Pebble Project

NORTHERN DYNASTY MINES INC.

DRAFT ENVIRONMENTAL BASELINE STUDIES
2004 PROGRESS REPORTS

CHAPTER 11. FISH & AQUATIC HABITAT

NOVEMBER 2005

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ACRONYMS

AASHTO	American Association of State and Highway Transportation Officials
ABA	acid-base accounting
ac-ft	acre-feet
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADOT/PF	Alaska Department of Transportation and Public Facilities
agl	above ground level
AHRS	Alaska Heritage Resource Survey
ALS	ALS Environmental Laboratory
ANCSA	Alaska Native Claims Settlement Act
AP	acid potential
APE	area of potential effect
ASCI	Alaska Stream Condition Index
ASTM	American Society for Testing and Materials
ASTt	Arctic Small Tool tradition
BBNA	Bristol Bay Native Association
BEESC	Bristol Environmental & Engineering Services Corporation
BLM	Bureau of Land Management
BP	before present
ºC	degrees Celsius
^{14}C	Carbon 14
CEMI	Canadian Environmental and Metallurgical Laboratory
cfs	cubic feet per second
cm	centimeter(s)
CQ	continuous flow
CRM	cultural resources management
CUEQ%	copper equivalent grade
DEM	digital elevation model
DI	deionized
EBD	environmental baseline document
EIS	environmental impact statement
EPT	Ephemeroptera, Plecoptera, or Trichoptera
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration

FHWA	Federal Highway Administration
FL	fork length
fps	feet per second
FR	Federal Register
ft	foot (feet)
ft^2	square foot (feet)
GIS	geographic information system
GLM	general linear model
GMU	Game Management Unit
GPS	global positioning system
GS	gauging station
HC-3	high-gradient, contained channel
HDR	HDR Alaska, Inc.
HWM	high-water mark
ICP	inductively coupled plasma
IQ	instantaneous flow
KC	Kaskanak Creek
KR	Koktuli River Main Stem
L	liter(s)
LC-1	low-gradient, contained channel
LIDAR	light detection and ranging
m	meter(s)
m^2	square meter(s)
M.A.	Master of Arts
MC-1	moderate-gradient, narrow, shallow, contained channel
MCHTWG	Mulchatna Caribou Herd Technical Working Group
MDC	mine development concept
me-Hg	methyl-mercury
MEND	mine environment neutral drainage
mg	milligram(s)
mi^2	square mile(s)
ml	milliliter(s)
ML/ARD	metal leaching/acid rock drainage
mm	millimeter(s)
MM-1	moderate-gradient, mixed-control channel
MMS	Minerals Management Service
MODIS	moderate resolution imaging spectroradiometer
mph	miles per hour

µL	microliter(s)
NASA	National Aeronautics and Space Administration
NDM	Northern Dynasty Mines Inc.
NEPA	National Environmental Policy Act
NK	North Fork Koktuli River
NMFS	National Marine Fisheries Service
NP	neutralization potential
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
Nv	calculated variance
NWR	National Wildlife Refuge
OHMP	Office of Habitat Management and Permitting
OHW	ordinary high water
PA-1	narrow, placid-flow habitat
PA-3	shallow-ground, water-fed slough
PA-5	palustrine beaver habitat
PAG	potentially acid-generating
PSD	Prevention of Significant Deterioration
PVC	polyvinyl chloride
Q	discharge
QA	quality assurance
QAPP	quality assurance project plan
RBP	Rapid Bioassessment Protocols
SHPO	State Historic Preservation Officer
SK	South Fork Koktuli River
SRB&A	Stephen R. Braund & Associates
SRK	SRK Consulting (Canada) Inc.
SWE	snow/water equivalent
USC	United States Code
USDA	United States Department of Agriculture
USDI	United States Department of Interior
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UT	Upper Talarik Creek
VHF	very high frequency
WRIR	water-resources investigations report

11. FISH AND AQUATIC RESOURCES

11.1 Mine Area Fish and Aquatic Resources

11.1.1 Introduction

This section presents the findings of the 2004 fish resources study for the proposed mine area. The information presented is based on data collected during the 2004 field season. Although some data analysis has been conducted, it is important to note that additional data will be collected in 2005. The results presented here should be considered preliminary and are subject to change after additional data have been collected.

11.1.2 Study Objectives

The objectives of the fish resource study are as follows:

- Characterize the distribution and relative abundance of fish resources within and adjacent to the mine-site area in sufficient detail to provide information required for impact assessment and mitigation planning.
- Acquire predevelopment baseline data for comparison with post-development monitoring.

11.1.3 Study Area

The mine-site study area consists of a 10-mile radius around the ore body that encompasses the footprint(s) of current mine development alternatives. However, some study programs assess potential downstream effects and are not spatially limited to the footprint of the mine; examples are salmon-spawning surveys, qualitative habitat assessments, fish-tissue collection, and index-species monitoring. These study programs extend beyond the 10-mile study-area boundary to include the full length of the North Fork of Koktuli River (NK), South Fork of Koktuli River (SK), and Upper Talarik Creek (UT) (Figure 11-1).

11.1.4 Scope of Work

The research and field work for this study were conducted during 2004 and are ongoing. Additional field work is planned for 2005. The studies were conducted by HDR Alaska, Inc., Northern Ecological Services, and Buell and Associates. The study was conducted according to the approach described in the *Draft Environmental Baseline Studies, Proposed 2004 Study Plan* (NDM, 2004a).

Tasks associated with the 2004 field effort for fish and aquatic resources consisted of nine primary study efforts, which are briefly described below.

- **Winter Trapping**—Winter trapping occurred from April 10 through 16. Minnow traps were set throughout the three primary drainages within the study area. A total of 39 sample sites within various open-water habitats were sampled (Figure 11-2).
- **Spring Spawning Surveys—** Spawning surveys for arctic grayling and rainbow trout were conducted May 11 through May 14 and again June 1 through 4. A total of seven surveys were completed: two surveys on the upper reaches of the NK, four surveys on the upper reaches of the SK, and one survey on the upper reach of UT.
- **Summer and Fall Salmon-spawning Surveys (Chinook, Sockeye, Coho, and Chum)**—Seventeen aerial salmon-spawning surveys were conducted during 2004 in the three primary drainages. Spawning-salmon abundance was visually estimated. Between July 12 and October 13, the NK was flown six times. The SK was surveyed five times between July 18 and October 13, and the UT was surveyed six times between July 22 and October 14.
- **Population Estimate for Frying Pan Lake**—The 2004 mark-recapture study was conducted from July 9 to 20 (mark period) and July 29 to August 5 (recapture period).
- **Fish-tissue Sampling and Index-species Monitoring**—Fish-tissue sampling and index-species monitoring were completed at 16 stream sites and two lake sites in the mine study area (Figure 11-3).
- **Flow-Habitat Relationship Study**—Three site visits were completed in the 2004 field season. Nine to ten study sites were selected for each of the three major drainages (Figure 11-4): generally three riffles, three runs, two pools, and two island complexes. Additionally, a cross-section was collected in the SK in a reach affected by a beaver dam. Cross-section geometry, water-surface elevation, top width, and energy-slope measurements were collected.
- **Aquatic-habitat Mapping**—Aquatic-habitat mapping was completed on 11 streams in the mine study area. Geo-referenced digital video was completed for the full length of the NK, the SK, and UT.
- **Quantitative Abundance Sampling**—During the 2004 field effort, quantitative fish sampling was conducted within the mine study area (Figures 11-5 through 11-7).
- **Qualitative Abundance Sampling—**During the 2004 field effort, qualitative stream-sample sites were also investigated (Figure 11-8).

11.1.5 Methods

11.1.5.1 Review of Existing Information

The review of information relative to mine area drainages and the study area is ongoing. The information review for the mine study area includes all aspects of aquatic resources within the UT and Koktuli River drainages, including portions of drainages downstream from potential development areas, so that mine-area resources can be placed in the context of the overall watersheds. Information sources being gathered and reviewed include scientific literature, gray literature, resource-agency files, interviews with agency personnel, and interviews with local sport-fishing guides. A bibliography, developed to date, is provided in Appendix 11-A.

11.1.5.2 Overwintering Fish Survey

To identify overwintering habitat and establish fish use in the mine study area during winter conditions, minnow traps were set in open-water sections of the NK, the SK, and UT. During mid-April, a two-person team used a helicopter to gain access to open-water areas. At 39 discrete sample sites, three to four 1/4-inch-mesh minnow traps were baited with cured salmon eggs and set in open-water reaches. Traps were fished overnight, and then checked. All fish captured were identified by species, measured to fork length (FL), and released at the point of capture. In addition, general habitat observations were recorded.

11.1.5.3 Aquatic-habitat Mapping and Qualitative Characterization of Fish Use in the Study Area

Aquatic-habitat Mapping

Detailed habitat classification and mapping based on ground studies are not practical in the total study area because of the area's size and the abundance of waterbodies. In the outer study area, which is generally defined as more than 10 miles from the ore body, basic habitat mapping was conducted using low-level geo-referenced videography and available aerial photography. Post-processing of the geo-referenced video will create a habitat map of the mine area extending from the headwaters of the NK and the SK to the main stem of the Koktuli River and the full extent of the UT.

Qualitative Fish Sampling

Qualitative study techniques were emphasized in the outer study area. Building on information from studies completed in the early 1990s (Buell, 1991; 1993), qualitative investigations were conducted throughout the outer study area to document the general distribution and abundance of fish and aquatic habitats in both palustrine (stream) and lacustrine (lake) environments. The stream notation system (See Numbered Stream Reference Maps in Appendix 11-B) developed by Buell (1991) was used to provide consistency with previous studies. Stream sampling methods involved the use of a backpack electrofisher (Smith-Root Model LR-24), angling, and direct observation. In lake environments, angling and observation methods involved the use of a two-person crew who angled from nearshore areas of small lakes and ponds with the use of spinning tackle. The crew worked its way around the pond or lake until the entire shoreline had been traversed.

Sample sites were selected based on aerial reconnaissance and the need for additional information. To confirm preliminary baseline studies and fill in areas not previously sampled, sites included unstudied areas, as well as areas previously surveyed for comparison of earlier data to current fish use. Emphasis was placed on establishing the distribution limits of fish.

On the basis of stream-sampling methods employed by Buell (1991, 1993), a minimum effort generally encompassed a continuous sample reach of at least 100 feet in length or until it was felt that a representative determination of fish distribution and habitat characteristics had been obtained. Within each sample reach, general habitat characteristics were recorded and all fish captured were identified, measured to FL, and released at the point of capture. Sample locations were marked using global positioning system (GPS) coordinates.

11.1.5.4 Quantitative Characterization of Fish and Aquatic Habitats

A more detailed level of study occurred in areas that may be directly affected by proposed mine-development alternatives. Such areas included the proposed mine pit, as well as alternatives for tailings-disposal sites.

11.1.5.5 Aquatic-habitat Mapping

Streams in the proposed mine-pit area and in proposed tailings-disposal sites received the greatest attention, including all streams and ponds flowing south into Frying Pan Lake, upper reaches of the SK, upper reaches of the main stem of UT, selected tributaries of UT, and areas that may be directly affected by mine development located in the NK drainage. These areas were surveyed on foot by using stream-habitat survey methods adapted from the *Aquatic Habitat Management Handbook* developed by the U.S. Forest Service (USFS, 2001). This handbook establishes standard quantitative methods for aquatic ecologists conducting fish and aquatic stream-habitat surveys in coastal Alaska. Method protocols are described in detail and address specific needs. A modified Tier II survey was used for the areas described above and included measurement and/or description of stream length, habitat distribution, habitat surface area, channel type, presence of bank cover, and presence of woody debris. Cross-sectional geometry and flow were also measured at selected locations along each stream reach.

11.1.5.6 Quantitative Fish Sampling (Removal Sampling)

Within stream habitats, abundance or density of fish was estimated in a subsample of habitat units following the method of Hankin and Reeves (1988). A subsample of habitat units (such as pools, riffles, and runs) was selected at a sample frequency of every fifth pool, fifth glide, and tenth riffle. The fish numbers and density per unit of surface area were then estimated in each unit. Average fish density in each habitat unit could then be calculated, and overall fish abundance in the waterbody could be estimated by extrapolating over the full stream reach. Fish-density estimation methods for streams included electrofisher total counts and electrofisher removal method. In some small streams with uniform habitat distribution, sampling was conducted by representative reach, rather than by habitat unit.

11.1.5.7 Frying Pan Lake Population Estimate

In Frying Pan Lake, the number (population) of northern pike was estimated using the mark-and-recapture method. Frying Pan Lake was divided into three sectors, and hoop-net traps (one net per sector) with wings and a center lead were deployed perpendicular to the shoreline. All traps were checked once daily. All northern pike were released immediately after capture and data collection.

Northern pike were measured to the nearest 1-millimeter (mm) FL, and a minimum of two scales were removed from the preferred zone adjacent to the lateral line above the pelvic fins, as described by Williams (1955). All fish larger than 300 mm were inspected for the presence of a tag. If none was found, the fish was tagged, and a small section of the upper lobe of the caudal fin was removed as a secondary mark to identify any tag loss during the recapture event. All captured northern pike with an FL greater than 300 mm were tagged using individually numbered T-bar anchor tags. Scales collected in the field were placed on gummed cards and sent to the Alaska Department of Fish and Game (ADF&G) laboratory in Fairbanks for aging.

Stratified Population Analysis System software (Arnason et al., 1996) was planned for use in analyzing mark-and-recapture data; however, comments by agency personnel indicated that a less rigorous population estimator would be satisfactory. Therefore, estimated abundances of northern pike in Frying Pan Lake will be calculated by using the Chapman estimator (Seber, 1982).

11.1.5.8 Spawning Surveys

Spring Spawning Surveys—Arctic Grayling and Rainbow Trout

Angling surveys were conducted in the headwaters of the NK and SK drainages (streams flowing into Frying Pan Lake) and the headwaters of UT to locate arctic-grayling and rainbow trout spawning areas. Two surveys were conducted during the immediate post-breakup period from May 11 through 14 and June 1 through 4.

Summer and Fall Salmon-Spawning Surveys—Chinook, Sockeye, Coho, and Chum

Aerial surveys for adult salmon were conducted from a low-flying helicopter during the spawning season to determine distribution and estimate the number of spawners. A total of 17 salmon-spawning surveys were conducted in an attempt to observe the spawning peaks. During most surveys, the full length of the NK, the SK, and UT were surveyed; however, poor weather conditions occasionally prevented the survey from covering the entire length of each stream. Salmon were counted by species, and GPS waypoints were entered at each spawning location. Live fish and carcasses were counted separately.

Constants relating peak abundance to escapement for each species were unavailable from ADF&G for the study area. Peak abundance estimates will instead be estimated by comparing peak run timing at the ADF&G weir on the Nushagak River and other spawning-survey data collected in the study area.

11.1.5.9 Fish-tissue and Index-species Monitoring

A total of 16 monitoring sites were established in the three primary drainages of the proposed mine area to document measurable baseline conditions and to provide a means of comparing stream conditions from year-to-year. Standard monitoring procedures using minnow traps were established and can be repeated at each station and will provide reliable quantitative comparisons between sampling events.

Sixteen stream and two lake monitoring sites were selected to provide a basis for detecting potential changes in the primary drainages over time. Monitoring at standard locations will allow a determination of homogeneity, heterogeneity, or both of the study area and will establish intra-annual variation. Fish index-species monitoring sites were co-located with sampling sites for each of five principal monitoring parameters: water quality and quantity, fish tissue, periphyton, macroinvertebrates, and sediment. In general, sites were distributed so that some are upstream of mineralized areas and/or zones of potential man-made influence (potential reference sites), some are in zones that might be affected by mine development, and some are downstream from the mine area.

Stream-Monitoring Procedures

The following measurements and or sampling procedures occurred at each of the stream-monitoring sites (unless otherwise noted):

- **Site Description**—During the first sampling session, stream morphology and aquatic habitats within a 200-meter (m) reach surrounding the ore body were recorded.
- **Standardized, Repeatable Fish Monitoring**—Standard fish monitoring targeted juvenile salmonids, if present, and consisted of capture using 1/4-inch-mesh steel minnow traps baited with salmon eggs. Ten traps were set at 16 locations in a variety of habitat types. Traps were fished for about 24 hours. Captured fish were identified, counted, measured, and released. Catch per unit effort will be calculated for each sample event. In the event that sites were selected in areas where key fish species were not vulnerable to trap capture, alternative means of capture (such as electrofisher and nets) were used. Level of effort was standardized in a manner that was appropriate for the technique and sample site.
- **Fish-tissue Sampling: Ecological Indicators**—Fish tissues were sampled for trace elements to create a baseline against which post-development changes might be measured. One or more fish species were selected for each monitoring site and sampled for tissue metals analysis, in accordance with procedures adopted by ADNR for use at Red Dog, Greens Creek, Fort Knox, and other mines in Alaska. Juvenile salmonids were selected as key species based on abundance. A total of 10 discrete whole-body samples were collected for individual analysis to provide an adequate measure of variability. Individual sample fish were placed directly into Ziploc bags with minimal handling by gloved personnel, frozen at the earliest opportunity, and transported to an analytical laboratory under standard chain-of-custody procedures. Parameters to be analyzed were consistent with those listed in the *Pebble Gold Copper Project 2004 Quality Assurance Project Plan* (NDM, 2004b).
- **Fish-tissue Sampling: Human consumption**—Fish tissues from species potentially consumed by humans in recreational or subsistence fisheries were sampled for naturally occurring constituents to create a baseline against which project-induced changes might be measured. Emphasis was placed on methyl-mercury (me-Hg) due to elevated concentrations of this compound in fish tissues elsewhere in western Alaska. Tissue sampling from adult fish occurred in Big Wiggly and Frying Pan lakes. The fish species sampled in 2004 was northern pike because of its position as an apex predator, and concentrations of certain naturally occurring constituents are more elevated in northern pike than in other species. It was originally planned to collect arctic grayling and/or whitefish in lakes because of their use in subsistence and sport fisheries; however, in the lakes sampled, neither species was taken in sufficient numbers to permit sampling.

For fish-tissue sampling, liver and muscle tissues were removed for analysis using field dissection techniques. Muscle was sampled because this tissue is generally consumed preferentially by humans, and because muscle generally contains the highest concentrations of naturally occurring constituents, especially me-Hg. Liver was sampled because this organ is the site of demethylation of me-Hg, generally resulting in measurable concentrations of this compound. There is an existing and potentially complementary database for both muscle and liver from northern pike in western Alaska.

The following procedures were used during fish dissection:

1. Immediately upon capture, fish were placed in clean plastic bags and placed in a cooler with ice.
2. Dissection occurred inside at a clean site in Iliamna.

3. Prior to dissection, the cutting surface was washed with soap and water and covered with heavy duty aluminum foil.
4. Stainless steel knives were used for dissection. Knives were washed with soap and water and rinsed with deionized water between uses.
5. A sample of liver and muscle tissue was extracted from each fish and placed in an individually labeled Ziploc bag. Tissue samples were immediately placed in a freezer.
6. An equipment blank was prepared after each set of dissections by rinsing the cutting surface and the knives with deionized water and collecting the deionized rinsate in an acid-washed jar.
7. Frozen tissue samples were packaged in a cooler and sent to the laboratory using packaging recommendations provided by the laboratory. Chain-of-custody procedures were followed.

11.1.5.10 Flow-Habitat Relationships

Flow-habitat study sites were established for each major mesohabitat type identified in each of the SK, the NK, main stem of Koktuli River, and UT. The downstream limits of the study sites were set based on the 10 percent flow-change location (Bovee, 1982), developed using drainage area methods. Whenever reasonable, the study sites were established within reasonable distance of long-term hydrology stations. Each instream flow-study site was visited three times: in June to set up the stations and take initial measurements, in July, and in August.

At each site, measurements were taken using the following methods:

- **Establishment of temporary benchmarks—**Vertical-elevation-control and horizontal-profile data were obtained through use of standard differential engineering-survey methods. A Lietze/Sokkisha BC2 Automatic Level was employed for differential observation and collection. Because of a lack of a published vertical-control datum in the study area, temporary benchmarks were set for vertical control with an assumed elevation of 100.00 feet at each study site. Two benchmarks were set at each study site, except some of the study sites shared vertical benchmarks because of the sites proximity to each other. The benchmarks were marked with fluorescent paint and flags, and their locations were geospatially recorded with a hand-held GPS unit.
- **Establishment of headpins and tailpins—**Headpin (bank right-facing downstream) and tailpin (bank left-facing downstream) locations for each study site were set well above bank-full flow elevation to describe the primary floodplain. These locations created a cross-section line perpendicular to the dominant streamflow direction. The pins were set with 1/2-inch rebar and marked with fluorescent paint, flags, and painted lath, and the location of each headpin was geospatially recorded with a hand-held GPS unit.
- **Collection of stream geometry data—**A fiberglass survey tape ("rag tape") was attached and pulled taut between headpin and tailpin to create a chord. In the floodplain, a survey rod was traversed along the rag tape manually to vertical inflection points. The horizontal distance and vertical elevation were observed and recorded at these points. In the active stream channel, all major inflection points were surveyed.
- **Collection of water-surface elevation data—**Water-surface elevations also were collected using protocol described in Bovee et al. (1998). On most occasions, three water-surface elevations were

collected at left, center, and right side; more water-surface elevations were collected when the flow was very turbulent, and water-surface elevations were not collected in areas of zero flow or low terraces. Average water-surface elevations at each cross-section during each monitoring event were calculated by averaging the measured water-surface elevations after outliers had been omitted from the data set.

