Exxon Valdez Oil Spill
Restoration Project Annual Report

Assessment, Protection and Enhancement of Wildstock Salmon Streams in the Lower Cook Inlet

Restoration Project 97263
Annual Report

This annual report was prepared for peer review as part of the *Exxon Valdez* Oil Spill Trustee Council restoration program for the purpose of assessing project progress. Peer review comments have not been addressed in this annual report.

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Wildstock Salmon Streams in the Lower Cook Inlet

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Study History: The project effort was initiated under Restoration Project 97263 and will be continuing through the FY98 implementation stage. FY99 will consist of monitoring enhancement projects, and will conclude with the final report.

Abstract: This project began in FY97 and was designed to replace lost subsistence services resulting from the *Exxon Valdez* oil spill. The first phase of this project was to conduct an inventory and assessment for enhancement projects on the four major salmon streams in the Lower Cook Inlet (LCI) oil spill area. During FY98 and FY99 restoration and enhancement projects will be implemented with instream fisheries habitat improvement techniques, primarily creation of spawning channels, removing natural barriers to spawning and constructing wall-based rearing structures. A literature and data survey search was conducted on the four streams. We then conducted fisheries habitat assessments with aerial photos to the USDA Forest Service Region 10 protocols. During the field season we surveyed the stream reaches to verify the Region 10 channel types and inventory stream reaches with no existing data. With this existing and the newly obtained data we have designed six enhancement projects on three streams in the survey area primarily for coho salmon (*Oncorhynchus kitusch*).

Key Words: Coho salmon, enhancement, *Exxon Valdez* oil spill, instream fisheries habitat, lower Cook Inlet, *Oncorhynchus kitusch*, restoration, subsistence.

Project Data: (will be addressed in the final report)

Citation:

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Executive Summary

Subsistence users in the LCI area and specifically the residents of Port Graham are heavily dependent on salmon from the Port Graham River, Windy Creek, Scurvy Creek and Rocky River. These four major salmon streams and their tributaries were inventoried and assessed with existing data from previous EVOS projects including aerial photo interpretation, ground truthing, and field inventories. The goal is to replace lost or damaged resources by replacing or enhancing the habitat of wildstocks of salmon important to the people who live in Lower Cook Inlet. Subsistence users were interviewed to assess the historical level of runs and the current, depressed level due to EVOS and preferences for replacing damaged susbsistence resources. Existing data includes the baseline studies commissioned by the EVOS Trustee Council: Stream Habitat Assessment Project: Prince William Sound and Lower Kenai Peninsula Project No. R-51, (Sundet & Kuwada, 1994), Fish Habitat and Channel Conditions for Streams on Forested Lands of Coastal Alaska: An Assessment of Cumulative Effects, (Martin,1996), Survey and Evaluation of Instream Habitat and Stock Restoration Techniques for Wild Pink and Chum Salmon (Carpenter, Dickson Dudiak, Honnold & Willette, 1995). Habitat Protection Information for Anadromous Fish Channel Type Classification Study (Olson & Zemke, 1993)

Field surveys were then conducted to augment existing data and to ground truth aerial photo inventories. As a result eight specific enhancement and restoration projects were then developed from this field inventory. With the information from the interviews with local subsistence users and an evaluation of the existing species and available quantities, the decision was made to target coho salmon for enhancement and restoration for subsistence purposes. We will coordinate the design and implementation of the specific projects with Dr. Doug Martin and Dr. William Hauser Assistant Fisheries Program Manager of the Alaska Dept. of Fish and Game Habitat and Restoration Division.

For several decades fisheries biologists have successfully modified existing stream structures as a technique to improve habitat conditions for salmon spawning and rearing in Alaska and the Pacific Northwest. Fish passes and wall based rearing ponds can be very effective in adding spawning and rearing habitat for the existing wildstock salmon. These structures will be installed with data and insight derived from a thorough inventory and analysis of the current habitat conditions in the entire watershed and the specific needs of a particular salmon species. These enhancement and restoration projects will primarily target coho salmon with beneficial effects for pink, chum and sockeye salmon.

Introduction

These surveys are the first phase of a three year project commissioned by the *Exxon Valdez* Trustee Council, and are designed to promote the restoration and enhancement of salmon for subsistence. The freshwater streams and the associated riparian areas are critical habitat for several species of injured fish and wildlife resources. Coho, Pink and sockeye salmon and Dolly Varden use freshwater environments for important life functions such as spawning, rearing and overwintering. However, it is the restoration or the effective replacement of the subsistence resources relied on by the indigenous peoples which is the focus of this project.

Precipitation on the lower Kenai Peninsula, mostly rain, averages 25 to 100 inches per year, and much higher levels on the mountains. The Gulf of Alaska is a noted originator of fierce storms, some approaching hurricane force. The lower Kenai Peninsula is characterized by steep slopes. The streams in our study area contained extensive and complex primary, secondary and tertiary spawning and rearing areas. Although intertidal spawning is quite common for pinks and chums, the primary spawning habitat of the coho salmon, the targeted species for this project extends to the headwaters of these watersheds.

The Alaska Earthquake of March 27, 1964, measuring 8.6 on the Richter scale created subsidence in the study area ranging from -3.0 to -5.0 feet. This subsidence had an undetermined effect on available spawning areas for pink and chum salmon. Chum runs in the study area have remained depressed but pink runs seem to have rebounded in the last three years in Rocky, Windy and Port Graham River (ADF&G Harvest and Escapement reports 1959-1997). The absence of a commercial harvest and the capability of pink salmon to exploit any suitable spawning area with the inherent benefit of a two year life cycle has generated an accelerated recovery.

Objectives

This project addressed these objectives:

1. Consolidate existing information on wildstock salmon habitat and augment with new information from surveys. Enter relevant data into a GIS for future management. Study historical levels of salmon returns to present returns and extrapolate potential for building runs to historical highs.

2. Inventory, assess and develop protection and enhancement projects on the four major salmon streams and lakes on PGC land closest to the Native Village of Port Graham and have, or will have road access.

3. Improve the in-stream spawning and rearing habitat for Coho, Pink and Chum salmon through enhancement projects, for example, fish ladders, spawning channels, wall-based rearing ponds, etc.

4. Enhance existing wildstocks of salmon to serve as substitution and compensation for the lost and damaged subsistence resources important to the subsistence users of Lower Cook Inlet.

5. Educate and involve the subsistence users in the fundamentals of fisheries management and wise land stewardship. Improve quality and quantity of wildstock salmon as a subsistence resource in the LCI. Gauge success by comparing returns in next ten years with historical averages.

Objective One of this project concentrated on a compilation of the existing data and literature from ADF&G and other sources as cited who have inventoried these streams and existing runs since the 1960's.

Objective Two consisted of targeted habitat surveys, based on the information gathered in Objective One, using USDA Forest Service Region 10 Survey protocols on Port Graham River, Windy Creek, Scurvy Creek and Rocky River.

The classification of streams, and their associated habitat would provide not only the available spawning and rearing habitat but would be useful for determining the impacts of land use practices, assessing basin wide cumulative impacts of the management practices on the stream habitats, and providing generalized information on stream habitats from site specific data. The USDA Forest Service, Alaska Region channel type system (Paustian et al., 1990) was developed in the Alaska Region, and as a result, it is tailored to many of the stream systems found throughout Alaska. The channel type system uses geomorphic features, that are identifiable on aerial photos, to classify stream channels into subunits or reaches that can be used to assess fish habitat quality and to identify areas suitable for restoration or enhancement. As such it provides a useful tool for quantifying available spawning and rearing habitat for the targeted species of this survey. The system provides an ecosystem approach to restoration on the watershed scale.

[1]The channel typing system is based three major concepts:

> 1). Geomorphic processes that are independent of in-channel processes affect stream channel characteristics. Time, initial relief, climate, geology and vegetation are the dominant independent variables that influence the progress of the erosional evolution of a landscape and its hydrology. Runoff water acts as a principal landscape sculptor, producing a characteristic drainage network morphology (drainage density, channel shape, gradient, and pattern) and hill slope morphology (slope, length, and profile form),(Schurnm, 1979). The relief and area of the drainage basin remaining above base level is determined by geology, climate, and vegetation. Relief, in turn, significantly influences runoff and sediment yield per unit area from the drainage basin. Drainage basin area determines the volume of runoff generated at the mouth of a given drainage basin. Runoff volume and basin relief together determine the potential energy available to the drainage basin for channel erosion and sediment transport..
>
> 2). In-channel fluvial processes affect channel characteristics. Stream gradient, cross-sectional area, and substrate in a given stream reach are directly related to stream flow

[1] Olson & Zemke

regimen, upstream erosion rates, and sediment routing through the drainage network. Most natural channels tend to approach an equilibrium condition where erosional and depositional processes balance one another. However, a shift in headwater erosion, sediment delivery, or basin runoff characteristics may result in rapid and dramatic changes to stream channel morphology until a new equilibrium configuration is reached.

3). Abiotic processes within the riparian zone affect in-channel characteristics. Riparian vegetation strongly influences bank morphology and flood plain characteristics. Roots of stream side vegetation determine stream bank form and erosion rating, particularly in alluvial channels. Riparian vegetation dissipates the energy of erosive flood flows and acts as a filter for sediment laden water. Fallen trees and rootwads (large woody debris) that enter the channel play a major role in trapping sediment and creating structural diversity such as pools and undercut banks that are very important aquatic habitat features.

Intensive surveys for the Port Graham drainage have been accomplished by Dr. Doug Martin from 1993-97. For consistency purposes these survey protocols were then used to inventory the upper Port Graham River.

Objective Three consisted of identifying the most promising and feasible restoration and enhancement projects based on the data review, aerial photo interpretation and ground surveys.

Objective Four: Select the most appropriate and cost effective restoration and enhancement projects. The appropriate prescriptions for structural improvement will then be based on the species and the objectives desired for that stream.

Methods

Objective One: □Objective One focused on the compilation and review of all available fisheries information relevant to the four major salmon streams. We consulted with personnel in ADF&G (Fish & Habitat) and the USDA Forest Service. We then proceeded to acquire all available maps, aerial photos, ADF&G records and reports concerning these streams. Meetings were scheduled with ADF&G, COMFISH, and Cook Inlet Aquaculture in May and June of 1997. We also consulted with the Seward Harbormaster on a fish enhancement project at Jap Creek in Seward.

Once all the available data was collected it was inventoried and catalogued for each stream. On Port Graham River, the existing data included inventories completed by Sundet & Kuwada, 1993 USFS Inventory by Olson & Zemke, 1993 and Martin Environmental in 1993 to 1996. This data consisted of comprehensive inventories of habitat and species up to the barrier falls in Section 20

Data on Windy Creek consisted of historical compilations of pink and chum harvest and escapement from 1959 to present (Table 1) In addition, channel typing had been accomplished through Olson & Zemke, 1993.

Scurvy Creek had been the targeted for an enhancement project by CIAA in 1984. The project was construction of a spawning side channel just below the bridge of the road to Rocky River. In addition, a private entity has proposed constructing a hatchery on Scurvy Creek with source water from Scurvy Lake for hatchery production. Water quality data on Scurvy Lake has been documented. Low historical runs for pink salmon were noted by ADF&G foot surveys.

Rocky River has been extensively inventoried and studied. Logging activities in the 1970's under a State of Alaska timber sale could have had some effect on the productivity of this system. Historical salmon run data suggest that runs were also affected by the Alaska Earthquake of 1964 which caused subsidence and a receding of 500 meters at the mouth. Pink runs are currently near historic averages. Chum runs remain depressed. Coho runs have never been officially documented because there was no targeted commercial harvest of this species in this district.

Unrectified photo mosaics at a scale of 1" =660' from 1993 air photos (original scale 1'=1000') were generated for each stream showing the existing Region 10 data and channel types. These were plasticized for field use and evaluation.

Objective Two: Once existing data was evaluated and potential projects for each stream were considered, then targeted habitat surveys were designed for each stream. These were based on the information gathered in Objective One, using USDA Forest Service Region 10 Survey protocols on Port Graham River, Windy Creek, Scurvy Creek and Rocky River.

Field: During June 25-28, 1997 field crew training was accomplished on the lower Port Graham River. Field surveys were then scheduled for August 24-31, 1997. Habitat surveys were accomplished to verify stream channel types and calls and evaluate previous inventories on each stream. Due to the limited amount of funding available for field work not all reaches of each stream were inventoried. Assessing the existing data, aerial photos and local knowledge, reaches with the highest potential for restoration were targeted. Each discrete stream channel reach was classified according to the Region 10 Stream Classification protocols. Habitat types were also noted, including: rapid, riffle, glide, cascade, falls, backwater pool, dam pool, lateral scour pool, straight scour pool, trench pool, side channel pool, plunge pool and beaver pond. The field surveys were conducted using one person to estimate habitat unit areas, one to record data and measure habitat unit areas and depth. Available spawning and rearing areas were then calculated. Field inventoried stream reaches were measured with a hip chain in meters. Stream width was measured with a three meter pole after the habitat was measured visually. Areas suitable for spawning were evaluated by the size of the substrate and level of fine material. The number and sizes of large woody debris were also inventoried. Also, disturbances, channel

type, harvest history, bank condition, riparian vegetation, substrate, and juvenile and adult fish present were noted (Sample Survey Forms—Appendix Three).

Objective Three: On the basis of the existing data survey, local knowledge and the aerial photos several restoration and enhancement projects were identified for each stream. These potential projects were: a fish pass ladder on Port Graham River, wall based rearing Ponds on Windy Creek Left, fish ladders or step pools on Scurvy Creek and side channel restoration and enhancement on Rocky River.

This field survey data was then analyzed to determine the limiting factors for each targeted salmon species (Coho) in the four individual streams. Based on the limiting factors analysis and the targeted species, habitat enhancement prescriptions were then developed for each enhancement area on the four major streams.

Objective Four was to select the most appropriate and cost effective restoration and enhancement projects for each watershed.

The prescriptions for structural improvement on each stream became evident on analyzing the existing data and field surveys. Coho salmon became the targeted species for enhancement based on interviews with local subsistence users. Pink salmon, on their present odd-year cycle and levels of returns documented this year revealed strong, wild runs. The lack of a heavy commercial harvest due to the low market value of pinks is also a contributing factor to the good runs in 1997. Chum and pink salmon utilize essentially the same habitat and chum runs should continue to recover for the same reasons the pinks have. However, due to their four year cycle recovery will take longer. Sockeye runs in these watersheds are currently low and kings show up as anomalies. Therefore, based on local subsistence users' preference and the opportunity to enhance habitat for coho, it was decided to target specifically those projects that would enhance or restore habitat for coho primarily with secondary effects for pink, chum and sockeye.

Results and Discussion

Objective One: A substantial amount of existing data concerning fisheries habitat in the project area was obtained during the literature search and survey. This data enabled us to make a preliminary assessment of the fisheries habitat and relative strength of salmon runs for each watershed. On the basis of this research and a compilation of the harvest and escapement for Windy Creek (Left & Right) and Rocky River (Table 1), it was determined through statistical analysis that the most recent returns of pink salmon were at or near their historical average. During the last 30 years there were three years with exceptional returns (Chart 1). In our statistical analysis, these three years were deleted from the data set because these numbers were

significantly higher than any of the other years and severely skewed the average. The average for the other 27 years was determined. This average was then inserted into the three years which were deleted to arrive at a more accurate number for the 30 year average return. This new average was one half to one third lower than the current escapement and harvest goals for these areas. (Chart 2) Pink returns are currently exceeding these new escapement goals but chum returns remain at depressed levels. On the basis of this data the decision was made to eliminate the enhancement or restoration of projects targeted for pink or chum salmon. Current available habitat for pink salmon is more than adequate to sustain this fishery. The best strategy for chum salmon restoration is to eliminate all harvest: commercial, sport or subsistence until escapement goals are met.

On Port Graham River there have been extensive surveys of anadromous fish habitat conducted by Martin, Sundet and Kuwada and Olson & Zemke. However, no on the ground surveys had ever been conducted upstream from the 3 meter falls located in Section 20, Township 10 South 14 West. Sundet & Kuwada identified these falls as a barrier to fish passage. It was decided after make a preliminary field survey of the falls that a fish passage device was quite feasible for this falls. A detailed inventory of the anadromous fish habitat upstream from the falls was needed to evaluate the net benefit to subsistence which would result by constructing a fish pass.

Windy Creek Left & Right had extensive harvest and escapement data (ADF&G), and an aerial photo inventory (Olson & Zemke). No field surveys had been conducted other than those done by ADF&G to determine escapement and extent of anadromous use (ADF&G Fish Habitat Catalog). The existing data from Olson & Zemke was transferred to a 1" = 660' unrectified photo mosaic.

