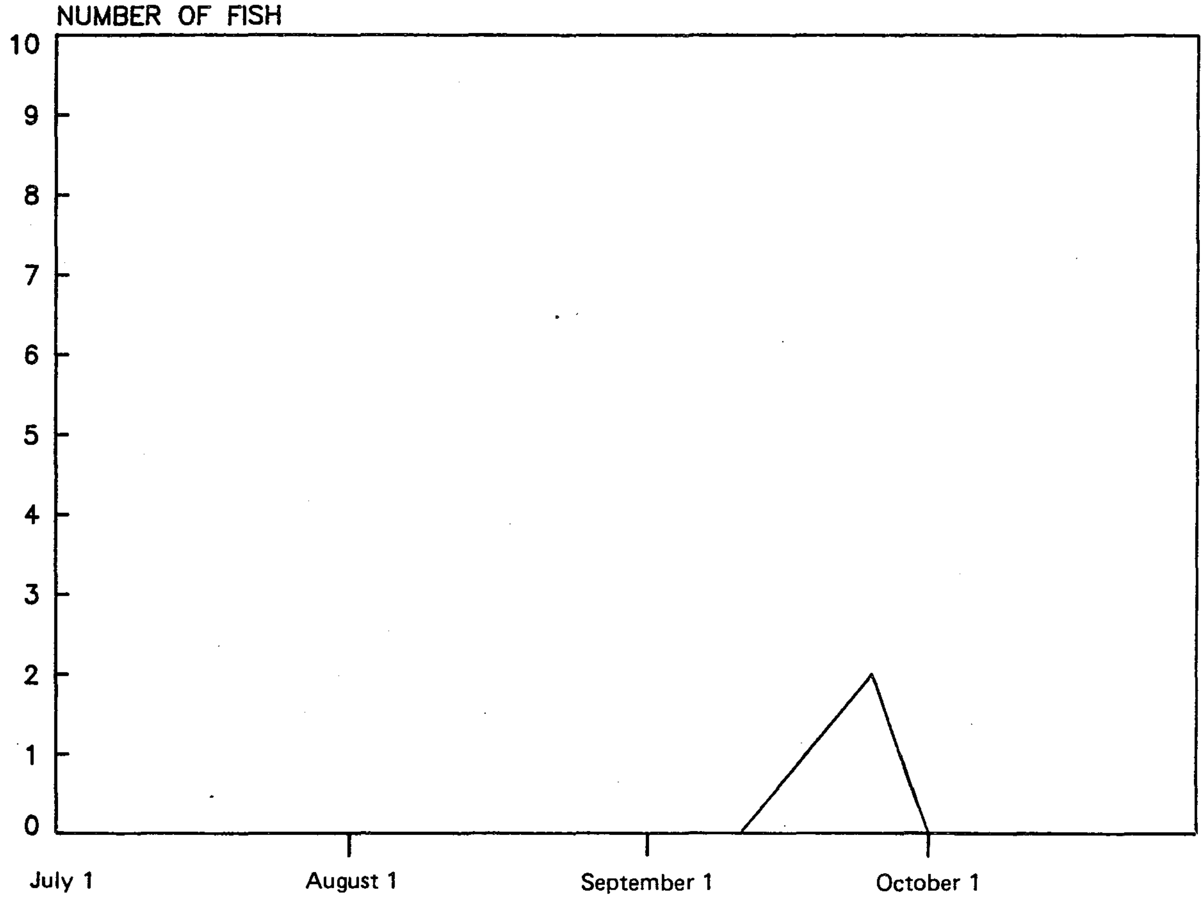


Figure 6.109

Coho Salmon
Estimated Fish
Escapement For
Tributary 12.5

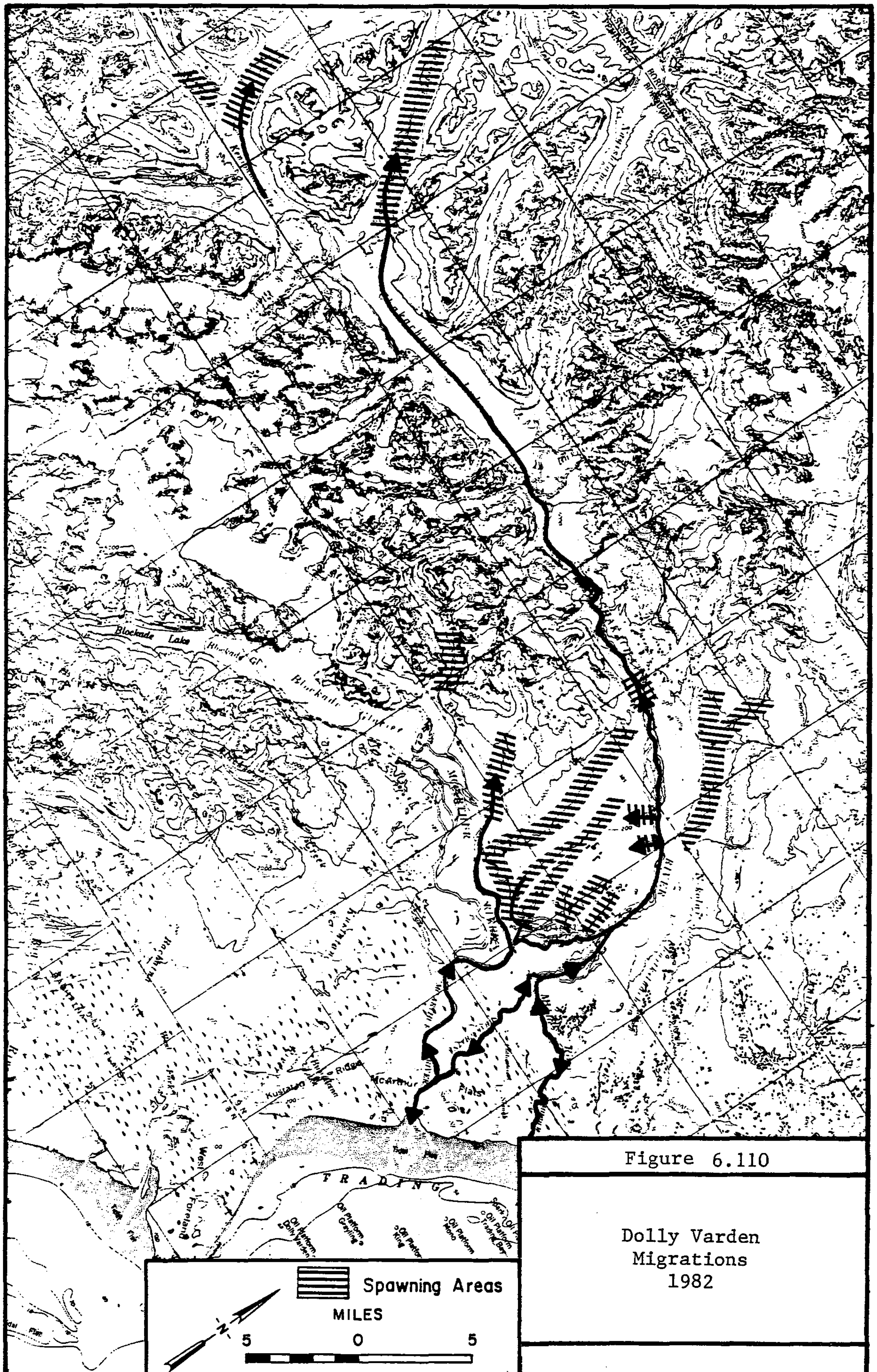


Figure 6.110

Dolly Varden
Migrations
1982

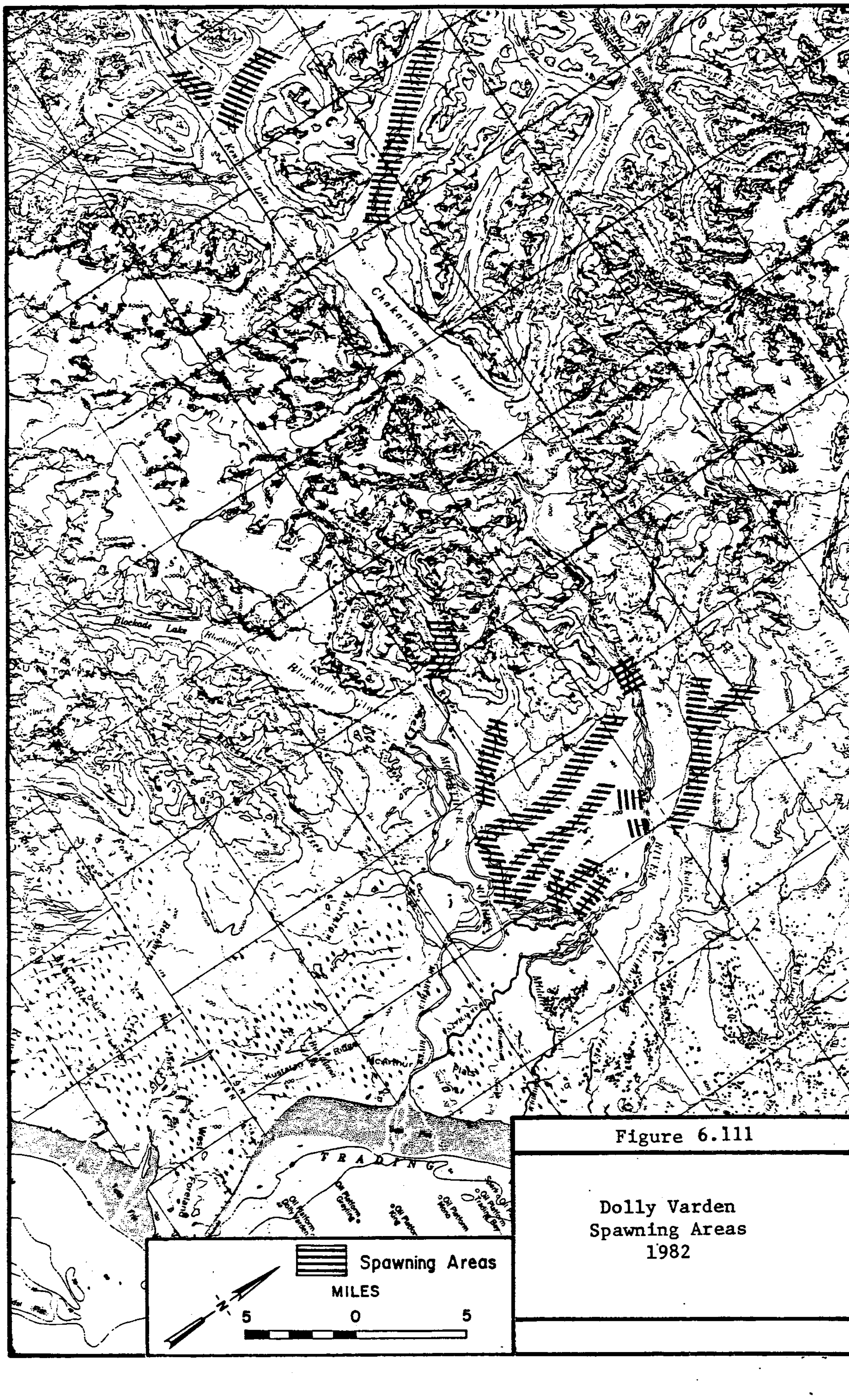


Figure 6.111

Dolly Varden
Spawning Areas
1982

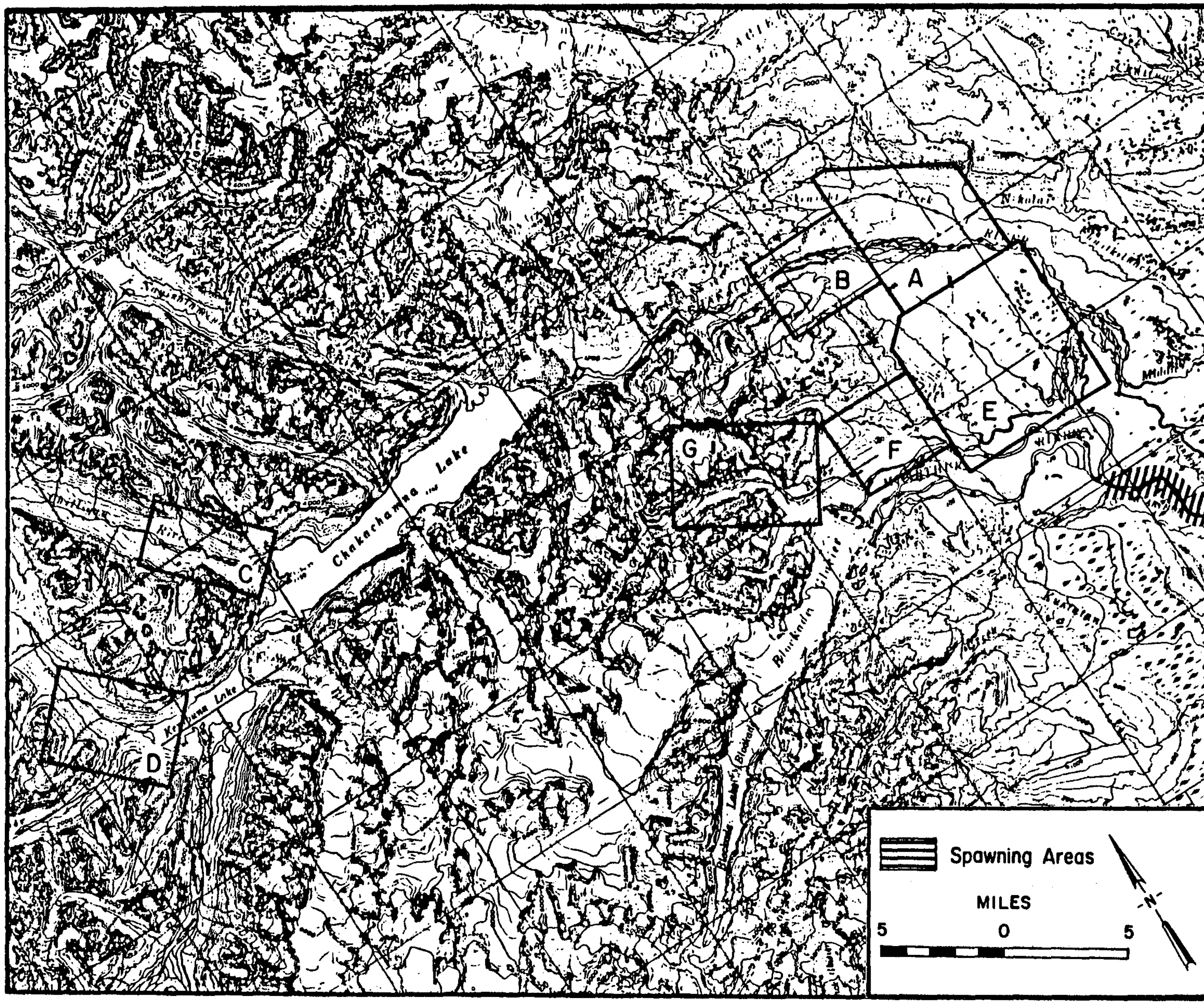


Figure 6.112

Eulachan
Spawning Area
Spring 1982

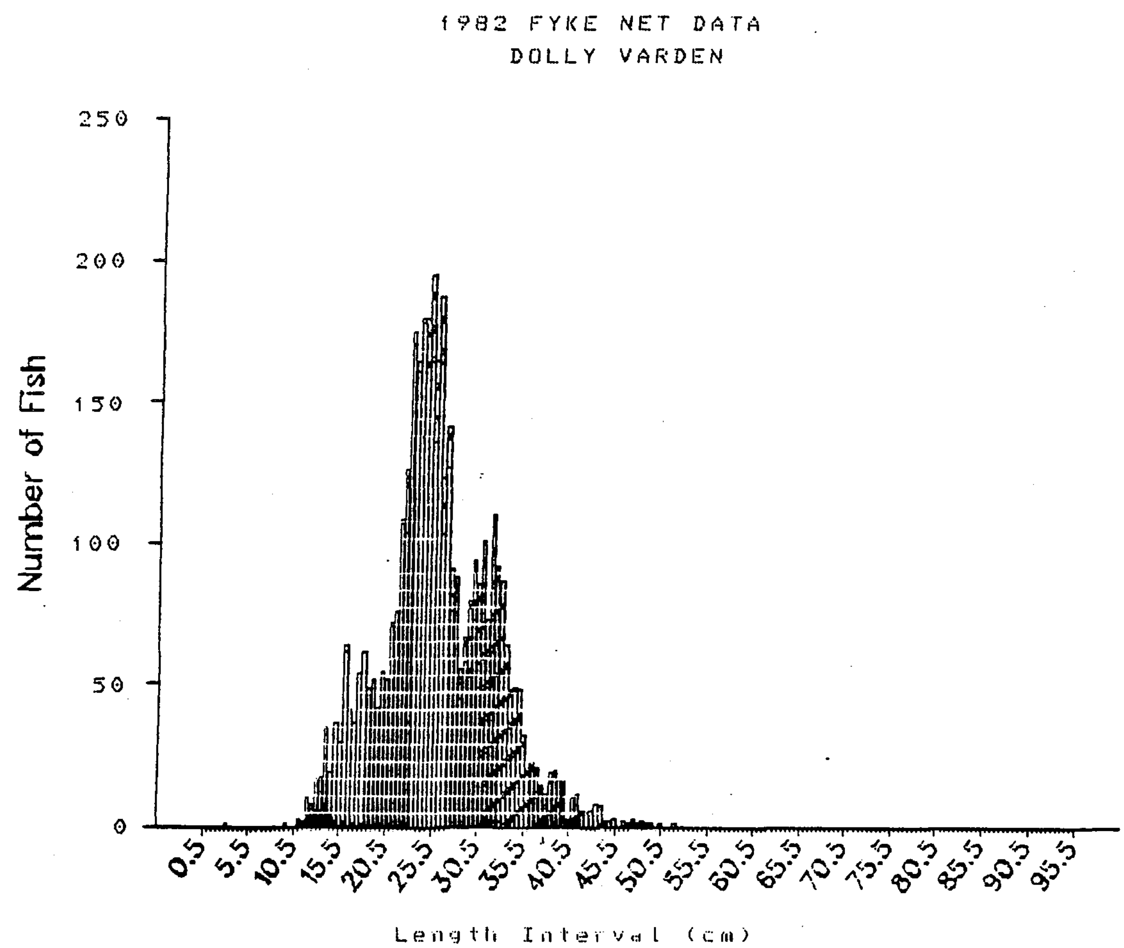


Figure 6.113

Dolly Varden
Length-Frequency Histogram
August-October Fyke Nets
1982

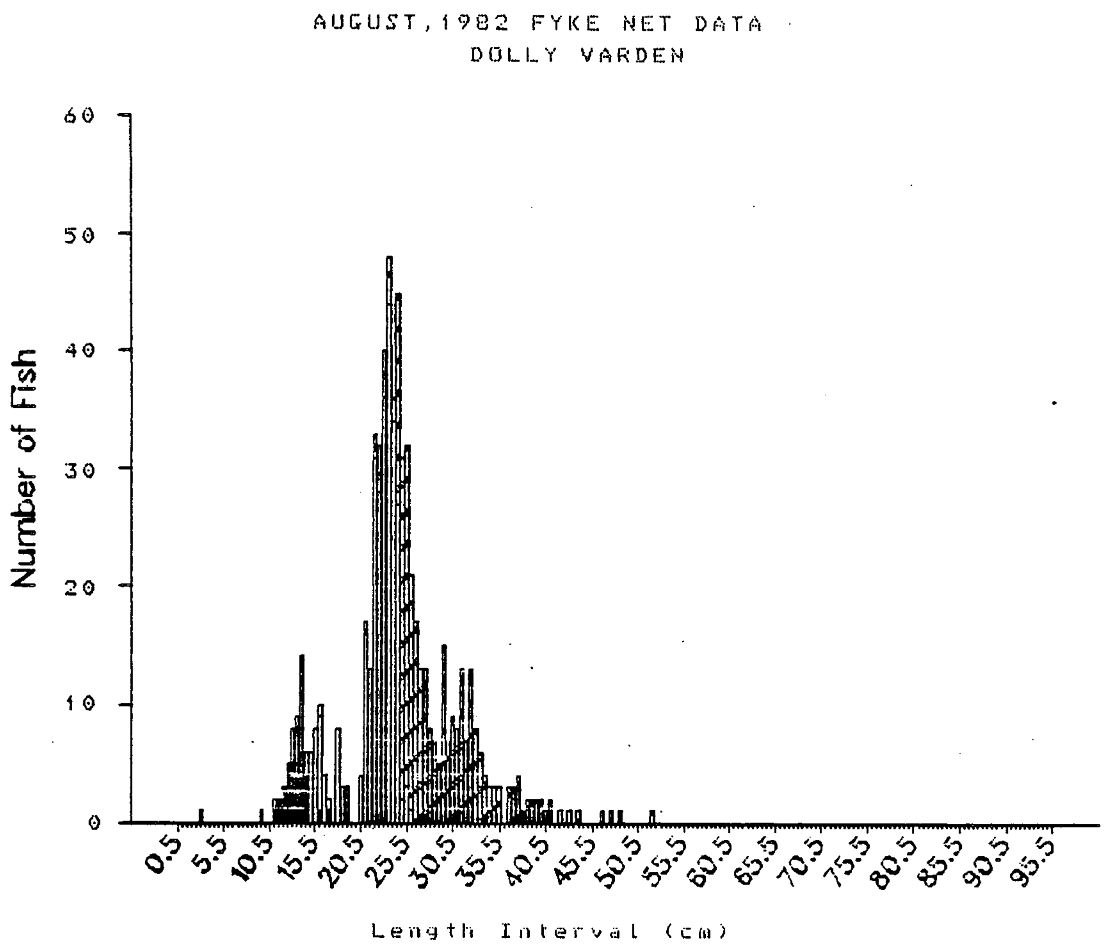


Figure 6.114