- **Collection of top-width data—**A fiberglass survey tape was pulled taut between the headpin and tailpin to create a chord. The distance between the edge of water on each side of the stream was calculated and recorded.
- **Collection of hydraulic-slope data—**Hydraulic slope was determined for each study site by using the known distances between the cross-sections and the average upstream and downstream water-surface elevations.

11.1.6 Results and Discussion

11.1.6.1 Winter Trapping

Winter trapping occurred from April 10 through 16 in the three primary drainages. A total of 39 sample sites in various open-water habitats were sampled (Figure 11-2). Trapping results for each primary drainage are shown in Table 11-1.

TABLE 11-1
Winter Trapping Results

Drainage	Species	Number Captured
North Fork Koktuli River	Coho	19
	Dolly Varden	17
	Sculpin	9
	Threespine stickleback	0
	Ninespine stickleback	11
South Fork Koktuli River	Coho	5
	Dolly Varden	17
	Sculpin	34
	Threespine stickleback	10
	Ninespine stickleback	2
Upper Talarik Creek	Coho	23
	Dolly Varden	15
	Sculpin	14
	Threespine stickleback	2
	Ninespine stickleback	1
	Chinook	1
	Rainbow trout	1

Winter trapping occurred during early breakup conditions. Main channels in the three primary drainages contained flowing water. Peak breakup flows had not yet occurred, and most tributaries were still frozen

over. Access to open water in main channels was considered good, and based on the overall condition in the study area, it was thought that fish were still holding in overwintering habitats.

Catch rates in all three primary drainages were low. Overall, sculpins were the most abundant species captured, followed by Dolly Varden, coho, ninespine stickleback, and threespine stickleback. One chinook and one rainbow trout were captured in the UT drainage.

It is possible that trap avoidance was occurring or that fish were entering the traps and were able to escape. Additional steps such as electrofishing and shorter soak times will be employed in 2005 to determine whether avoidance or escapement was occurring.

11.1.6.2 Spring Spawning Surveys—Arctic Grayling and Rainbow Trout

Spawning surveys for arctic grayling and rainbow trout were conducted from May 11 through 14 and from June 1 through 4. A total of seven surveys were completed: two surveys on the upper reaches of the NK, four surveys on the upper reaches of the SK, and one survey on the upper reach of UT. Surveys were conducted on foot using angling, direct observation, and aerial observation. Arctic grayling were captured and observed in the NK, the SK, and the upper reaches of UT. None were in spawning condition. Arctic grayling that were captured by angling ranged in size from 285 to 346 mm. Electrofishing conducted later in the inner study area produced age-zero arctic grayling, suggesting that grayling spawning occurs in the inner study area. No rainbow trout were captured or otherwise observed.

11.1.6.3 Summer and Fall Salmon-spawning Surveys

A total of 17 salmon-spawning surveys were conducted over the entire lengths of the main stem of the UT, NK, and SK. Table 11-2 presents salmon-spawning survey results for each drainage. Please note that aerial spawning-survey results are an index of overall spawning abundance in the project area and are not intended to serve as escapement estimates.

TABLE 11-2
Spawning Survey Results—Number of Adults (Live Fish)

Drainage	Date	Chinook	Sockeye	Coho	Chum	Dolly Varden
North Fork Koktuli River	7/12/2004	1,495	435		435	
	7/27/2004	3,555	563		20	
	8/30/2004	1,788	473			
	9/5/2004			300		
	9/21/2004			391		
	10/13/2004			211		500
South Fork Koktuli River	7/18/2004	2,230	1,379			
	7/27/2004	2,780	1,439			
	8/3/2004	2,468	1,953			
	10/2/2004			270		
	10/13/2004			101		

Drainage	Date	Chinook	Sockeye	Coho	Chum	Dolly Varden
Upper Talarik Creek	7/22/2004	83	29,474			
	8/1/2004	272	32,702			
	9/5/2004			3,121		
	9/21/2004			1,482		
	10/3/2004			513		
	10/14/2004			305		

11.1.6.4 North Fork Koktuli River Spawning Surveys

Chinook Salmon

The first spawning survey occurred on July 12. Both chinook and sockeye were observed moving upriver, with chinook being more abundant than sockeye. During this survey, 1,495 chinook were observed. Behavior of the chinook during the July 12 survey showed that they were still moving upriver and had not yet begun to spawn. A limited number of carcasses were observed. The July 27 survey appears to have occurred during the peak spawning period for chinook. Active redd-building and spawning behaviors were observed, and carcasses were more abundant than during the previous surveys. A total of 3,555 fish were observed during the July 27 survey. The August 30 spawning survey appears to have taken place after peak chinook spawning; the number of live fish, 1,788, was about 50 percent less than on July 27, and more carcasses were observed than during the previous survey. During the July 27 survey, 12 chinook were observed in the NK reach above Big Wiggly Lake.

Sockeye Salmon

During the July 12 survey, sockeye were moving upriver although no spawning or redd-building behavior was observed. During the July 27 spawning survey, the number of sockeye observed was greater than during the previous survey, with the majority of sockeye observed in the lower reaches of the NK closer to the confluence of the north and south forks. Active spawning was observed in these lower reaches, primarily in riffle habitats. The August 30 survey counted 90 fewer fish than the July 27 survey and likely occurred after the peak spawning period. This assumption is supported by the occurrence of peak counts on the SK on August 3. During the August 30 survey, six sockeye were observed in Big Wiggly Lake.

Coho Salmon

Coho were first observed in the NK on September 5, when 300 coho were observed in the lower reaches. On September 21, 391 coho were counted and no carcasses were observed in the upper reaches. Because of bad weather conditions, the lower reaches of the NK were not surveyed. On October 13, 211 coho were counted and 66 carcasses were observed, indicating that the peak spawning period likely occurred in late September, near the time of the previous survey or shortly thereafter. No actual spawning behavior or redd building was observed, but several pairs were identified during the last two surveys. During the September 21 survey, six live coho were observed in Tributary 1.190 (G—Impoundment).

Chum Salmon

The NK supports a run of chum salmon. During the July 12 spawning survey, 435 chum salmon were observed in the middle to lower reaches of the NK; many of the fish were in post-spawn condition. Active spawning behavior was not observed, indicating that by July 12, spawning was for the most part over. On July 27, only 20 live chum salmon were observed.

Dolly Varden

Large Dolly Varden were observed during coho-spawning surveys. On October 13, 500 Dolly Varden were counted over the length of the NK and a 1-mile reach of the main stem Koktuli River. A large school of Dolly Varden (more than 150 fish) was observed at the confluence of the NK and the SK.

11.1.6.5 South Fork Koktuli River Spawning Surveys

Chinook Salmon

The first spawning survey occurred on July 18. Similar to the NK, on the SK, sockeye salmon also were observed moving upriver with chinook. On July 18, 2,230 live chinook and six carcasses were observed. During this time, fish were not paired up and were still moving upriver in fairly large schools. The July 27 survey tallied 2,780 chinook. Redd building and active spawning was observed during this survey, and a total of 124 carcasses were observed. Because of the large size of the sockeyes, it was difficult to determine the species of carcasses. Most of the observed carcasses were thought to be chinook because the sockeye were not yet exhibiting spawning behavior. On August 3, 2,468 live chinook and 901 carcasses, most of which were thought to be chinook, were counted in the SK. This information indicates that peak spawning activity likely occurred during the last week in July. It should also be noted that intermittent flow occurs in parts of the SK above SK Tributary 1.190.

Sockeye Salmon

The sockeye surveys occurred at the same time as the chinook surveys. Sockeye were more abundant in the SK than in the NK. A survey conducted on July 18 counted 1,379 live sockeye and limited carcasses. The surveys conducted on July 27 and August 3 counted 1,439 sockeye and 1,953 live sockeye, respectively. On August 3, carcasses counts were high, totaling 904 fish, most of which were thought to be chinook. Peak sockeye spawning appears to have occurred toward the end of the first week of August.

Coho Salmon

Coho were observed during the October 2 and 13 surveys, which counted 270 and 101 fish, respectively. The large decline in abundance between the surveys appears to indicate that peak spawning occurred on or before October 2.

Chum Salmon

No chum salmon were observed on the SK.

Dolly Varden

No Dolly Varden were observed on the SK.

11.1.6.6 Upper Talarik Creek Spawning Surveys

Chinook Salmon

The first spawning survey occurred on July 22. Both chinook and sockeye were observed moving upstream. Sockeye were more abundant than chinook, of which only 83 were observed. The July 29 survey was not completed because of extremely poor visibility. Although three chinook were observed, the data are not presented in Table 11-2 because they are incomplete. During the August 1 chinook survey, 272 live fish and 301 carcasses were observed. No chinook were observed during the September 5 spawning survey.

Sockeye Salmon

The first spawning survey occurred on July 22 and 29,474 sockeye were observed. (Because of the large number of fish present, fish counts are estimates based on aggregate density versus individual fish counts.) Both sockeye and chinook were using the UT during this time, and 14 carcasses were observed. These mortalities were most likely chinook because the run had reached its peak spawning. The July 29 survey was shortened because of extremely poor visibility, and only 20 sockeye were observed. These data are not presented in Table 11-2 because they are incomplete. Comparing survey numbers, peak sockeye spawning may have occurred during or near the August 1 spawning survey at which time 32,702 sockeye were observed in the UT.

Coho Salmon

Coho spawning surveys began on September 5, at which time 3,121 coho were counted, including an estimated 500 fish at the mouth of the UT. During the September 21 survey, 1,482 coho were observed, of which 400 coho were observed on the northeast tributary (UT 1.305). This count is thought to be low because of overcast conditions and poor visibility. The next survey was conducted on October 3, when 513 live fish and 12 carcasses were observed. This total includes counts on the northeast tributary, UT 1.350. During the final coho survey conducted on October 14, 305 live fish and 52 carcasses were observed. Peak spawning is likely to have occurred during or before the September 5 survey.

Chum Salmon

No chum salmon were observed on the UT.

Dolly Varden

No large Dolly Varden were observed on the UT.

11.1.6.7 Population Estimate in Frying Pan Lake

A Petersen mark-recapture study was conducted in Frying Pan Lake to approximate the abundance of northern pike. The sampling results were analyzed using the Chapman estimator. During the mark period,

46 northern pike were captured, marked, and released alive. During the recapture period, a total of 61 fish were examined for marks; 10 of the fish (recaptures) were tagged.

Northern pike abundance was estimated to be 264 fish, with a calculated variance (Nv) of 69. This calculated abundance equates to a density of 2.0 fish per hectare. The population-abundance estimate variance is high because of the low sample size. The low sample size is likely a result of conducting the mark-recapture too late in the summer (July) and the associated higher water temperatures.

Population Estimate Results:

M = (46) number of northern pike marked and released alive during marking event

C = (61) number of northern pike examined for marks during the recapture event

R = (10) number of northern pike recaptured during the recapture event

N = estimated abundance of northern pike at the time of marking

Abundance:

$$N = \frac{(M+1)(C+1)}{R+1} - 1 = \frac{(46+1)(61+1)}{10+1} - 1 = 264$$

Data from scales collected in the field and sent to the ADF&G laboratory in Fairbanks for aging will be reported later.

11.1.6.8 Fish-tissue and Index-species Monitoring

Fish-tissue sampling and index-species monitoring were completed at 16 stream sites and two lake sites (Figure 11-3—please note that the site labeled “Previous NK100B” on the figure was dropped from the sampling program). The laboratory results for the fish-tissue sampling and analysis of the data will be presented at a later time. Index-monitoring species were established in the three primary drainages of the proposed mine area to document measurable baseline conditions for species composition and relative abundance and to provide a means of comparing stream conditions from year-to-year. The index-monitoring species identified at each stream-sampling site are listed in Table 11-3 and were used for tissue analysis. For salmon, only juveniles were collected because the juvenile life stage is spent in the same general area until out-migration to sea and trace element in juvenile tissues are reflective of local geochemical conditions. Some sub-adult resident fish (i.e., arctic grayling) also were sampled and should also contain trace elements reflective of the local geochemical conditions.

TABLE 11-3
Fish Index and Tissue Species

Site	Index Species[1]
North Fork Koktuli River	
NK-100A	Coho, chinook
NK-100B	Coho, chinook, Dolly Varden
NK-100C	Coho, Dolly Varden , arctic grayling
NK-119A	Dolly Varden
South Fork Koktuli River	
SK-100A	Coho, chinook
SK-100B	Chinook, Dolly Varden
SK-100C	Dry stream
SK-100F	Arctic grayling
SK-100G	Arctic grayling
SK-119A	Coho, Dolly Varden
Upper Talarik Creek	
UT-100B	Coho
UT-100C	Coho, rainbow trout
UT-100D	Coho, Dolly Varden
UT-100E	Dolly Varden
UT-119A	Dolly Varden
Kaskanak Creek	
KC-100 A	Coho

1. All index species are juvenile salmon or sub-adult resident fish

11.1.6.9 Flow-Habitat Relationships

Flow-habitat stations (Figure 11-4) were set up for 40 sites, which are listed in Table 11-4.

At each station, two temporary benchmarks were set and their relative elevations recorded. Each site included a headpin and tailpin that created a line across the stream perpendicular to the dominant flow line. The headpins and tailpins were marked by steel rebar and with GPS coordinates. Each site was visited three times, and the following parameters were measured using the methods described in Subsection 11.1.5.10: water-surface elevation, channel geometry, top width, and hydraulic slope.

After each field trip, the survey data were downloaded into electronic spreadsheet files. This information will be compiled following collection of the 2005 data to develop stage-discharge curves and flow-habitat relationships.

TABLE 11-4
Flow-Habitat Stations

Mesohabitat Type	Number of Study Sites
North Fork Koktuli River	
Riffle	3
Run	3
Pool	2
Island Complex	2
South Fork Koktuli River	
Riffle	3
Run	3
Pool	2
Island Complex	3
Main Stem Koktuli River	
Riffle	2
Run	3
Pool	2
Island Complex	2
Upper Talarik Creek	
Riffle	3
Run	3
Pool	2
Island Complex	2

11.1.6.10 Aquatic-habitat Mapping

Detailed aquatic-habitat mapping was completed on 11 stream reaches in the study area. Geo-referenced digital video was completed for the full lengths of the NK, the SK, and the UT.

Geo-referenced Digital Video

Geo-referenced video was completed for the entire lengths of the NK, the SK, and the UT. Post-processing of the geo-referenced video will occur at a later time.

Aquatic-habitat Mapping

The Tier II stream-habitat survey was conducted on 11 stream reaches in the main stem Koktuli, tributaries of the NK and the mainstem of the SK upstream of SK1.240, and on the upper reaches of the UT adjacent to the proposed mine. The aquatic-habitat mapping effort will provide consistent, quantitative estimates of habitat parameters necessary to evaluate the conditions of a stream. Metrics included habitat parameters that are subdivided into hierarchal levels and channel cross-sectional morphology.

Approximately 22,400 meters of macro-habitat (pools, riffles, and glides) and 1,300 meters of side-channel habitat were surveyed. Channel morphology cross-sections were completed in all three primary drainages for each channel type.

The NK channel types were predominately moderate-gradient, narrow, shallow, contained channel (MC-1) and low-gradient, contained channel (LC-1) with sections of palustrine beaver habitat (PA-5). Three channel morphology cross-sections were completed along the MC-1 and LC-1 channels. Additionally, in the NK, 153 habitat units were surveyed. These units totaled 5,130 meters in length and covered 23,665 square meters in area.

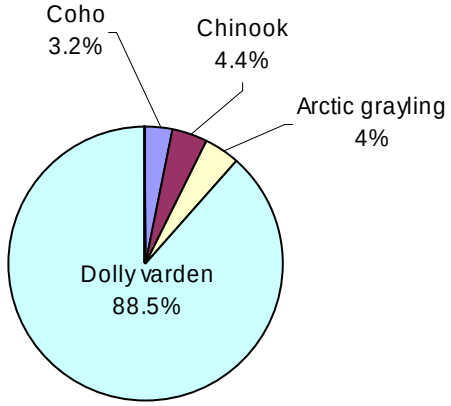
In the SK above and below Frying Pan Lake, channel types were predominately MC-1 and PA-1 (narrow, placid flow), with sections of PA-5. Above Frying Pan Lake, 197 habitat units were surveyed. They totaled 15,900 meters and covered 19,090 square meters of area. In the SK below Frying Pan Lake, 228 habitat units were surveyed. They totaled 7,210 meters and covered 46,401 square meters. Additionally, 18 channel morphology cross-sections were completed in both the upper and lower reaches of the SK.

Cross-sections of UT channel types included MC-1; moderate-gradient, mixed-control channel (MM-1); and high-gradient, contained channel (HC-3); interspersed with PA-5 and PA-3 (shallow-ground, water-fed slough) channel morphology. Maps will be made by using aerial photography and GIS to provide a visual description of the habitat survey.

11.1.6.11 Quantitative Abundance Sampling

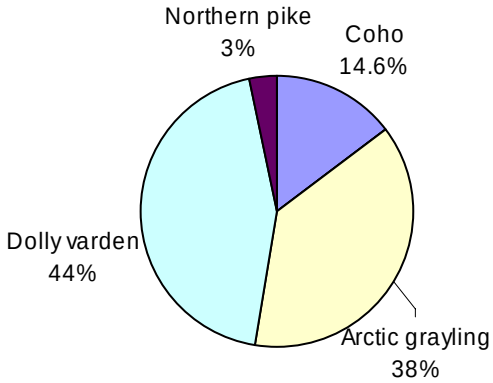
Removal sampling (Figures 11-5, 11-6, and 11-7) was conducted using a backpack electrofisher that proved to be an effective and efficient means of sampling. Fish species captured in the NK included Dolly Varden, chinook, arctic grayling, coho, and sculpin. (Because of the large abundance of sculpins, they were not included in the estimation of relative species abundance calculation.) Dolly Varden (at 88.5 percent) was the most abundant species captured. The SK above Frying Pan Lake contained Dolly Varden, arctic grayling, northern pike, coho, and sculpin. Dolly Varden (49.3 percent) and arctic grayling (31 percent) were the most abundant. The SK below Frying Pan Lake contained Dolly Varden, arctic grayling, coho, northern pike, round whitefish, burbot, sculpin, and stickleback. Note that only one round white fish and one burbot were captured. Dolly Varden (44 percent) and arctic grayling (38 percent) were the most abundant. For the UT, coho (95.7 percent) was the most abundant species. Dolly Varden, rainbow trout, arctic grayling, and sculpin also were present in the UT. Charts 1 through 4, below, graphically show the relative abundance of fish captured during removal sampling in each primary drainage.

CHART 1. North Fork Koktuli River



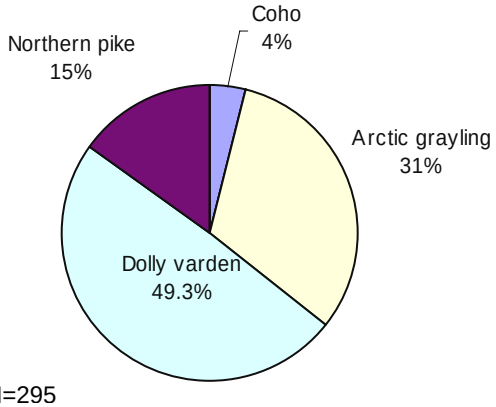
N=721

CHART 2. South Fork Koktuli River Below Frying Pan Lake



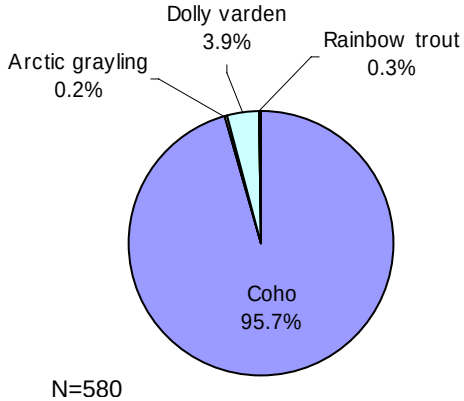
N=362

CHART 3. South Fork Koktuli River Above Frying Pan Lake



N=295

CHART 4. Upper Talarik Creek



N=580

Density per Habitat-unit Area

Average fish density for per habitat-unit (i.e., run, riffle, pool) area sampled was calculated. Appendices 11-C and 11-D, respectively, contain length-frequency histograms and graphs showing fish densities per habitat unit area. Fish densities were calculated for each habitat unit sampled by graphing the number of fish captured in each pass (Y axis) over the number of fish previously captured (X axis). A trend line was added to each graph. The total number of fish captured in all passes (N) and the estimated population generated by the trend line (P) are shown on each graph (Appendix 11-D).