Scurvy Creek was the focus of an effort by CIAA in 1984 to build the pink salmon run through construction of a side channel for spawning. Spawners were transferred up to above the falls by helicopter on the lower creek that were thought to hinder upstream migration. A private individual has proposed building a salmon hatchery on Scurvy Creek with water for hatchery production to be derived from Scurvy Lake. Relevant data fro this report consisted of mainly water quality and temperature taken from the lake.

Rocky River has been extensively inventoried and studied for habitat and restoration (Sundet & Kuwada, Olson & Zemke, Willette, et al). The 1964 earthquake has a measurable effect by subsiding the land base which resulted in a loss of 500 meters of pink and chum spawning habitat. In addition, it is alleged that logging activities in this watershed in the 1970's have reduced the overall productivity. Based on a report by Pentec for Koncor Forest Products titled Examination of Variation in Returns of Pink Salmon to Lower Cook Inlet Fishery Areas Before and After Commercial Timber Harvest in 1968-69 and 1978-1980. October 3, 1991

revealed that there was no statistical relation between the size of runs and areas that had been logged or not logged. However, there are several areas where logging activities altered the channels of several important tributaries. In addition, we identified a possible lack of large woody debris for the long term in this watershed. These areas were targeted for intensive habitat surveys and evaluation for restoration and/or enhancement.

Objective Two:

OB2: Port Graham River: On August 25, we inventoried the barrier falls on Port Graham River. A three meter pole and clinometer were used to draft a channel profile of the falls. The fall consists of two channels which spilt around a large 6 by 10 meter bedrock outcropping in the center of the channel (Chart 3). We inventoried both the left and right channels of the falls. The field survey conducted on August 26, 1997, evaluated the stream reaches above the barrier falls. These three reaches contain 1,297 meters of channel type FP4, 495 meters of FP3 and 290 meters of MC2. There are also 1,200 meters of HC3 which was not inventoried. We inventoried this stream reach to the upper end of the habitat until reaching a short section of MC1. Based on aerial photo analysis additional habitat suitable for coho spawning and rearing exists upstream and was inventoried using aerial photo techniques. These upper reaches contain a total of 10,127 lineal meters of habitat suitable for coho spawning and rearing, including 82,596 square meters of habitat with 20,004 square meters of spawning habitat and 24,318 square meters of rearing habitat (Table 8). The dominate substrates for reaches which were field inventoried were gravel (67%), cobble (19%) and boulder (0.5%) the remainder is in bedrock and sand. The reaches in lower Port Graham contain 19,533 lineal meters, with 366,683 square meters of potential habitat with 64,662 square meters of available spawning habitat and 178,516 square meters of available rearing habitat. The upper Port Graham reaches contain 23 percent of the total available spawning and 12 percent of the total available rearing habitat for the entire Port Graham River watershed. Construction of a fish pass could result in additional 23,476 coho spawners annually (Table 8). Sufficient rearing habitat exists throughout the entire watershed to support the additional production from these spawners (Table 9) Based upon a cost-benefit analysis with each coho valued at $22.50 for subsistence purposes this creates a net benefit over 20 years (the expected life of the fish pass of $???. (Table 12)

OB2 Windy Creek L&R: Stream channel types were then verified with Region 10 Stream Protocols. A total of six reaches were inventoried and verified. Stream channel identifications from Olson and Zemke were very accurate in this watershed, however based on our surveys the boundary between channel types was adjusted on the photo mosaic in the field. Windy Creek Right,4,562 lineal meters, contains 30,658 square meters of anadromous fish habitat 225 square meters of available spawning habitat and 2,479 square meters of available rearing habitat (Table 3). During stream surveys, thousands of pinks were spawning. We estimate that there were upwards of 60,000 spawners this year pending ADF&G foot and aerial

surveys. No previously unknown barriers to fish passage were identified during our photo or field surveys. While in the Windy Creek watershed we inventoried Dog Creek and Dog Creek Jr.. These streams, 5,681 lineal meters, contain 22,875 square meters of anadromous fish habitat with 1,491 square meters of available spawning area and 3,159 square meters of available rearing area. Windy Creek Left, 8,340 lineal meters contains 66,548 square meters of anadromous fish habitat with 4,029 square meters of available spawning habitat and 8,377 square meters of available rearing habitat (Table 4). Approximately 4,135 meters upstream from the mouth are two low wet meadows adjacent of the stream channel which show evidence of being ancient abandoned stream channels. During our field survey these were investigated for the suitability for enhancement into wall based rearing habitat structures. Ground water was found in several small channels with 3 dead pinks and two live pinks. Fry were observed in the shallow pools. There is excellent access to the main channel at the base of a large pool. The other meadow contained similar conditions. On the basis of the total amount of rearing habitat available on Windy Left, these enhancement projects would add critical off-channel winter rearing habitat for Coho. These enhancement projects would add an additional 40,000 square meters of available rearing habitat for coho salmon. There is sufficient spawning area to fully seed these ponds (Table 4).

OB2 Scurvy Creek: Scurvy Creek has been the subject of several enhancement projects and a proposed private fish hatchery. The main channel is 8,340 meters long and originates in Scurvy Lake. However, the there is an overall steep gradient and the channel is of the medium confined types (MC 2, MM1&MM2). Three falls are evident from the aerial photos and ground surveys. The lower fall is passable by salmon during high flows. Presently Scurvy Creek supports a small run of pink salmon (avg. escapement 400 fish per year, ADF&G foot Surveys). Preliminary field investigations revealed that the upstream falls were remote, confined by bedrock and would be cost prohibitive to build either step pools or fish ladders at this time. The stream channel types found on Scurvy Creek are charactereized by poor quality spawning and rearing habitat in addition to the number and size of major falls. Scurvy Creek, 6,710 lineal meters, contains 49,811 square meters of anadromous fish habitat, 461 square meters of available spawning habitat and 4,290 square meters of available rearing habitat (Table 6). On August 29, 1997 we investigated the side channel which CIAA had constructed below the bridge. There were no spawners using the channel. We did find coho fry and large smolts in the side channel. We determined that further inventory of Scurvy Creek habitat was unwarranted. No enhancement or restoration projects are contemplated as a part of this project on Scurvy Creek due to the high gradient, confined channel types (predominantly boulder and cobble), scarcity of suitable spawning gravel and three major barriers to fish passage. Scurvy Lake might have potential for stocking of rainbows or cutthroats in a future project.

OB2: Rocky River: On August 29, 1997 we conducted field reviews of channel types on Rocky River. Rocky River, 30,664 lineal meters, contains of 823,831 square meters of

anadromous fish habitat 189,906 square meters of available spawning habitat and 206,470 square meters of available rearing habitat (Table 7). Due to the wealth of existing data located during OB1 we determined that verifying channel types from the aerial photos and conducting field surveys on known problem areas within the system. In section 26 an inadequately placed culvert from a 1970's era logging road was blocking access to the main river. 636 square meters of coho rearing habitat is currently being blocked from use at this location. Restoration of access to this side channel could result in additional return of 81 adult coho of which 33 would be harvestable. (Table 11)

In section 23 a small lake that has verified runs of coho and sockeye a major tributary to the lake has become diverted and is currently in a new channel which follows a logging road before emptying into the main channel of Rocky River. We surveyed the abandoned FP3-MM1, dry channel 350 meters upstream to where we located a logjam that has allowed the stream to spread gravel into an alluvial fan. We further surveyed this channel upstream to where the channel type changed into MC1. The channel was full with gravel from the upstream canyon. A large log jam appears to have contributed to the diversion of this channel. Restoration would involve removing the gravel from the upper abandoned stream channel and redirecting the flow in to the old channel. A new large culvert or bridge would be needed to ensure that the stream will stay in its old channel instead of creating an alluvial fan. This would restore 723 square meters of spawning habitat for this lake tributary which contains coho and sockeye adults and juveniles. This project could result in an annual return of 848 coho of which 344 would be harvestable. Estimated annual return of harvestable coho would equal $7,732.000. This un-named lake (ADF&G 242-30-10120-0010) currently provides 1,080,000 square meters of rearing habitat more than sufficient to support the additional fry (Tables 12&13).

While reviewing the past and current condition of Rocky River, the long term supply of woody debris became a concern. Logging in the 1960's and 1970's did not have buffer strips to protect the riparian zone. Large spruce trees were removed in the area the river is likely to migrate in the next one hundred years. It was decided that a possible restoration project was to analyze the stream channel morphology and inventory the future supply of large woody debris in this system by comparing the number and size of large spruce or cottonwood located within the 100 year flood plain of this system. Future recruitment of large woody debris was deemed to be important for the future runs of coho. Other channel types in the Rocky River system were verified using site checks as needed.

Objective Three: The field survey data was analyzed to determine barrier or lack of spawning or rearing habitat was a limiting factor for the targeted salmon species (Coho and Pink Salmon) in the four individual streams. Based upon the limiting factors analysis and the targeted species, habitat enhancement projects were then selected for each individual stream., except Scurvy Creek which was deemde to expensive to pursue at this time. The proposed enhancement and restoration projects are:

1. Port Graham River: Construction of a fish pass ladder on falls located in Section 20.

2. Windy Creek Left: Construction of two wall based rearing ponds adjacent to Mile Post of the Port Graham Road.

3. Rocky River: Culvert and bridge replacement to restore impacted fish habitat from State managed timber sales in the 1970's

4. Rocky River: Stream diversion into restored channel into Red Lake with installation of adequate culvert.

5. Rocky River: Photo interpretation of riparian zone and analysis of future recruitment of large woody debris. Plant spruce wildings as necessary to restore riparian zone for future LWD recruitment.

Objective Four: To select the most appropriate and cost effective restoration and enhancement projects for each watershed. The above projects were selected and project plans with estimates for each project. The summary of these costs are shown below.

Estimated Project Summary	**FY98**	**FY99**	**FY00**
Port Graham River Fish Pass	57.0	15.5.	15.5
Windy Creek L Ponds	50.0	6.5	6.5
Rocky River			
Rearing Channel	24.0	2.0	2.0
Red Lake Spawning Ch	20.0	2.5	2.5
Large Woody Debris Study	5.0	10.0	10.0
Summary	156.0	36.5	34.5

Conclusions

The habitat, accessibility and the known size of the historical runs on these streams make them excellent candidates for enhancement projects.

As needed, environmental assessments will be prepared and submitted to USDA-Forest Service. The necessary permits from ADF&G Habitat for enhancement projects will be applied for and secured by the Port Graham Corporation.

Instream restoration and enhancement will occur during the early summer of 1998 (May 15th to July 15th). Most salmon in these streams have runs that occur in the late summer to fall and this timing would avoid conflicts with the salmon runs and subsistence harvest. Enhancement projects will be scheduled to not conflict with the out migration of fry and smolts in these streams. Construction will be coordinated with the ongoing timber sale and road building operators and their equipment in the Port Graham drainage. It is anticipated that with the excellent road access and the availability of heavy equipment, that PGC will be able to implement these projects on a cost effective basis. Work crews will be necessary for most projects and will consist of four to five persons. Proposed projects include: spawning channel restoration, construction of fish ladders or removing impediments to spawning, creation of wall-based rearing habitat long term management, study and restoration of riparian zones for future large woody debris recruitment.

All structures or projects will subsequently be mapped. Future monitoring will be critical to assess the rate of success and to determine which objectives have been met or exceeded. Monitoring will continue for ten years conducted by PGC. A final report and GIS data will be compiled in FY 1999. Construction and enhancement would occur during FY 98 and FY 99. All of these streams are accessible by the Port Graham Corporation Forest Road System. Heavy equipment is available from the logging and road building contractors on an extremely cost effective basis. In addition, hand tools and manual labor will be utilized extensively by the local subsistence users when appropriate. Engineering and design is proposed for fall and winter 1997-98.

Preliminary Project Plans: See Appendix

AKNOWLEDGEMENTS

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Year	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Rocky River Pinks															
Pink Escapement	0.0	130.0	2.0	200.0	12.0	80.0	0.3	44.0	1.0	43.1	1.0	32.0	1.6	8.2	2.0
Pink Harvest	2.3	17.0	0.0	225.9	1.4	53.2	0.1	0.0	0.0	10.8	0.0	36.8	0.1	0.0	0.2
Total Run	2.3	147.0	2.0	425.9	13.4	133.2	0.4	44.0	1.0	53.9	1.0	68.8	1.7	8.2	2.2

Year	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Windy Cr L&R Pinks															
Pink Escapement	0.0	16.0	15.0	25.0	9.4	13.9	12.0	14.0	12.0	9.7	26.2	15.1	48.4	0.5	17.5
Pink Harvest	3.1	29.2	2.2	85.5	0.0	68.6	5.4	20.1	0.0	3.4	0.0	0.8	57.3	0.0	68.5
Total Run	3.1	45.2	17.2	110.5	9.4	82.5	17.4	34.1	12.0	13.1	26.2	15.9	105.7	0.5	86.0

Year	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Rocky-Windy															
Chum Escapement														3.0	2.0
Chum Harvest	14.9	6.4	2.2	8.5	0.3	33.8	8.1	1.7	0.0	0.5	0.0	39.4	1.4	0.0	0.9
Total Run	14.9	6.4	2.2	8.5	0.3	33.8	8.1	1.7	0.0	0.5	0.0	39.4	1.4	3.0	2.9

Source: ADF&G Surveys 1959 to 1996

No Data on Scurvy Creek

Year	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Scurvy Creek															
Pink Escapement															
Coho															
Total Run	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
1.5	4.4	2.7	36.7	8.2	85.0	6.4	25	6.6	16.6	9.0	12.1	12.0	4.5	5.4	10.3	18.0	26.1
0.0	0.0	0.0	11.6	0.0	122.2	1.4	16.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.5	4.4	2.7	48.3	8.2	207.2	7.8	41.5	6.6	16.6	9.0	12.1	12.0	4.5	5.4	10.3	18.0	26.1

74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
0.2	28.4	0.4	58.4	1.4	85.2	14.2	36.0	9.1	16.2	5.9	14.3	4.7	7.6	4.7	31.8	14.6	55.2
0.0	18.1	0.0	173.2	0.0	552.7	0.0	2.9	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	49.1
0.2	46.5	0.4	231.6	1.4	637.9	14.2	38.9	9.1	16.2	5.9	19.1	4.7	7.6	4.7	31.8	14.6	104.3

74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
1.0	25.0	12.0	10.5	6.3	35.0	23.0	12.5	2.8	4.0	3.5	2.5	2.0	0.2	0.3	1.2	0.8	0.0
0.0	0.3	0.0	17.7	0.0	76.7	2.1	7.4	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
1.0	25.3	12.0	28.2	6.3	111.7	25.1	19.9	2.8	7.2	3.5	2.5	2.0	0.2	0.3	1.2	0.8	0.5

74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
																0.2	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0

96	60-96 Avg	ADF&G Goal	PGC Goal
80.1	26.94	50.0	15.00
0.0	13.50		5.00
80.1	40.44		20.00

96	60-96 Avg	Goal	
12.4	19.87	40-60	15.00
0.0	30.94		10.00
12.4	50.81		25.00

96	60-96 Avg	Goal	
2.0	4.28	20.0	5.00
0.0	6.11		0.00
2.0	10.39		5.00

96	60-96 Avg	Goal
0.0	0.06	0.0
	0.00	
0.0	0.06	

Table 2 **Channel and habitat characteristics in representative stream reaches of Port Graham River, Summer 1997.**

a Dominant substrate is listed in order relative to the frequency of occurrency.