Dolly Varden
Length-Frequency Histogram
August Fyke Nets
1982

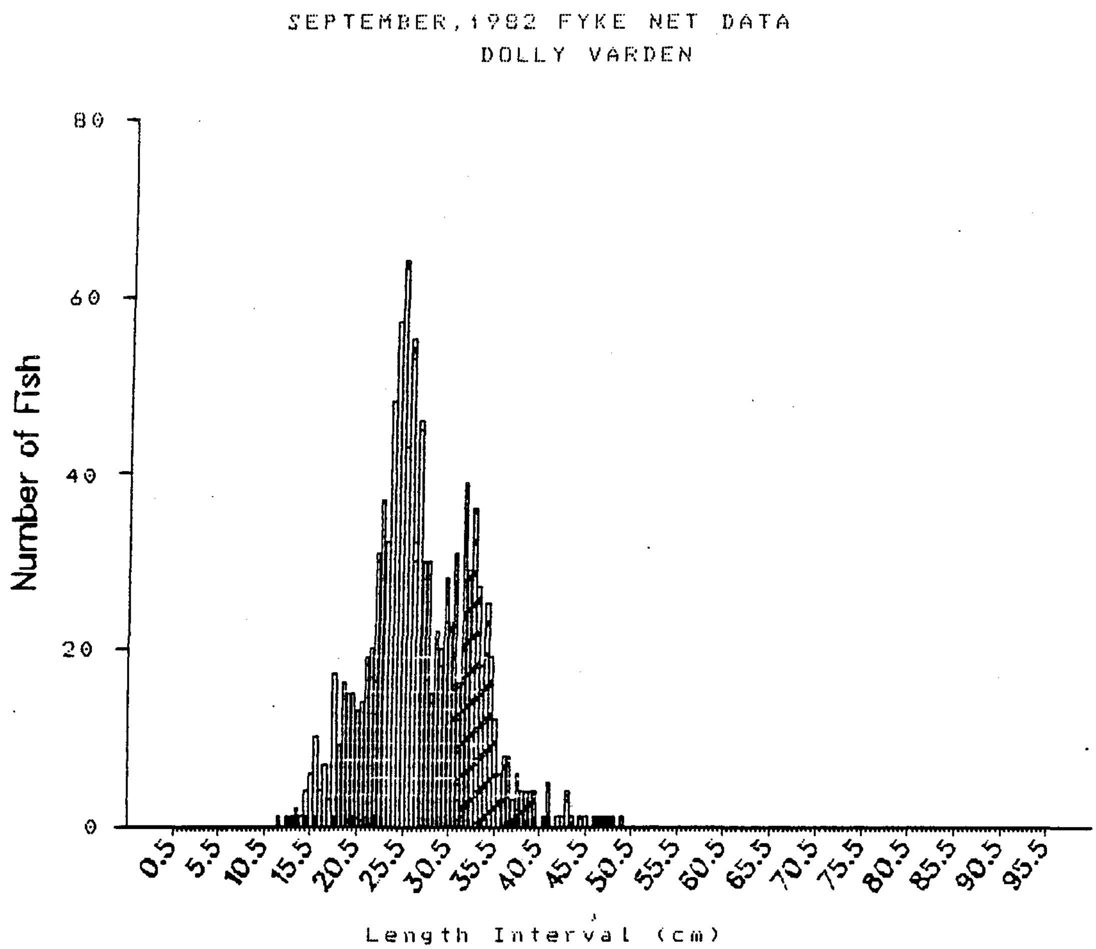


Figure 6.115

Dolly Varden
Length-Frequency Histogram
September Fyke Nets
1982

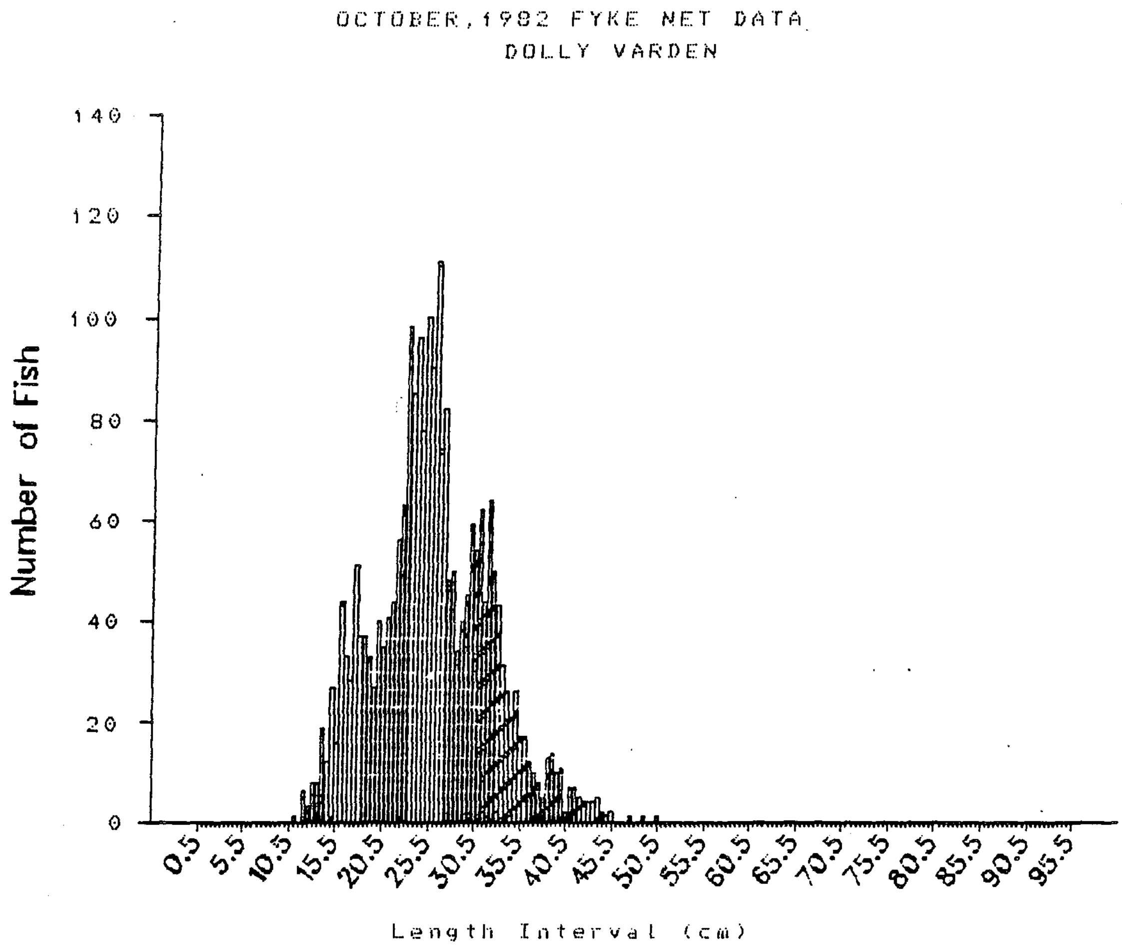


Figure 6.116

Dolly Varden
Length-Frequency Histogram
October Fyke Nets
1982

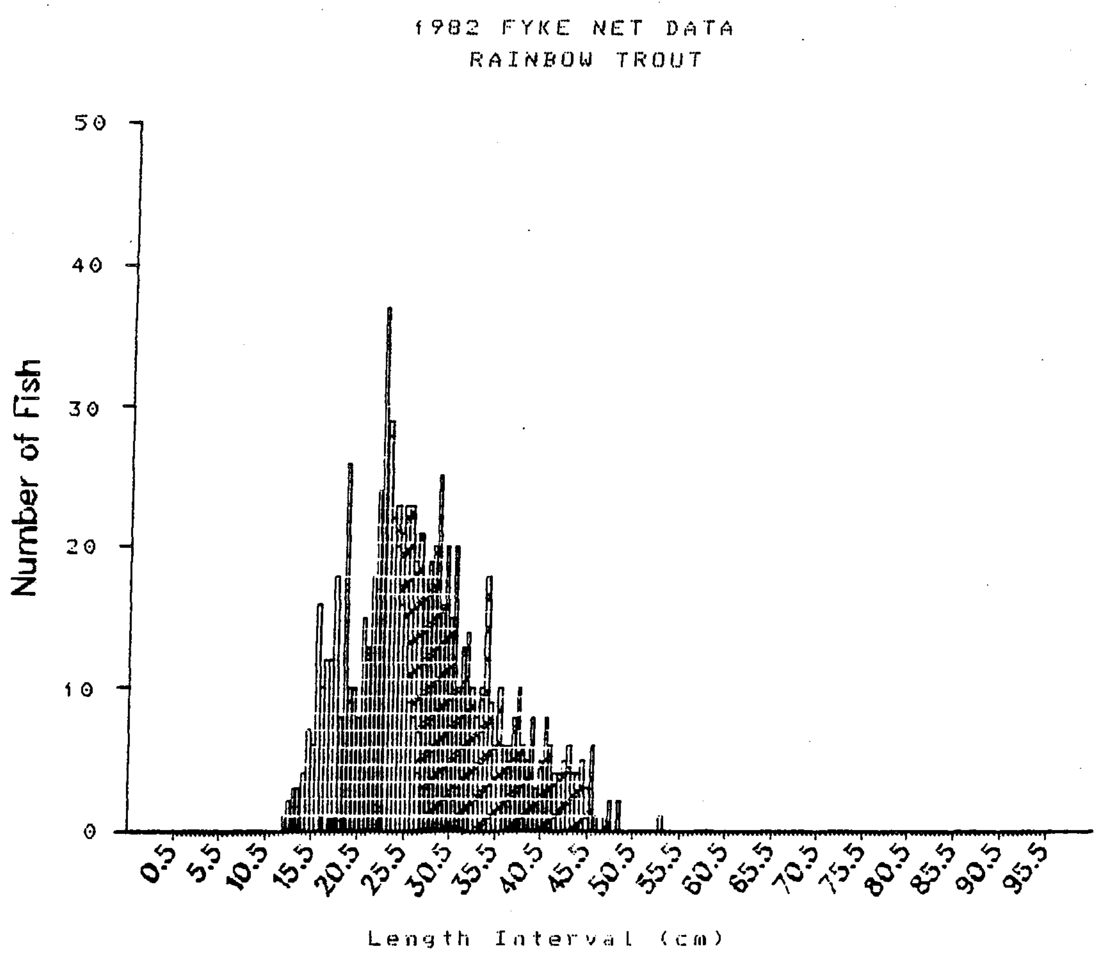


Figure 6.117

Rainbow Trout
Length-Frequency Histogram
August-October Fyke Nets
1982

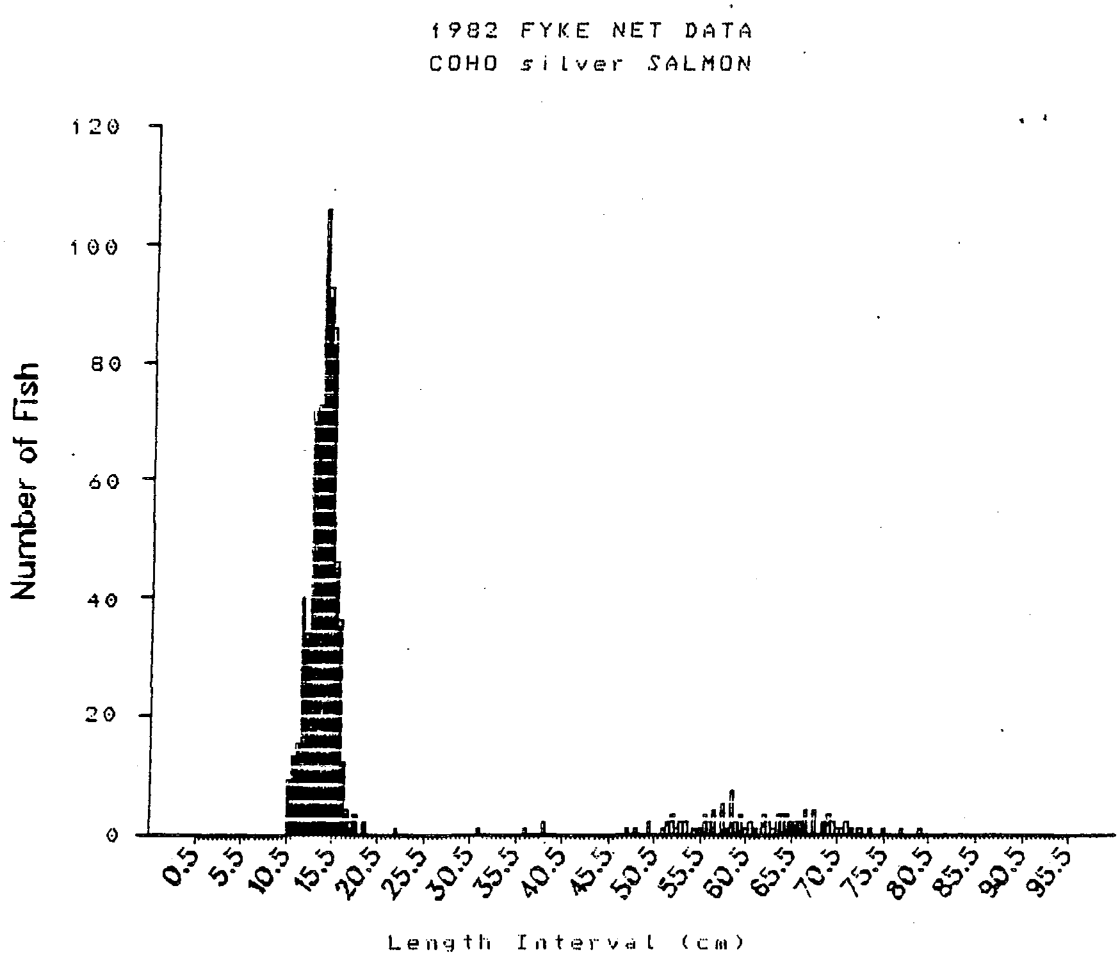


Figure 6.118

Coho (Silver) Salmon
Length-Frequency Histogram
August-October Fyke Nets