11.1.6.12 Qualitative Abundance Sampling

During the 2004 field effort, qualitative stream sample sites were investigated (Figure 11-8). Fish that were captured were identified by species, measured to FL, and released alive. All sample-site locations were recorded by using GPS. Sites were chosen on the main stems and tributaries of the NK, the SK, and the UT. In the NK, Dolly Varden, arctic grayling, coho, chinook, and northern pike were sampled. Sampling conducted in the SK collected coho, arctic grayling, Dolly Varden, rainbow trout, northern pike, burbot, and lamprey. Sampling efforts conducted in the UT collected coho, Dolly Varden, rainbow trout, and arctic grayling. It should be noted that burbot and lamprey were captured in very low numbers (fewer than five between both species).

11.1.7 Summary

- **Winter Trapping**—These investigations occurred mid-April in the three primary drainages. Trapping occurred at a total of 39 sample sites in the various open-water habitats. All three main channels contained sections of flowing water. In the NK, coho and Dolly Varden were the most abundant. In the SK, sculpin and Dolly Varden were the most abundant. In the UT, coho and Dolly Varden were predominant.
- **Spring Spawning Surveys—**Spawning surveys for arctic grayling and rainbow trout were done mid-May and early June using angling, visual observation, and aerial-survey techniques. A total of seven surveys were completed throughout the three primary drainages. Captured fish were checked for maturity and measured. Arctic grayling were observed and captured in the NK, the SK, and UT.
- **Summer and Fall Salmon-spawning Surveys—**A total of 17 salmon-spawning surveys were conducted in the three primary drainages surrounding the mine study area. Aerial surveys began July 12, 2004, and continued regularly through October 14, 2004. Chinook, sockeye, and coho were observed in all three primary drainages. Additionally, chum and Dolly Varden were observed in the NK drainage during mid- to late July and in mid-October, respectively. Peak runs for chinook and sockeye occurred in late July to early August. Peak runs for coho occurred in early to mid-September.
- **Population Estimate for Frying Pan Lake—**A mark-and-recapture study was conducted on northern pike to determine the approximate population in Frying Pan Lake. The investigation was conducted mid-summer, and the estimated population was 264 fish. An additional recapture study may be conducted in early summer 2005 on the 2004 marked population.
- **Fish-tissue Sampling and Index-species Monitoring—**Fish-tissue sampling and index-species monitoring were completed at 16 stream and two lake sites in the study area. Standard and

repeatable procedures were established at each station to provide reliable quantitative comparisons. The five principal monitoring parameters were water quality and quantity, fish, periphyton, macroinvertebrates, and sediment. Sites were distributed in and around the major zones that might be affected by mine development. Fish-tissue samples were prepared, stored, and sent to a laboratory for analysis according to a set protocol.

- **Flow-Habitat Relationship Study**—Flow-habitat study sites were established for each of the identified major mesohabitat types in each of the SK, the NK, the main stem Koktuli River, and the UT. The downstream limits of the study sites were set based on the 10 percent flow-alteration location, which was developed using drainage-area methods rather than base-flow estimates. Whenever reasonable, the study sites were established within reasonable distance of long-term hydrology stations. Each instream-flow study site was visited three times: in June to set up the stations and take initial measurements, in July, and in August
- **Aquatic-habitat Mapping—**Approximately 2,530 meters (14 miles) of aquatic habitat were surveyed in 2004. These surveys provide information on the quality and availability of aquatic habitat surrounding the mine site. The NK drainage is predominately riffle habitat. The SK below Frying Pan Lake is predominately glide/riffle habitat. The SK above Frying Pan Lake is predominately glide. The UT is predominately riffle habitat. Geo-referenced video was completed in the three primary drainages and will be processed in 2005 so that aquatic-habitat maps can be created for those areas that were not surveyed on the ground. Aquatic-habitat and channel morphology assessments will be compiled and illustrated using aerial photography and GIS.
- **Quantitative Abundance Sampling**—Removal sampling was conducted at 182 sites in the study area. All three drainages were sampled, and various species were found to use the existing habitat. The NK supports an abundance of Dolly Varden. The SK, above and below Frying Pan Lake, supports predominately Dolly Varden and arctic grayling. The UT supports predominately juvenile coho.
- **Qualitative Abundance Sampling**—Qualitative removal sampling was conducted at 42 sites throughout the study area. This investigation provided distribution information for salmon and other important resource species.

11.2 Road Corridor Fish and Aquatic Resources

11.2.1 Introduction

This section presents the findings of the 2004 fish resources study for the proposed access road to the Pebble Project mine site. The information presented is based on data collected during the 2004 field season. Although some data analysis has been conducted, it is important to note that additional data will be collected in 2005. The results presented here should be considered preliminary and are subject to change after additional data have been collected.

11.2.2 Study Objectives

The principal objective of the road-corridor study program was to delineate fresh-water fish resources and aquatic-habitat values in the proposed road corridor to provide enough information so that road crossings of streams or other waterbodies can be adequately designed and permitted.

11.2.3 Study Area

The study area for proposed access road is a 3,500-foot-wide by 85-mile-long corridor extending from Iliamna Bay on Cook Inlet to the proposed mine site (Figure 11-9). The road-corridor study area includes alternative corridors that are shown in Figure 11-9.

11.2.4 Scope of Work

The research and field work for this study were conducted during 2004 and are ongoing. Additional field work is planned for 2005. The study was conducted by Paul McLarnon (HDR Alaska, Inc.) according to the approach described in the *Draft Environmental Baseline Studies, Proposed 2004 Study Plan* (NDM, 2004a).

The following summary of work for the road-corridor fish study briefly describes information collected during the course of the 2004 field season and any data analysis completed to date:

- Survey of 120 stream crossings for the presence of anadromous and resident fish species, and habitat characteristics. The GPS locations and photographs were recorded. It should be noted that of the 120 crossings surveyed, 41 contained no water at the time of the survey.
- At six locations along the road corridor, fish-tissue samples (juvenile salmon) were collected using the same methods as those for collection of juvenile fish-tissue samples at the mine study area.

11.2.5 Methods

A preliminary list of probable and potential fish-bearing streams was prepared based on corridor alignment, map and aerial-photograph interpretation, and review of existing literature. Maps with GPS coordinates for each stream crossing were created before the work was conducted and were used as the primary means of locating each stream. Some field investigation was required to locate some streams that were not visible on the aerial photographs. Actual coordinates for each sample site were recorded in the field. The study emphasized data collection at smaller streams where culvert crossings are most likely; larger streams with well-known resources and planned bridge crossings received less effort.

A two-person biological team, plus one observer, gained access to each stream near the road-corridor crossing location. Because road routes were not surveyed in the field and will likely be subject to field design change, the access points were only an approximation of crossing locations. The team collected a standard suite of physical data and descriptive information at each stream crossing with the effort concentrated in a stream reach extending for a distance of 40 channel widths at the likely corridor-crossing location. The data collected included basic water-quality information (pH, dissolved oxygen, conductivity, temperature, and turbidity), average and maximum depth, average width, water velocity,

cover characteristics, bank characteristics, substrate composition, habitat distribution, and channel type, as well as photographs. If spawning salmon were present, their numbers were enumerated over the length of the study reach. Each stream was inspected in the vicinity of the potential road corridor and downstream for the presence of barriers to upstream fish migration; all observed barriers were noted.

The study reach was sampled for fish presence using a backpack electrofisher. The amount of effort expended in sampling at each stream was determined by the team leader. The intent was to adequately characterize fish use within the sample reach. All fish captured were identified by species, were measured, and were released alive near the point of capture.

11.2.6 Results and Discussion

Field data for the road corridor were collected in August and early September. With the exception of a few streams (fewer than five), all streams in the proposed road corridor were surveyed. Streams that were not surveyed in 2004 will be surveyed during 2005 field efforts.

Fish tissues for juvenile salmon were colleted from six locations and were received by the appropriate laboratory for analysis. No quality control issues were identified by the laboratory. Fish-tissue laboratory results and analysis of those results will be presented at a later date.

11.2.7 Summary

Fish studies for the proposed road corridor occurred in August and early September. A total of 120 streams were surveyed, 41 of which were dry at the time of the survey. At six locations along the access road corridor, fish-tissue samples were collected. Laboratory results for the tissue analyses will be presented at a later time, as will analysis of field data.

11.3 Mine Site Macroinvertebrates and Periphyton

11.3.1 Introduction

This section presents the findings of the 2004 macroinvertebrate and periphyton study for the proposed mine area. The information presented is based on data collected during the 2004 field season. Although some data analysis has been conducted, it is important to note that additional data will be collected in 2005 and further analysis will be included in follow-up documents. These results should be considered preliminary and are subject to change after additional data have been collected and quality control activities have been performed.

11.3.2 Study Objectives

Macroinvertebrate and periphyton populations are effective indicators of changes in water quality, productivity, and habitat health. Macroinvertebrates are invertebrates that are large enough to see with the naked eye and spend at least a portion of their life history (usually larval and pupal) in the aquatic environment. Periphyton is loosely defined as “attached algae.” The 2004 sampling program focused on one type of periphyton, the brown algae, or diatoms. The varied life histories and contaminant tolerances

of macroinvertebrate and periphyton indicator species integrate both short- and long-term environmental changes. For example, macroinvertebrate taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) orders are generally recognized as sensitive to changes in the aquatic habitat and water quality, while macroinvertebrate taxa in the Diptera (blackfly) order (primarily the family Chironomidae) are generally recognized as being relatively tolerant to poor water-quality conditions or less-than-diverse habitats. Collection of baseline information on the macroinvertebrate and periphyton community makeup in and near the project study area is valued because changes in community structure can indicate response to changes in study-area habitat.

The objective of the 2004 macroinvertebrate and periphyton study was to characterize baseline populations and habitat conditions. Preliminary 2004 results were used to develop the 2005 study plan. The 2005 sampling effort and subsequent data analysis will further characterize the diversity and abundance of aquatic macroinvertebrates and periphyton in the project study area.

11.3.3 Study Area

The study area for the project has two components: the proposed mine area and the corridor for proposed road and port sites (Figure 11-1). The mine-site study area includes the general project vicinity consisting of a 10-mile radius around the ore body. Specific study sites, described below, were selected to characterize macroinvertebrate and periphyton populations upstream and downstream of proposed project facilities.

Macroinvertebrate and periphyton studies were not required at all sites designated for hydrology, water-quality, and fish studies. Study sites in the proposed mine area are located on the north and south forks of the Koktuli River, on Kaskanak Creek, on Upper Talarik Creek, at Frying Pan Lake, and at Big Wiggly Lake (Figure 11-3). One site on the Chulitna River was initially sampled in the spring, but was subsequently dropped from the study due to changes in the project design.

11.3.4 Scope of Work

The research, field work, and analysis for this study were conducted during 2004. Research and analysis are ongoing. Additional field work is planned for 2005. The studies were conducted by Andra Love, Isaac Watkins, Lynn Spencer, Josh Hedberg, and Brian Cook of HDR and Sally Morsell of Northern Ecological Services. The study was conducted according to the approach described in the *Draft Environmental Baseline Studies, Proposed 2004 Study Plan* (NDM, 2004a).

The 2004 sampling program in the mine study area consisted of five primary sample collection tasks, which are briefly described below.

- **Macroinvertebrate Sampling, Alaska Stream Condition Index (ASCI) Method—**The ASCI macroinvertebrate-sampling method was adapted from the U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (RBP) (Barbour et al., 1999). ASCI-method sampling was performed at all stream sites in the mine study area from June 1 through June 6, 2004, and from August 14 through August 18, 2004. Frying Pan and Big Wiggly lakes were sampled in August using a slightly modified ASCI sampling protocol.

- **Macroinvertebrate Sampling, Drift Net Method—**Drift-method sampling was performed at all ASCI stream sites; it was not performed at Frying Pan and Big Wiggly lakes.
- **Periphyton Sampling, Modified RBP Method—**Periphyton was collected at all sites using a modification of RBP.
- **Riparian and Instream Habitat, Visual Survey—**Macroinvertebrate habitat surveys were performed at all locations according to ASCI protocols. Periphyton habitat surveys were performed according to RBP.
- **Ambient Water Quality—**Dissolved oxygen, temperature, conductivity, and pH were measured at each site at the time of sampling and a water sample was collected for alkalinity analysis.

Macroinvertebrate samples were processed and identified to genus by HDR scientists. Periphyton samples were processed to isolate diatom shells, which were mounted to slides according to RBP. Slides were sent to Scott Rollins, a graduate student and teaching assistant at the Michigan State Algal Ecology Laboratory, for identification to genus. The procedures used are described below.

11.3.5 Macroinvertebrate Methods

11.3.5.1 Review of Existing Information

Review of information for the mine and road-corridor study areas is ongoing. Preliminary results indicate that little macroinvertebrate information is available for the project study areas. To date, the literature review has included scientific literature, gray literature, and resource-agency files.

11.3.5.2 Field Sampling Protocol

Sampling of macroinvertebrate and periphyton was conducted concurrently. Generally, three team members began the collection process at the downstream end of the stream reach and worked upstream for 100 meters. Two team members collected macroinvertebrate samples, and the third member collected the periphyton samples. The combined sampling was intended to avoid site disturbance upstream at the time of sample collection.

Several protocols were used for field sampling to allow collection of a variety of data in one sampling trip. For quality assurance and quality control, duplicate samples were taken at 10 percent of the sample sites for the ASCI drift protocols during both the June and August efforts. A duplicate modified-ASCI sample was collected at one lake site in August.

Habitat Assessment

The aquatic and riparian habitat assessments consisted of multiple steps. The sites were first established by measuring a 100-meter stream reach. According to ASCI protocols, 20 samples (termed “subsamples” because they are later composited into one sample) are to be collected in the reach based on proportionate habitat representation. For example, if 50 percent of the stream bottom was estimated to be cobble/riffle habitat, 10 of the 20 subsamples would be collected from the cobble/riffle habitat. Determination of proportionate habitat representation occurs during the habitat assessment.

The measurements were recorded on data sheets. Other parameters noted on the habitat assessment data sheets include air and water temperature, riparian vegetation, signs of erosion, latitude and longitude, and canopy cover. Pictures were taken at each site to document site conditions.

ASCI Sampling

In accordance with ASCI sampling methodology, proportionate habitat representation was determined before sampling was initiated. Common instream habitats include undercut bank, snag, cobble/riffle, emergent vegetation, and sand/soft sediment. A total of 20 samples were collected in a proportionate distribution among all habitat types that composed at least 10 percent of the total stable habitat. Habitats with less than 10 percent representation were not included in the sampling. Samples were collected through jabs or kicks with a D-frame kick net with 363-micrometer mesh. The jabs and kicks were collected starting at the downstream end of the 100-meter stretch and working upstream to avoid disturbing the substrate upstream of the sample net. The distribution and the number of kicks or jabs from each habitat type were recorded on the field data forms.

Samples were collected by disturbing the substrate immediately in front of the D-frame net. Macroinvertebrates were scraped off the rocks and large debris by rubbing them with gloved hands in front of the net. The substrate was further disturbed by standing immediately in front of the net and kicking the substrate with felt-soled wading boots. Once the net was full, the contents were emptied into 1-liter Nalgene bottles and preserved with ethanol. Frequently, at a given site, the material collected with 20 kicks and jabs filled multiple bottles. The bottles were labeled to reflect total quantity (for example, bottle 1 of 3). However, the material collected from all 20 kicks and jabs was combined in the laboratory to form a single sample for processing and identification.

Drift Sampling

Drift samples were collected at each stream site. Five 12-inch by 18-inch, 363-micrometer-mesh nets were set across the stream to collect drifting organisms. They were positioned at the upstream end of the 100-meter reach to avoid sample disturbance.

The nets were left in place for a minimum of 1 hour, and the exact length of time was recorded on the field data sheets. The depth of the submerged portion of each net and the streamflow at the mouth of each net were recorded for use in calculating the total volume of water flowing through the net. Material removed from all nets was placed into 1-liter Nalgene bottles and composited as one drift sample per site. Drift samples and ASCI samples were not combined.

Ambient Water Quality

Along with flow data, a suite of water quality measurements was recorded at each site. These included temperature, dissolved oxygen (milligrams per liter and percent saturation), conductivity (relative and specific), and pH. Water-quality meter probes were placed in the water upstream of the drift nets to prevent them from being disturbed during sampling. Readings were recorded after sufficient time had been allowed for the meters to stabilize. The meters were calibrated once daily before they were transported to the first site.

Lake Sampling

Lake sampling occurred only during the second sampling event in August. Two lakes, Big Wiggly and Frying Pan, were sampled using a modified ASCI method. The primary modifications to the ASCI protocol centered around the lack of flowing water. The D-frame net had to be dragged through the habitat substrate, which sometimes had to be disturbed before the net was dragged, to get invertebrates to enter the net. Drift nets were not set during the lake sampling.

11.3.5.3 Laboratory Processing

Following field work, the following conditions were verified: (1) labeling on all samples was easily readable and (2) all bottles were accounted for and had sufficient alcohol to preserve the samples. All samples were then returned to Anchorage for processing.

Sorting and Subsampling

All material from one site was placed in a Caton subsampling tray. (For example, if the ASCI sampling material filled three bottles at one site, all three bottles were mixed in a subsampling tray.) The subsampling tray is marked in a 30-square grid. Squares were selected and sorted using a computer-generated random-number table until 300 organisms had been pulled from the sample. The last square sorted was completely processed even if the total exceeded 300 total organisms. This approach ensured accurate density calculations. All organisms from the sample were placed in a vial filled with 70 percent alcohol for later identification. Samples were logged on tracking sheets with site information, date sorted, date identified, processor's initials, and quality control information.

Identification

The organisms collected during subsampling were then identified to genus (when possible) with the use of a dissecting microscope. To identify Chironomidae larvae to genus level, 10 percent of the total number of Chironomidae larvae per subsample were mounted on slides with CMC-10 mounting media and were identified under 400-power compound microscopes. Identification of the Chironomidae genera was completed in May and is presented in Appendix 11-G.

Several widely-recognized macroinvertebrate keys were used in the identification process; however, HDR scientists relied primarily on *Introduction to Aquatic Insects of North America* (Merrit and Cummings, 1996). Additional sources included *Aquatic Entomology* (McCafferty, 1998), *Pond Life* (Reid, 1967) and *A Guide to the Study of Freshwater Biology* (Needham and Needham, 1962).

11.3.6 Periphyton Methods

11.3.6.1 Review of Existing Information

Review of information for the mine and road-corridor study areas is ongoing. As with the macroinvertebrate literature review, little existing periphyton information is available.

11.3.6.2 Field Sampling Protocol

As described above, sampling of macroinvertebrate and periphyton was conducted concurrently. Generally, three team members began the collection process at the downstream end of the stream reach and worked upstream for 100 meters. Two team members collected macroinvertebrate samples, and the third member collected the periphyton samples. The combined sampling was intended to avoid site disturbance upstream at the time of sample collection.

Periphyton methods were modified from the periphyton portion of the EPA RPB (Barbour et al., 1999). Modifications to the protocols consisted of sampling five transects, instead of four, and sampling various periphyton habitats based on proportionate representation, instead of sampling four riffle/run areas. These modifications were performed to improve comparison of the macroinvertebrate and periphyton results in later stages of the project.

For quality assurance and quality control, duplicate samples were collected at 10 percent of the sample sites during both the June and August sampling.

Habitat Assessment

Four periphyton habitat types were documented while performing the habitat assessment survey: hard, removable substrates (woody debris, cobble, gravel); soft, removable substrate (mosses and macrophytes); large substrates (boulders, bedrock, logs); and loose substrate (sand, silt, clay).

Periphyton Sampling

A total of 20 periphyton subsamples were collected from each sampling site and composited to form one sample per site. These 20 subsamples were divided proportionally among the four habitat types based on the percentage of each habitat that existed in the stream site. As described earlier, sampling began at the downstream end of the 100-meter stream reach and continued upstream. Sampling procedures varied, depending on the habitat classification being sampled.

A rubber sampling band was created by cutting a hole with a 4.5-centimeter (cm) diameter in a bicycle tube. The hole was reinforced with a rubber washer to prevent stretching or tearing. In the field, cobble and/or gravel was removed from the stream and placed in a bucket. Each piece removed constituted 1 of the 20 samples. Samples were transported to onshore for removal of the periphyton. The rubber tube was wrapped around the cobble or gravel with the 4.5-cm hole exposing the upper surface of the cobble or gravel. This exposed area was then scrubbed clean with a small toothbrush. The collected material was rinsed into a pan and then drained into a 1-liter Nalgene bottle. This process was repeated for the appropriate number of cobble/gravel samples to be collected at a given site.

Mosses and macrophytes were not sampled frequently because of the relative lack of this material compared to other periphyton habitat. When mosses and macrophytes were sampled, the following sampling technique was used. Approximately 16 square cm (cm^2) of material was collected from the stream, and the material was placed in an empty 1-liter Nalgene bottle. The material was rinsed with a small amount of water and shaken vigorously to dislodge the periphyton from the plant material. The water-containing periphyton was transferred to the 1-liter Nalgene sample bottle containing the composite hard substrate samples.