ADF&G Code	Subbasin	Reach	Channel Type	Survey Lngth (m)	Gradient (%)	Stream BF Width	Dominant Substrate	Area M2	ASA %	ASA Calc	ARA %	ARA Calc	LWD #	LWD Factor
	241-20-10550													
10550	PGR-MC	1	FP5	1,925	0.9	26.8	grv-pgrv	51,590	41%	21,152	35%	18,057	247	4.65
10550	PGR-MC	2	FP4	1,023	1.1	20.7	grv-cob	21,176	48%	10,165	45%	9,529	263	13.37
10550-2024	PGR-MC	4a	FP4	2,892	1	16.5	grv-cob	47,718	48%	22,905	45%	21,473	77	5.84
10550-2024	PGR-MC	4b	LC1	1,067	2	10	grv-cob	10,670	10%	1,067	0%	0	-	-
10550	PGR-SF	3a	MM2	585	1.3	12.1	grv-cob	7,079	25%	1,770	26%	1,840	107	21.52
10550-2018	PGR-photo	3b	MM1	2,000	2	8	grv-cob	16,000	11%	1,760	18%	2,880	-	-
10550-2018	PGR-photo	3c	MC1	500	3	6	cob-grv	3,000	5%	150	15%	450	-	-
10550-2018	PGR-photo	3d	MM1	1,387	2	6	grv-cob	8,322	11%	915	18%	1,498	-	-
10550	PGR-NF	5a	FP3	400	1.7	9.9	grv-cob	3,960	48%	1,901	52%	2,059	166	41.75
10550	PGR-Photo	5b	MM1	3,000	3	6	grv-cob	18,000	11%	1,980	18%	3,240	-	-
10550	PGR-Trib	T1	PA1	990	1	3.5	sd-sl-grv	3,465	0%	0	20%	693	NA	NA
10550-2018	PGR-Trib	T2	PA1	391	1	2	grv-md-org	782	0%	0	20%	156	NA	NA
10550	PGR-Trib	T3	PA1	280	1	1.5	sl-org-sd	420	0%	0	20%	84	NA	NA
10550	PGR-Trib	T4	MM1	186	4	2.5	grv-cob-sd	465	11%	51	18%	84	-	-
10550	PGR-Trib	T5	PA1	50	1	3	m-sd-org	150	0%	0	20%	30	-	-
10550-2024	PGR-Trib	T6	MM1	45	1	3	grv-cob-sd	135	11%	15	18%	24	-	-
10550-2024	PGR-Trib	T7	MM1	1,360	2.5	5.5	grv-cob-rb	7,480	11%	823	18%	1,346	-	-
10550	PGR-Trib	T8	PA1	168	1	2.2	md-org-sl	370	0%	0	20%	74	-	-
10550	PGR-Trib	T9	MC1	52	6	3.5	rb-cob-grv	182	5%	9	15%	27	-	-
10550	PGR-Trib	T10	PA1	460	1	1	m-org-sd	460	0%	0	20%	92	-	-
10550	PGR-Trib	T11	PA1	137	0	1.5	m-org-sd	206	0%	0	20%	41	-	-
													-	-
2009	PG Lake	L	L	465		320	m-org-sd	148,800	0%	0	70%	104,160	-	-
P3-02	PG Pond 3-02	L	L	24		92.89	m-org-sd	2,239	0%	0	70%	1,567	-	-
P8-01	PG Pond 8-01	L	L	146		96	m-org-sd	14,016	0%	0	65%	9,110	-	-
				19,533				366,683		64,662		178,516		

<BARRIER FALLS>

10550-2024 UP-PGR-MC	6	FP4	1,297	1	18	grv	23,346	48%	11,206	45%	10,506	300	23.13
10550-2024 UP-PGR-MC	7	FP3	495	1	14	grv-cob	6,930	48%	3,326	52%	3,604	93	18.79
10550-2024 UP-PGR-MC	8	MC2	290	4.0-9.0	12	cob-bdrk-bld	3,480	1%	35	11%	383	10	3.45
10550-2024 UP-PGR-MC	9	MC2	2,380	3.0 - 6.0	12	cob-bldr	28,560	1%	286	11%	3,142	-	-
10550-2024 UP-PGR-MC	10	MM1	2,135	3	1	grv-cob	2,135	11%	235	18%	384	-	-
10550-2024 UP-PGR-MC	11	FP3	920	1.5	10	grv-cob	9,200	48%	4,416	52%	4,784	-	-
10550-2024 UP-PGR-MC	T12	MC1	420	6	5	cob-brk-bld	2,100	5%	105	15%	315	-	-
10550-2024 UP-PGR-MC	T12b	PA1	456	1	2	md-org	912	0%	0	20%	182	-	-
10550-2024 UP-PGR-MC	T13	PA1	529	1	2	md-org	1,058	0%	0	20%	212	-	-
10550-2024 UP-PGR-MC	T14	MC1	785	1	3	cob-grv	2,355	5%	118	15%	353	-	-
10550-2024 UP-PGR-MC	T15	MM1	420	3	6	grv-cob	2,520	11%	277	18%	454	-	-
			10,127				82,596		20,004		24,318		
TOTAL			29,660				449,279		84,665		202,834		
Lower Port Graham River			65.86%				81.62%		76.37%		88.01%		
Upper Port Graham River (above the falls)			34.14%				18.38%		23.63%		11.99%		

Table 3 Channel and habitat characteristics in representative stream reaches of Windy Creek Right, Summer 1997.

a Dominant substrate is listed in order relative to the frequency of occurrency.

ADF&G Code	Subbasin	Reach	Channel Type	Survey Length (m)	Gradient (%)	Stream BF Width	Dominant Substrate	Area M2	ASA %	ASA Calc	ARA %	ARA Calc
	242-10-10160											
10160	WIndy R MC	1	ES3	191	1.5	25	grv-cob	4,775	0%	0	0%	0
10160	WIndy R MC	2	MC2	1,454	1.5-5.0	10	grv-cob-bldr	14,540	1%	145	11%	1,599
10160	WIndy R MC	3	HC3	709	5.0-7.0	3	cob-bldr	2,127	0%	0	0%	0
10160	WIndy R MC	4	HC6	608	7.0-12.0	2	bldr-cob	1,216	0%	0	0%	0
10160	Windy R Trib	T1	MC2	1,600	4.0-5.0	5	grv-cob-bldr	8,000	1%	80	11%	880
				4,562				30,658		225		2,479

Table 4 Channel and habitat characteristics in representative stream reaches of Windy Creek Left, Summer 1997.

Dominant substrate is listed in order relative to the frequency of occurrency.

ADF&G Code	Subbasin	Reach	Channel Type	Survey Length (m)	Gradient (%)	Stream BF Width	Dominant Substrate	Area M2	ASA %	ASA Calc	ARA %	ARA Calc	LWD #	LWD #/100m
	242-10-10170													
10170	Windy L L-Frk	1	ES4	491	1.5	25	grv-cob	12,275	0%	0	0%	0	0	0.00
10170	Windy L L-Frk	2	MM2	1,252	1	9	grv-cob-bldr	11,268	11%	1,239	18%	2,028	90	7.19
10170	Windy L L-Frk	3	MC2	1,785	2.0-3.0	8	cob-grv	14,280	1%	143	11%	1,571	0	0.00
10170	Windy L L-Frk	T1	MC2	164	7.0-12.0	2	bldr-cob	328	0%	0	0%	0	0	0.00
10170	Windy L L-Frk	4	MC2	681	1.0-3.0	7	grv-cob	4,767	1%	48	11%	524	0	0.00
10170	Windy L R-Frk	T2	MM1	616	2	3	grv-cob	1,848	11%	203	18%	333	0	0.00
10170	Windy L R-Frk	5	MM2	3,351	0.5-3.0	6.5	grv-cob	21,782	11%	2,396	18%	3,921	319	9.52
				8,340				66,548		4,029		8,377		

Table 5 Channel and habitat characteristics in representative stream reaches of Dog Creek & Dog Jr. Creek, Summer 1997.

Dominant substrate is listed in order relative to the frequency of occurrency.

ADF&G Code	Subbasin	Reach	Channel Type	Survey Length (m)	Gradient (%)	Stream BF Width	Dominant Substrate	Area M2	ASA %	ASA Calc	ARA %	ARA Calc	LWD #	LWD Factor
	242-10-10180													
10180	Dog Creek MC	1	MC2	812	2	4.7	cob-bdrk-bldr	3,816	1%	38	11%	420	36	4.43
10180	Dog Creek MC	2	MC2	858	2	4.5	cob-grv	3,861	1%	39	11%	425	-	-
10180	Dog Creek MC	3	MM2	751	2.5-3.0	4	grv-cob	3,004	11%	330	18%	541	-	-
10180	Dog Creek MC	4	HC6	510	6.0-9.0	3.5	bldr-cob	1,785	0%	0	0%	0	-	-
10180	Dog Creek Trib	T1	MM2	1,733	3	4	grv-cob	6,932	11%	763	18%	1,248	-	-
10175	Dog Jr. Creek*	1	MC2	205	3	2.7	cob-grv-bldr	554	0%	0	0%	0	-	-
10175	Dog Jr. Creek	2	MC2	812	2.0-3.0	3.6	cob-grv-bldr	2,923	11%	322	18%	526	32	15.61
				5,681				22,875		1,491		3,159		

LWD and habitat not surveyed channel is small and not suitable for fish

Table 6 Channel and habitat characteristics in representative stream reaches of Scurvy Creek, Summer 1997.

Dominant substrate is listed in order relative to the frequency of occurrency.

ADF&G Code	Subbasin	Reach	Channel Type	Survey Length (m)	Gradient (%)	Stream BF Width	Dominant Substrate	Area M2	ASA %	ASA Calc	ARA %	ARA Calc	LWD #	LWD Factor
	242-32-10140													
10140	Scurvy Cr MC	1	ES3	140	1	22	cob-bldr	3,080	0%	0	0%	0	-	-
10140	Scurvy Cr MC	2	MC3	175	5	15	cob-bldr	2,625	0%	0	0%	0	-	-
10140	Scurvy Cr MC	3	MC2	1,176	4	10	cob-bldr	11,760	1%	118	11%	1,294	-	-
10140	Scurvy Cr Trib	T1-1	MC2	432	3.5	8	cob-bldr	3,456	1%	35	11%	380	-	-
10140	Scurvy Cr Trib	T1-2	HC6	636	6	5	cob-bldr	3,180	0%	0	0%	0	-	-
10140	Scurvy Cr MC	4	MC2	2,348	4	9	cob-bldr	21,132	1%	211	11%	2,325	-	-
10140	Scurvy Cr MC	T2-1	MC1	486	3	4	cob-grv	1,944	5%	97	15%	292	-	-
10140	Scurvy Cr MC	T2-2	HC2	895	4	2	cob-bldr	1,790	0%	0	0%	0	-	-
10140	Scurvy Cr MC	5	HC2	422	4	2	cob-bldr	844	0%	0	0%	0	-	-
sub-total				6,710				49,811		461		4,290		
	<BARRIER FALLS>													
10140	Scurvy Cr MC	6	MC2	345	3.5	5	cob-grv	1,725	1%	17	11%	190	-	-
10140	Scurvy Cr Trib	T3	MC1	286	3	3	cob-grv	858	5%	43	15%	129	-	-
10140	Scurvy Cr MC	7	PA1	382	1	1.5	m-org-sd	573	0%	0	20%	115	-	-
10140	Scurvy Cr MC	8	MM1	395	1.5	2	grv-cob	790	11%	87	18%	142	-	-
10140	Scurvy Lake	L	L	883		389	grv-org-sd	343,487	0%	0	40%	137,395	-	-
sub-total				2,291				347,433		147		137,970		
TOTAL				9,001				397,244		608				

Table 7 Channel and habitat characteristics in representative stream reaches of Rocky River, Summer 1997.

ADF&G Code	Subbasin	Reach	Channel Type	Survey Length (m)	Gradient (%)	Stream BF Width	Dominant Substrate	Area M2	ASA %	ASA Calc	ARA %	ARA Calc
241-30-10120	**Rocky River**											
-10120	Rocky MC	1	ES4	1,317	0.0	47.0	m/s-snd-grv	61,899	0%	0	0%	0
-10120	Rocky MC	2	FP5	3,861	1.1	42.0	grv-snd	162,162	41%	66,486	35%	56,757
-10120	Rocky MC	3	FP3	579	1.0	12.0	grv-sd	6,948	48%	3,335	45%	3,127
-10120	Rocky MC	4	FP5	1,647	1.0	32.0	grv-sd-cob	52,704	41%	21,609	35%	18,446
-10120	RMC 0-01	5	MC2	3,964	2.0	17.0	rb-cob-grv	67,388	0%	0	11%	7,413
-10120	RT 5-01	T5-01	PA1	-	0.0	0.0	ms-sd-org	205,198	11%	22,572	18%	36,936
-10120	RT 6-01	T5-02	MM1	530	1.0	3.5	grv-cob-ms	1,855	11%	204	18%	334
-10120	RT 7-01	T5-03	PA1	296	1.0	3.0	grv-sl-org	888	11%	98	18%	160
-10120	RT 9-01	T5-04	PA1	92	1.0	1.0	grv-org-sl	92	0%	0	0%	0
-10120-2155	Rocky Trib	T1-1	MM1	466	1.0	4.5	grv-sd	2,097	40%	839	50%	1,049
-10120-2155	Rocky Trib	T1-2	FP5	647	1.0	25.3	grv-sd-cob	16,369	70%	11,458	60%	9,821
-3048	RT 0-04	T2	FP3	727	1.0	15.0	grv-cob-sd	10,905	41%	4,471	35%	3,817
-3048	RT 0-02	T3	FP3	2,009	1.0	15.0	grv-cob	30,135	41%	12,355	35%	10,547
-3048	RT 0-04	T4	MM2	1,085	1.0	15.0	grv-cob-sd	16,275	11%	1,790	18%	2,930
-3048	RT 0-03	T5	PA4	300	0.0	200.0	m-sd-org	60,000	0%	0	20%	12,000
-3048	RT 0-01	T6	FP3	2,718	1.0	7.0	grv-cob-sd	19,026	41%	7,801	35%	6,659
-3048	RT 0-02	T7	MM2	1,178	2.5	15.0	grv-cob-rb	17,670	11%	1,944	18%	3,181
-10120	RT 0-08	T8	PA1	679	1.0	3.5	md-org-sl	2,377	0%	0	11%	261
-2160	RT 2160	T9	FP4	505	1.5	3.5	grv-sd-cob	1,768	48%	848	45%	795
-2160-2120	R ST 0-0S1	SC-1	FP3	2,837	2.0	8.0	grv-sd-org	22,696	41%	9,305	35%	7,944
-2160-2120	R ST 0-0S2	SC-2	PA4	30	0.0	10.0	m-org-sd	300	0%	0	70%	210
-2120	RS C	LC-1	FP5	2,635	1.0	15.0	grv-sd-cob	39,525	41%	16,205	35%	13,834
-2120	RS C	LC-2	FP3	1,363	1.0	12.0	grv-sd-cob	16,356	48%	7,851	52%	8,505
-2120	RT 0-012	T12	PA4	20	0.0	20.0	ms-org	400	0%	0	70%	280
-2120	RT 0-015	T15	MM1	328	1.0	2.5	grv-sd	820	11%	90	18%	148
-2120	RT 0-017	T17	PA1	59	1.0	1.0	grv-ms-org	59	0%	0	11%	6
-2120	RT 0-016-1	T16-1	MM1	414	2.0	10.0	cob-grv-bld	4,140	11%	455	18%	745
-2120	RT 0-016-2	T16-2	MC1	378	2.0	10.0	bld-cob-grv	3,780	5%	189	15%	567
TOTAL				**30,664**				**823,831**		**189,906**		**206,470**

TABLE 7

-2160	**RT 2160**	**T10a**	**FP3**	**350**	**2.0**	**3.5**	**grv-cob**	**1,225**	**41%**	**502**	**35%**	**429**
-2160	**RT 2160**	**T10b**	**MM1**	**670**	**2.0**	**3.0**	**grv-cob-rb**	**2,010**	**11%**	**221**	**18%**	**362**
				1,020				3,235		723		791
Percent of total				3.33%				.39%		.38%		.38%
TOTAL w/ Enhancement				**31,684**				**827,066**		**190,630**		**207,261**

***BOLD= Proposed channel restoration project.**
Dominant substrate is listed in order relative to the frequency of occurrency.