1982

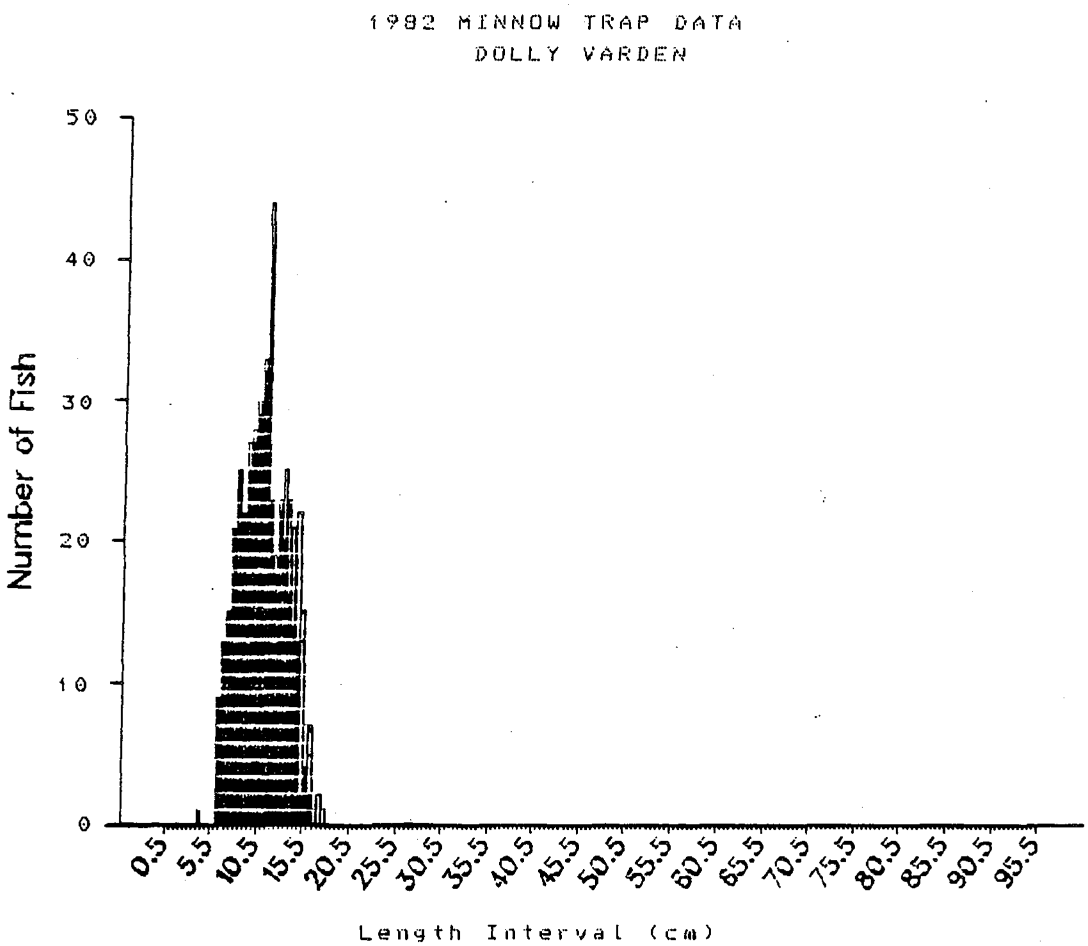


Figure **6.119**

Dolly Varden
Length-Frequency Histogram
Summer-Fall Minnow Traps
1982

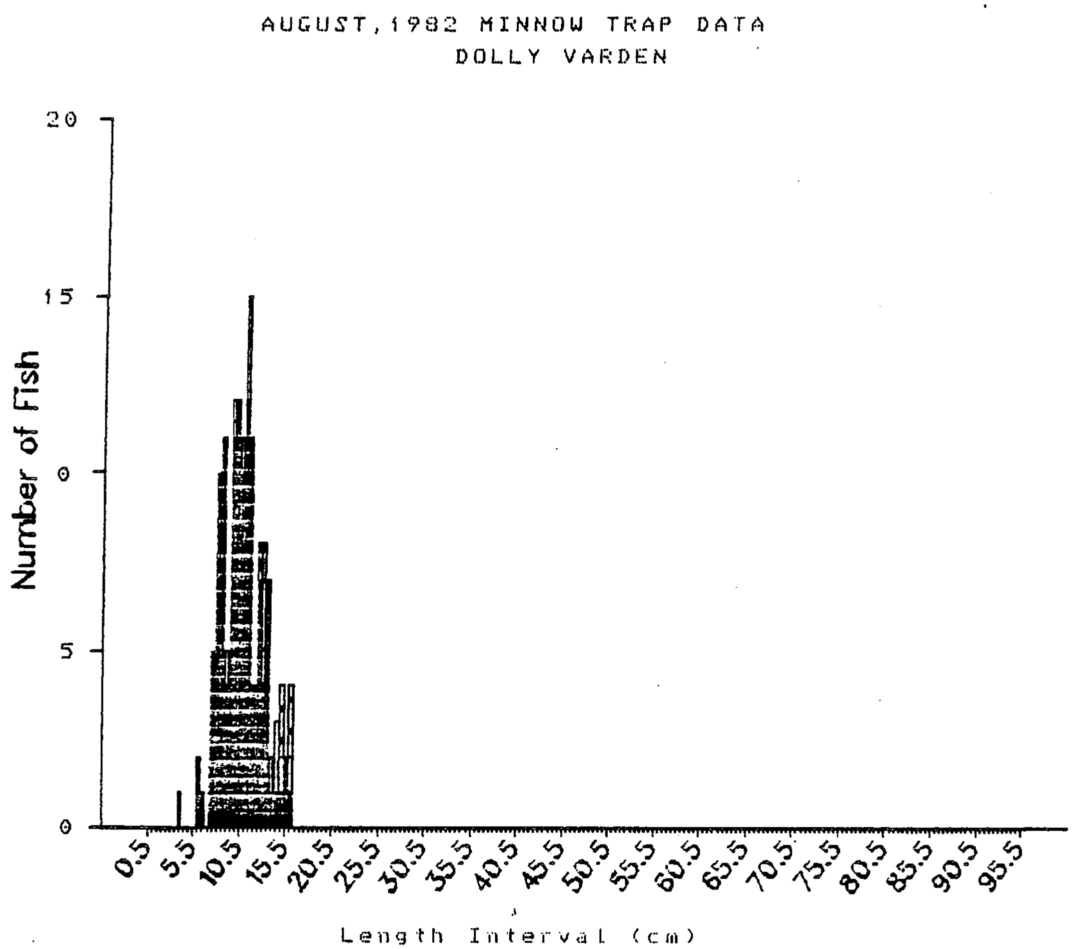


Figure 6.120

Dolly Varden
Length-Frequency Histogram
August Minnow Traps
1982

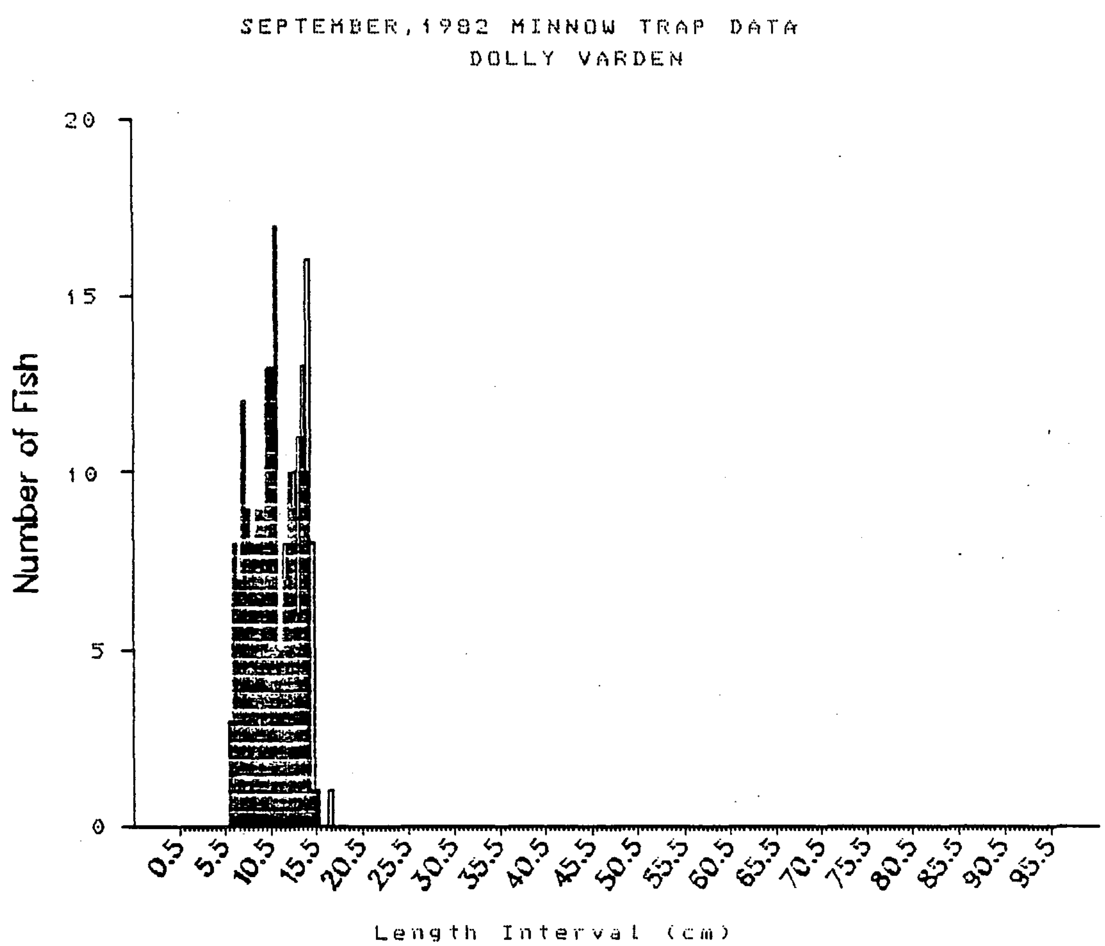


Figure 6.121

Dolly Varden
Length-Frequency Histogram
September Minnow Traps
1982

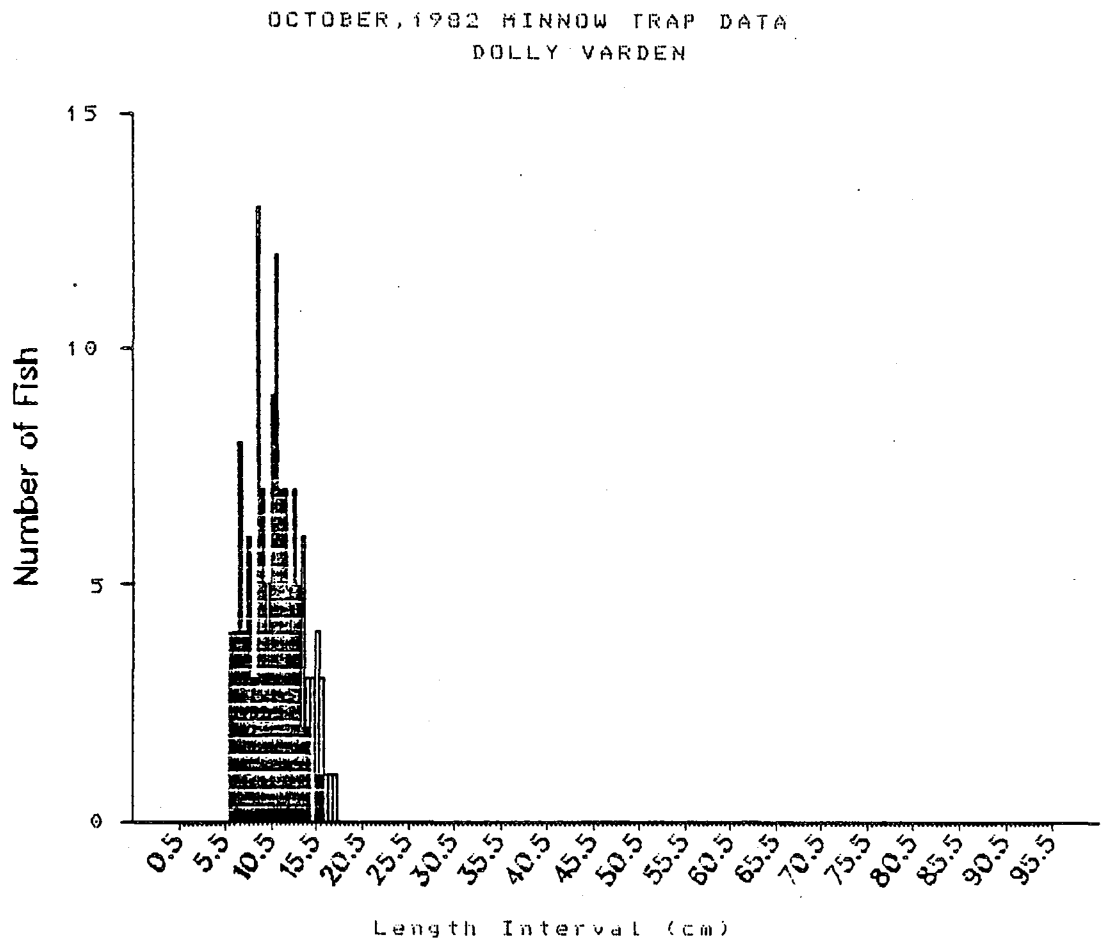


Figure 6.122

Dolly Varden
Length-Frequency Histogram
October Minnow Traps
1982

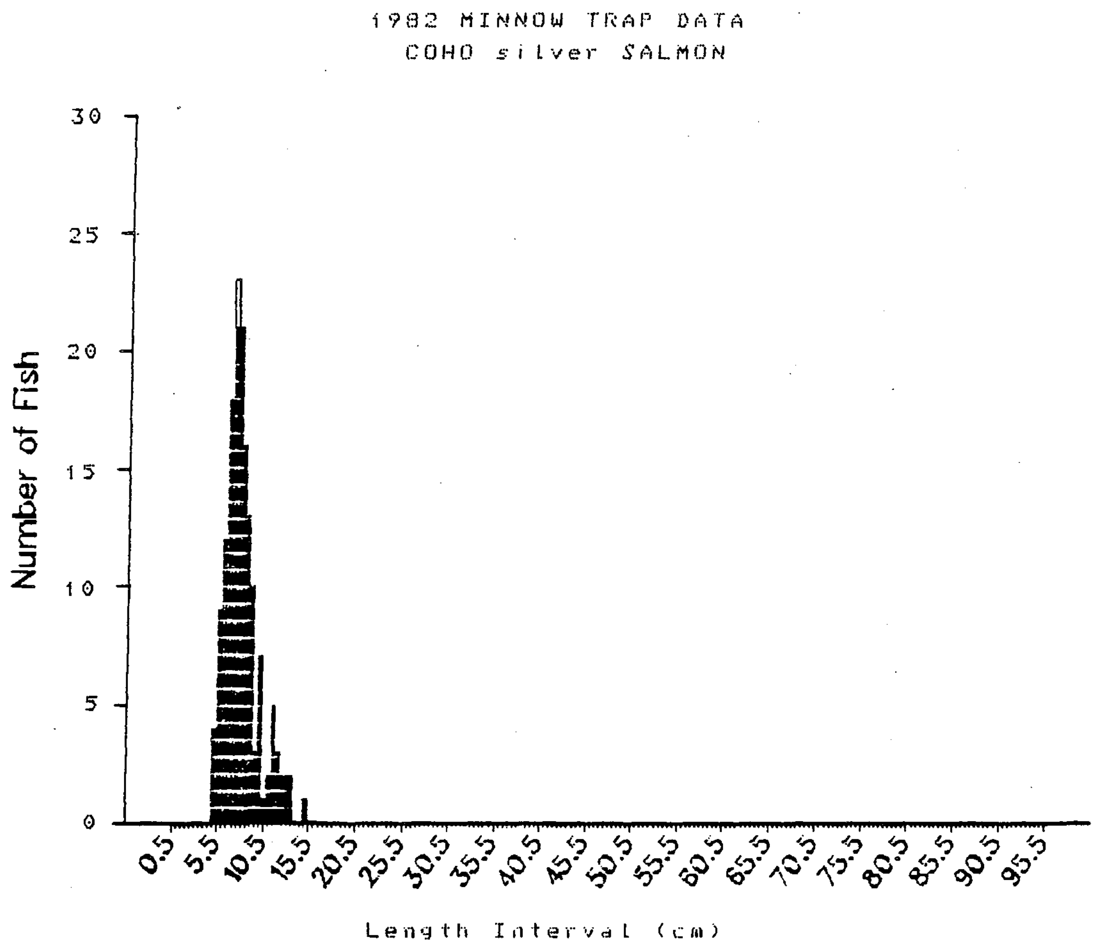