Large substrates were sampled in situ with a 4.5-cm-diameter sampling tube of polyvinyl chloride (PVC) and a toothbrush with a head that was modified to allow it to fit inside the PVC tube. Foam lining was attached to the PVC tube to create a "seal" when pressed against the large substrate. This assembly resulted in an isolated 4.5-cm sample area on the boulder or other large substrate that would not be subject to running water at the time of sampling. The modified toothbrush was used to scrub the surface of the substrate inside of the PVC tube to dislodge the periphyton. The tube was washed with a small amount of water, and a turkey baster was used to draw out the water containing the periphyton. The sample was transferred to the primary composite 1-liter bottle.

Loose sediments were sampled using small plastic 4.5-cm-diameter Petri dishes. Sand and soft sediment were sampled by pressing the Petri dish into the substrate and sliding a flat metal spatula under the Petri dish. The substrate was removed and placed in an empty 1-liter bottle. A small amount of water was placed in the bottle, and the bottle was capped. The material was then shaken vigorously to dislodge the periphyton and given only a few seconds for the sand to settle out before the water containing the periphyton was transferred into the composite sample jar.

At the end of the collection process, one composite 1-liter Nalgene bottle contained the water-periphyton mixture from all 20 subsamples. This 1-liter bottle had been calibrated in the laboratory using standardized scientific beakers. Enough ambient water was added to the composite bottle to bring the volume up to the next volume marked on the bottle, and this volume was recorded on the data sheet. The composite sample was shaken vigorously for 1 minute. Immediately after shaking, enough water was drawn out of the composite bottle to fill a 100-milliliter (ml) Nalgene bottle, and two to three drops of Lugol's solution were added for preservative. These bottles were stored in coolers and transported to Anchorage with the HDR team at the end of the field event.

11.3.6.3 Laboratory Processing

Periphyton samples were processed by HDR scientists under a vented chemistry hood at Alaska Pacific University.

Diatom Preparation

Acid Digestion. Samples were first logged on a tracking sheet and a data processing sheet. Two 400-ml graduated beakers were labeled for each sample. Each sample was then transferred into the properly labeled 400-ml graduated beaker. The actual sample volume was recorded on the processing sheet. The sample was then homogenized using a hand-held blender to thoroughly mix material and break down large colonies. The blender and the walls of the beaker were washed with deionized (DI) water. The new volume was recorded as the "working volume" on the processing sheet.

The beaker was then placed on a stirring plate, and a stir bar was inserted into the sample. While the first sample was being stirred, 20 ml (20,000 microliters [µL]) of the sample were withdrawn with a 1,000-µL pipette equipped with a disposable tip. The extracted portion of the sample was placed in the second labeled 400-ml beaker for acid digestion. The remaining material was returned to the original sample bottle for storage.

Samples were digested in nitric acid on a hot plate set at 200ºC. Personnel performing the procedure wore protective goggles, gloves, and a laboratory coat while adding 30 ml of nitric acid to the sample under a

fume hood. The beaker was allowed to heat for 2 hours and was carefully monitored during that time to avoid overheating. After digestion was complete, a dash of potassium dichromate was added to the sample to catalyze the reaction. The beaker was allowed to cool.

After completion of the acid digestion, several additions of DI water were used to increase the pH. The samples were covered with DI water and left for 12 hours undisturbed while the diatoms settled in the bottom of the beaker. With a large-volume pipette, the samples were drawn down to about 50 ml while care was taken to avoid disturbing the diatom layer on the bottom of the beaker. After this initial drawdown, DI water was used to refill the beaker. Strips of pH paper were used to test the pH of the sample water. This process was repeated several times until the pH of the water neared a safe level of 6.0 or higher. The sample was drawn down to a volume between 25 and 50 ml. This volume was transferred to the graduated 100-ml storage vial. This volume was recorded as the diatom volume "after digestion" on the processing data sheet.

Slide Preparation. After all samples were acid-digested, the diatoms were mounted on slides for identification. Cover slips were laid out on ceramic tiles that were labeled with the site identifications. Approximately 1 ml of DI water was added to each cover slip with a clean pipette tip. The sample vial was shaken to mix the diatoms, and 200 µL of sample was added to the cover slip. This amount was recorded on the processing data sheet as "drip cover slip." The pipette was set at 0.3 ml, and the sample was drawn in and out to mix the sample with the DI water. The cover slip was then loosely covered in foil and allowed to dry.

After it was dry, the cover slip was examined with a compound microscope under 400-power magnification for the proper distribution and density of diatoms. If the density of diatoms was too great, a new cover slip was created with less sample material and the new volume was recorded. If the density was too thin, more sample was added. The volume of material added to the cover slip was recorded as "drip additional" on the data sheet. Some cover slips were remade because of large amounts of sand and silt in the samples.

Slides were labeled with the sample identification. A few drops of Naphrax were spread on the center of the slide with a flat-edge wooden toothpick. The cover slip was placed material-side-down on the Naphrax. The slide was then placed on a hot plate under a fume hood to boil the Naphrax. The completed slide was set aside to cool, and the hardened excess Naphrax was removed with a straight-edge razor blade.

Identification

Scott Rollins, of the Michigan State University Algal Ecology Laboratory, trained the sampling team on periphyton sampling, processing, and identification. Identification of diatom frustules (the single cells composed of silica remaining after digestion) on the preparation slides is done under 1,000-power magnification with the aid of identification manuals. Identification manuals used included *How to Know the Freshwater Algae* (Prescott, 1978), *Diatoms in Alaska* (Foged, 1981), and *Freshwater Diatoms from Northern Quebec and Labrador (Canada)* (Fallu, 2000). Samples were mounted to slides by HDR scientists and were sent to Scott Rollins for identification. Results of the diatom identification are presented in Appendix 11-G.

11.3.7 Results and Discussion

Field data were collected in the mine study area in June and August. Three sample sites were omitted from the August sampling event. Site CR199A on the Chulitna River was dropped from the study because of changes in potential facility locations. At the time of the August sampling event, it was determined that NK100B on the North Fork of Koktuli River was no longer going to be sampled in its current location. This site was later moved upstream. The new location had not been determined and was not included in the August sampling. SK100C was not sampled because this section of the stream had no flow at the time of sampling. Big Wiggly and Frying Pan lakes were added to the study in August because of their proximity to the proposed mine area. The tables and graphs referred to in the following sections contain data collected from the mine site, road corridor, and port site.

It is important to note that all data and analysis presented in this document are preliminary. *Chironomidae* and diatom identifications are still occurring, and the quality control for taxa identification has not yet occurred for any data.

11.3.7.1 Macroinvertebrate Taxa

A summary of macroinvertebrate taxa is provided in Table 11-5. A total of 139 macroinvertebrate taxa were collected in the June and August samples. Of those taxa, 46 were not identified to genus for various reasons. Only 9 of those 46 taxa are in the Ephemeroptera, Plecoptera, or Trichoptera (EPT) families. These organisms were identified only to family level, mainly because of the condition of the specimens. The remaining 36 taxa that were not identified to genus are not typically identified to that level for these sampling methodologies. Chironomidae genera data are presented in Appendix G.

TABLE 11-5
Macroinvertebrate Taxa Presence in ASCI and Drift Samples

Order	Family	Genus	ASCI	Drift
Ephemeroptera	Ameletidae	*Ameletus*	X	X
Ephemeroptera	Baetidae	*Baetidae* — unid	X	X
Ephemeroptera	Baetidae	*Acentrella*	X	X
Ephemeroptera	Baetidae	*Baetis*	X	X
Ephemeroptera	Ephemerellidae	*Ephemerellidae* — unid		X
Ephemeroptera	Ephemerellidae	*Drunella*	X	X
Ephemeroptera	Ephemerellidae	*Ephemerella*	X	X
Ephemeroptera	Ephemerellidae	*Serratella*		X
Ephemeroptera	Heptageniidae	*Cinygmula*	X	X
Ephemeroptera	Heptageniidae	*Epeorus*	X	X
Ephemeroptera	Heptageniidae	*Rithrogena*	X	
Ephemeroptera	Oligoneuriidae	*Lachlania*	X	
Plecoptera	Plecoptera — unid	*Plecoptera* — unid		X
Plecoptera	Capniidae	*Capniidae* — unid	X	

TABLE 11-5
Macroinvertebrate Taxa Presence in ASCI and Drift Samples

Order	Family	Genus	ASCI	Drift
Plecoptera	Capniidae	*Alocapnia*	X	
Plecoptera	Capniidae	*Nemocapnia*	X	
Plecoptera	Capniidae	*Paracapnia*	X	X
Plecoptera	Leuctridae	*Despaxia*		X
Plecoptera	Leuctridae	*Moselia*	X	
Plecoptera	Leuctridae	*Perlomyia*		X
Plecoptera	Chloroperlidae	*Alloperla*	X	X
Plecoptera	Chloroperlidae	*Kathroperla*	X	
Plecoptera	Chloroperlidae	*Neaviperla*	X	X
Plecoptera	Chloroperlidae	*Plumiperla*	X	X
Plecoptera	Chloroperlidae	*Plumiperla - Triznalia*	X	X
Plecoptera	Chloroperlidae	*Suwallia*	X	X
Plecoptera	Chloroperlidae	*Sweltsa*	X	
Plecoptera	Nemouridae	*Malenka*	X	
Plecoptera	Nemouridae	*Zapada*	X	X
Plecoptera	Perlodidae	*Perlodidae* — unid	X	
Plecoptera	Perlodidae	*Arcynopteryx*	X	
Plecoptera	Perlodidae	*Isogenoides*		X
Plecoptera	Perlodidae	*Isoperla*	X	X
Plecoptera	Pteronarcyidae	*Pteronacys*	X	X
Plecoptera	Pteronarcyidae	*Pteronarcella*	X	X
Plecoptera	Taeniopterygidae	*Taenionema*	X	
Trichoptera	Trichoptera -unid	*Trichoptera* — unid	X	X
Trichoptera	Apataniidae	*Apatania*	X	
Trichoptera	Brachycentridae	*Brachycentridae* — unid	X	
Trichoptera	Brachycentridae	*Amiocentrus*	X	
Trichoptera	Brachycentridae	*Brachycentrus*	X	X
Trichoptera	Brachycentridae	*Eobrachycentrus*	X	
Trichoptera	Brachycentridae	*Micrasema*		X
Trichoptera	Glossosmatidae	*Glossosmatidae* — unid		X
Trichoptera	Glossosmatidae	*Glossosoma*	X	X
Trichoptera	Hydroptilidae	*Agraylea*	X	X
Trichoptera	Hydroptilidae	*Ochrotrichia*		X
Trichoptera	Hydroptilidae	*Oxyethira*	X	X

TABLE 11-5
Macroinvertebrate Taxa Presence in ASCI and Drift Samples

Order	Family	Genus	ASCI	Drift
Trichoptera	Hydrosychidae	*Hydropsyche*	X	X
Trichoptera	Lepidostomatidae	*Lepidostoma*	X	X
Trichoptera	Leptoceridae	*Oecetis*	X	
Trichoptera	Limnephilidae	*Limnephilidae* — unid	X	X
Trichoptera	Limnephilidae	*Chyranda*		X
Trichoptera	Limnephilidae	*Dicosmoecus*	X	
Trichoptera	Limnephilidae	*Ecclisomyia*	X	X
Trichoptera	Limnephilidae	*Eocosmoecus*	X	X
Trichoptera	Limnephilidae	*Halesochila*		X
Trichoptera	Limnephilidae	*Ironoquia*	X	
Trichoptera	Limnephilidae	*Limnephilus*	X	
Trichoptera	Limnephilidae	*Moselyana*	X	X
Trichoptera	Limnephilidae	*Nemotaulius*	X	
Trichoptera	Limnephilidae	*Pedomeocus*	X	
Trichoptera	Limnephilidae	*Psychoglypha*	X	X
Trichoptera	Odontoceridae	*Namamyia*	X	X
Trichoptera	Polycentropodidae	*Polycentropus*	X	
Trichoptera	Rhyacophilidae	*Rhyacophila*	X	X
Diptera	Diptera — unid	*Diptera* — unid	X	
Diptera	Ceratopogoniidae	*Ceratopogoniidae* — unid		X
Diptera	Ceratopogoniidae	*Bezzia*	X	X
Diptera	Ceratopogoniidae	*Probezzia*	X	X
Diptera	Chironomidae	*Chironomidae* — unid	X	X
Diptera	Dixidae	*Dixa*	X	
Diptera	Dolichopodidae	*Dolichopodidae* — unid		X
Diptera	Empididae	*Empididae* — unid	X	
Diptera	Empididae	*Chelifera*	X	X
Diptera	Empididae	*Clinocera*	X	X
Diptera	Empididae	*Hemerodromia*		X
Diptera	Empididae	*Rhamphomyia*	X	
Diptera	Empididae	*Wiedemannia*	X	
Diptera	Ephydridae	*Ephydridae* — unid	X	X
Diptera	Muscidae	*Muscidae* — unid		X
Diptera	Psychodidae	*Psychodidae* — unid		X

TABLE 11-5
Macroinvertebrate Taxa Presence in ASCI and Drift Samples

Order	Family	Genus	ASCI	Drift
Diptera	Psychodidae	*Pericoma*	X	X
Diptera	Psychodidae	*Psychoda*		X
Diptera	Simuliidae	*Gymnopais*	X	X
Diptera	Simuliidae	*Prosimullium*	X	
Diptera	Simuliidae	*Simullium*	X	X
Diptera	Tabanidae	*Tabanidae* — unid	X	
Diptera	Tipulidae	*Dicranota*	X	X
Diptera	Tipulidae	*Hesperoconopa*	X	X
Diptera	Tipulidae	*Hexatoma*	X	X
Diptera	Tipulidae	*Leptotarsus*	X	
Diptera	Tipulidae	*Molophilus*		X
Diptera	Tipulidae	*Ormosia*		X
Diptera	Tipulidae	*Pedicia*	X	
Diptera	Tipulidae	*Tipula*	X	
Coleoptera	Coleoptera	*Coleoptera* — unid	X	X
Coleoptera	Carabidae	*Carabidae* — unid	X	X
Coleoptera	Curculionidae	*Curculionidae* — unid		X
Coleoptera	Dytiscidae	*Dytiscidae* — unid	X	X
Coleoptera	Dytiscidae	*Dytiscidae - Laccophilus*		X
Coleoptera	Elmidae	*Elmidae* — unid		X
Coleoptera	Helophoridae	*Helophoridae* — unid		X
Coleoptera	Hydrophylidae	*Hydrophylidae* — unid		X
Coleoptera	Psephenidae	*Psephenidae* — unid		X
Coleoptera	Salpingidae	*Salpingidae* — unid	X	
Coleoptera	Staphylinidae	*Staphylinidae* — unid		X
Nematoda	Nematoda	*Nematoda*	X	X
Oligochaeta	Oligochaeta	*Oligochaeta*	X	X
Gastropoda	Lymnaeidae	*Lymnaea*	X	X
Gastropoda	Physidae	*Physa*		X
Gastropoda	Planorbidae	*Planorbidae* — unid	X	X
Gastropoda	Sphaeriidae	*Sphaeriidae*	X	X
Arachnoidea	Hydracarina — unid	*Hydracarina* — unid	X	X
Arachnoidea	Water spider — unid	*Water spider* — unid		X
Crustacea	Conchostraca	*Conchostraca* — unid	X	X

TABLE 11-5
Macroinvertebrate Taxa Presence in ASCI and Drift Samples

Order	Family	Genus	ASCI	Drift
Crustacea	Gammaridae	*Gammaridae* — unid	X	X
Crustacea	Ostracoda	*Ostracoda* — unid	X	X
Crustacea	Cladocera — unid	*Cladocera* — unid	X	X
Crustacea	Copepoda	*Cyclopidae* — unid	X	X
Collembola	Collembola	*Collembola* — unid	X	X
Collembola	Entomobryidae	*Entomobryidae* — unid		X
Collembola	Hypogastruidae	*Hypogastruidae* — unid	X	X
Collembola	Isotomidae	*Isotomidae* — unid	X	X
Collembola	Sminthuirindae	*Sminthuirindae* — unid		X
Hemiptera	Hemiptera	*Corixidae*	X	X
Hemiptera	Hemiptera	*Hebridae*		X
Hemiptera	Hemiptera	*Saldidae*		X
Homoptera	Homoptera	*Homoptera* — unid		X
Homoptera	Homoptera	*Aphididae*	X	
Hirudenea	Hirundinea	*Hirundinea* — unid	X	X
Lepidopotera	Lepidoptera — unid	*Lepidoptera* — unid	X	X
Lepidopotera	Arctiidae	*Arctiidae* — unid		X
Lepidopotera	Arctiidae	*Estigmene*		X
Lepidopotera	Cossidae	*Prionoxystus*		X
Lepidopotera	Pyralidae	*Acentria*		X
Lepidopotera	Pyralidae	*Crambus*		X
Planaria	Planaria	*Planaria* — unid	X	
Rotifera	Rotifera	*Rotifera* — unid		X
Totals:		**139**	**100**	**103**

unid = unidentified

Generally, it appears that more EPT (contaminant-sensitive taxa) and Diptera (contaminant-tolerant taxa) samples were collected by ASCI sampling than by drift sampling and that drift sampling collected more taxa overall. Two graphs that compare June and August results by site are included in Appendix 11-E. Figure 11E-1 compares ASCI samples from the two sampling events. For the ASCI samples, it appears that more taxa were collected in August than in June; however, statistical analysis may disprove this trend and Chironomidae data may change that picture. Drift samples (Figure 11E-2) appear to have yielded fewer taxa per site than did the ASCI samples during both sampling events.

Additional graphs in Appendix 11-E, display June and August samples by taxa groups. Figures 11E-3, 11E-4, and 11E-5 show the percentages of EPT taxa, family Chironomidae, and non-Chironomidae Diptera taxa, respectively, at each site for ASCI and drift samples.

11.3.7.2 Periphyton Taxa

Periphyton identification is ongoing. Tables 11-6 and 11-7 display results of the periphyton sample slides that have been identified to date from June and August sampling, respectively. To date, 36 different periphyton genera have been identified in the June and August samples. The June samples have 29 genera and the August samples have 32 genera, many of which overlap between sampling events.

11.3.7.3 Water Quality

Graphs showing water-quality results for dissolved oxygen, pH, temperature, and conductivity are provided in Appendix 11-F. Figures 11F-1 and 11F-2 show results for dissolved oxygen measured in both percent saturation and milligrams per liter for June and August; Figures 11F-3 and 11F-4 display results for both temperature and pH for June and August; and Figures 11F-5 and 11F-6 show measurements of both relative and specific conductivity in June and August.

11.3.8 Summary

Macroinvertebrate and periphyton samples and water-quality measurements were collected during two field sampling events in 2004. In June, 17 stream sites in the mine study area were sampled. In August, samples from 16 mine sites were collected. In August, 14 of the previous stream sites were sampled and two lake sites were added.

- **Macroinvertebrates—**139 taxa (without Chironomidae genera) were collected during the June and August sampling events. This number is much higher than what has been encountered in some other mine development baseline monitoring efforts in Alaska. For example, Donlin Creek Mine macroinvertebrate monitoring results indicate the presence of approximately 31 taxa without Chironomidae identification (NES, 2000). Macroinvertebrates were collected using two methods. Preliminary analysis indicates that the Alaska (ASCI) modification of the EPA RBP yielded more EPT and Diptera taxa than did drift samples. Drift samples appear to have yielded 103 total taxa, 3 more than the total ASCI taxa. Tolerance levels of the taxa by site will be explored in the environmental baseline document.
- **Periphyton—**All periphyton samples from 2004 have been process and identified. To date, 38 periphyton genera have been identified from the June and August samples (Appendix 11-G).
- **Water Quality—**Dissolved oxygen, temperature, pH, conductivity, and alkalinity were measured and recorded at each site during both sampling events.
- **Analysis—**Preliminary results have been displayed graphically. Further analysis has not yet been completed and is ongoing.

11.4 Road Corridor Macroinvertebrates and Periphyton

11.4.1 Introduction

This section presents the findings of the 2004 macroinvertebrate and periphyton study for the proposed road corridor. The information presented is based on data collected during the 2004 field season. Although some data analysis has been conducted, it is important to note that the results presented here should be considered preliminary and are subject to change after additional data have been collected and quality control has been completed on the taxonomic identifications.

11.4.2 Study Objectives

Study objectives for macroinvertebrate and periphyton sampling along the proposed road corridor are the same as those described above for the proposed mine area.

11.4.3 Study Areas

The 2004 macroinvertebrate and periphyton road study area consisted of six stream-sampling locations along the potential road corridor (Figure 11-9). Specific study sites, as described below, were selected to characterize macroinvertebrate and periphyton populations downstream of the potential road corridor identified in August 2004. Road-corridor locations are subject to change as planning and design for the proposed project advances. Macroinvertebrate and periphyton studies were not required at all sites designated for hydrology, water-quality, and fish studies. These other studies did collect data at all six of the macroinvertebrate and periphyton study sites. At the time of sampling, the sites on the proposed road corridor were mostly on unnamed streams that were, for reporting purposes, named Y Creek, Bear Den Creek, Red Creek, Ursa 100B, Chum Creek, and UT138A. Subsequent naming conventions have resulted in Chum Creek being called "Y Valley Creek." The Y Creek along a northern road alternative has been dropped from the study because it is not in the project study area as it is currently defined.