Table 8 Estimated Coho salmon production in Upper Port Graham River

Stream	Length (m)	Area M2	ASA M2	ARA M2	Female Density (50/50)	#Females	Total Salmon	Fecundity	FW Survival	Marine Survival	Adult Return	Harvest #
Upper PGR (above falls)	10,127	82,396	20,004	24,318	0.08	1,600	3,201	4,835	0.074	0.041	23,476	9,508

Assumptions: Coho 50:50 sex ratio, fecundity 4835
Coho salmon average round weight 8.0 lbs
Coho average filleted weight = 4.5 lbs
Subsistence exploitation rate 40.5%
Per Coho Value @ $5/lbs = $ 22.5
Equals Value of Harvested Coho = **$213,922**

Tabel 9 Estimated Coho Salmon Rearing Production in Port Graham River
Density Independent Rearing Capability

Stream	Length (m)	Area M2	ARA M2	Fry Density 50.00	# Coho Fry	#Parr Coho *0.31	Smolt Factor *.2	Marine Survival	Adult Return	Harvest #
PGR (entire system)	29,660	449,279	202,834	50.00	10,141,700	3,143,927	0.2	0.041	25,780	10,441

Number of Spawners needed: 12,170
Total system ASA = 84,665
Optimum system spawner density = 6,773
Assumptions: Coho fry avg per m2 = 50.0
Coho winter parr avg. per m2 = 5.0
Winter smolt factor = 5.0 * 0.31 = 1.6

Assumptions: Coho 50:50 sex ratio, fecundity 4835
Coho salmon average round weight 8.0 lbs
Coho average filleted weight = 4.5 lbs
Subsistence exploitation rate 40.5%
Per Coho Value @ $5/lbs = $ 22.5
Value of Harvested Coho = **$234,922**

Table 10 Estimated Coho Salmon Rearing Production in Rearing Ponds Tributary to Windy Creek Left Density Independent Rearing Capability

Stream	Length (m)	Area M2	ARA M2	Fry Density 50.00	# Coho Fry	#Parr Coho *0.31	Smolt Factor *.2	Marine Survival	Adult Return	Harvest #
Windy Creek 2 X 1/2 acre Rearing Ponds	NA	40,000	40,000	50.00	2,000,000	620,000	0.2	0.041	5,084	2,059

Number of Spawners needed: 414
Total system ASA = 4,029
Optimum system spawner density = 322

Assumptions: Coho fry avg per m2= 50.0
Coho winter parr avg. per m2 = 20.0
Winter smolt factor = 5.0 * 0.31 = 1.6
1 acre = .4 hectare
1 hectare = 100,000 square meters

Assumptions: Coho 50:50 sex ratio, fecundity 4835
Coho salmon average round weight 8.0 lbs
Coho average filleted weight = 4.5 lbs
Subsistence exploitation rate 40.5%
Per Coho Value @ $5/lbs = $ 22.5
Value of Harvested Coho = **$46,328**

Table 11 Estimated Coho Salmon Rearing Production in Rearing Channel Tributary to Rocky River
Density Independent Rearing Capability

Stream	Length (m)	Area M2	ARA M2	Fry Density 50.00	# Coho Fry	#Parr Coho *0.31	Smolt Factor *.2	Marine Survival	Adult Return	Harvest #
Rocky River 318 M Rearing Channel	318	636	636	50.00	31,800	9,858	0.2	0.041	81	33

Number of Spawners needed: 7
Total system ASA = 190,630
Optimum system spawner density = 15,250

Assumptions: Coho fry avg per m2= 50.0
Coho winter parr avg. per m2 = 20.0
Winter smolt factor = 5.0 * 0.31 = 1.6
1 acre = .4 hectare
1 hectare = 100,000 square meters

Assumptions: Coho 50:50 sex ratio, fecundity 4835
Coho salmon average round weight 8.0 lbs
Coho average filleted weight = 4.5 lbs
Subsistence exploitation rate 40.5%
Per Coho Value @ $5/lbs = $ 22.5
Value of Harvested Coho = **$737**

Table 12 Estimated Coho salmon production in Tributary 2160 to Rocky River

Stream	Length (m)	Area M2	ASA M2	ARA M2	Female Density (50/50)	#Females	Total Salmon	Fecundity	FW Survival	Marine Survival	Adult Return	Harvest #
Trib 2160 (above Red Lake)	1,020	3,235	723	791	0.08	58	116	4,835	0.074	0.041	848	344

Assumptions: Coho 50:50 sex ratio, fecundity 4835
Coho salmon average round weight 8.0 lbs
Coho average filleted weight = 4.5 lbs
Subsistence exploitation rate 40.5%
Per Coho Value @ $5/lbs = $ 22.5
Equals Value of Harvested Coho
$7,732

Table 13 Estimated Coho Salmon Rearing Production in Lake 0010 Tributary to Rocky River
Density Independent Rearing Capability

Stream	Length (m)	Area M2	ARA M2	Fry Density 50.00	# Coho Fry	#Parr Coho *0.31	Smolt Factor *.2	Marine Survival	Adult Return	Harvest #
Lake 0010 (above Red Lake)	NA	1,080,000	1,080,000	50.00	54,000,000	16,740,000	0.2	0.041	137,268	55,594

Number of Spawners needed: 11,169
Total system ASA = 190,630
Optimum system spawner density = 15,250
Assumptions: Coho fry avg per m2= 50.0
Coho winter parr avg. per m2 = 20.0
Winter smolt factor = 5.0 * 0.31 = 1.6
1 acre = .4 hectare
1 hectare = 100,000 square meters

Table 14 Data Used for Cost Benefit EVOS Project

Species #1 Coho Salmon
Species #2 Pink Salmon
Species #3 Sockeye
Avg Wt #1 8.0 lbs
Avg Wt #2 3.6 lbs
Avg Wt #3 6.5 lbs

Variable Description:

COST -Annual cost of the project
SBHARV -Annual subsistence harvest of species #X in the area without the project
SBHARV -Annual subsistence harvest of species #X in the area with the project
SBEFT -Annual subsistence harvest of species #X in the area without the project
SBEFT -Annual subsistence harvest of species #X in the area with the project

Assumptions: Coho salmon average round weight 8.0 lbs
Coho average filleted weight = 4.5 lbs
Subsistence exploitation rate 40.5%
Per Coho Value @ $5/lbs = $ 22.5

		SPECIES #1				SPECIES #2				SPECIES #3			
Year	Cost	SBHARV1	SBHARV2	SBEFT1	SBEFT2	SBHARV1	SBHARV2	SBEFT1	SBEFT2	SBHARV1	SBHARV2	SBEFT1	SBEFT2
1	57,700	121,500	121,500	1,250	1,250								
2	15,500	121,500	121,500	1,250	1,250								
3	15,500	121,500	121,500	1,250	1,250								
4	1,500	121,500	121,500	1,250	1,250								
5	1,500	121,500	121,500	1,250	1,250								
6	1,500	121,500	335,422	1,250	2,625								
7	1,500	121,500	335,422	1,250	2,625								
8	1,500	121,500	335,422	1,250	2,625								
9	1,500	121,500	335,422	1,250	2,625								
10	1,500	121,500	335,422	1,250	2,625								
11	1,500	121,500	335,422	1,250	2,625								
12	1,500	121,500	335,422	1,250	2,625								
13	1,500	121,500	335,422	1,250	2,625								
14	1,500	121,500	335,422	1,250	2,625								
15	1,500	121,500	335,422	1,250	2,625								
16	1,500	121,500	335,422	1,250	2,625								
17	1,500	121,500	335,422	1,250	2,625								
18	1,500	121,500	335,422	1,250	2,625								
19	1,500	121,500	335,422	1,250	2,625								
20	1,500	121,500	335,422	1,250	2,625								
Total	114,200	2,430,000	5,638,830	25,000	45,625	0	0	0	0	0	0	0	0

Table 15 Data Used for Cost Benefit EVOS Project

Species #1 Coho Salmon
Species #2 Pink Salmon
Species #3 Sockeye
Avg Wt #1 8.0 lbs
Avg Wt #2 3.6 lbs
Avg Wt #3 6.5 lbs

Variable Description:

COST -Annual cost of the project
SBHARV -Annual subsistence harvest of species #X in the area without the project
SBHARV -Annual subsistence harvest of species #X in the area with the project
SBEFT -Annual subsistence harvest of species #X in the area without the project
SBEFT -Annual subsistence harvest of species #X in the area with the project

Assumptions: Coho salmon average round weight 8.0 lbs
Coho average filleted weight = 4.5 lbs
Subsistence exploitation rate 40.5%
Per Coho Value @ $5/lbs = $ 22.5

		SPECIES #1				SPECIES #2				SPECIES #3			
Year	Cost	SBHARV1	SBHARV2	SBEFT1	SBEFT2	SBHARV1	SBHARV2	SBEFT1	SBEFT2	SBHARV1	SBHARV2	SBEFT1	SBEFT2
1	50,000	13,500	13,500	750	750								
2	6,500	13,500	13,500	750	750								
3	5,500	13,500	13,500	750	750								
4	1,500	13,500	13,500	750	750								
5	1,500	13,500	13,500	750	750								
6	1,500	13,500	59,828	750	1,500								
7	1,500	13,500	59,828	750	1,500								
8	1,500	13,500	59,828	750	1,500								
9	1,500	13,500	59,828	750	1,500								
10	1,500	13,500	59,828	750	1,500								
11	1,500	13,500	59,828	750	1,500								
12	1,500	13,500	59,828	750	1,500								
13	1,500	13,500	59,828	750	1,500								
14	1,500	13,500	59,828	750	1,500								
15	1,500	13,500	59,828	750	1,500								
16	1,500	13,500	59,828	750	1,500								
17	1,500	13,500	59,828	750	1,500								
18	1,500	13,500	59,828	750	1,500								
19	1,500	13,500	59,828	750	1,500								
20	1,500	13,500	59,828	750	1,500								
Total	87,500	270,000	964,920	15,000	26,250	0	0	0	0	0	0	0	0

Table 16 Data Used for Cost Benefit EVOS Project

Species #1 Coho Salmon
Species #2 Pink Salmon
Species #3 Sockeye
Avg Wt #1 8.0 lbs
Avg Wt #2 3.6 lbs
Avg Wt #3 6.5 lbs

Variable Description:

COST -Annual cost of the project
SBHARV -Annual subsistence harvest of species #X in the area without the project
SBHARV -Annual subsistence harvest of species #X in the area with the project
SBEFT -Annual subsistence harvest of species #X in the area without the project
SBEFT -Annual subsistence harvest of species #X in the area with the project

Assumptions:
Coho salmon average round weight 8.0 lbs
Coho average filleted weight = 4.5 lbs
Subsistence exploitation rate 40.5%
Per Coho Value @ $5/lbs = $ 22.5

		SPECIES #1				SPECIES #2				SPECIES #3			
Year	Cost	SBHARV1	SBHARV2	SBEFT1	SBEFT2	SBHARV1	SBHARV2	SBEFT1	SBEFT2	SBHARV1	SBHARV2	SBEFT1	SBEFT2
1	24,000	22,500	22,500	1,000	1,000								
2	2,000	22,500	22,500	1,000	1,000								
3	2,000	22,500	22,500	1,000	1,000								
4	0	22,500	22,500	1,000	1,000								
5	0	22,500	22,500	1,000	1,000								
6	0	22,500	23,237	1,000	1,035								
7	0	22,500	23,237	1,000	1,035								
8	0	22,500	23,237	1,000	1,035								
9	0	22,500	23,237	1,000	1,035								
10	0	22,500	23,237	1,000	1,035								
11	0	22,500	23,237	1,000	1,035								
12	0	22,500	23,237	1,000	1,035								
13	0	22,500	23,237	1,000	1,035								
14	0	22,500	23,237	1,000	1,035								
15	0	22,500	23,237	1,000	1,035								
16	0	22,500	23,237	1,000	1,035								
17	0	22,500	23,237	1,000	1,035								
18	0	22,500	23,237	1,000	1,035								
19	0	22,500	23,237	1,000	1,035								
20	0	22,500	23,237	1,000	1,035								
Total	28,000	450,000	461,055	20,000	20,525	0	0	0	0	0	0	0	0

Table 17 Data Used for Cost Benefit EVOS Project

Species #1 Coho Salmon
Species #2 Pink Salmon
Species #3 Sockeye
Avg Wt #1 8.0 lbs
Avg Wt #2 3.6 lbs
Avg Wt #3 6.5 lbs

Variable Description:

COST -Annual cost of the project
SBHARV -Annual subsistence harvest of species #X in the area without the project
SBHARV -Annual subsistence harvest of species #X in the area with the project
SBEFT -Annual subsistence harvest of species #X in the area without the project
SBEFT -Annual subsistence harvest of species #X in the area with the project

Assumptions:
Coho salmon average round weight 8.0 lbs
Coho average filleted weight = 4.5 lbs
Subsistence exploitation rate 40.5%
Per Coho Value @ $5/lbs = $ 22.5

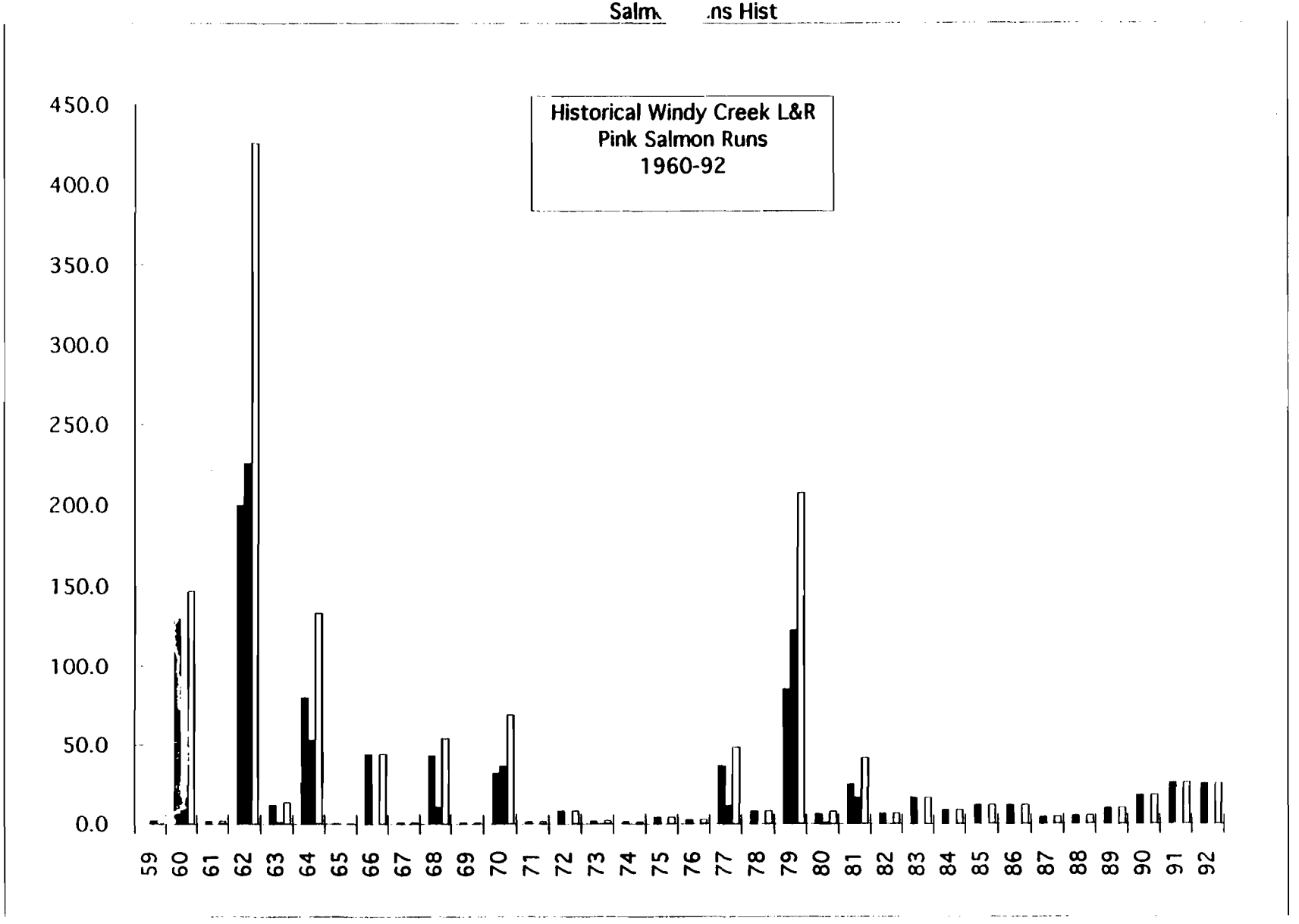
		SPECIES #1				SPECIES #2				SPECIES #3			
Year	Cost	SBHARV1	SBHARV2	SBEFT1	SBEFT2	SBHARV1	SBHARV2	SBEFT1	SBEFT2	SBHARV1	SBHARV2	SBEFT1	SBEFT2
1	20,000	22,500	22,500	1,000	1,000								
2	2,500	22,500	22,500	1,000	1,000								
3	2,500	22,500	22,500	1,000	1,000								
4	0	22,500	22,500	1,000	1,000								
5	0	22,500	22,500	1,000	1,000								
6	0	22,500	30,232	1,000	1,345								
7	0	22,500	30,232	1,000	1,345								
8	0	22,500	30,232	1,000	1,345								
9	0	22,500	30,232	1,000	1,345								
10	0	22,500	30,232	1,000	1,345								
11	0	22,500	30,232	1,000	1,345								
12	0	22,500	30,232	1,000	1,345								
13	0	22,500	30,232	1,000	1,345								
14	0	22,500	30,232	1,000	1,345								
15	0	22,500	30,232	1,000	1,345								
16	0	22,500	30,232	1,000	1,345								
17	0	22,500	30,232	1,000	1,345								
18	0	22,500	30,232	1,000	1,345								
19	0	22,500	30,232	1,000	1,345								
20	0	22,500	30,232	1,000	1,345								
Total	25,000	450,000	565,980	20,000	25,175	0	0	0	0	0	0	0	0