Figure 6.123

Coho (Silver) Salmon
Length-Frequency Histogram
August-October Minnow Traps
1982

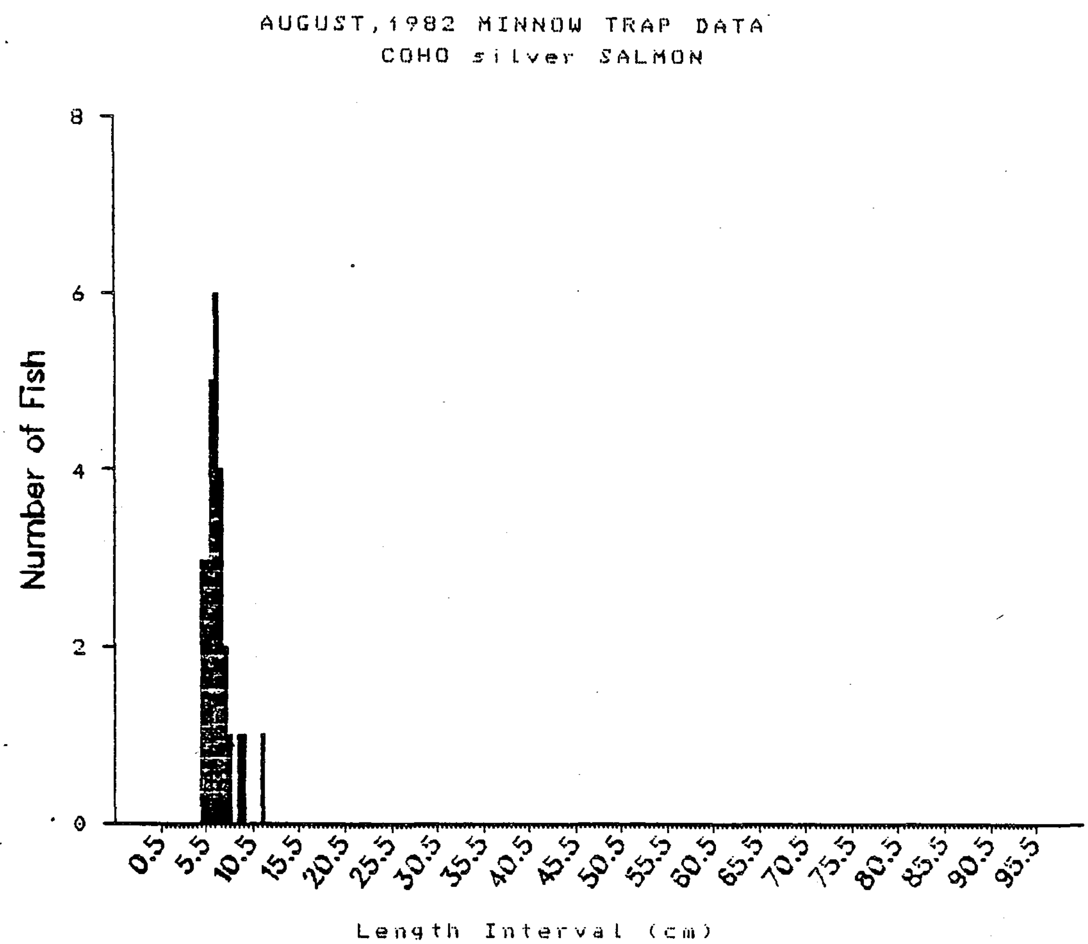


Figure 6.124

Coho (Silver) Salmon
Length-Frequency Histogram
August Minnow Traps
1982

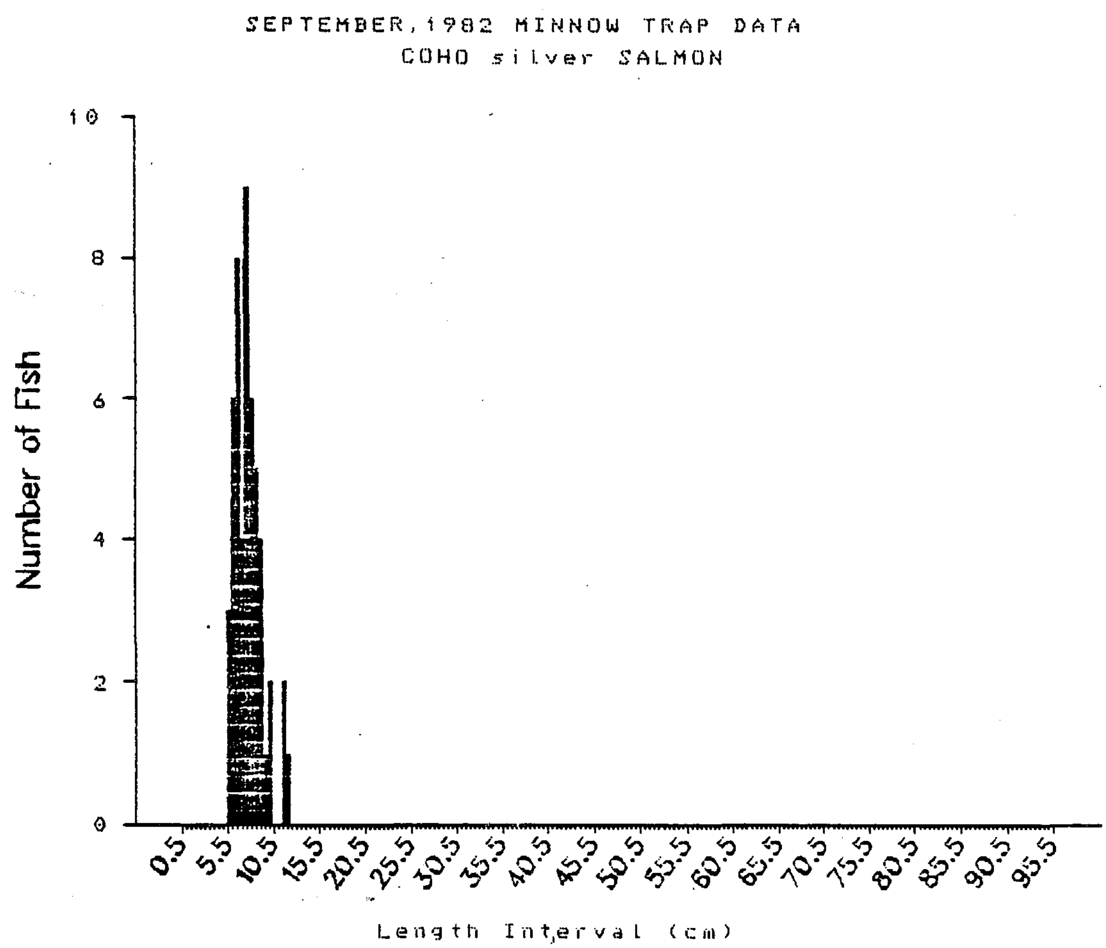


Figure 6.125

Coho (Silver) Salmon
Length-Frequency Histogram
September Minnow Traps
1982

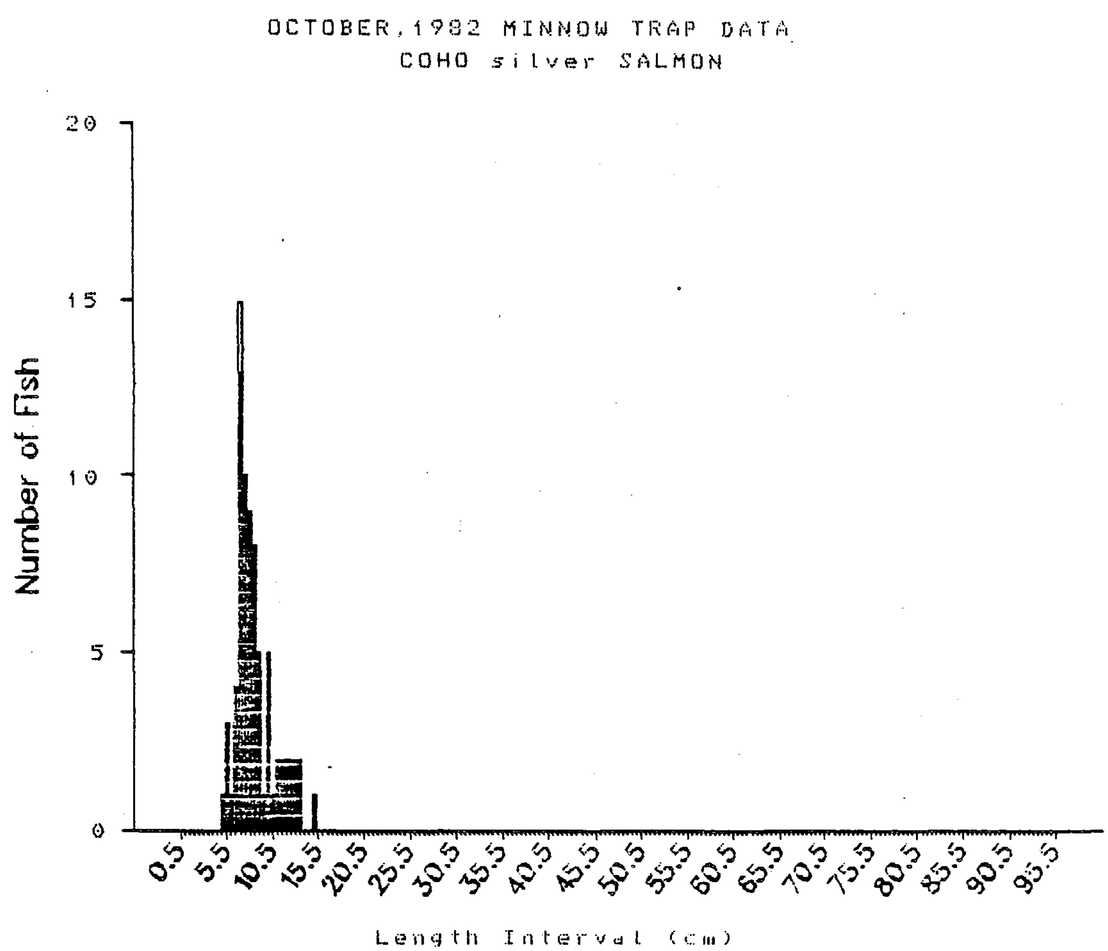


Figure 6.126

Coho (Silver) Salmon
Length-Frequency Histogram
October Minnow Traps
1982

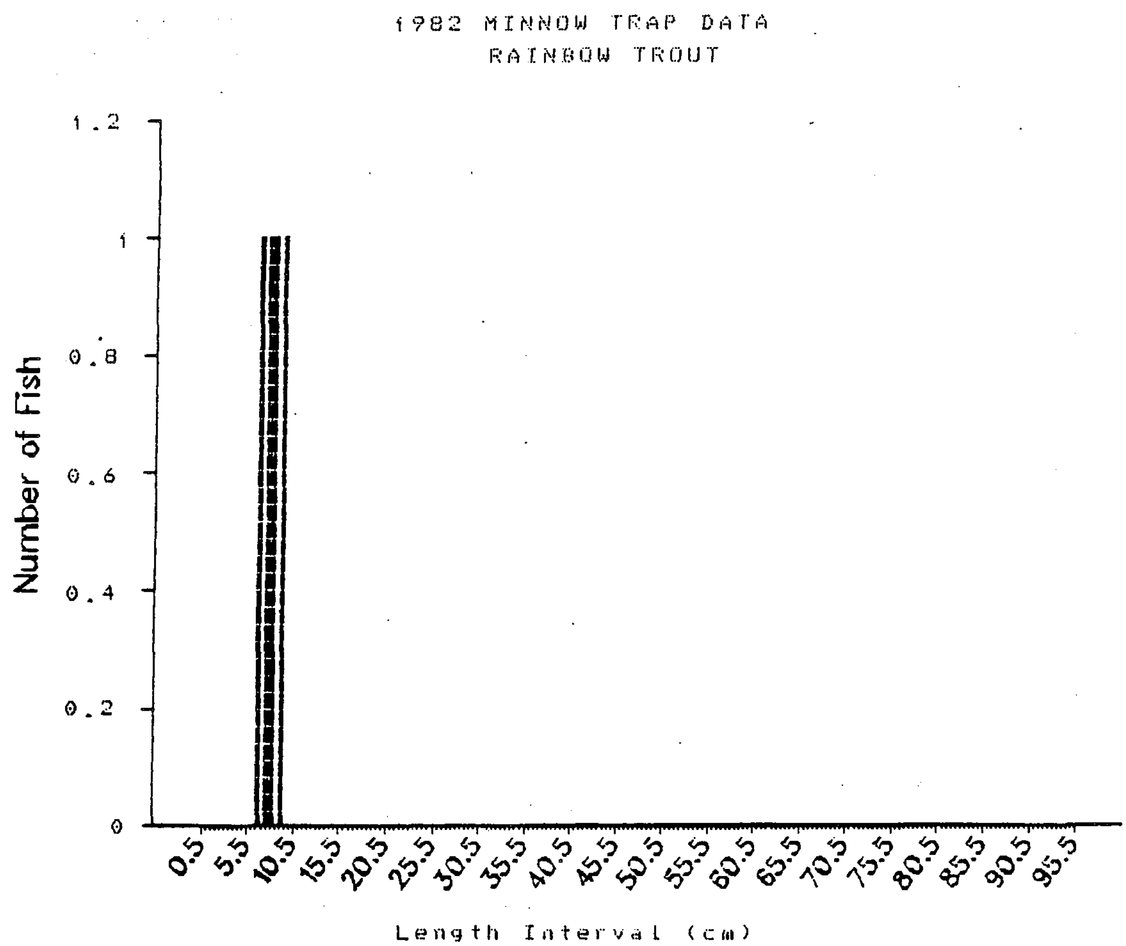


Figure 6.127

Rainbow Trout