11.4.4 Scope of Work

The research, field work, and analysis for this study were conducted during 2004. Research and analyses are ongoing. Additional field work is planned for 2005. The studies were conducted by HDR according to the approach described in the *Draft Environmental Baseline Studies, Proposed 2004 Study Plan* (NDM, 2004a). Tasks associated with the 2004 road-corridor field effort consisted of five primary study efforts, which are briefly described below:

- **Macroinvertebrate Sampling, ASCI Method—**The ASCI macroinvertebrate-sampling method was adapted from the EPA RBP (Barbour et al., 1999). ASCI-method sampling was performed at all six road corridor sites from August 14 through August 18, 2004.
- **Macroinvertebrate Sampling, Drift Net Method—**Drift-method sampling was performed at all sites.
- **Periphyton Sampling, Modified RBP Method—**Periphyton was collected at all sites by using a modification of the RBP.

- **Riparian and Instream Habitat, Visual Survey—**Macroinvertebrate habitat surveys were performed at all locations according to ASCI protocols. Periphyton habitat surveys were performed according to the RBP.
- **Ambient Water Quality—**Dissolved oxygen, temperature, conductivity, pH, and alkalinity were measured at each site at the time of sampling.

11.4.5 Macroinvertebrate Methods

Methods for collection and processing of macroinvertebrates at the road corridor sites in 2004 were identical to those used at the mine study area. A duplicate sample was collected for quality assurance and quality control purposes at one road site (10 percent).

11.4.6 Periphyton Methods

Methods for collection and processing of periphyton samples along the road corridor in 2004 were identical to those used at the mine area. A duplicate sample was collected for quality assurance and quality control purposes at one road site (10 percent).

11.4.7 Results and Discussion

Field data were collected along the proposed road corridor at five sites in August and at the Y Valley Creek (formerly called Chum Creek) site in early September. Results are discussed in Section 11.3.7, above. ASCI sampling yielded a large range of taxa diversity among the different streams along the proposed road corridor. At Bear Den Creek, 23 macroinvertebrate taxa were found, and at Chum Creek, only nine taxa were found.

11.4.8 Summary

With the exception of one site sampled in early September, road corridor sites were sampled during a single August event. Six stream sites along the proposed road corridor were sampled.

Methods for sampling at both the proposed mine and road corridor areas were identical. For this reason, all data for the two locations are combined for ease of analysis. Section 11.3.8 summarizes the 2004 sampling effort.

Because the data have not yet been taxonomically verified and statistical analysis has not yet been performed, limited conclusions are presented in this report. More comprehensive conclusions will be presented in the 2005 progress report and the environmental baseline document, expected to be prepared in 2006.

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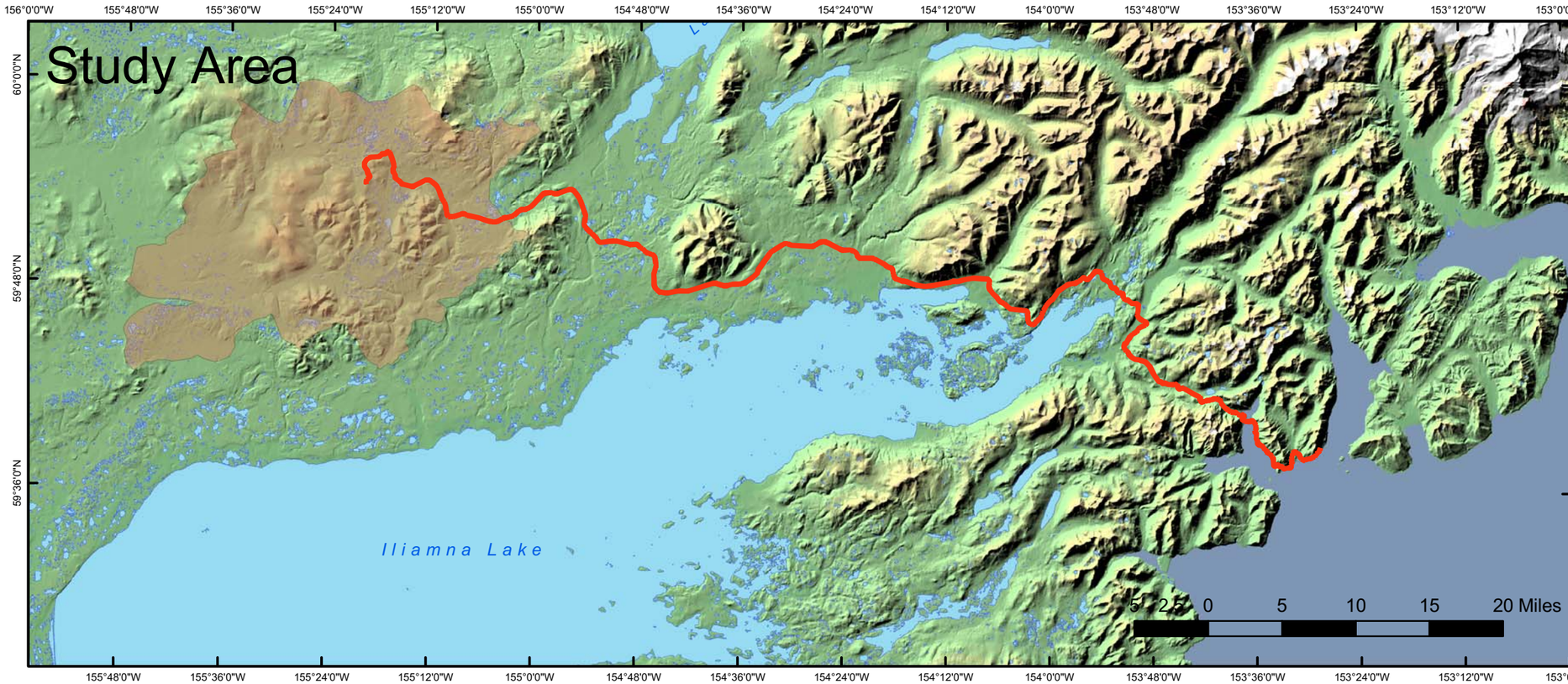
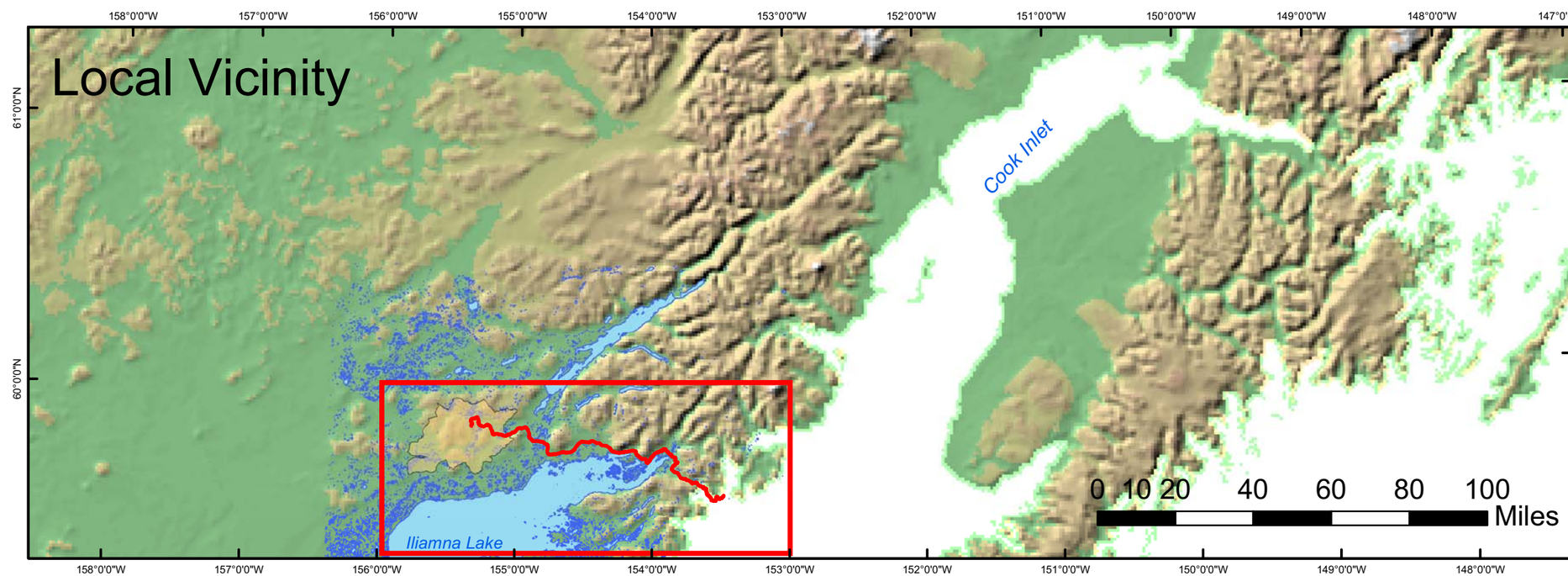
FIGURES





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Pebble Project

Fish and Aquatic Resources, Study Area
Figure 11-1

Legend

- 2004 Road Study Area
- 2004 Mine Study Area

HDR, file date 01/25/2005

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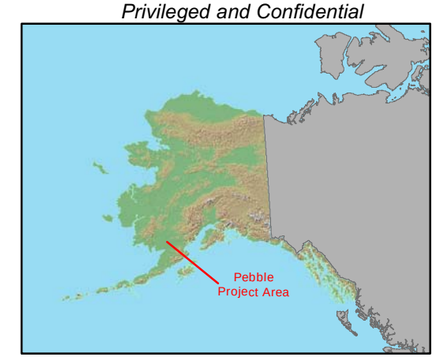

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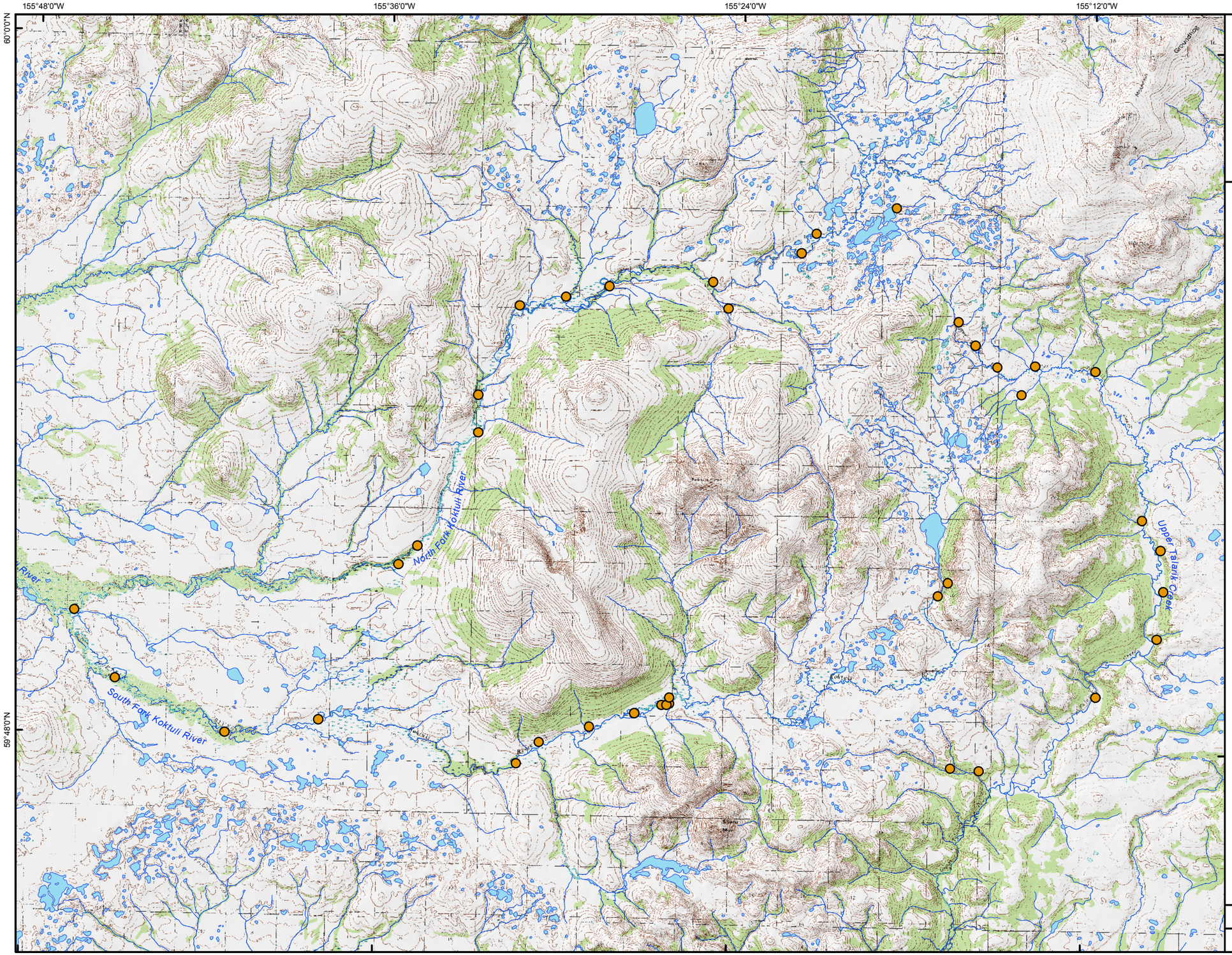

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Pebble Project

Winter Trapping Sites
Figure 11-2

Legend

Trapping Sites

Sites from HDR, file date 01/25/2005

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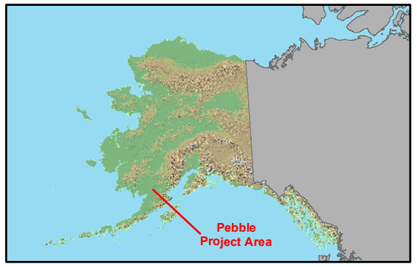

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1983 North American Datum

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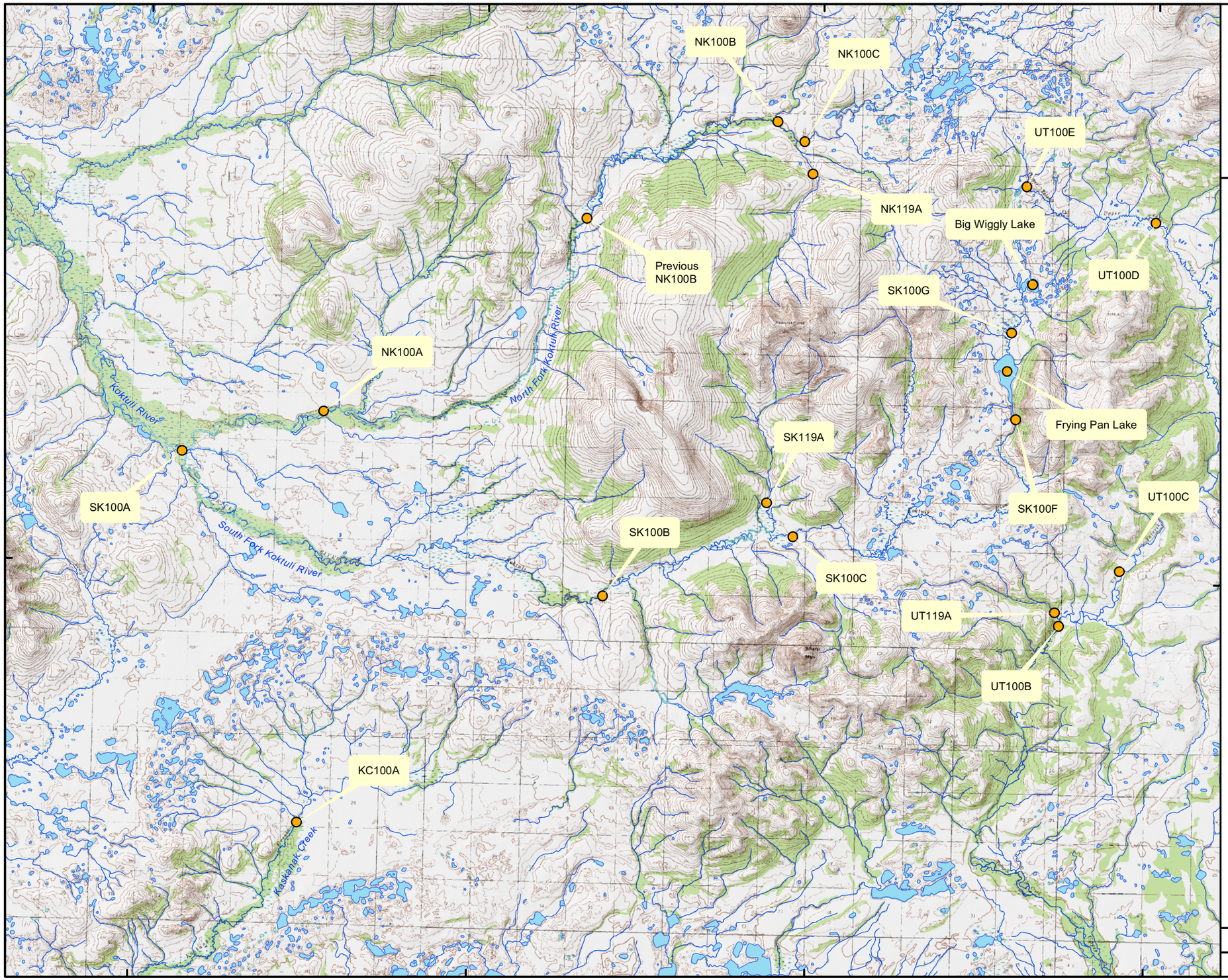


Northern Dynasty Mines Inc.

Pebble Project

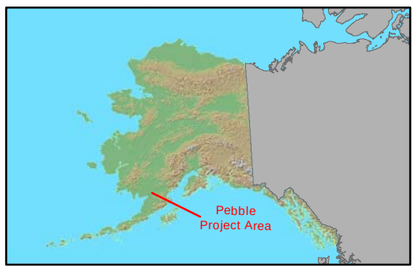
Aquatic Resource Sampling
Mine Site Locations
Figure 11-3

Legend

- Fish Tissue and Macroinvertebrate Sampling Locations

Sites from HDR, file date 01/25/2005

Privileged and Confidential



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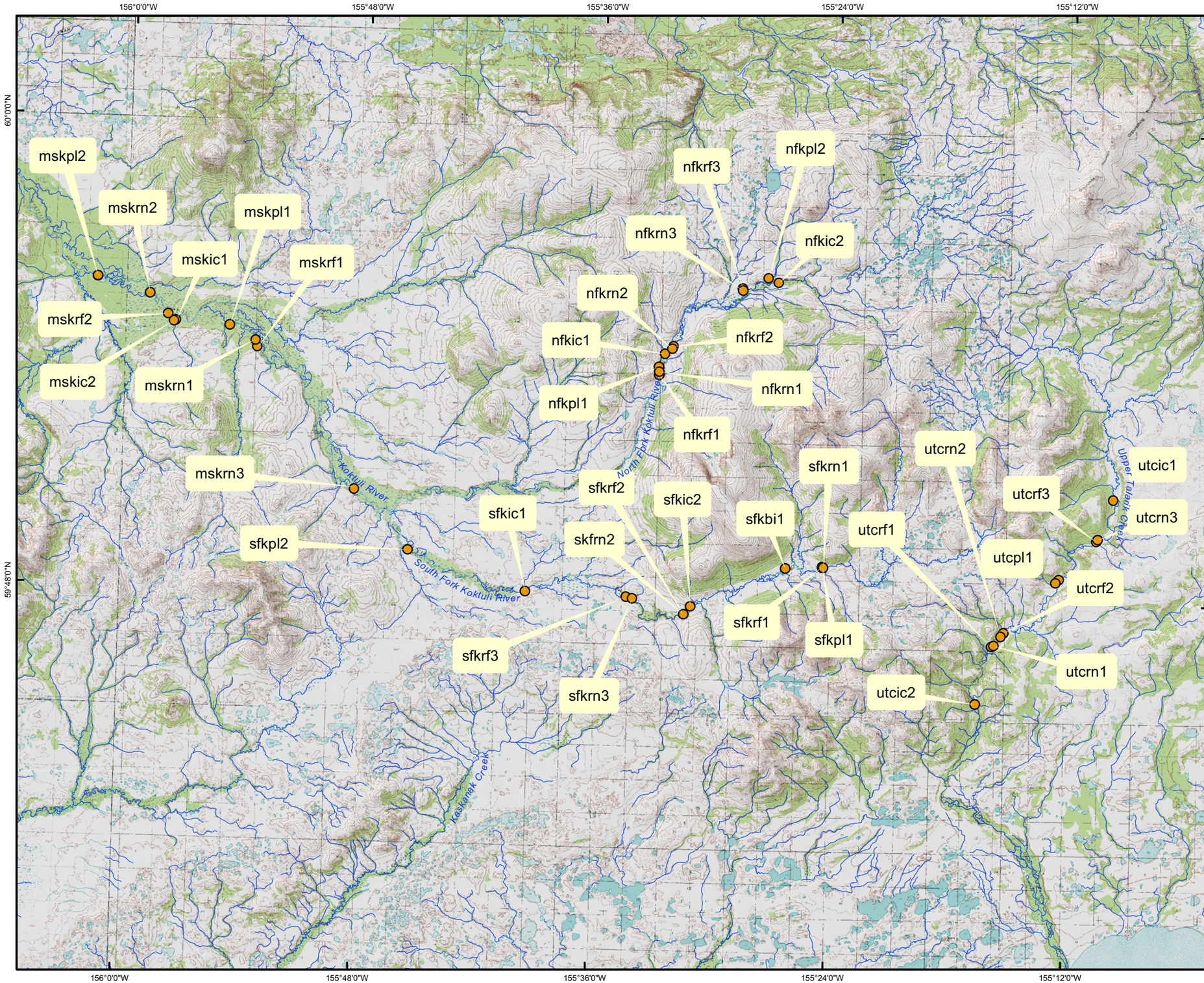

Northern Dynasty Mines Inc.