TABLE 18

Summary of Cost/Benefit Analysis

Projects w/ Positive NB	Cost	Net Benefit	B/C
Port Graham River Fish Pass	114,400	3,094,630.	27:1
Windy Creek L Ponds	87,000	607,420	6.9:1
Red Lake Spawning Ch	25,000	90,980	3.6:1
Projects with less than 0			
Rearing Channel	28,000	(16,945)	0.6:1
Large Woody Debris Study	25,000	NA	NA
Summary	279,400	3,776,085	13.5:1

CHARTS 1-3


Salm ns Hist
Historical Windy Creek L&R
Pink Salmon Runs
1960-92
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
59
60
61
62
63
64
65
66
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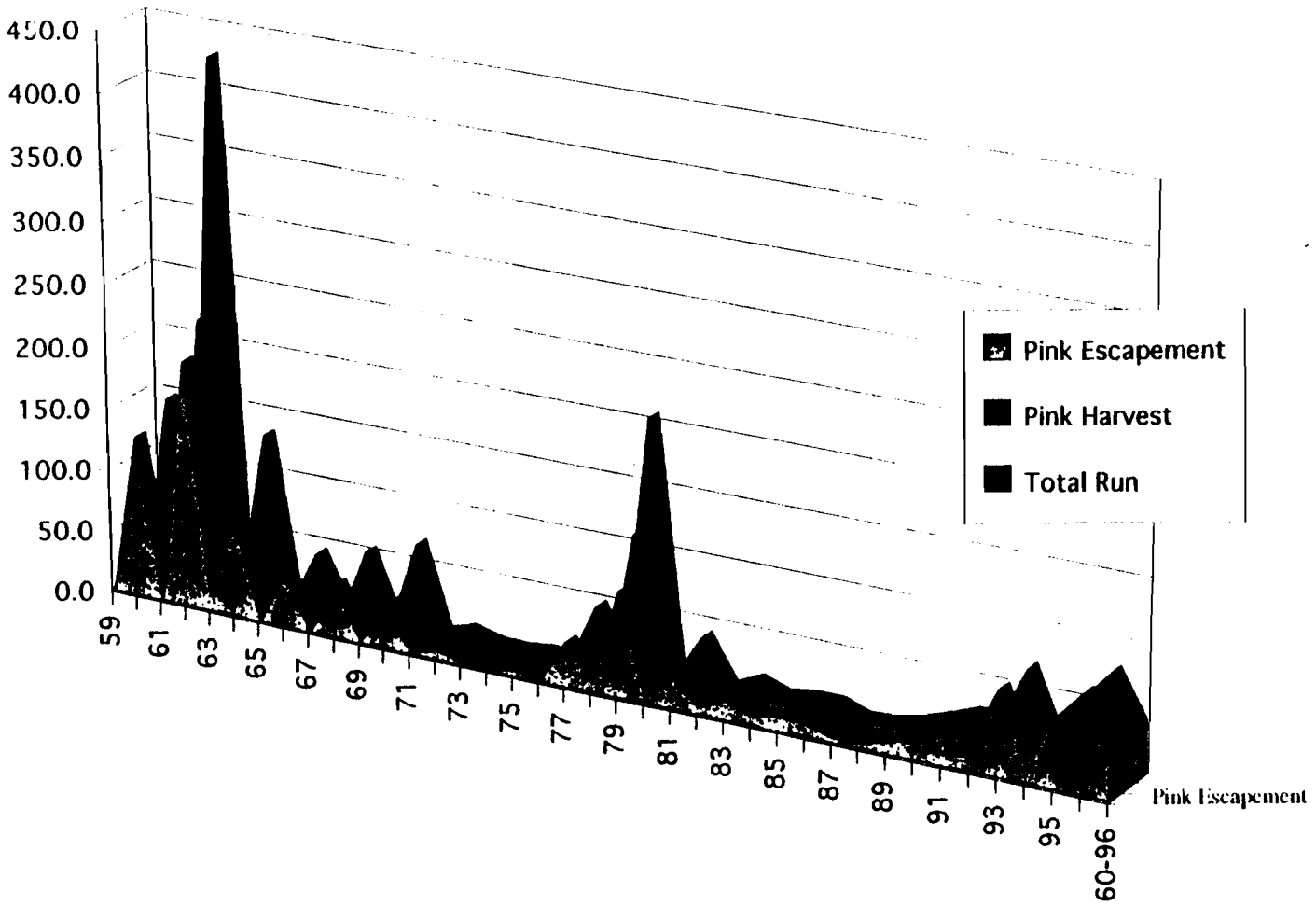
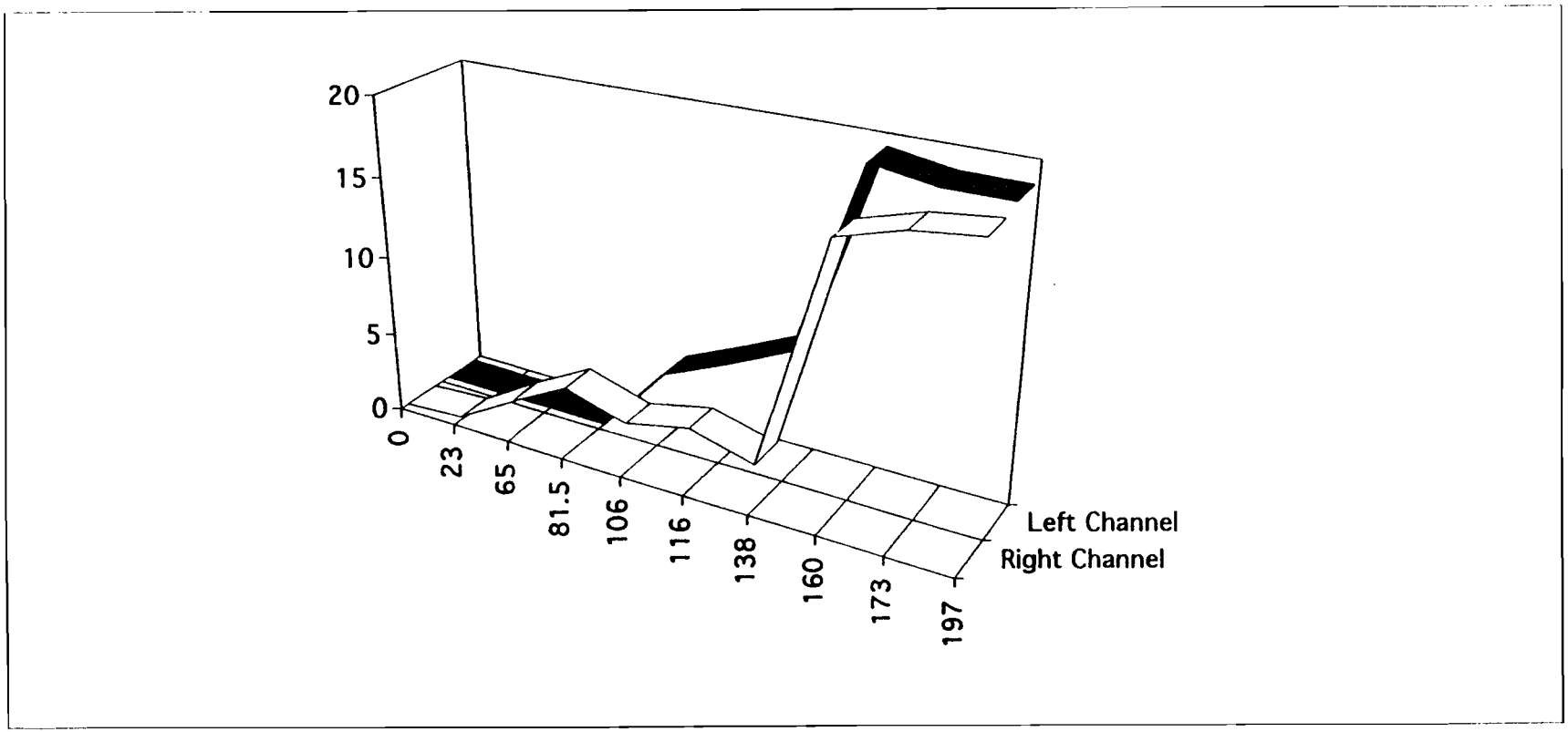
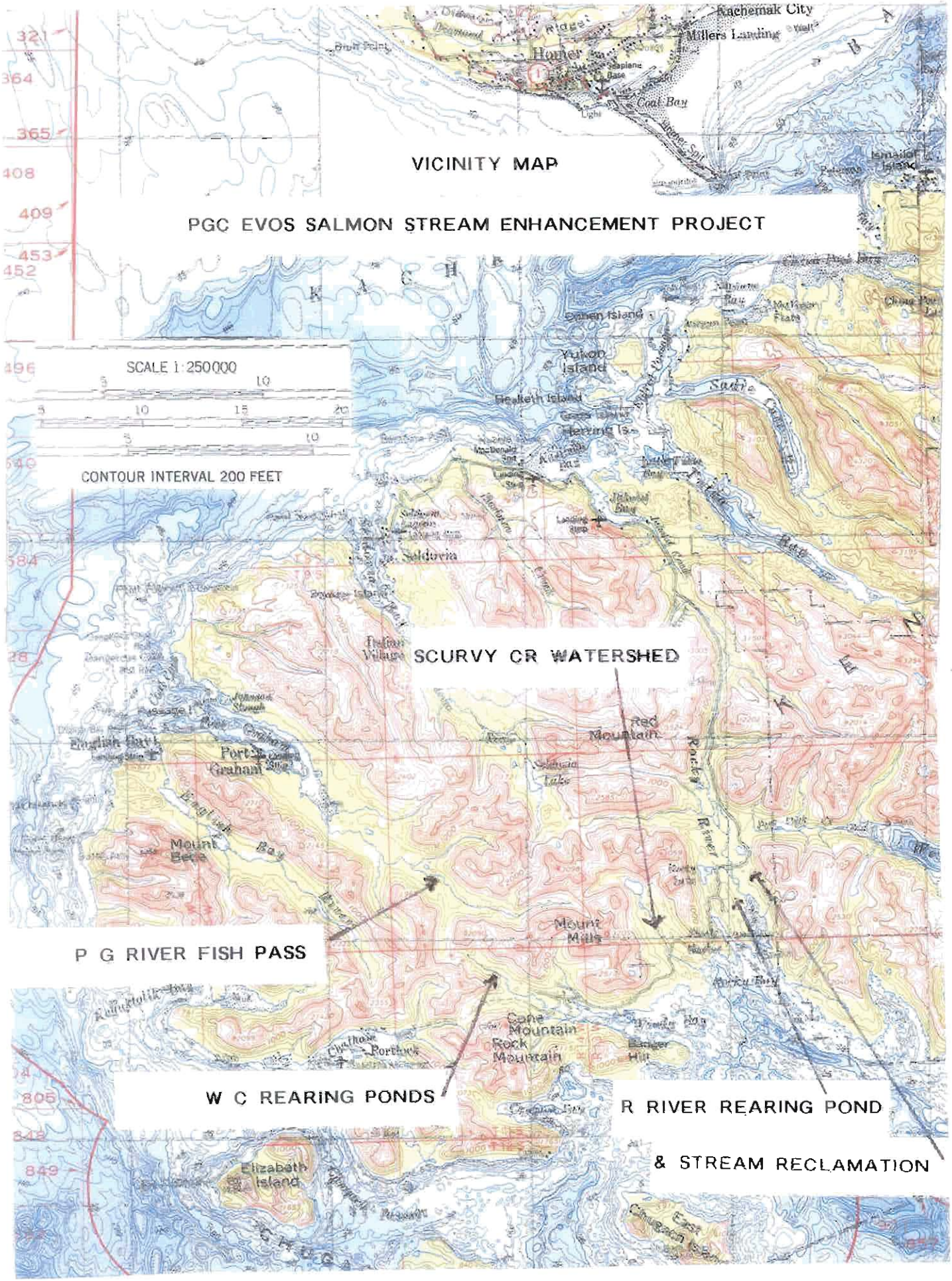

450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
59
61
63
65
67
69
71
73
75
77
79
81
83
85
87
89
91
93
95
60-96
Pink Escapement
Pink Escapement
Pink Harvest
Total Run

Port Graham River Falls Profile Left & Right Channels (Upstream)

Station	Distance RC	Elevation RC	Distance LC	Elevatio LC
0	0	0	0	0
0 - 1	23	0.23	0	0
1 to 2	65	2.33	0	0
2 to 3	81.5	4.31	0	0
3 to 4	105.5	3.11	130.5	4.31
4 to 5	115.5	3.91	154.5	5.99
5 to 6	137.5	2.81	168.5	7.81
6 to 7	159.5	16.89	186.5	19.51
7 to 8	172.5	18.06	216.5	18.91
8 to 9	196.5	18.54	216.5	18.91



Plates 1-17


VICINITY MAP
PGC EVOS SALMON STREAM ENHANCEMENT PROJECT
SCALE 1:250000
CONTOUR INTERVAL 200 FEET
SCURVY CR WATERSHED
P G RIVER FISH PASS
W C REARING PONDS
R RIVER REARING POND
& STREAM RECLAMATION
Homer
Kachemak City
Millers Landing
Coal Bay
Yukon Island
Seldovia
Port Graham
Mount Berie
Red Mountain
Mount Mills
Cone Mountain
Rock Mountain
Elizabeth Island

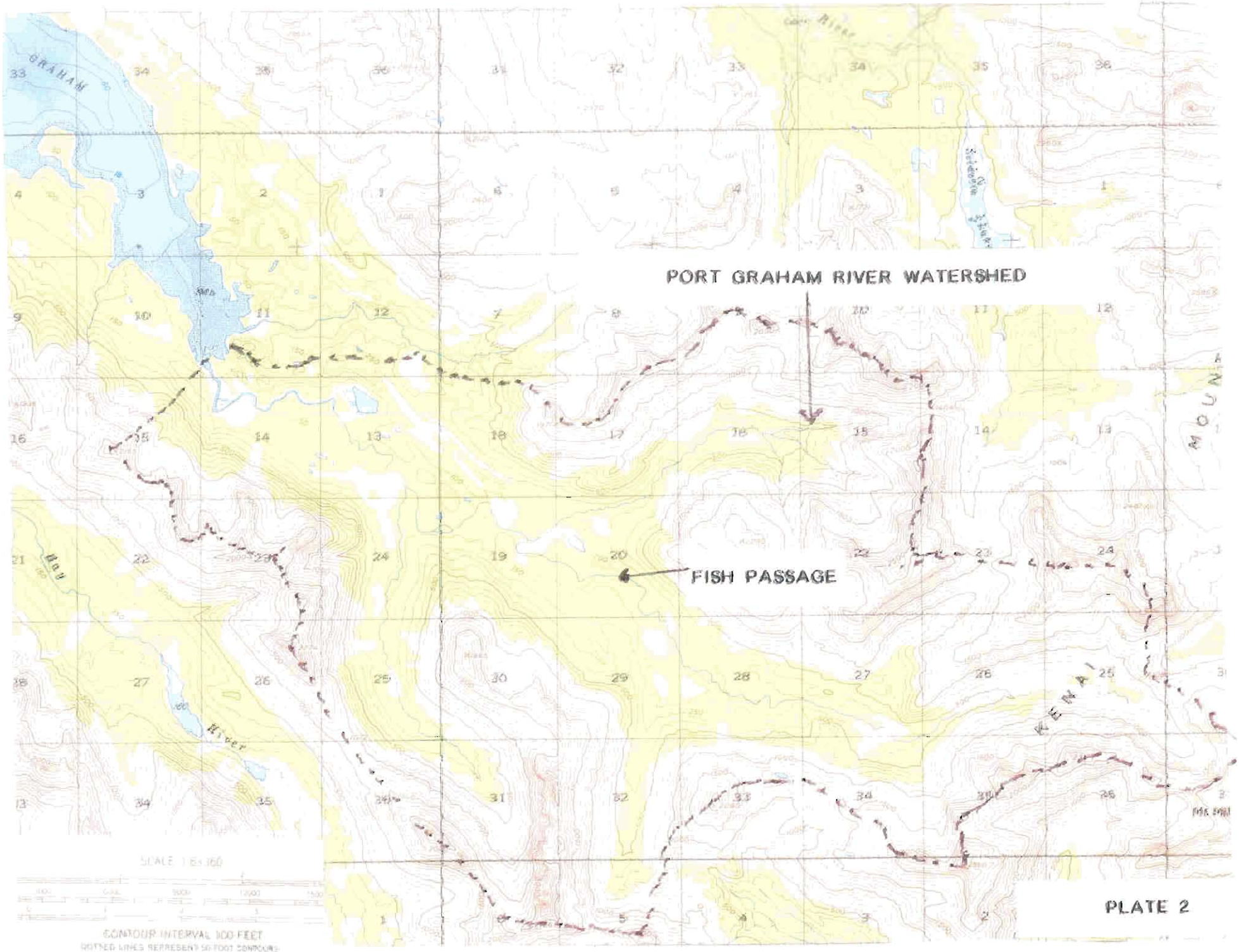

PORT GRAHAM RIVER WATERSHED
FISH PASSAGE
GRAHAM
Bay
River
MOUNTAIN
SCALE 1 IN 160
CONTOUR INTERVAL 100 FEET
DOTTED LINES REPRESENT 50 FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