Length-Frequency Histogram
August-October Minnow Traps
1982

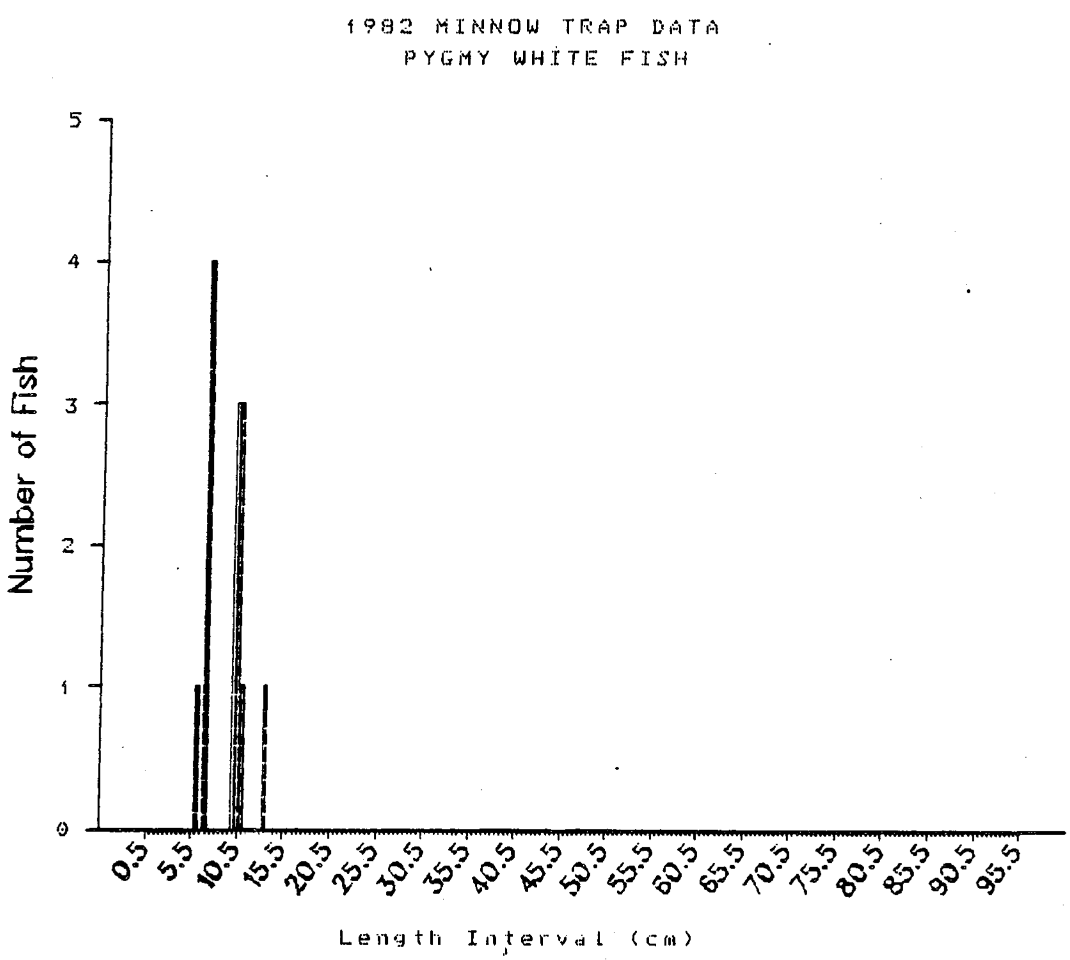


Figure 6.128

Pygmy Whitefish
Length-Frequency Histogram
August-October Minnow Traps
1982

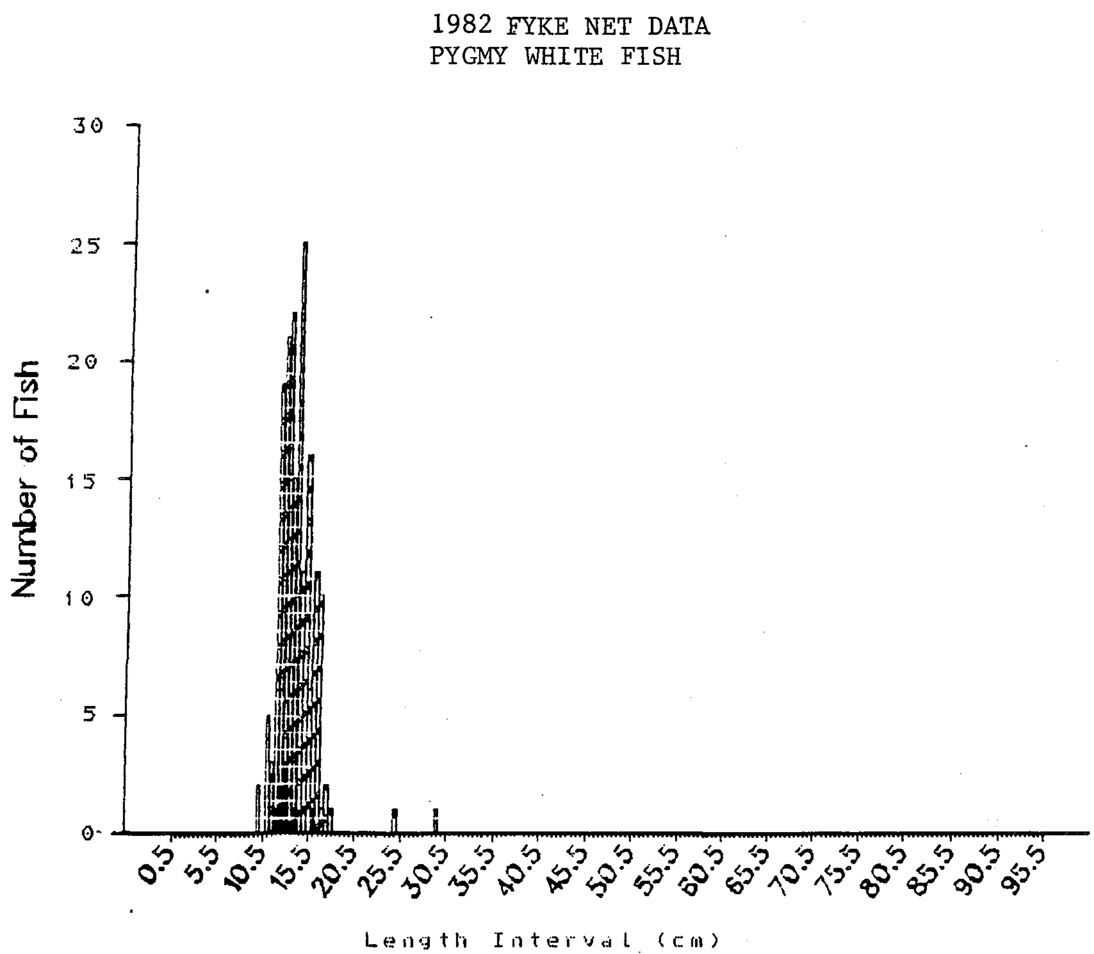


Figure 6.129

Pygmy Whitefish
Length-Frequency Histogram
August-October Fyke Nets
1982

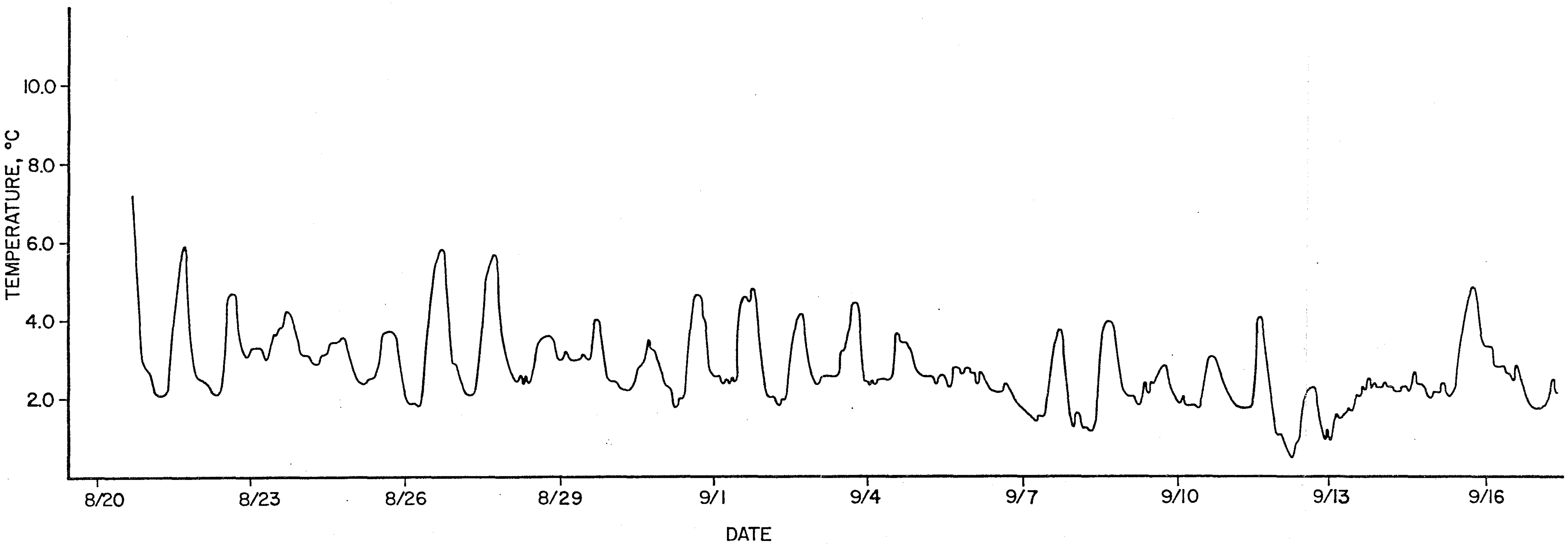
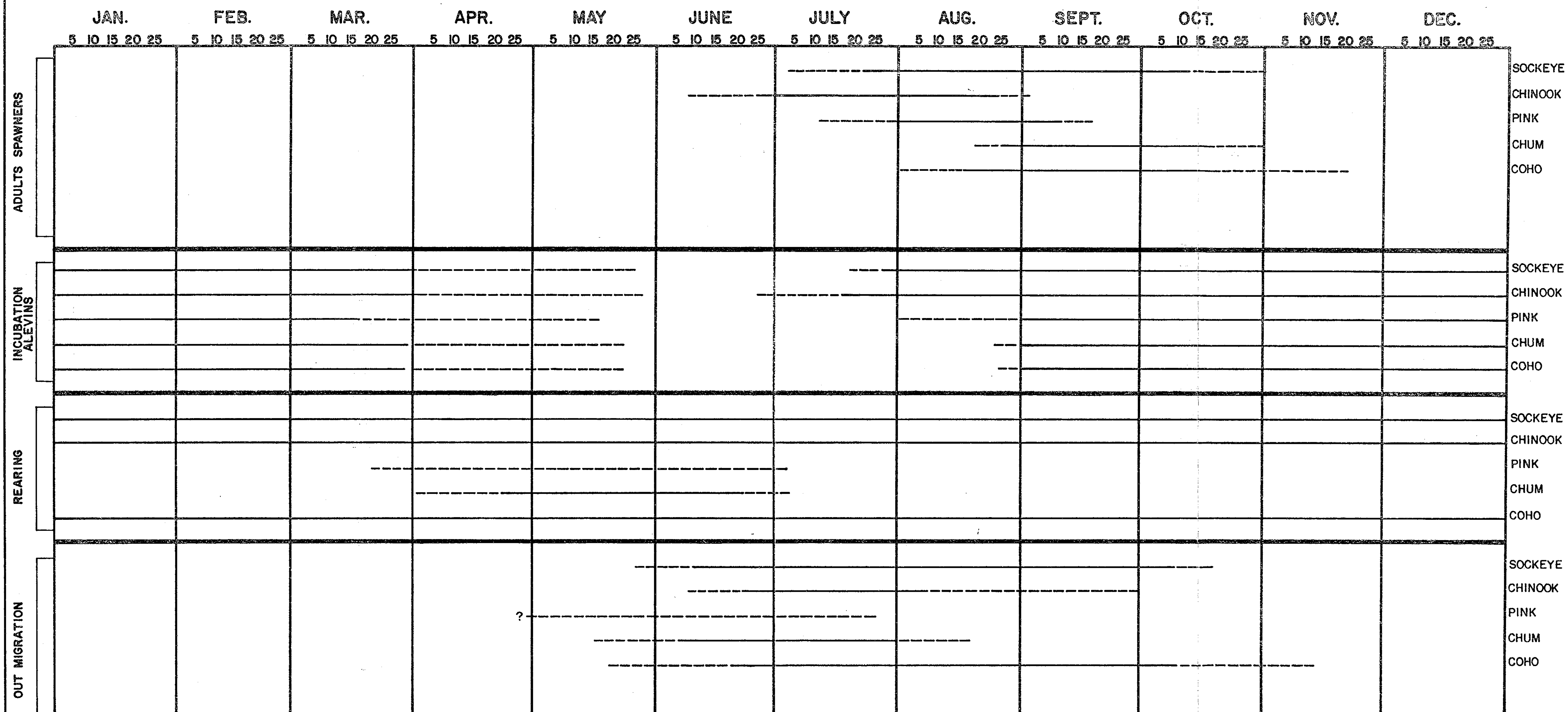


Figure 6.130

Water Temperature Record at Station 15
(Powerhouse Location)
Peabody-Ryan J-90 Thermograph



[1]Based in part on Susitna data (Trent, 1982).