Pebble Project

Flow Habitat Study Sites
Figure 11-4

Legend

- Site Locations

Sites from HDR, file date 01/25/2005

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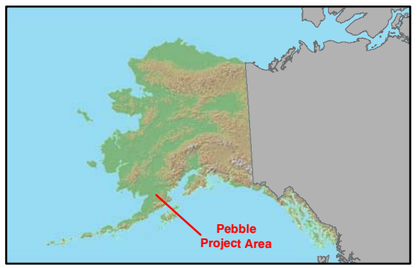

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00.51 2 3 4 5 Kilometers

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1983 North American Datum

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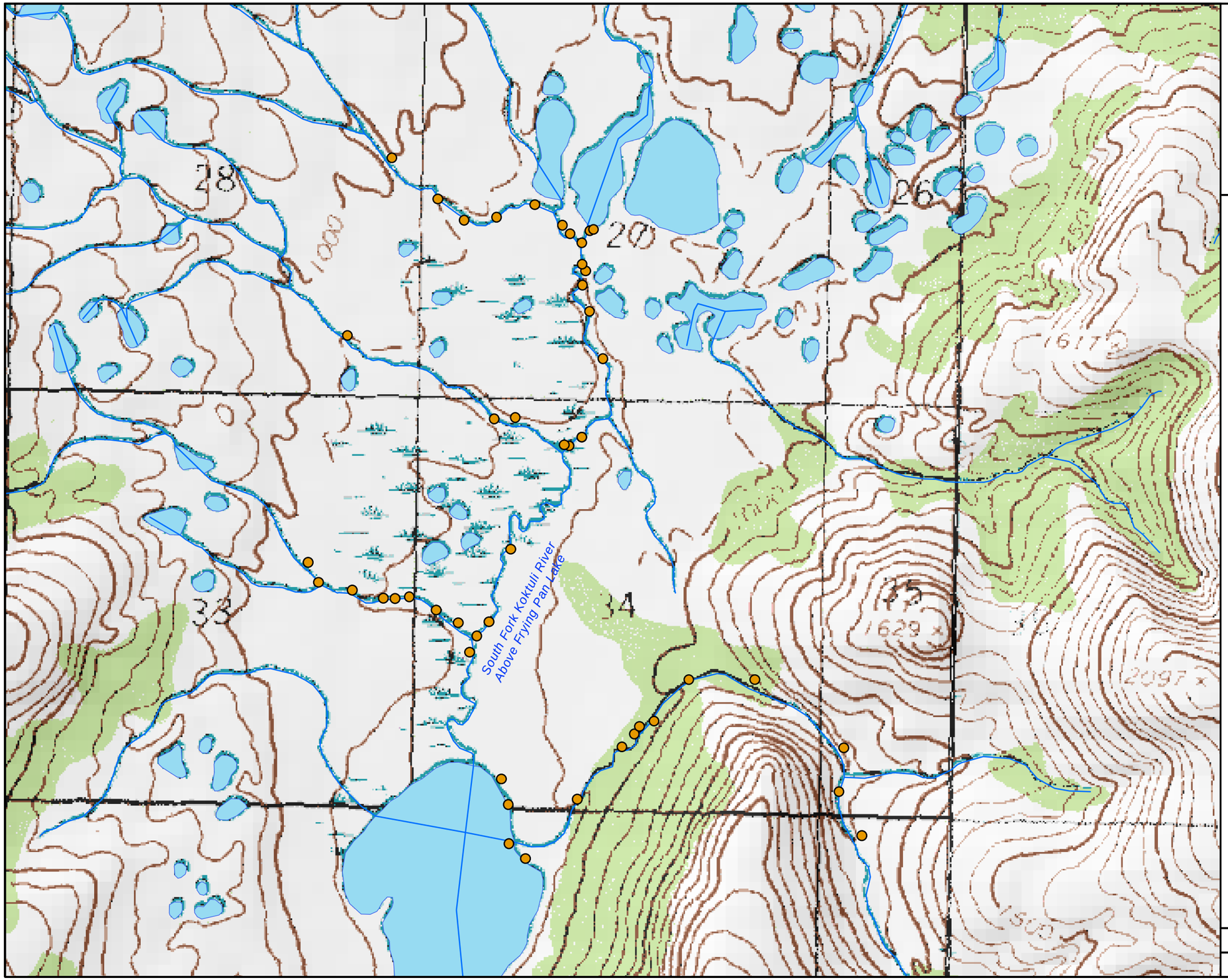

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Pebble Project

SFK Above Frying Pan Lake
Removal Sampling Sites
Figure 11-5

Legend

- Sampling Sites

Sites from HDR, file date 01/25/2005

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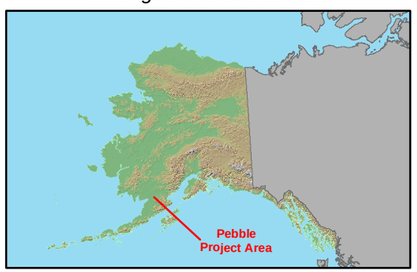

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0 100 200 400 600 800 1,000 Meters

Scale 1:15,522

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1983 North American Datum

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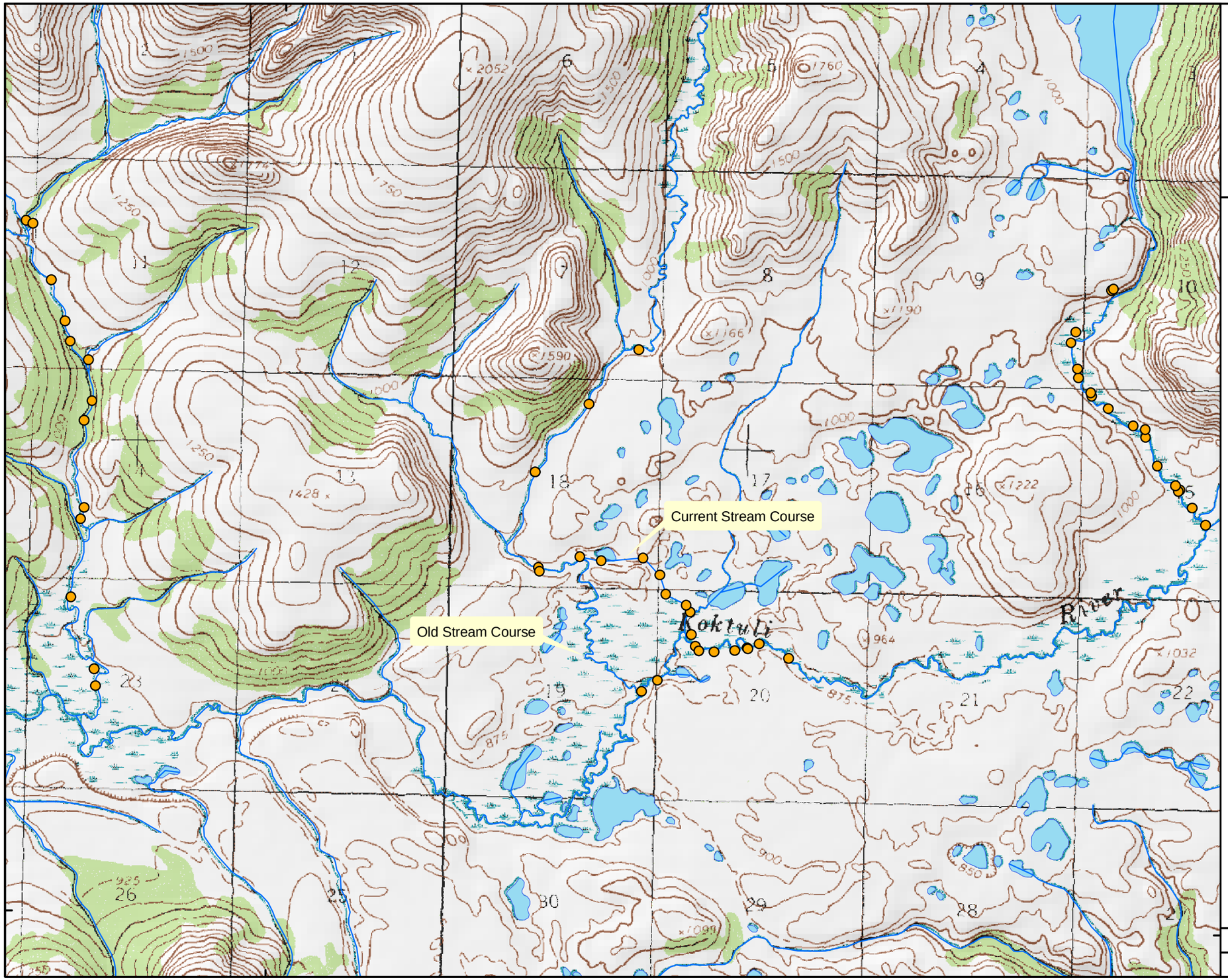
155°24'0"W



59°48'0"N

155°24'0"W

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Pebble Project

SFK Below Frying Pan Lake
Removal Sampling Sites
Figure 11-6

Legend

- Fish Removal Sampling Sites

Sites from HDR, file date 01/25/2005

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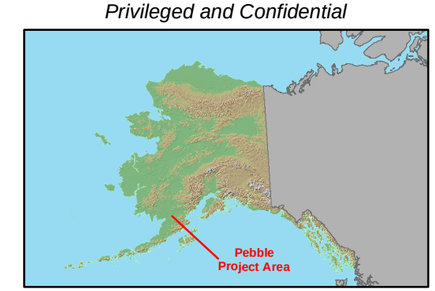

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Scale 1:30,287

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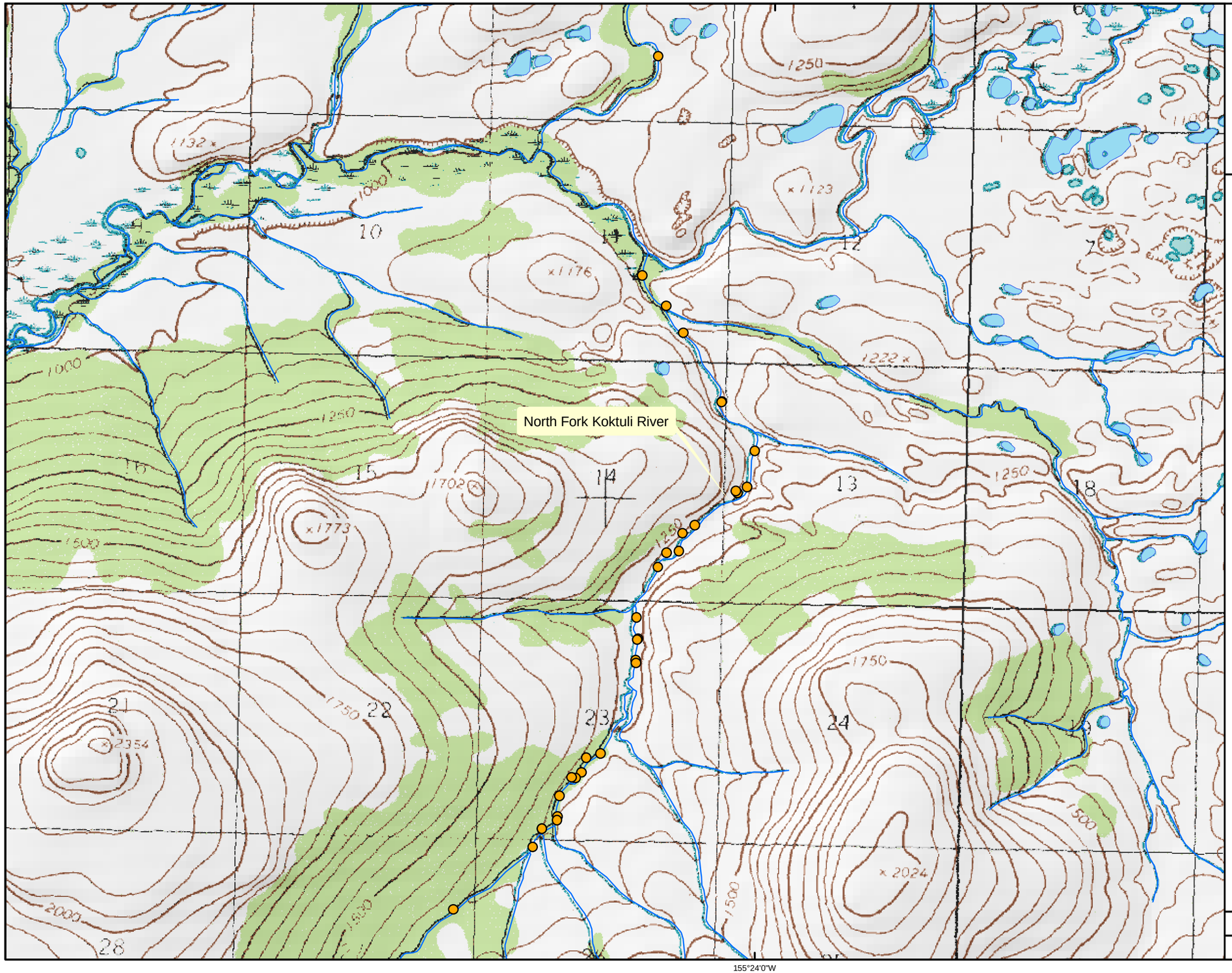

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Northern Dynasty Mines Inc.

Pebble Project
North Fork Koktuli 1.190
Removal Sampling Sites
Figure 11-7

Legend

- Sampling Sites

Sites from HDR, file date 01/25/2005

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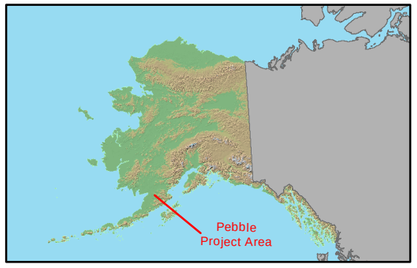

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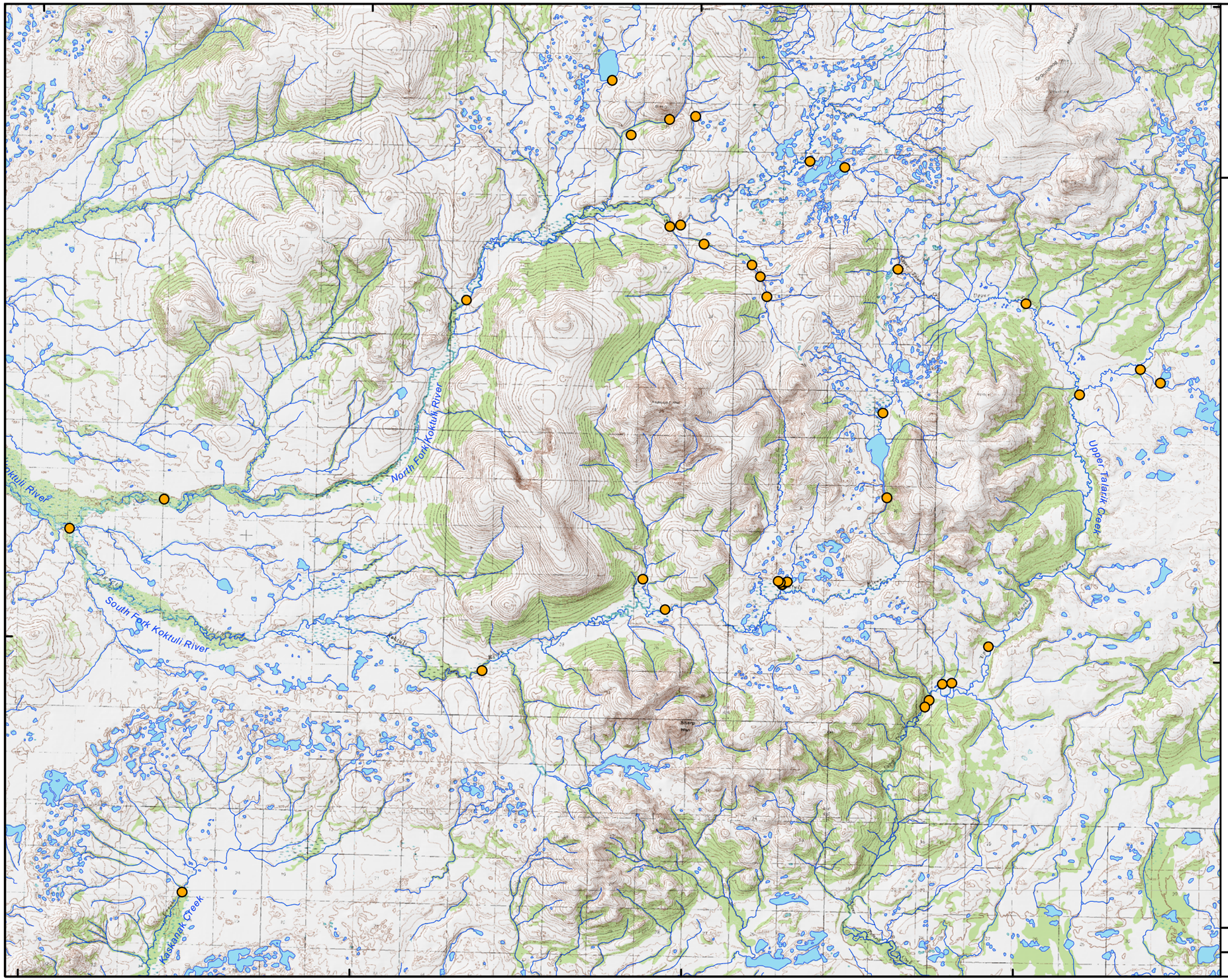

Northern Dynasty Mines Inc.

Pebble Project

Qualitative Abundance Sampling Sites
Figure 11-8

Legend

- Sampling Sites

Sites from HDR, file date 01/25/2005

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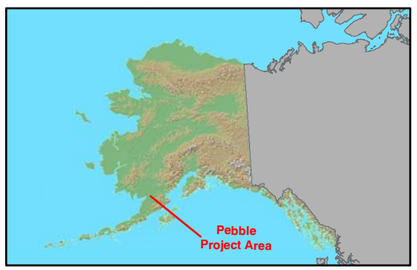

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Scale 1:134,122

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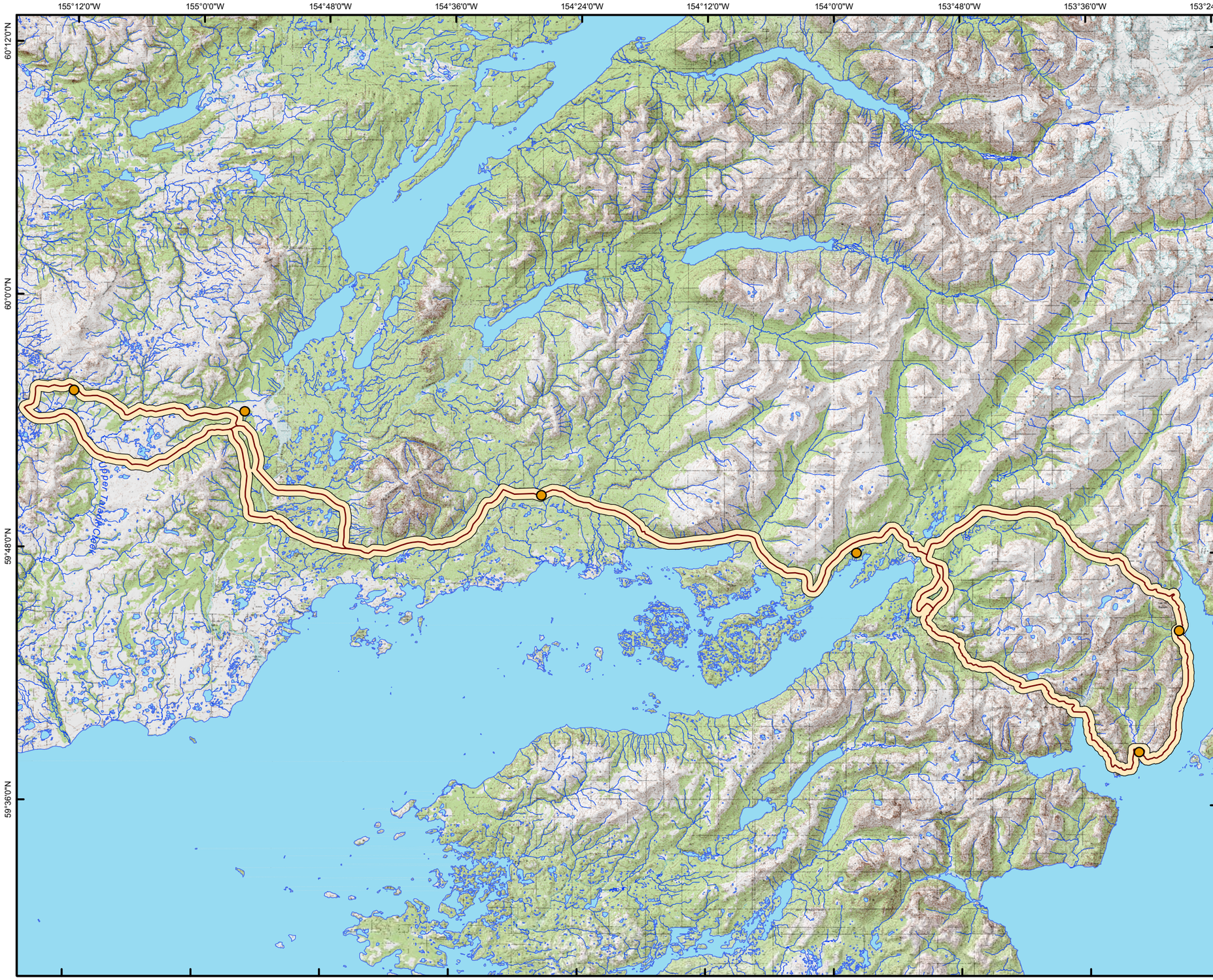


Northern Dynasty Mines Inc.