PLATE 2

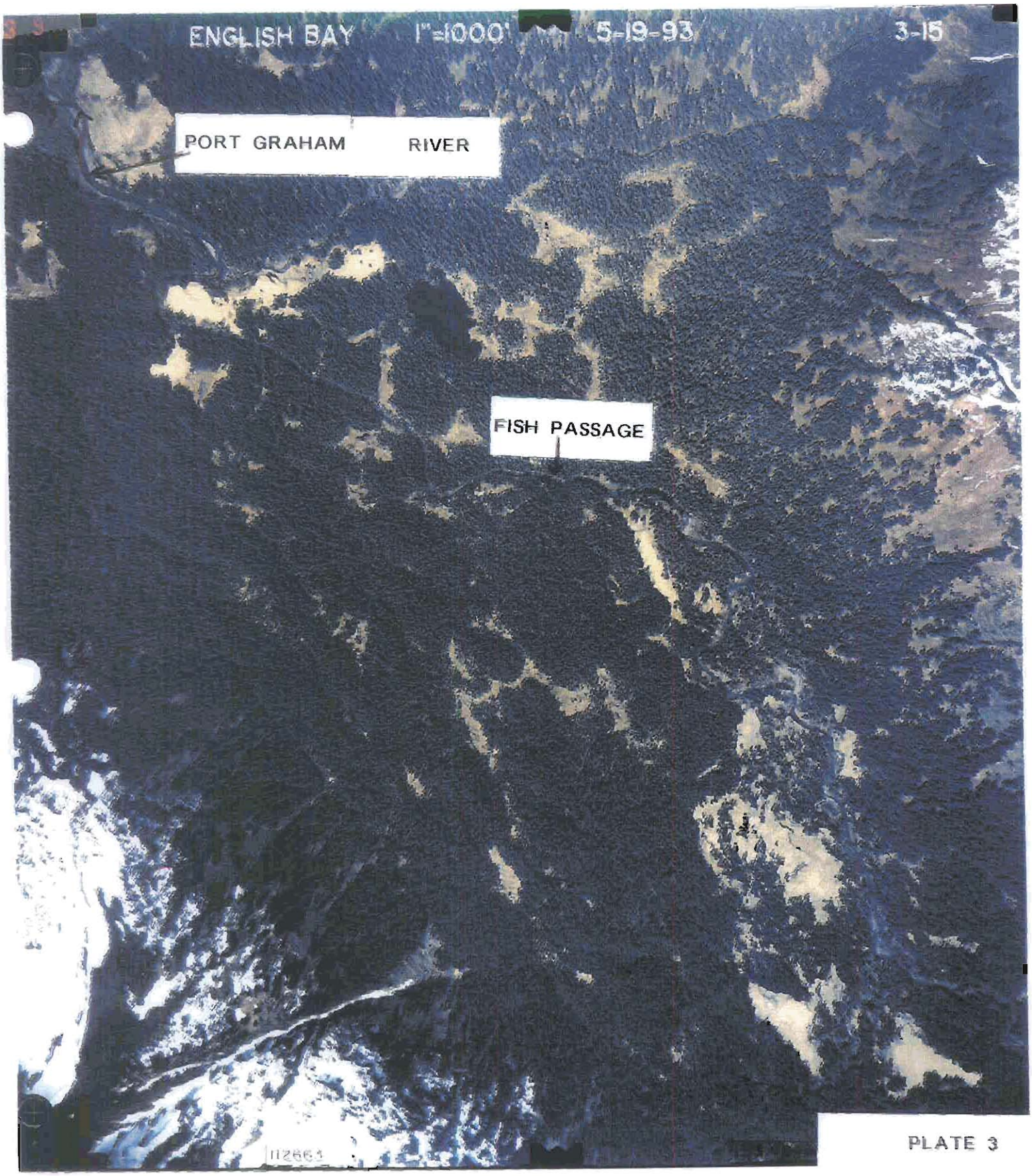
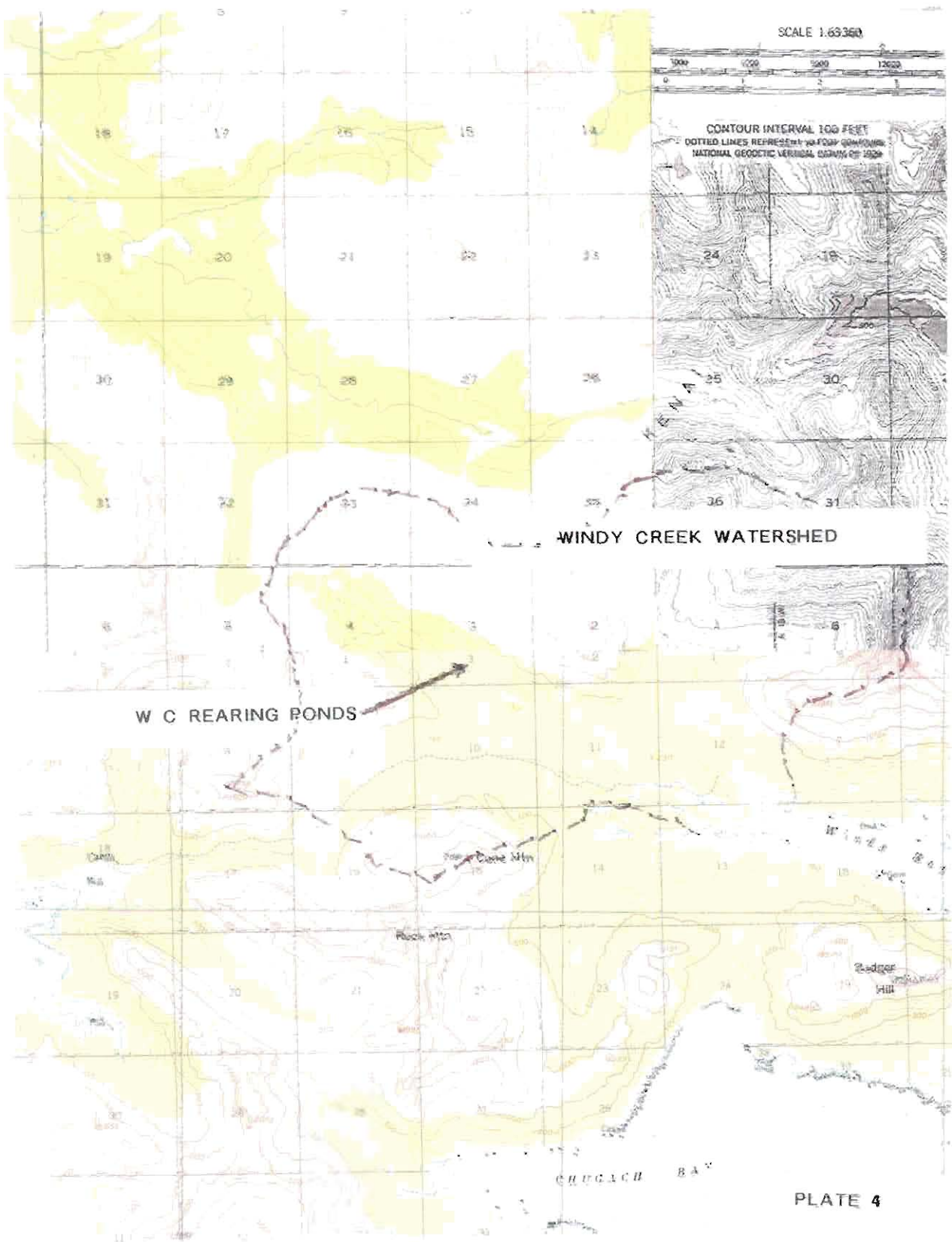
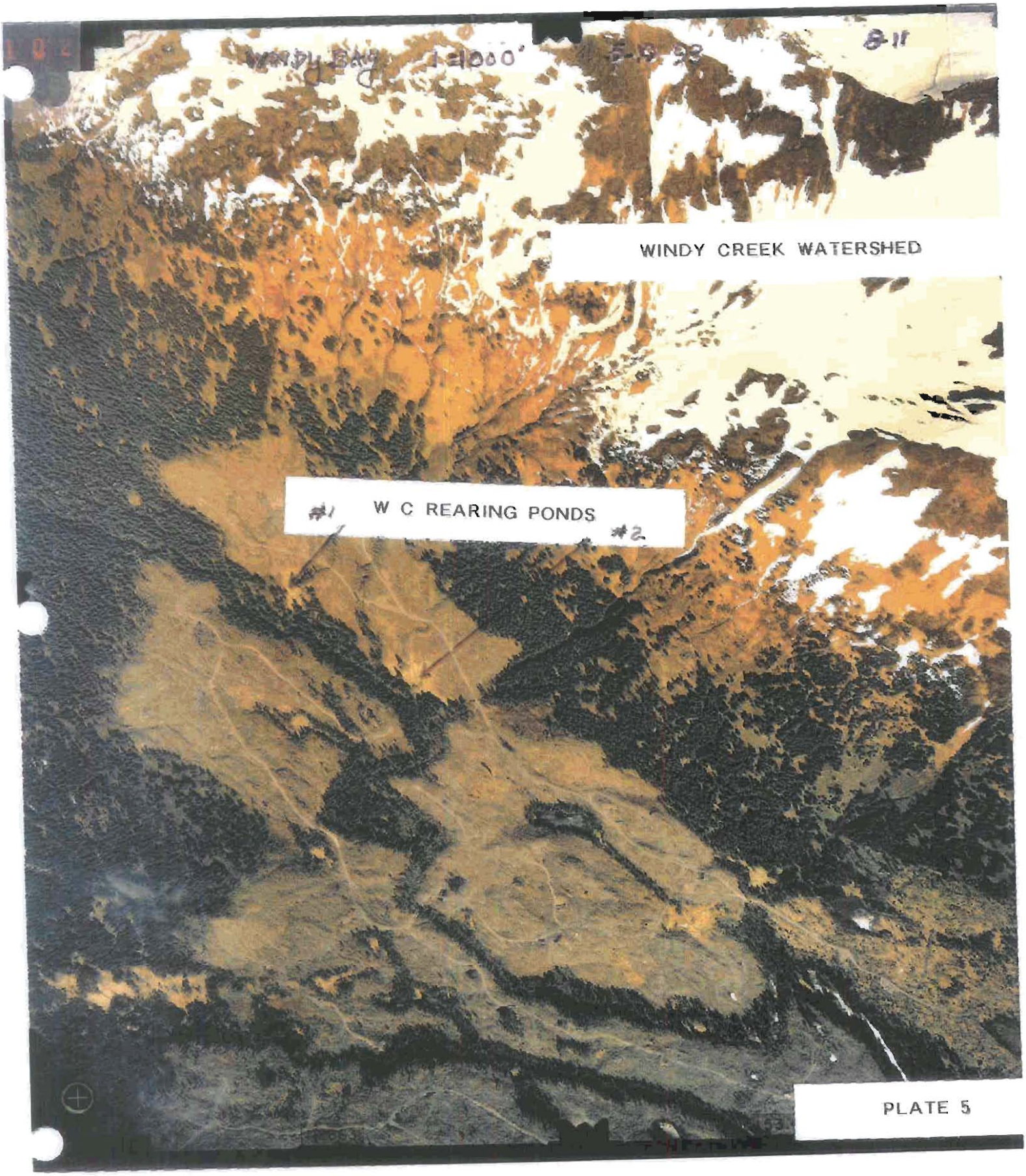
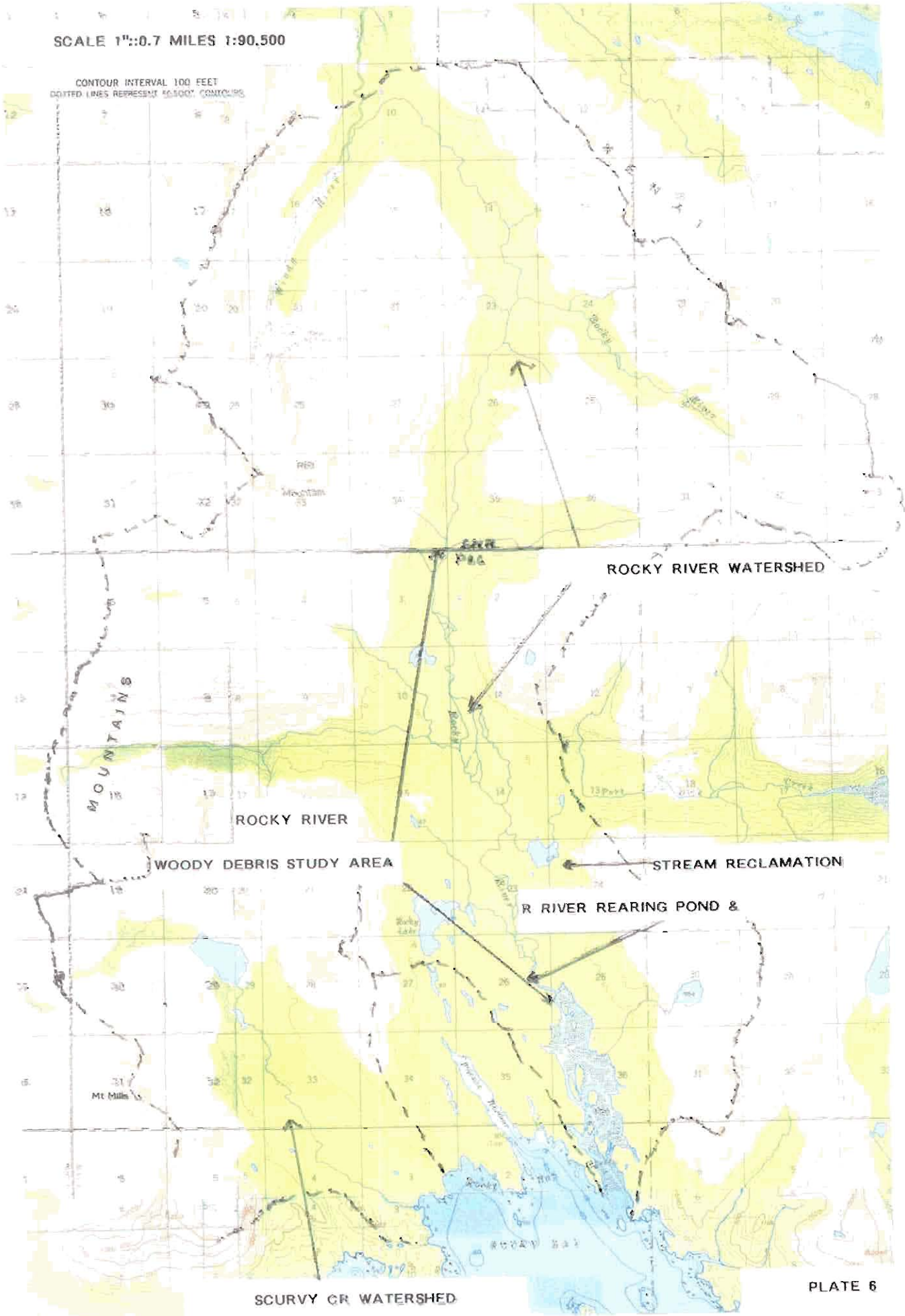
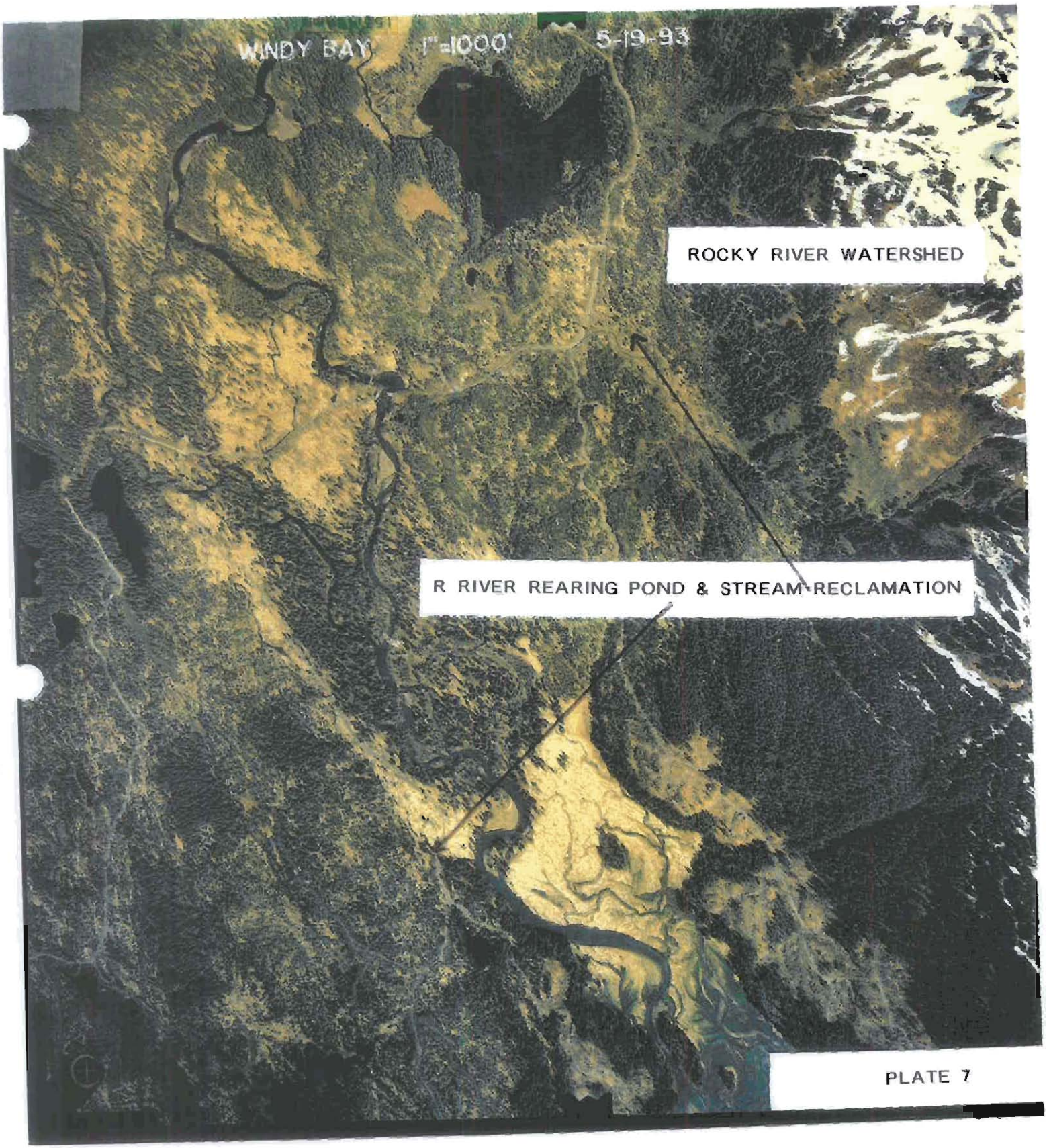