[2]Based entirely on Susitna data (Trent, 1982).

[3]May rear in system for more than one full year.

Figure 6.131

Phenology of Major Life History Events For Salmon Species Chakachatna and McArthur Rivers 1982

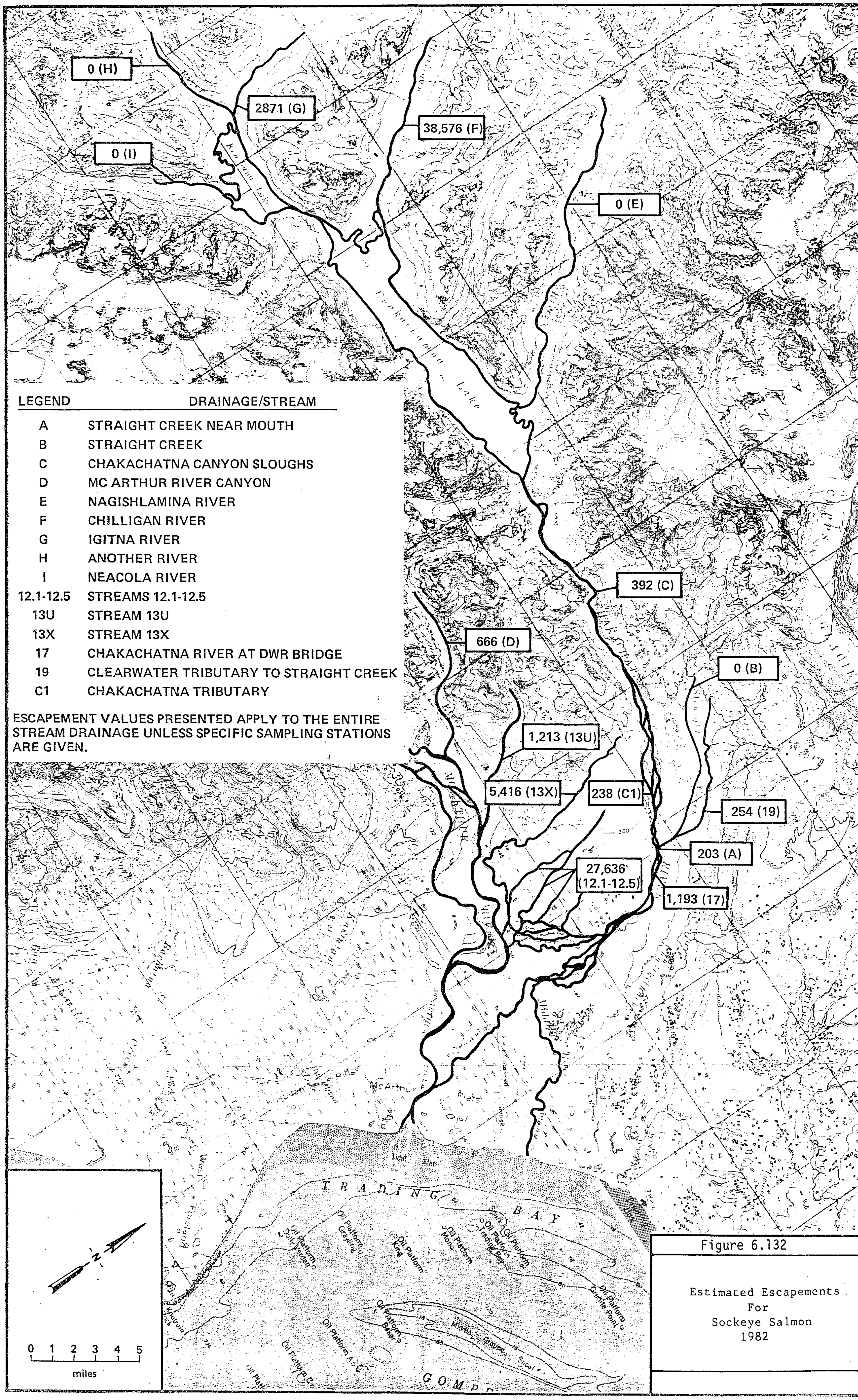


Figure 6.132

Estimated Escapements For Sockeye Salmon 1982

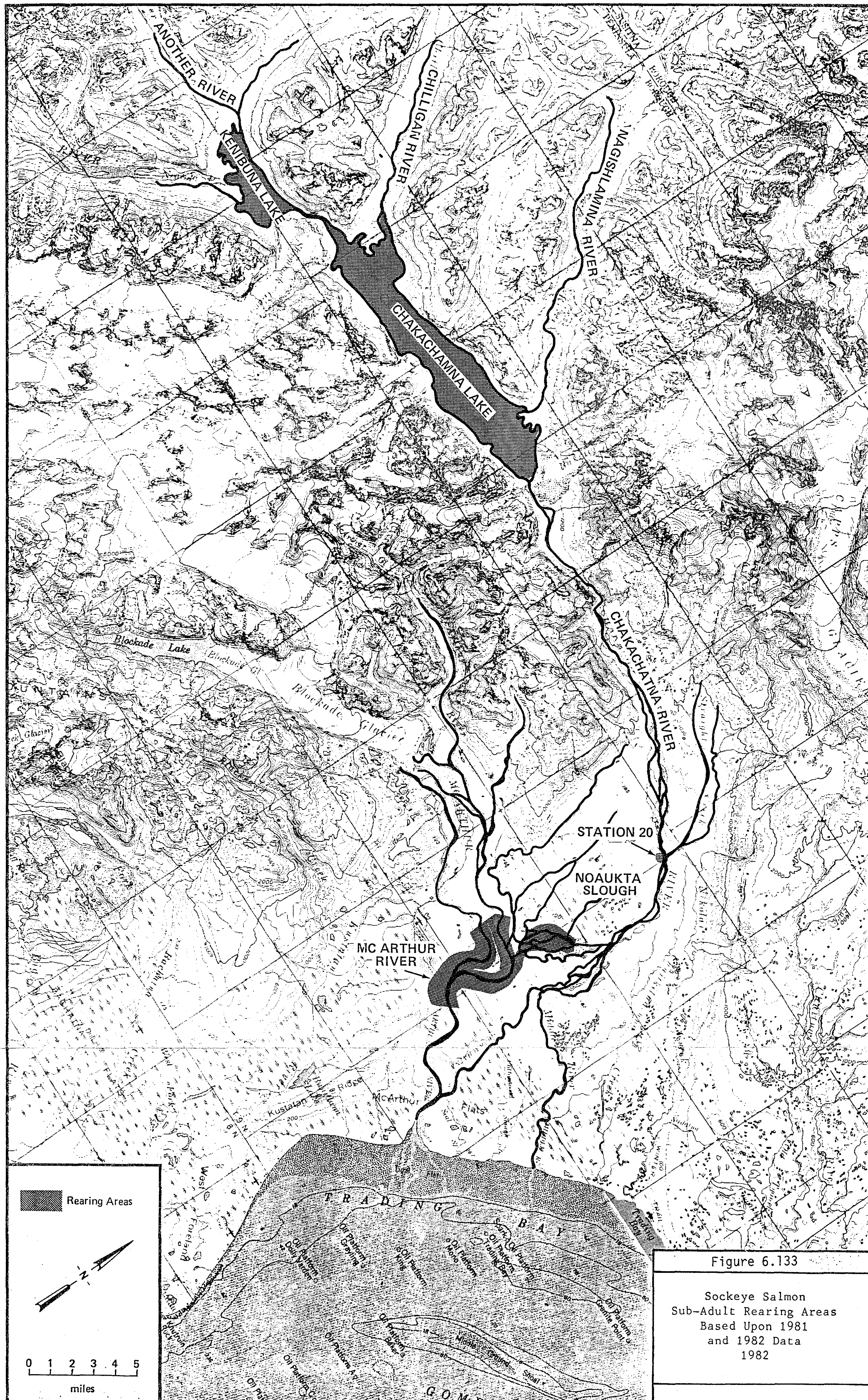


Figure 6.133

Sockeye Salmon
Sub-Adult Rearing Areas
Based Upon 1981
and 1982 Data
1982

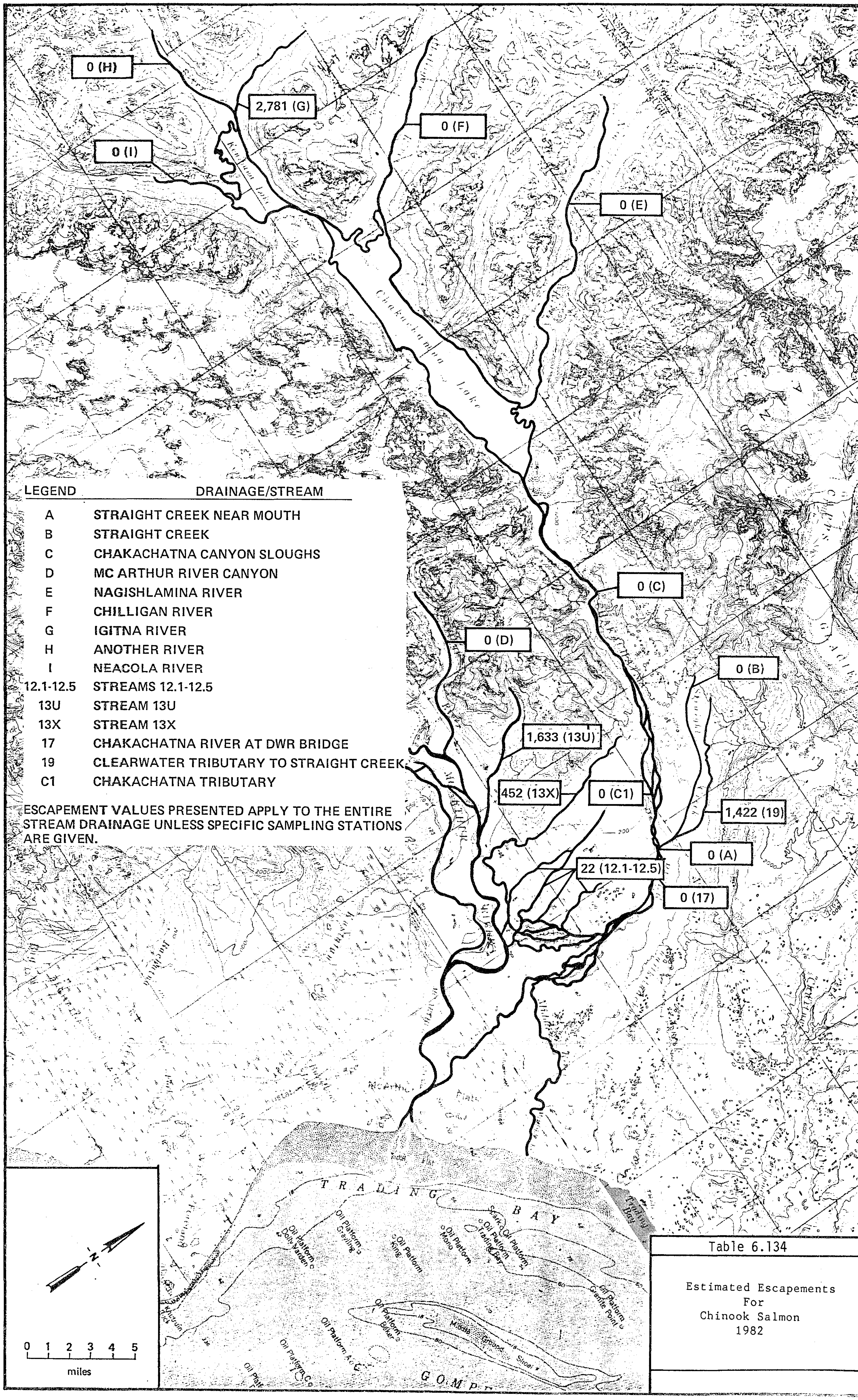


Table 6.134

Estimated Escapements
For
Chinook Salmon
1982