Pebble Project

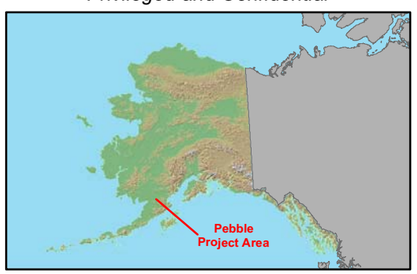
Aquatic Resource Sampling
Road Corridor Locations
Figure 11-9

Legend

- Fish Tissue and Macroinvertebrate Sampling Locations

Sites from HDR, file date 01/25/2005

Privileged and Confidential



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Alaska State Plane Zone 5 (units feet)
1983 North American Datum

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APPENDICES

APPENDIX A
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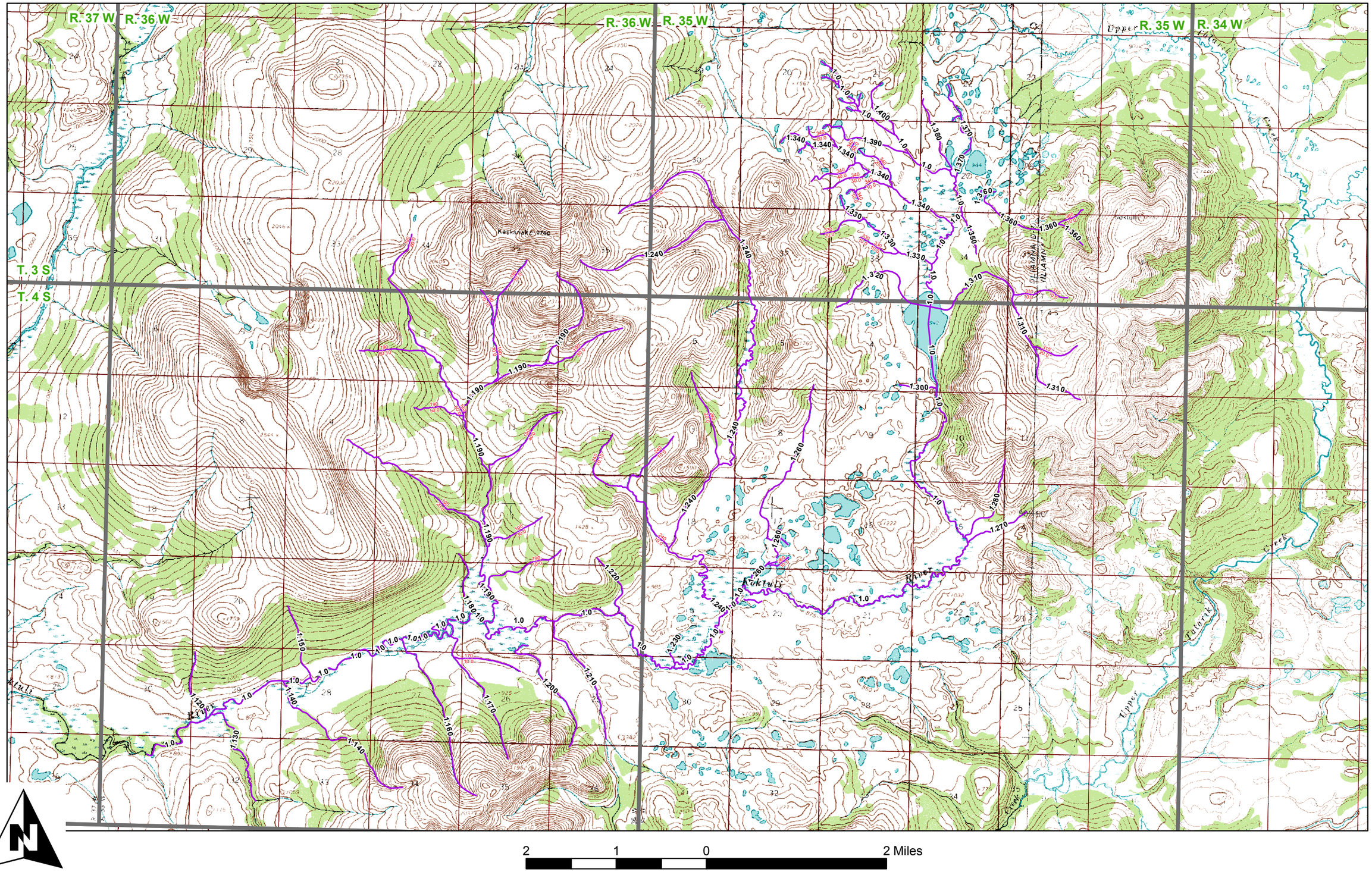
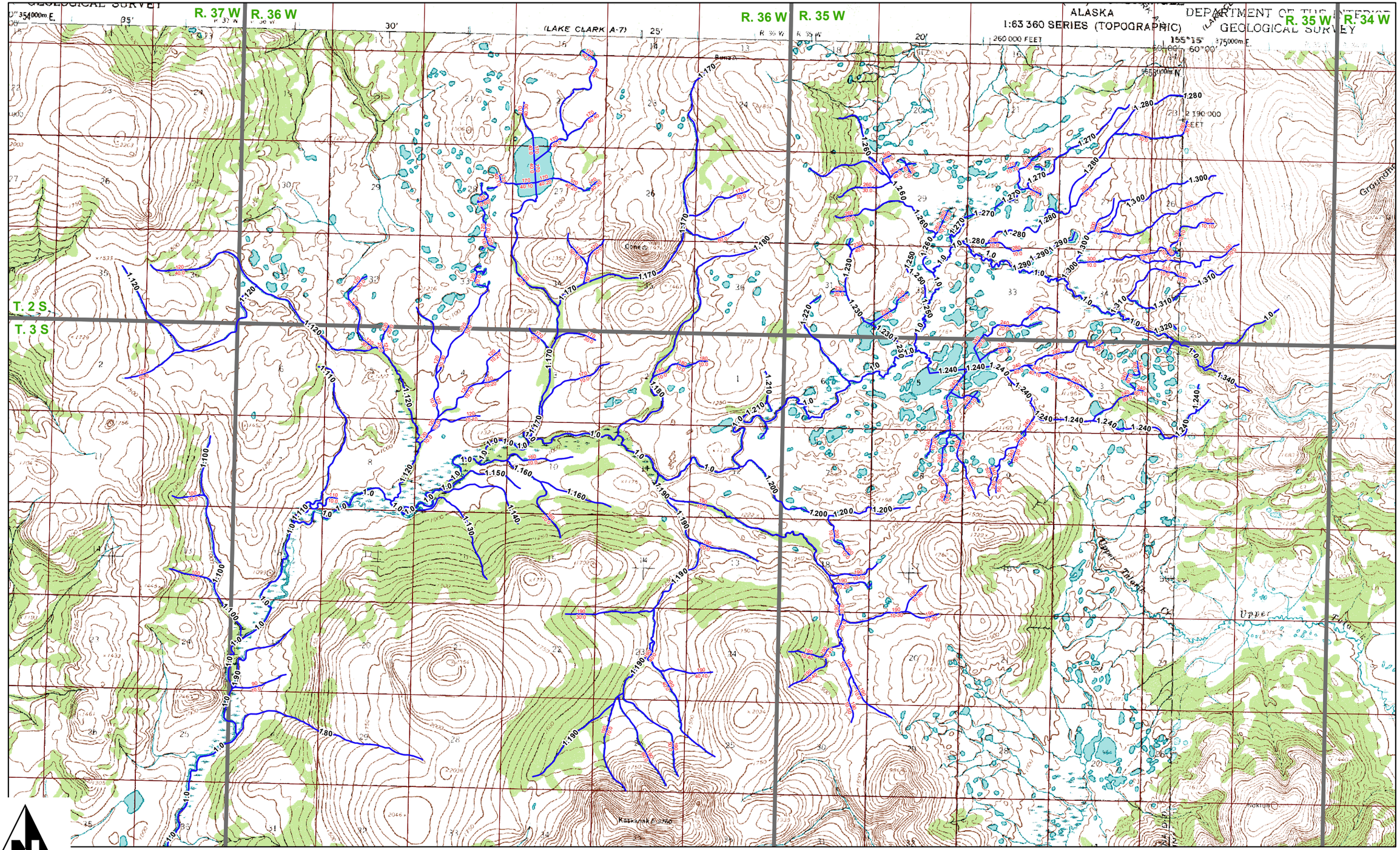
APPENDIX 11-B
Numbered Stream Reference Maps