PLATE 3


SCALE 1:63360
CONTOUR INTERVAL 100 FEET
WINDY CREEK WATERSHED
W C REARING PONDS
Badger Hill
PLATE 4


WINDY CREEK WATERSHED
#1 W C REARING PONDS #2
PLATE 5


SCALE 1":0.7 MILES 1:90,500
CONTOUR INTERVAL 100 FEET
DOTTED LINES REPRESENT 50-FOOT CONTOURS
ROCKY RIVER WATERSHED
MOUNTAINS
ROCKY RIVER
WOODY DEBRIS STUDY AREA
STREAM RECLAMATION
R RIVER REARING POND &
SCURVY CR WATERSHED
PLATE 6


WINDY BAY 1"=1000' 5-19-93
ROCKY RIVER WATERSHED
R RIVER REARING POND & STREAM RECLAMATION
PLATE 7

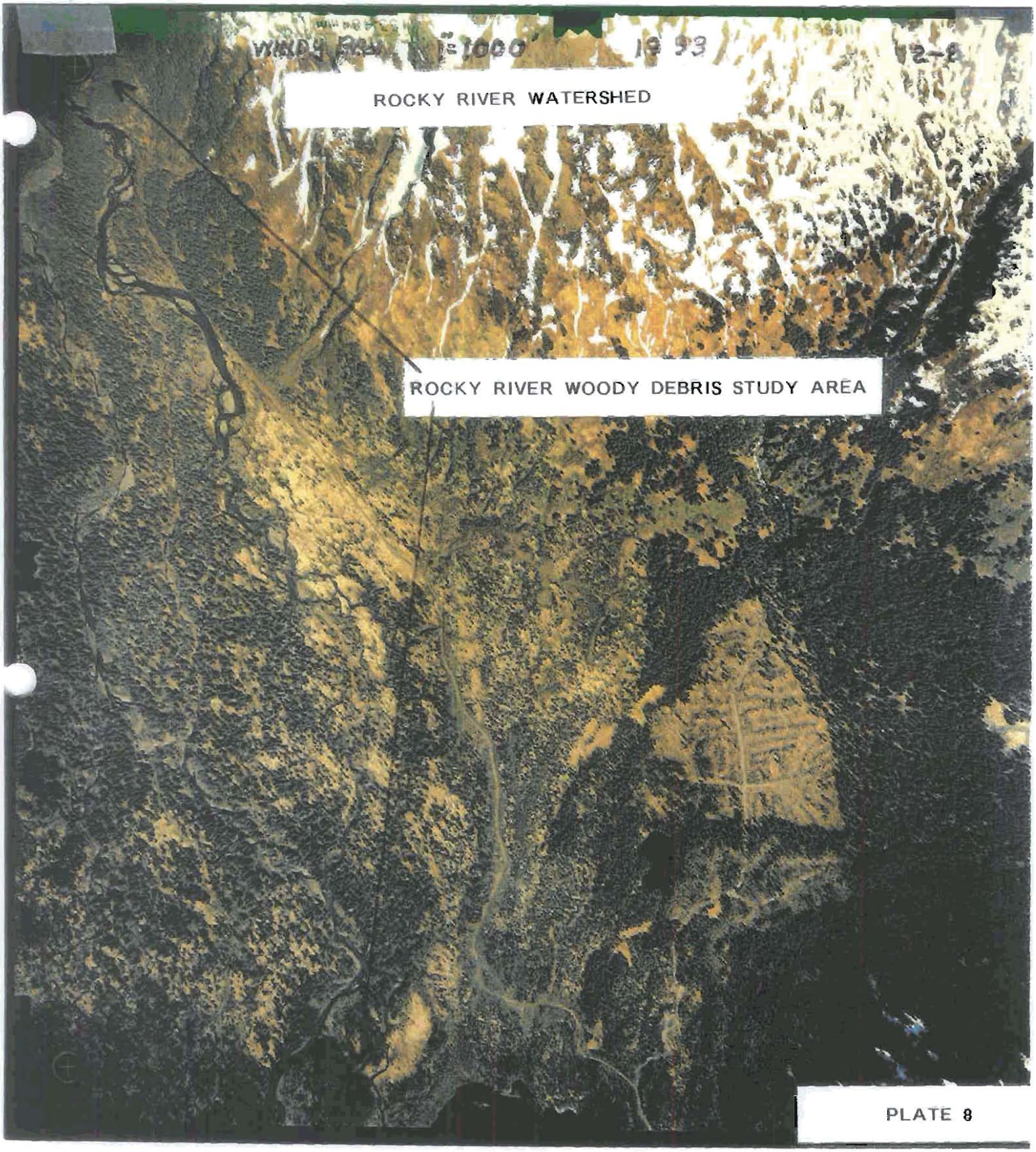
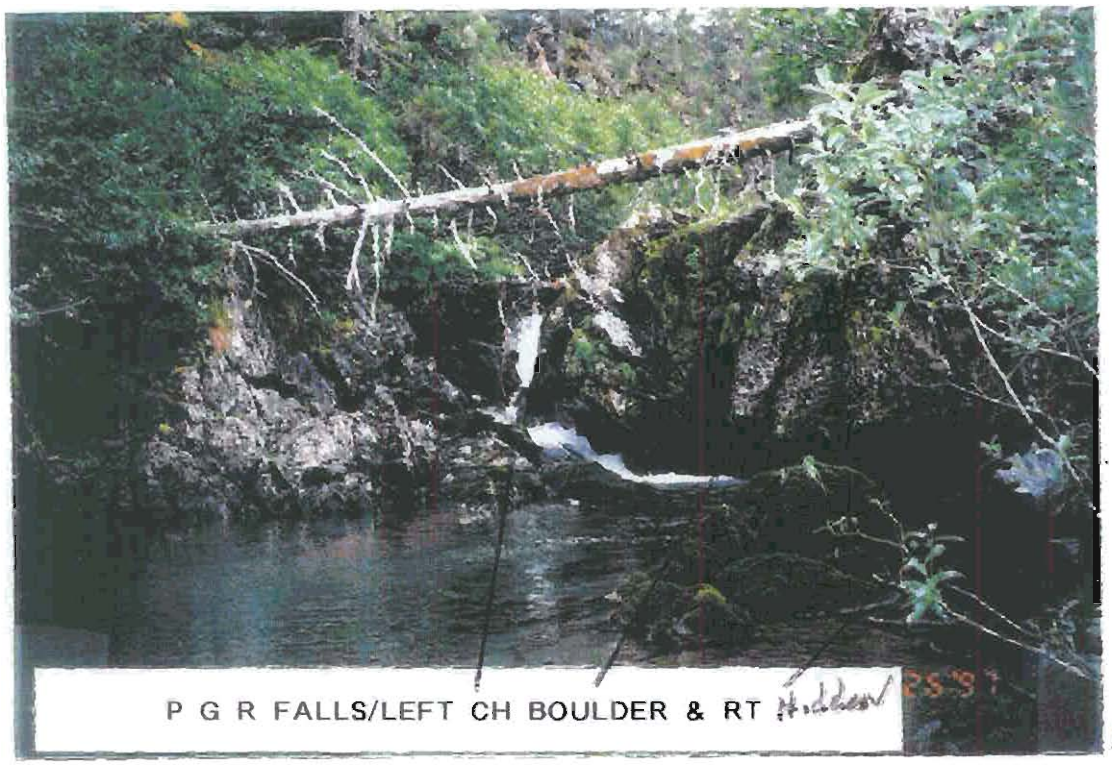
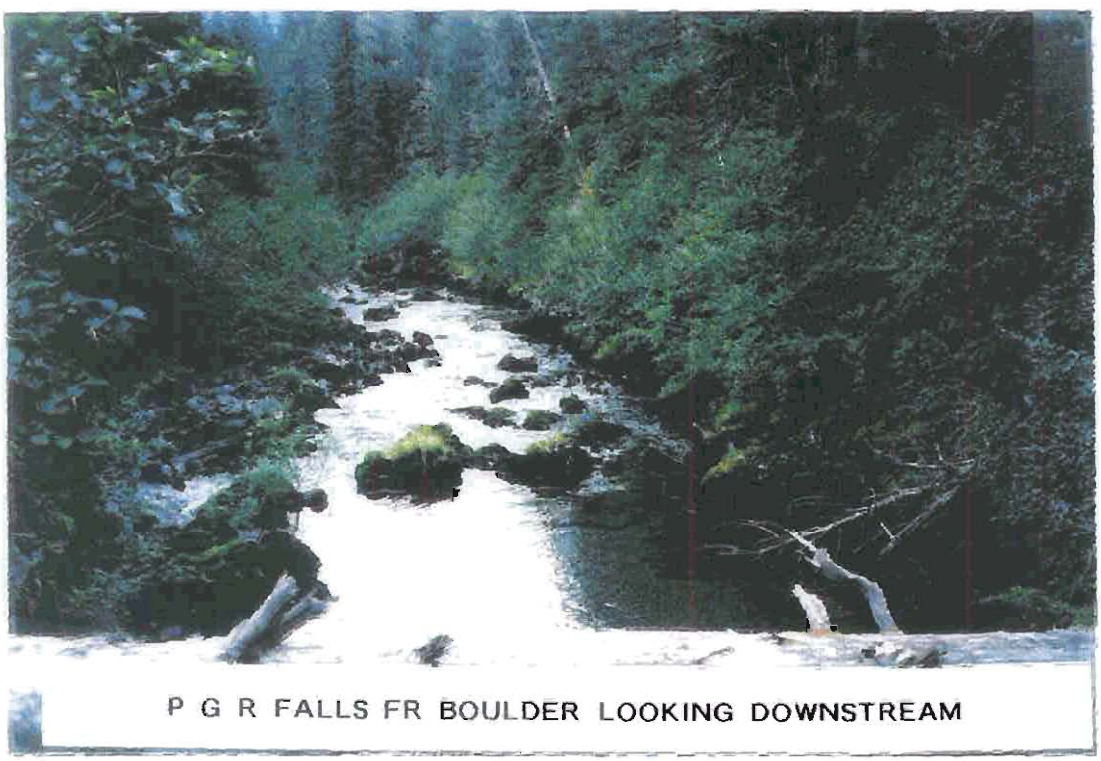