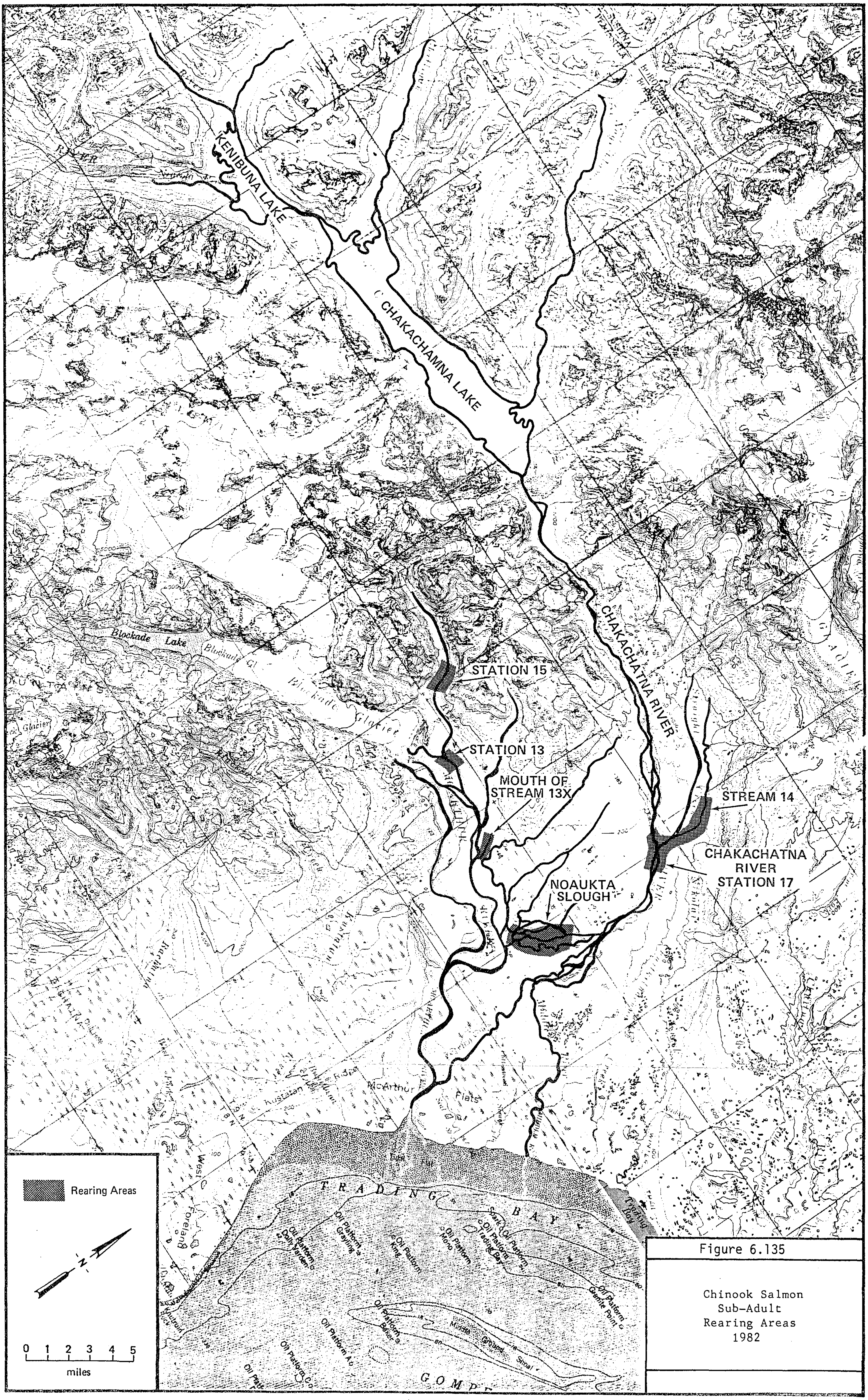


Figure 6.135

Chinook Salmon
Sub-Adult
Rearing Areas
1982

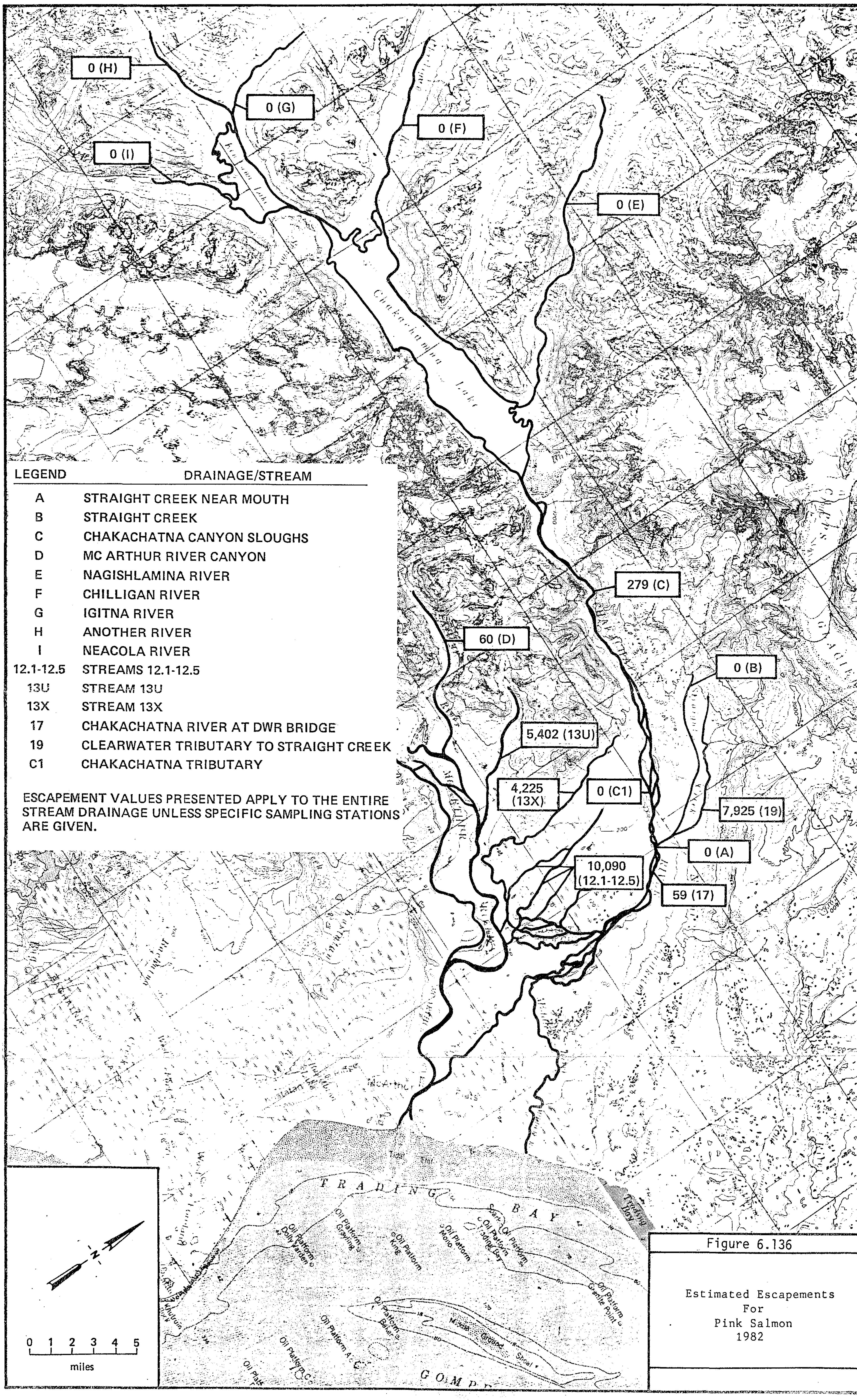


Figure 6.136

Estimated Escapements
For
Pink Salmon
1982

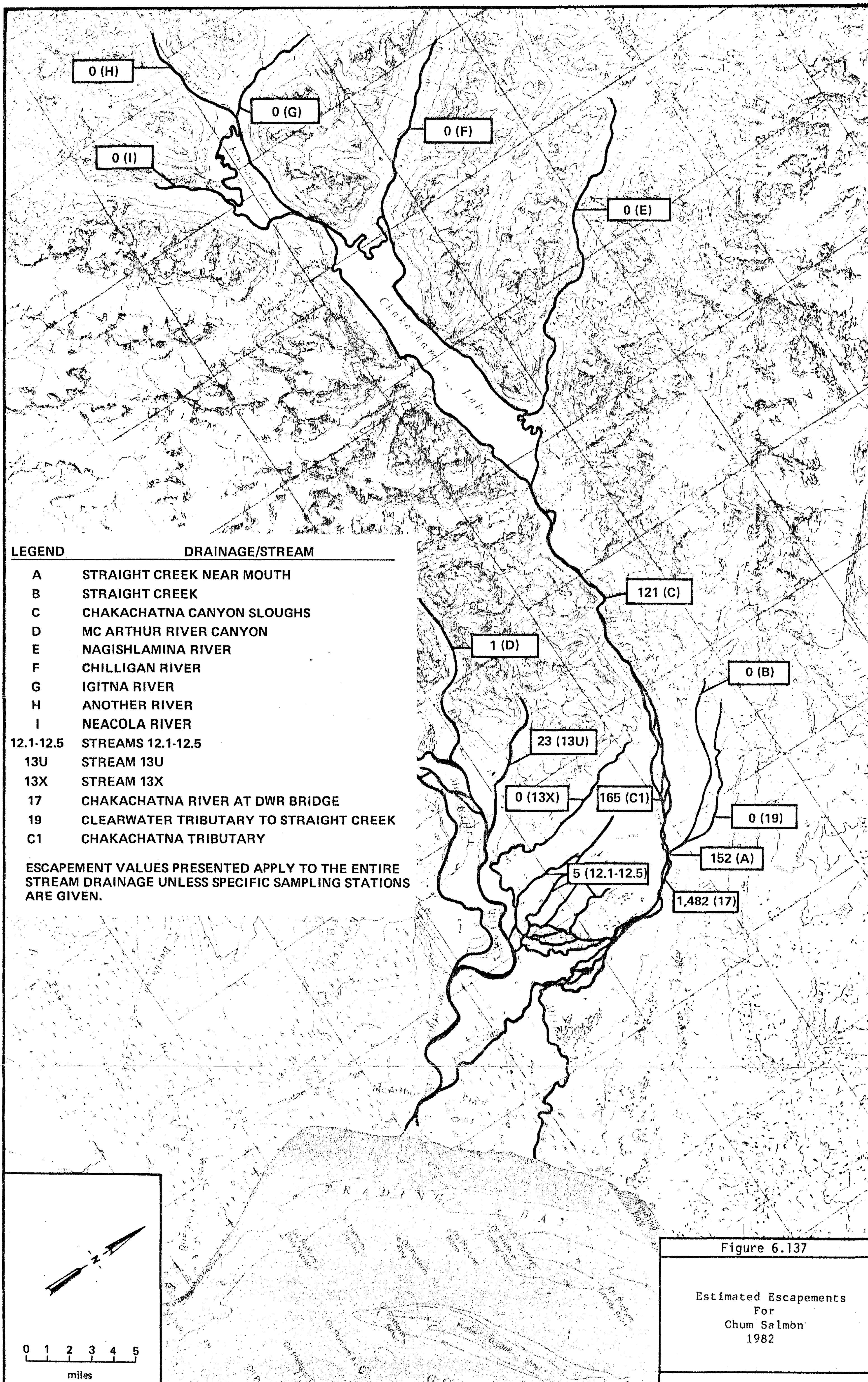


Figure 6.137

Estimated Escapements
For
Chum Salmon
1982

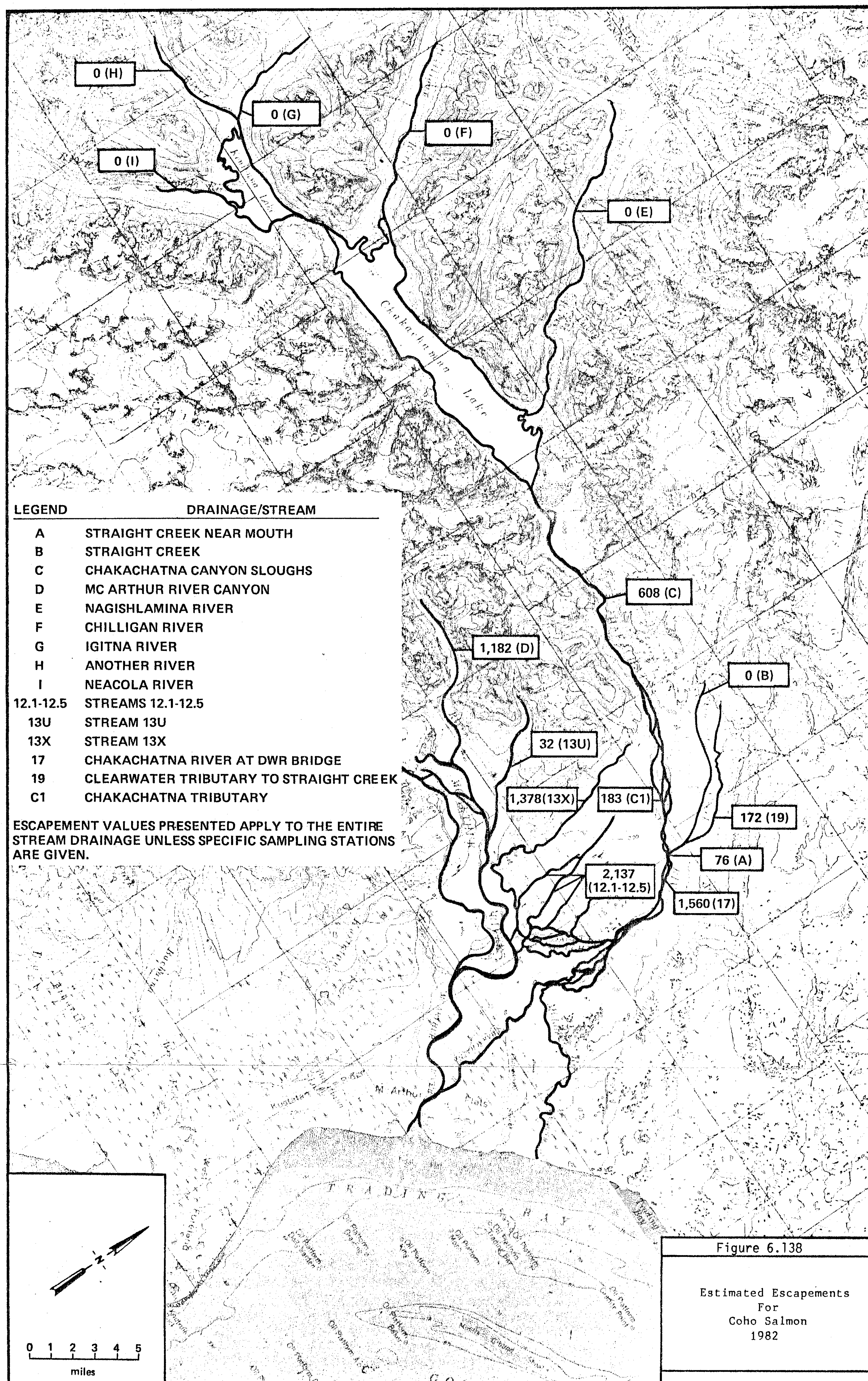


Figure 6.138

Estimated Escapements For Coho Salmon 1982

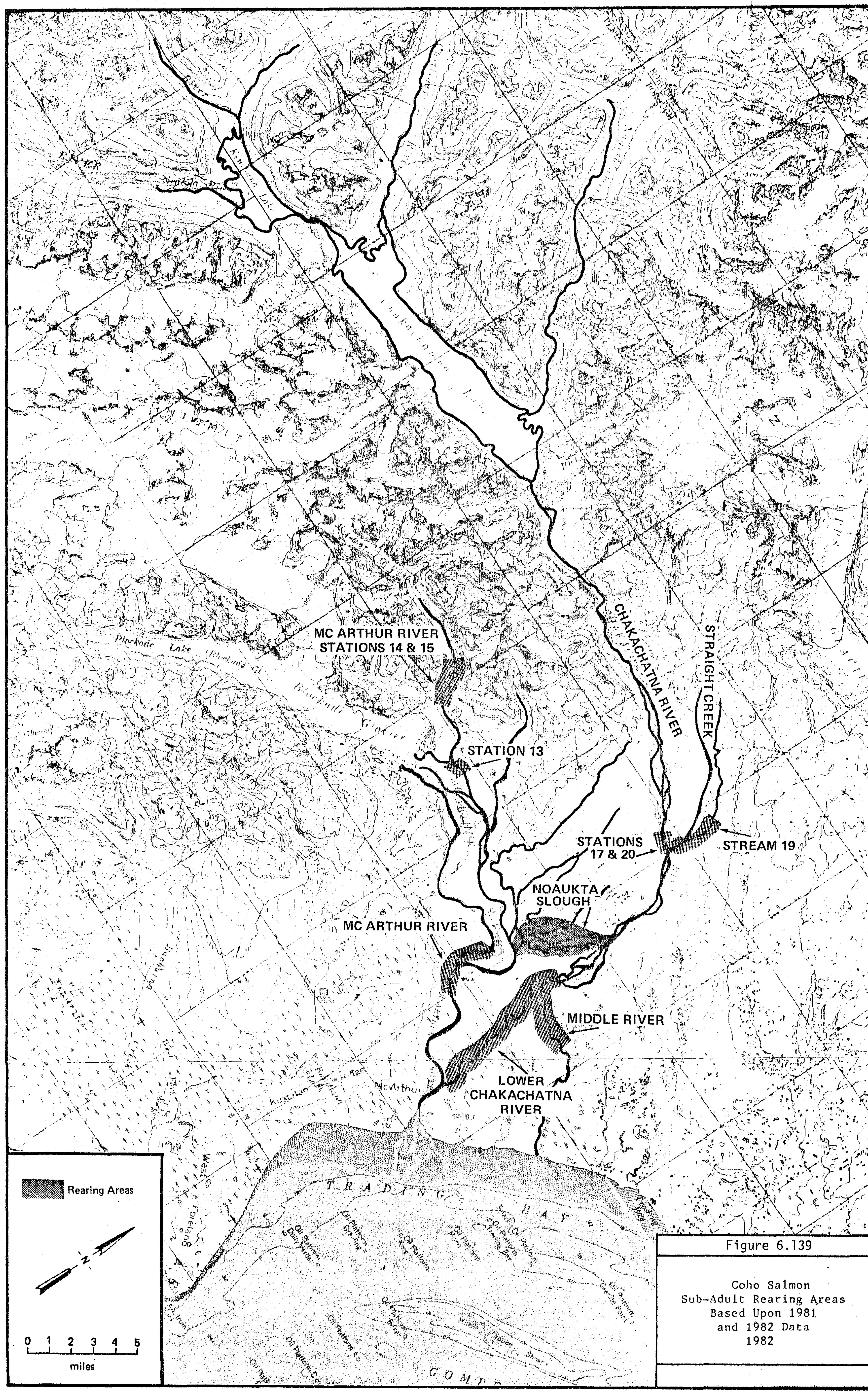


Figure 6.139

Coho Salmon
Sub-Adult Rearing Areas
Based Upon 1981
and 1982 Data
1982

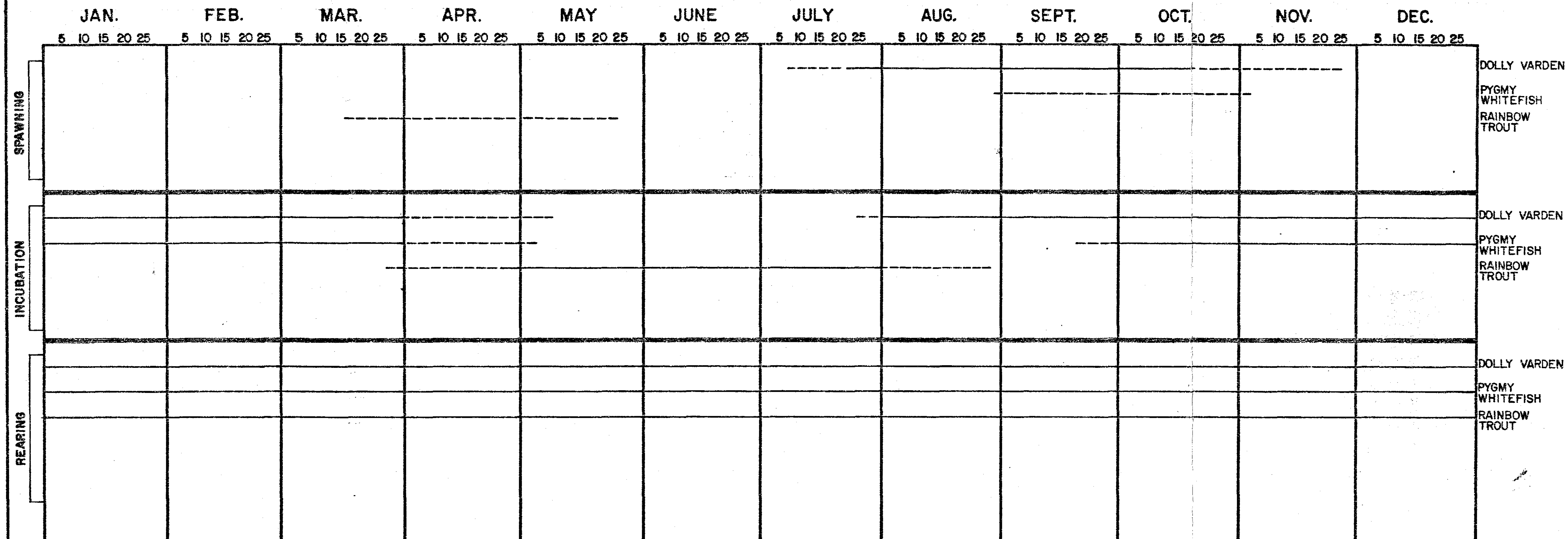


Figure 6.140

Phenology of Important Non-Salmon species Life History Events
Chakachatna and McArthur Rivers
1982

[1] Based partially upon Morrow, 1980.

[2] Based upon Morrow, 1980.

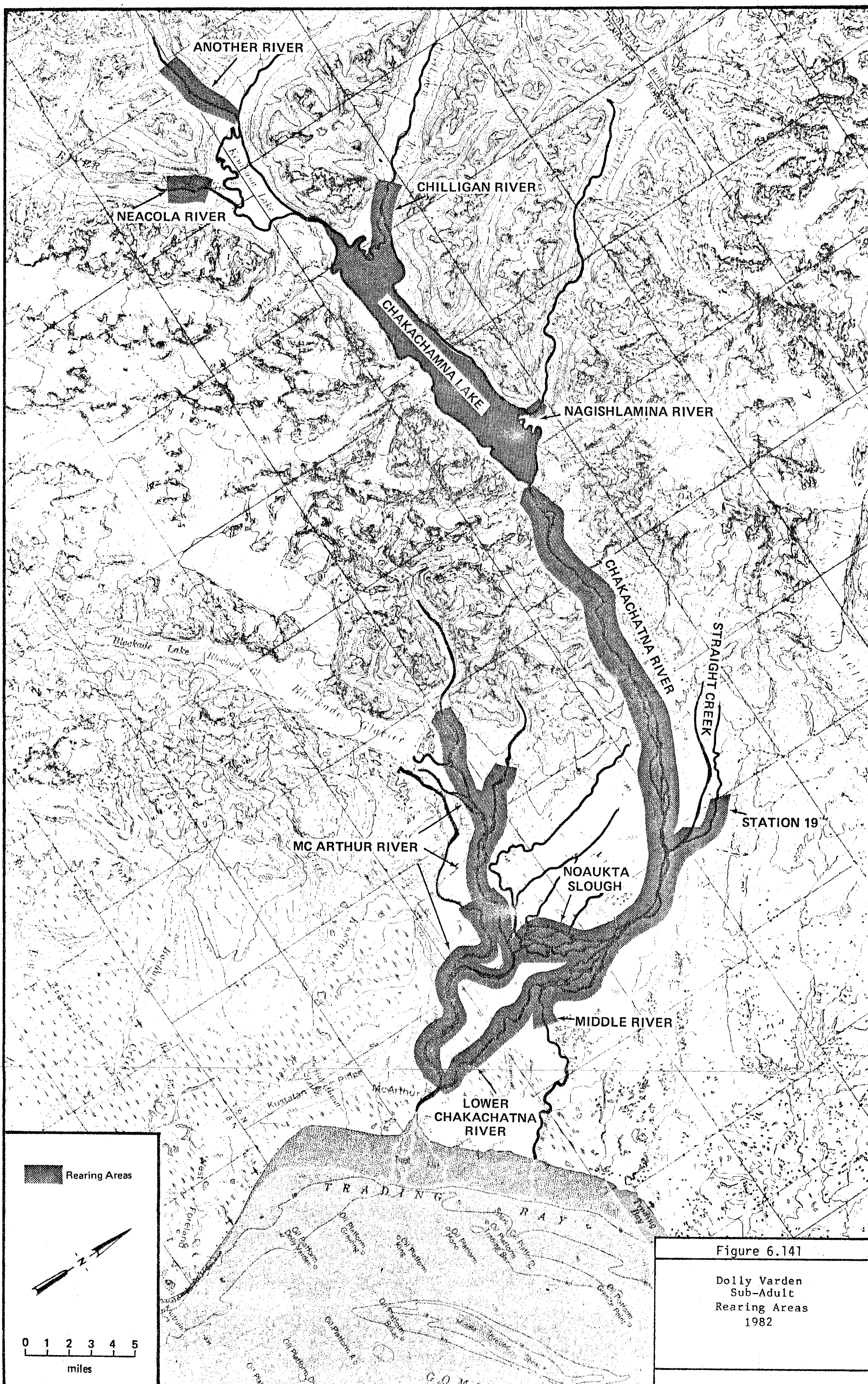


Figure 6.141

Dolly Varden
Sub-Adult
Rearing Areas
1982

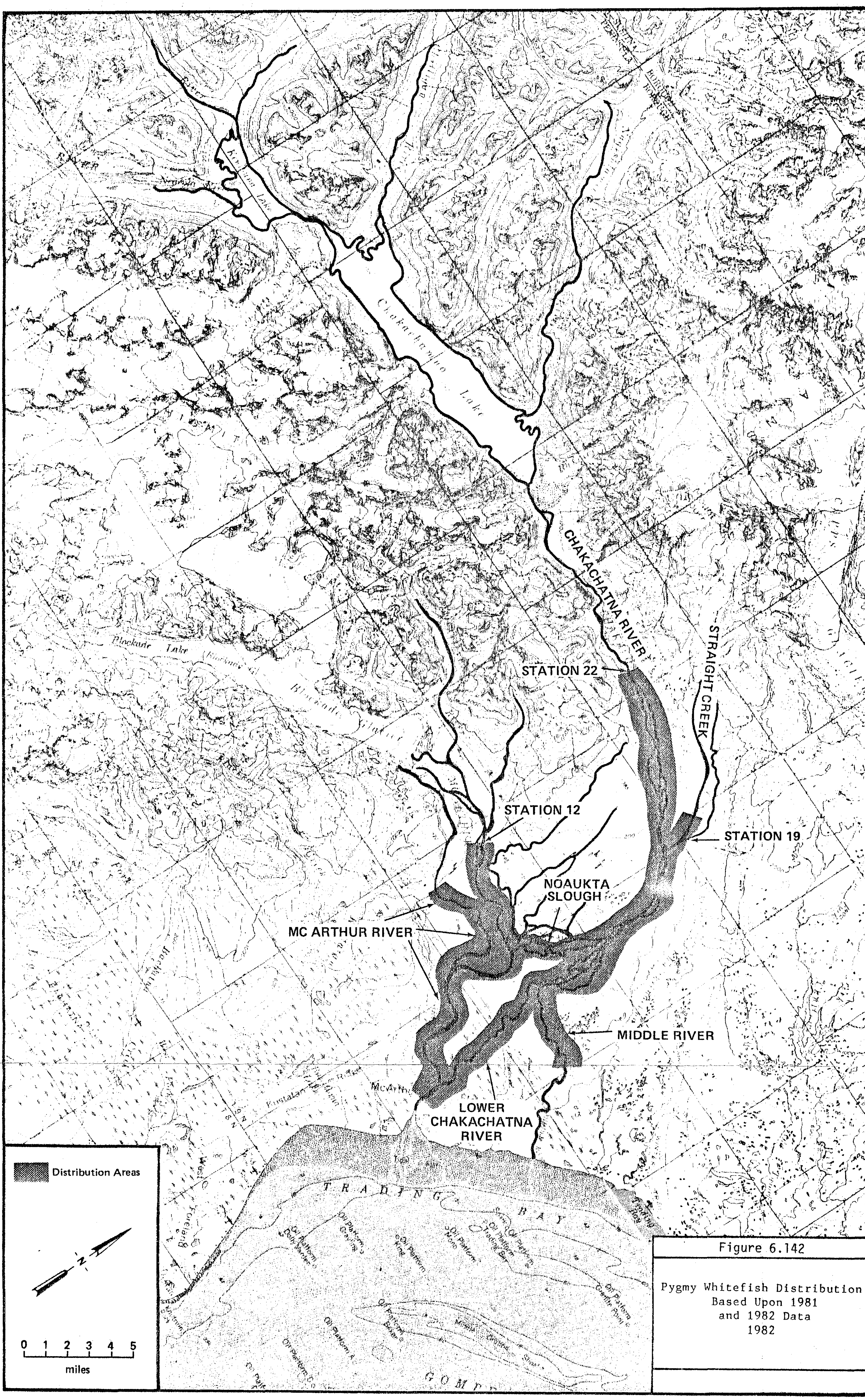


Figure 6.142

Pygmy Whitefish Distribution Based Upon 1981 and 1982 Data
1982

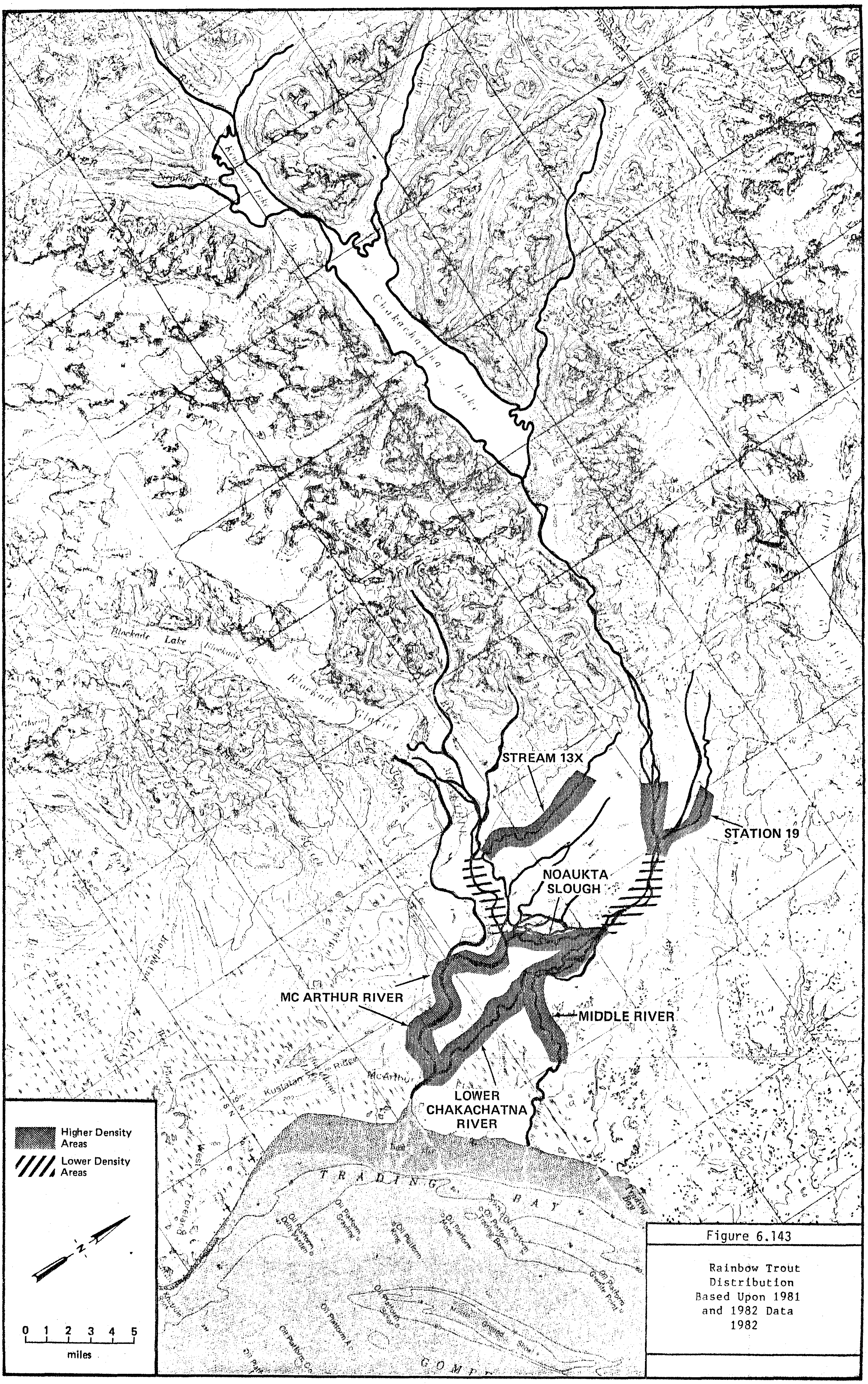


Figure 6.143

Rainbow Trout
Distribution
Based Upon 1981
and 1982 Data
1982