PLATE 8



P G R FALLS/LEFT CH BOULDER & RT

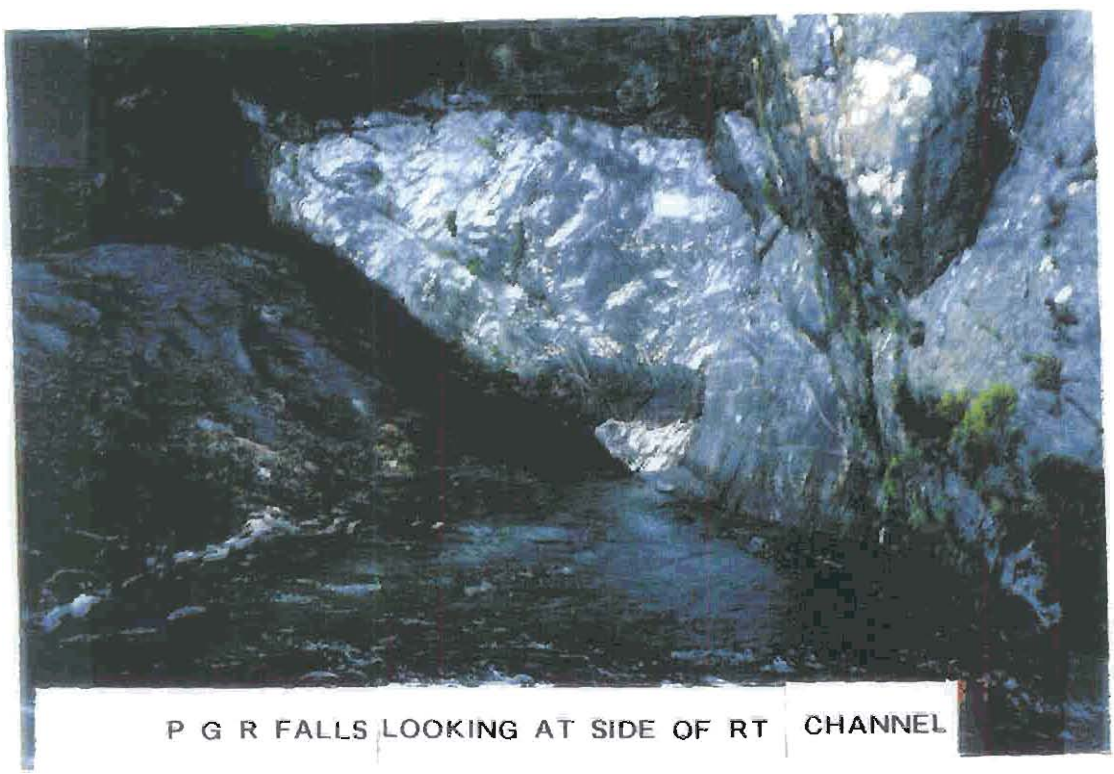
P#1



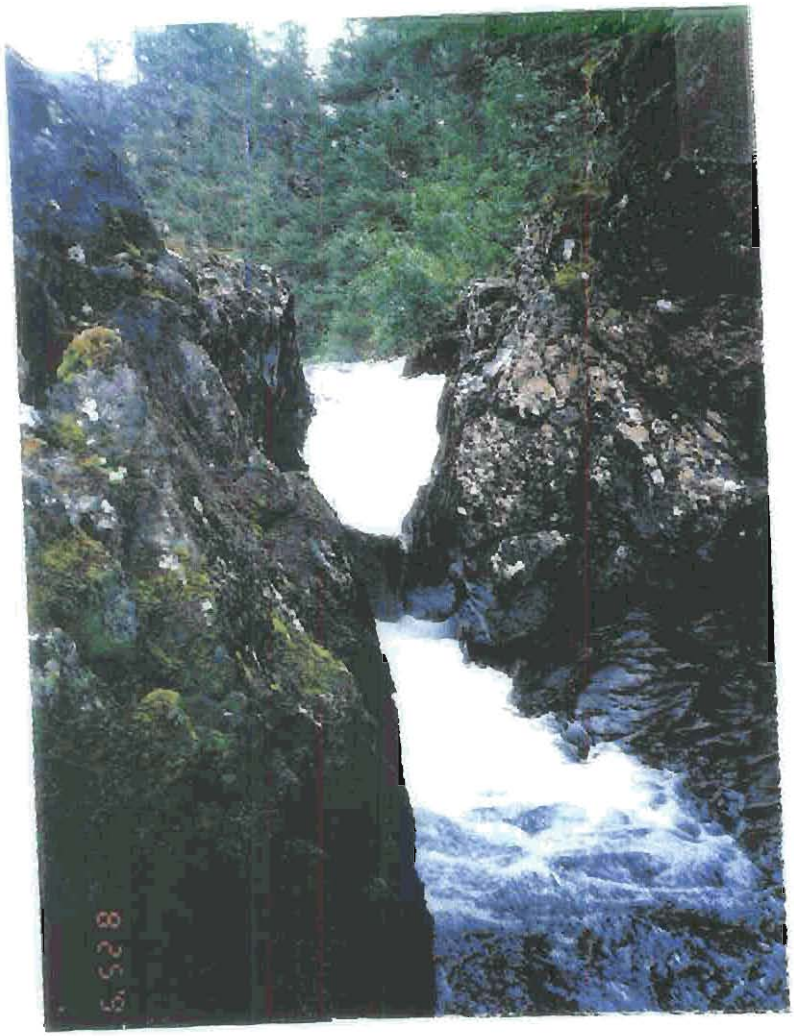
P G R FALLS FR BOULDER LOOKING DOWNSTREAM

P#2

P G R FALLS FR BOULDER LOOKING DOWNSTREAM P#3



P G R FALLS LOOKING AT SIDE OF RT CHANNEL P#4



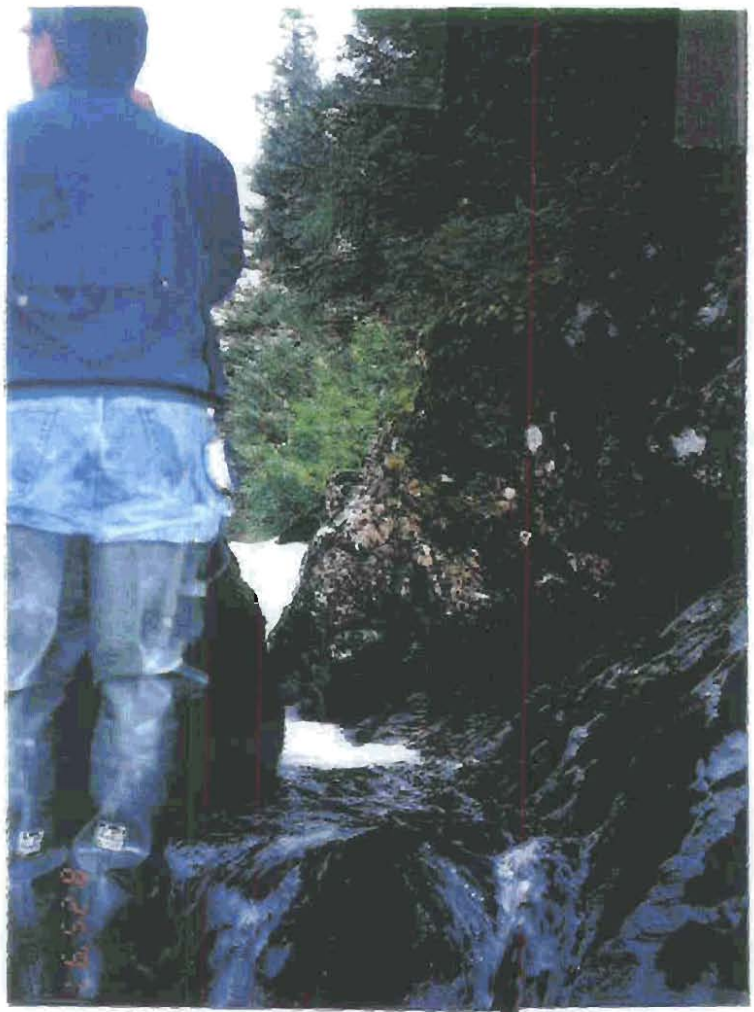
P#3

PG R FALLS RT CH LOOKING @ TOP

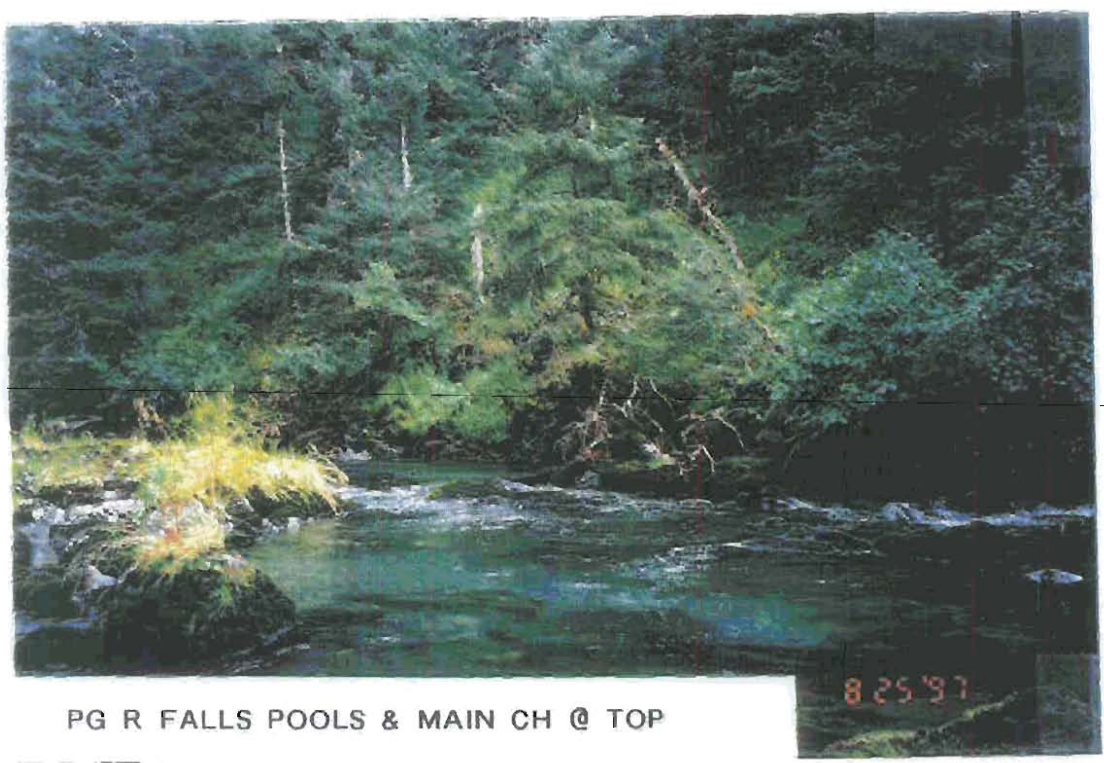
P#6

PG R FALLS POOLS & MAIN CH @ TOP

PLATE 10



PG R FALLS RT CH POOLS NEAR TOP



PG R FALLS POOLS & MAIN CH @ TOP

PORT GRAHAM RIVER WATERSHED ABOVE FALLS

POTENTIAL SPAWNING & REARING HABITAT

PLATE 12

WINDY CR LT DRY MEADOW

POTENTIAL REARING POND #1

WINDY CR LT DRY MEADOW

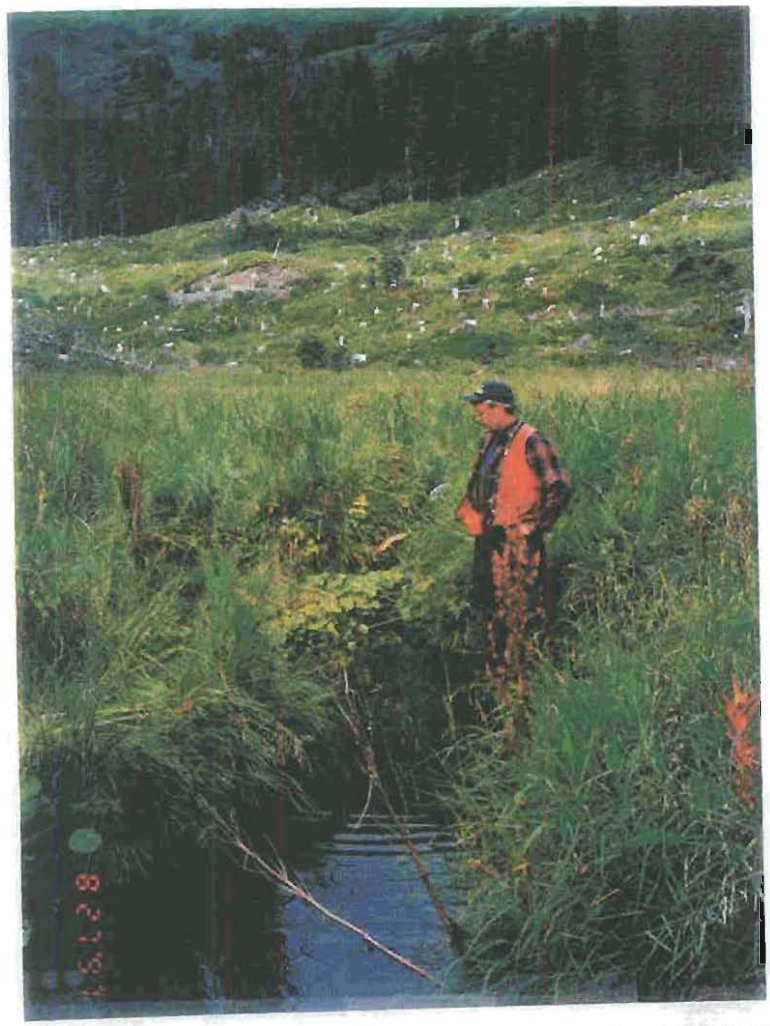
POTENTIAL REARING POND #2

PLATE 13

WINDY CR LEFT

WINDY CR LEFT NEAR POTENTIAL REARING POND #2

PLATE 14



STREAM IN POTENTIAL REARING POND #2 DR.MARTIN

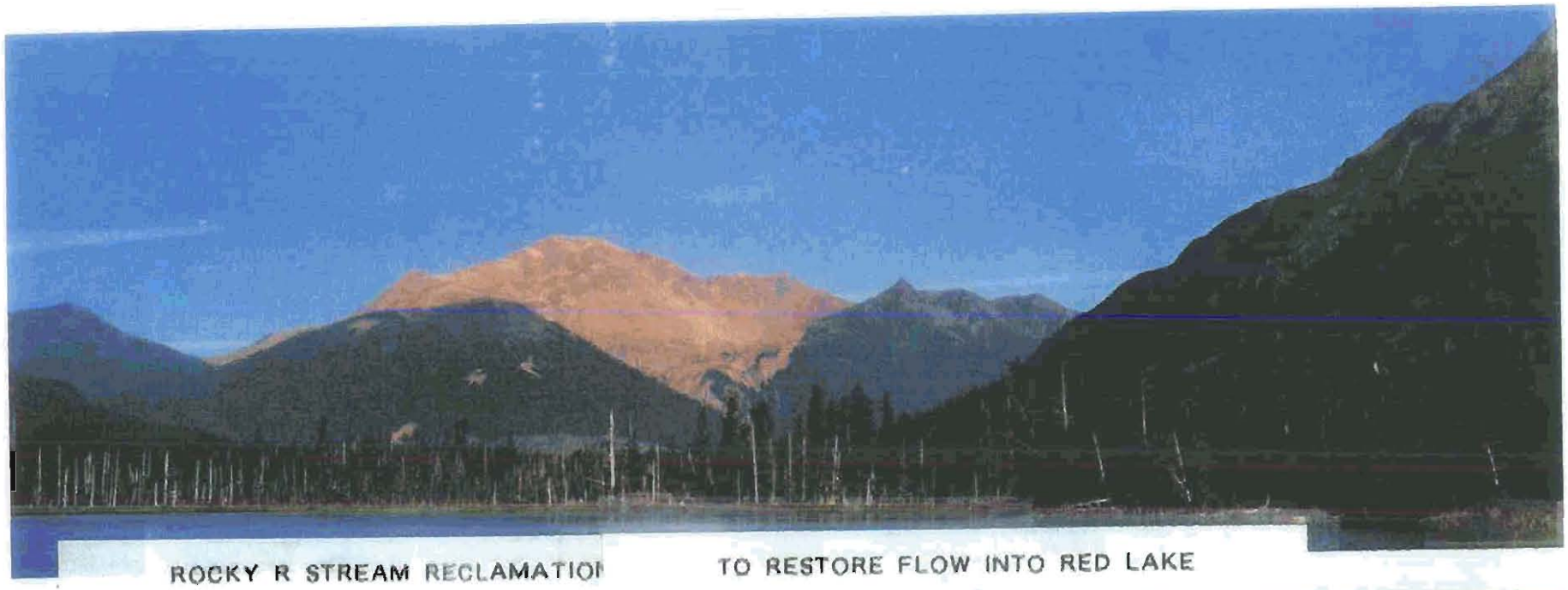
STREAM IN POTENTIAL REARING POND #2 PLATE 15

ROCKY RIVER REARING POND ENHANCEMENT

ROCKY RIVER REARING POND ENHANCEMENT

ARCHED CULVERT LOCATION TO RESTORE BLOCKED CHANNEL

PLATE 16


ROCKY R STREAM RECLAMATIOI
TO RESTORE FLOW INTO RED LAKE

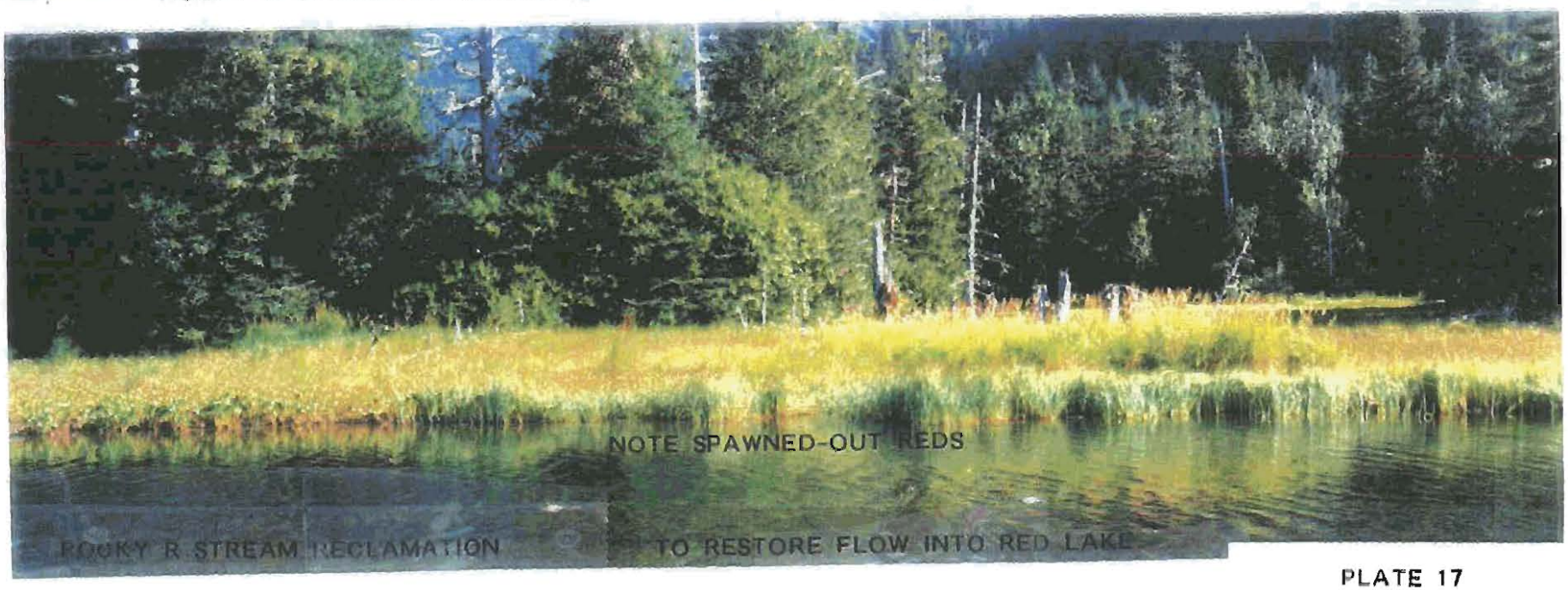

NOTE SPAWNED-OUT REDS
ROCKY R STREAM RECLAMATION
TO RESTORE FLOW INTO RED LAKE

PLATE 17