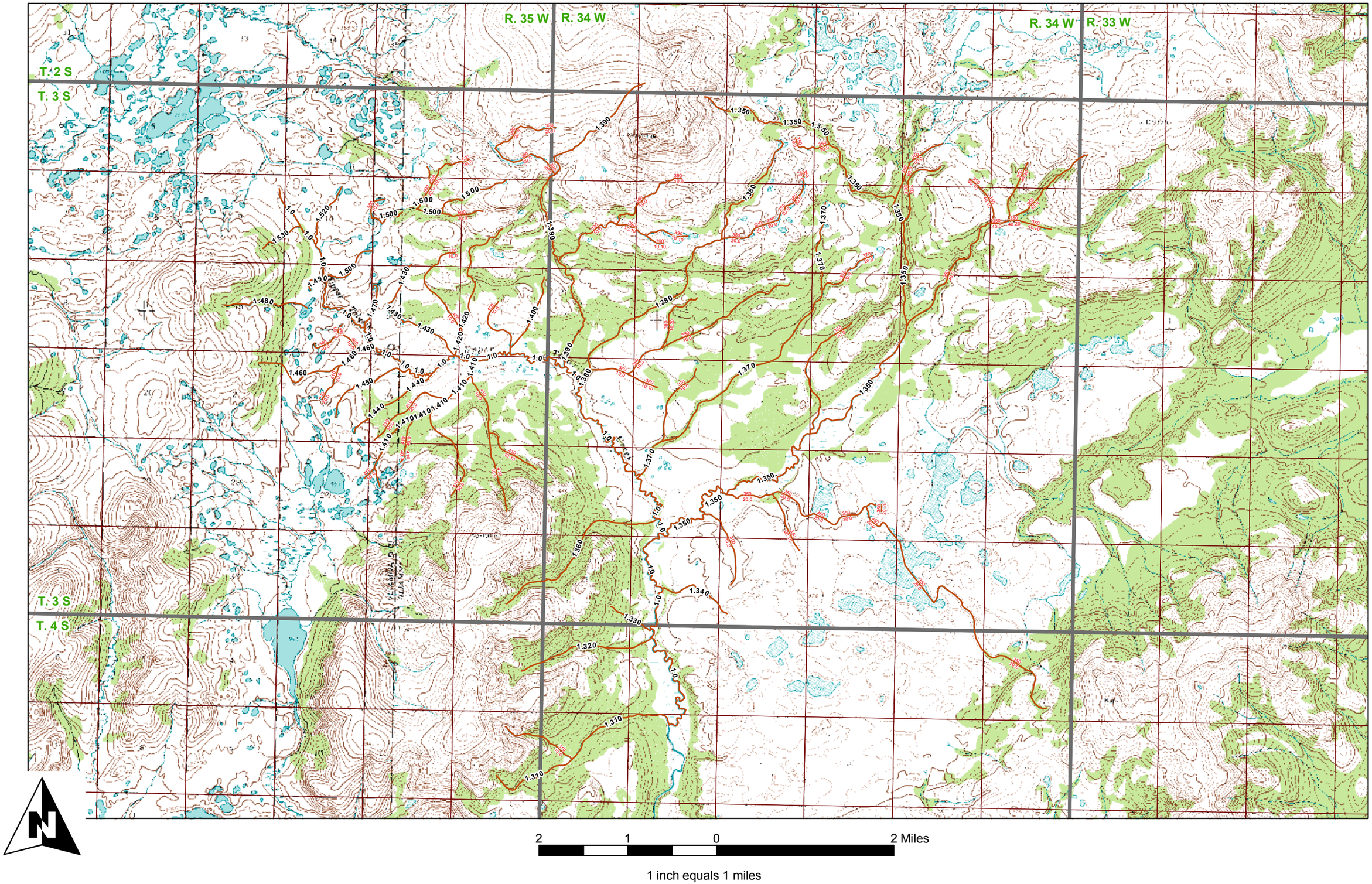
South Fork Stream Network



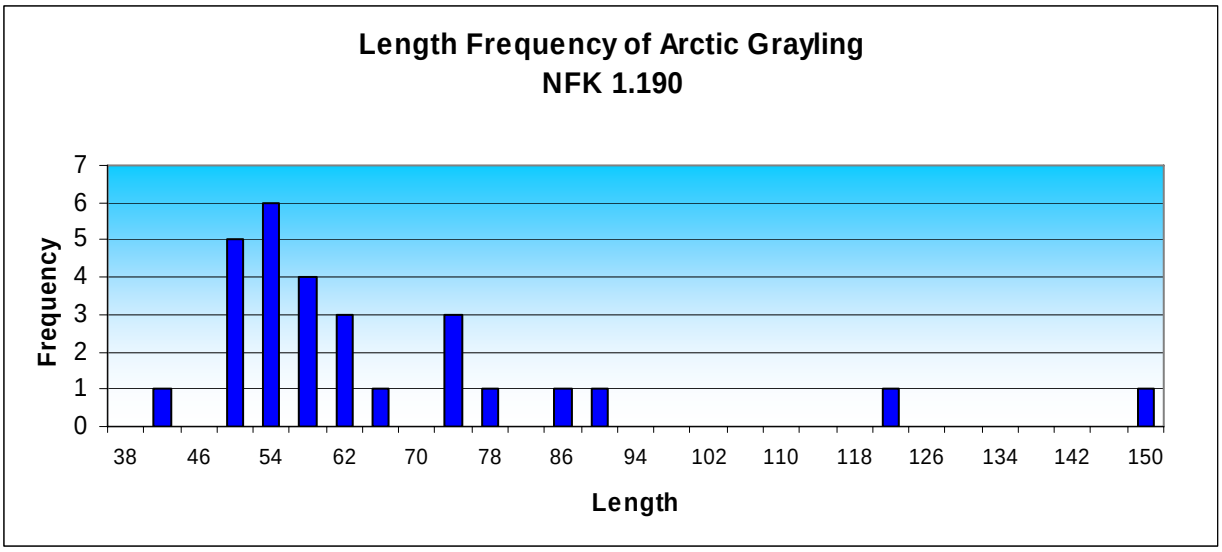
North Fork Stream Network

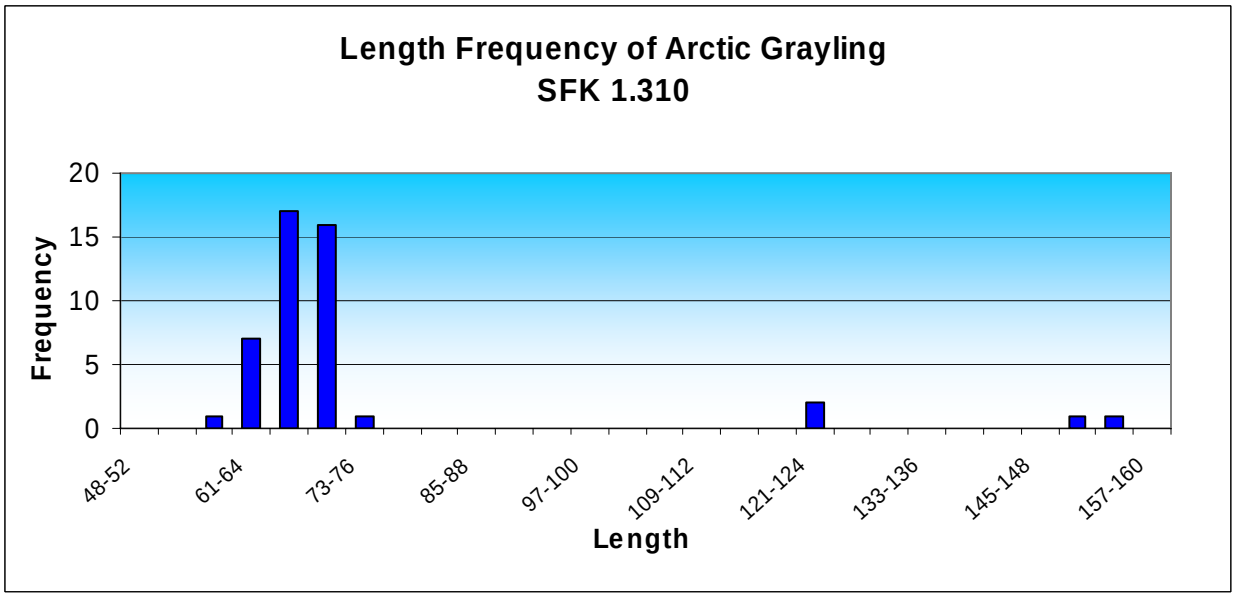


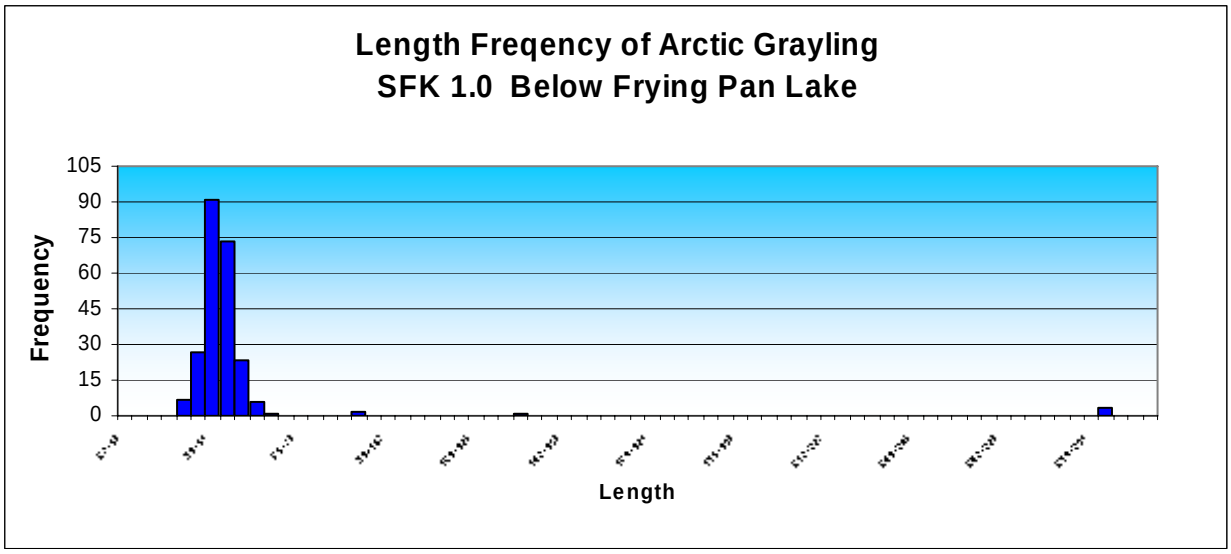
Upper Talarik Stream Network

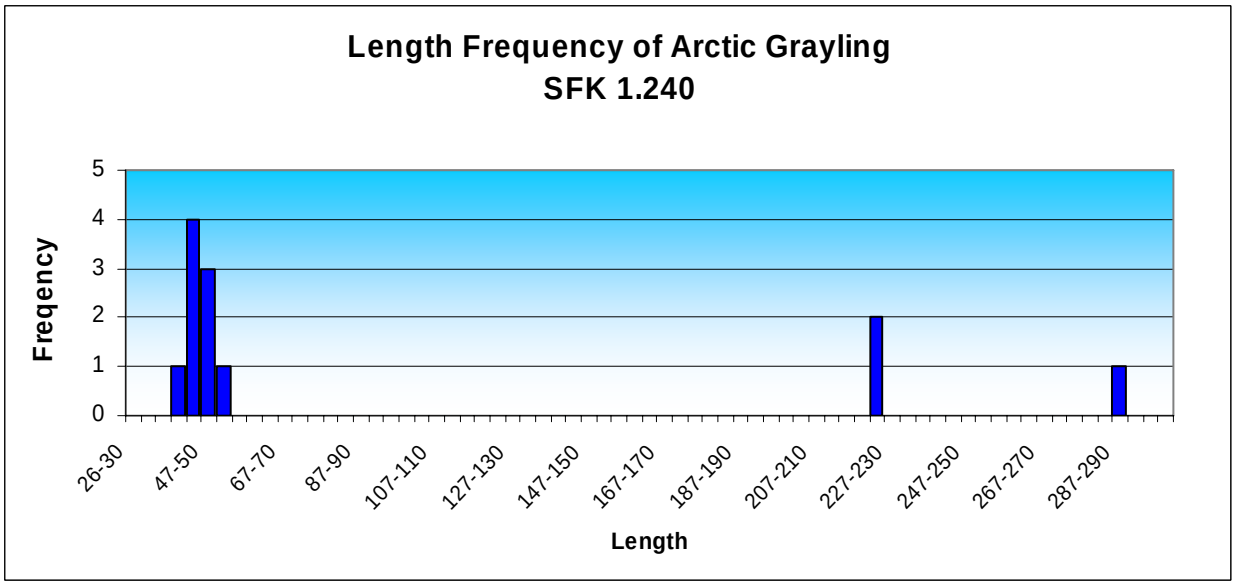


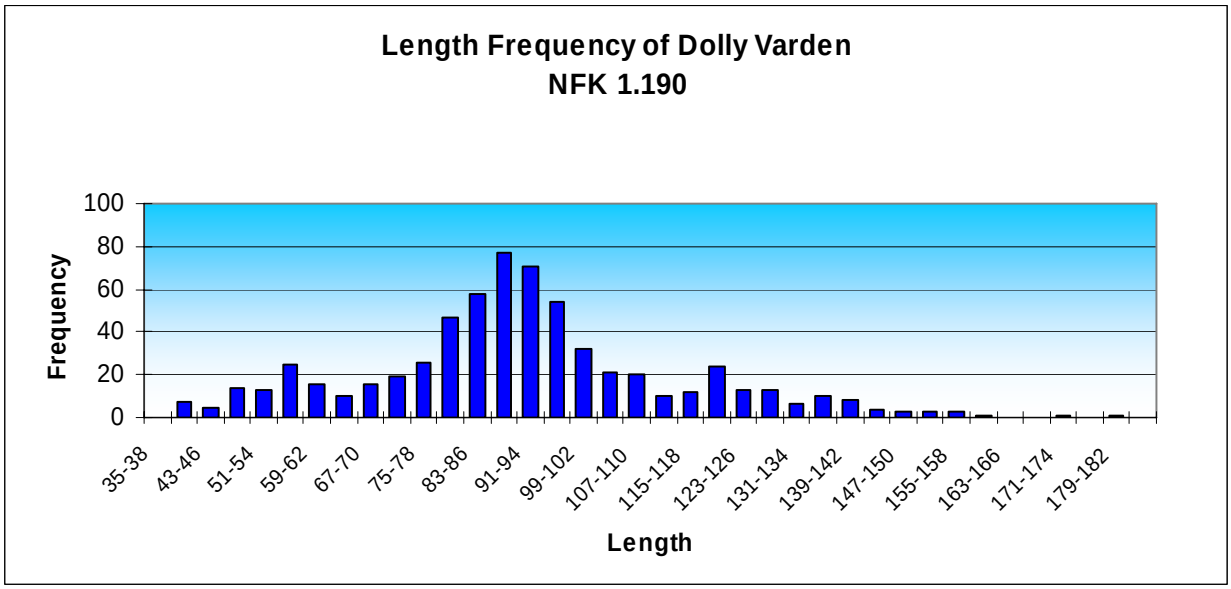
APPENDIX 11-C
Length Frequency Data

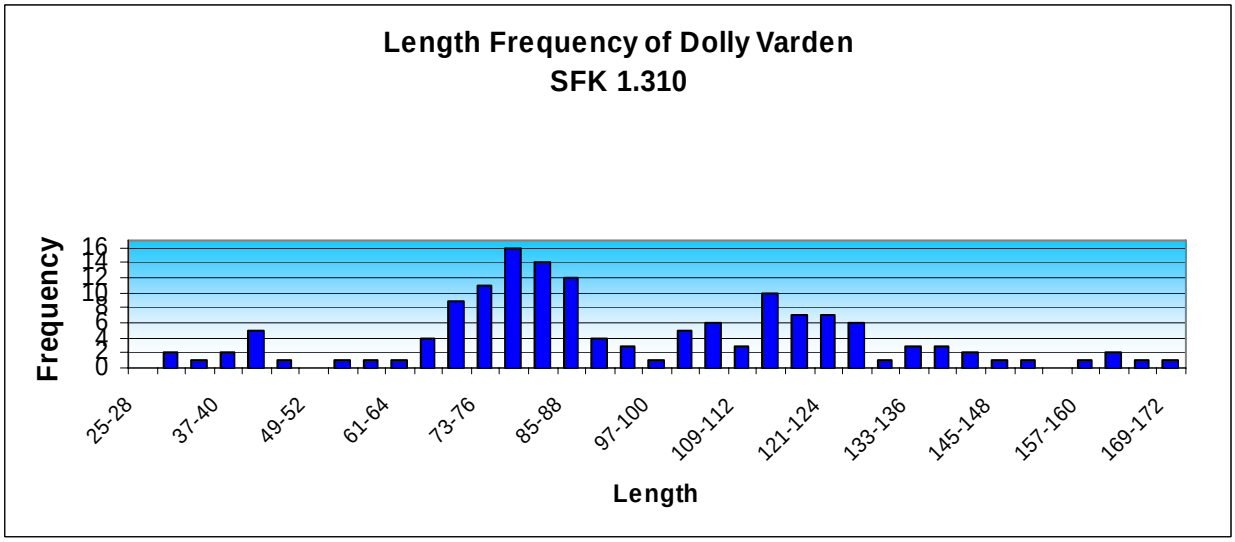

Length Frequency of Arctic Grayling
NFK 1.190
Frequency
0
1
2
3
4
5
6
7
38
46
54
62
70
78
86
94
102
110
118
126
134
142
150
Length

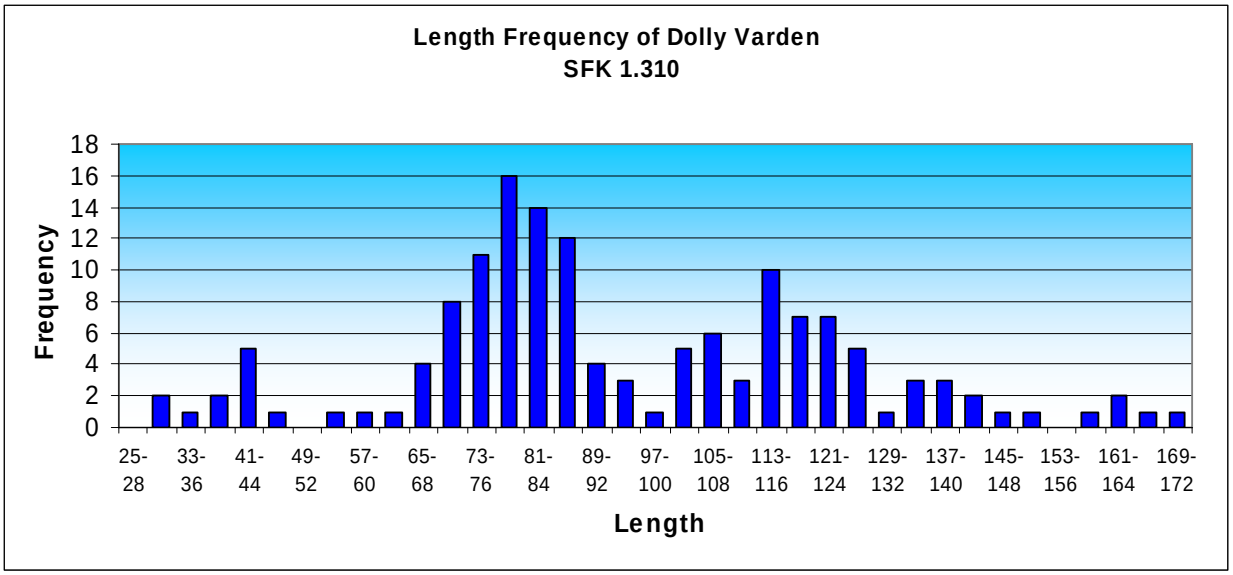

Length Frequency of Arctic Grayling
SFK 1.310
Frequency
0
5
10
15
20
48-52
61-64
73-76
85-88
97-100
109-112
121-124
133-136
145-148
157-160
Length

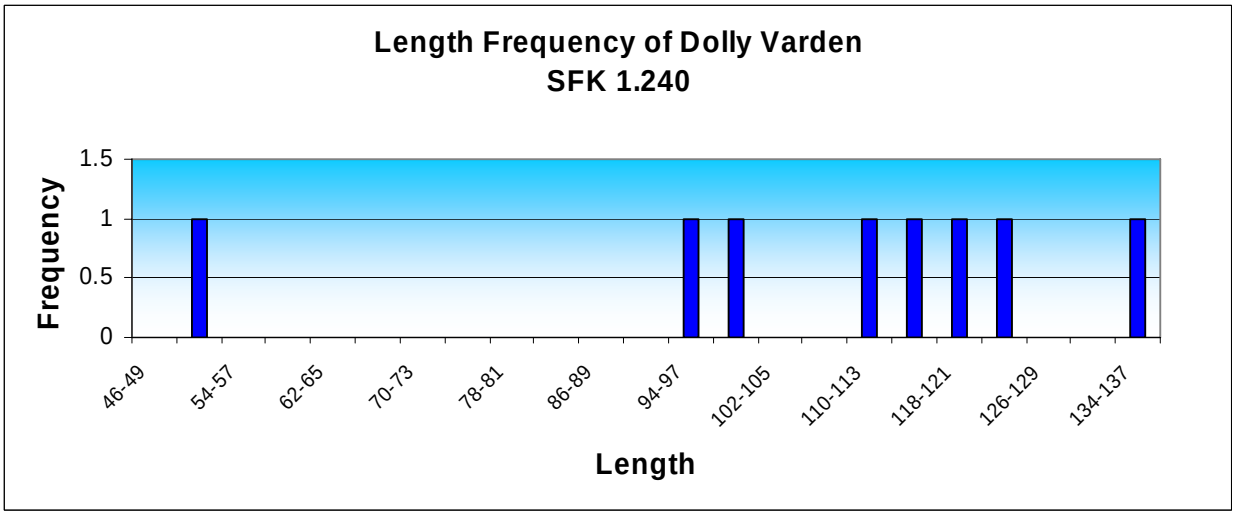

Length Freqency of Arctic Grayling
SFK 1.0 Below Frying Pan Lake
Frequency
105
90
75
60
45
30
15
0
Length

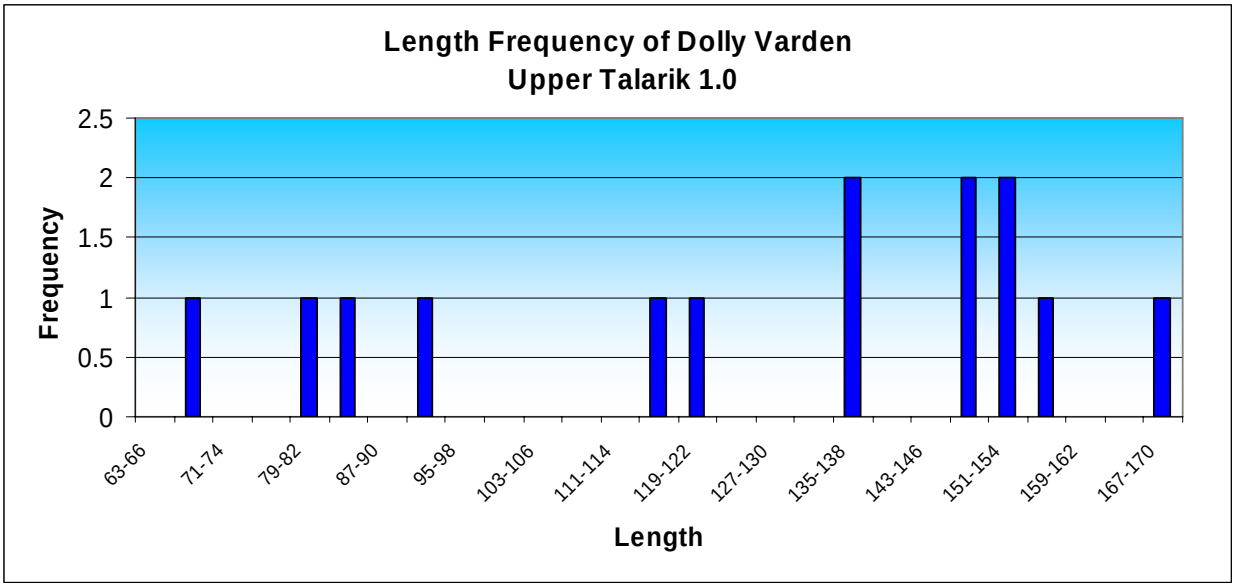

Length Frequency of Arctic Grayling
SFK 1.240
Freqency
5
4
3
2
1
0
26-30
47-50
67-70
87-90
107-110
127-130
147-150
167-170
187-190
207-210
227-230
247-250
267-270
287-290
Length

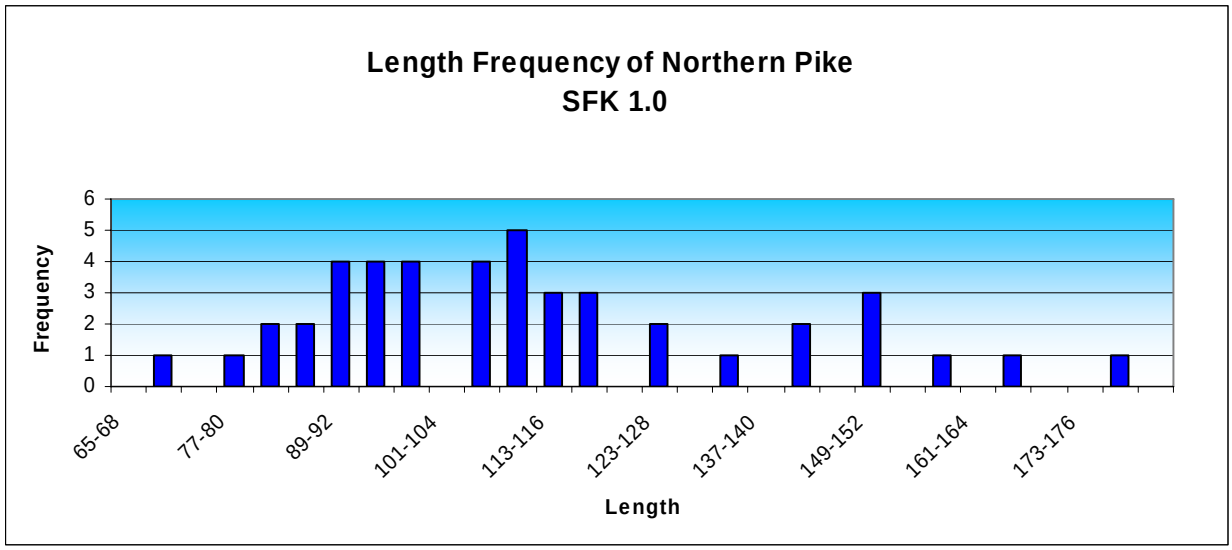

Length Frequency of Dolly Varden
NFK 1.190
Frequency
100
80
60
40
20
0
35-38
43-46
51-54
59-62
67-70
75-78
83-86
91-94
99-102
107-110
115-118
123-126
131-134
139-142
147-150
155-158
163-166
171-174
179-182
Length

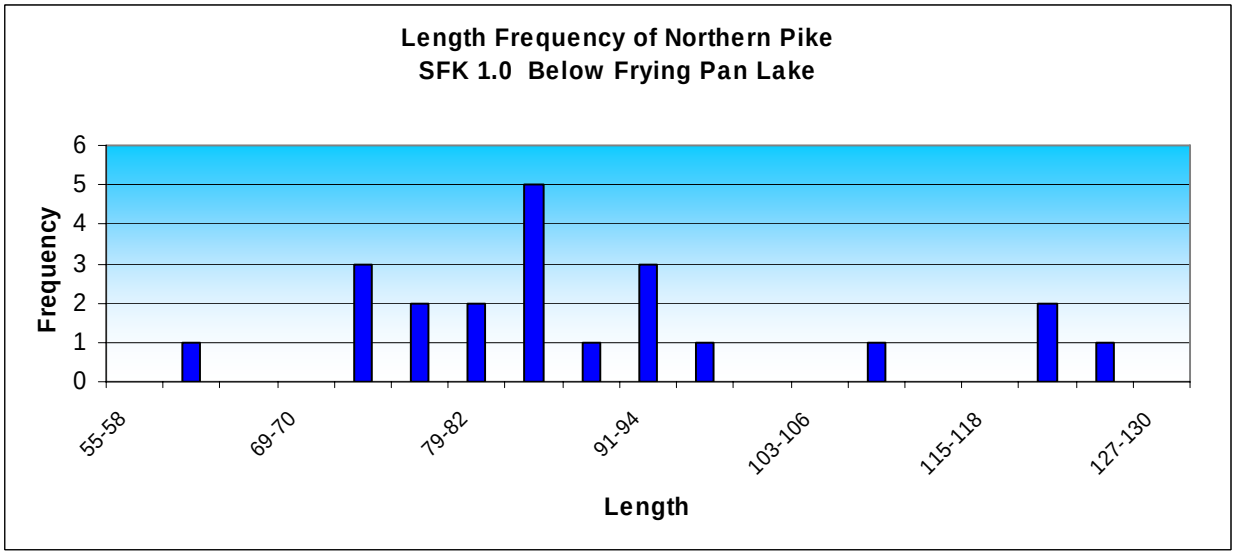

Length Frequency of Dolly Varden
SFK 1.310
Frequency
16
14
12
10
8
6
4
2
0
25-28
37-40
49-52
61-64
73-76
85-88
97-100
109-112
121-124
133-136
145-148
157-160
169-172
Length

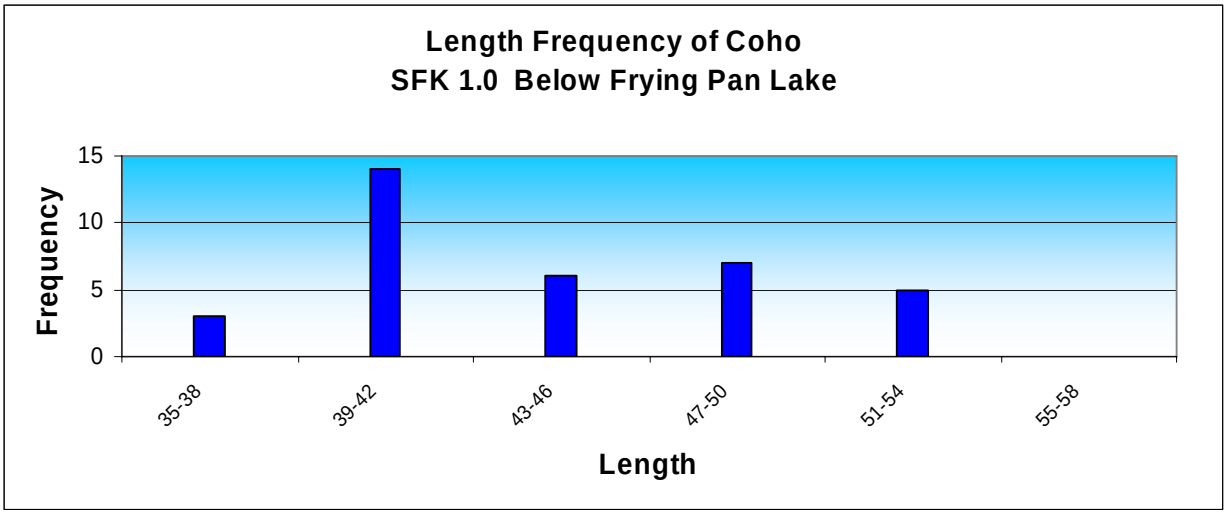

Length Frequency of Dolly Varden
SFK 1.310
Frequency
18
16
14
12
10
8
6
4
2
0
25-28
33-36
41-44
49-52
57-60
65-68
73-76
81-84
89-92
97-100
105-108
113-116
121-124
129-132
137-140
145-148
153-156
161-164
169-172
Length

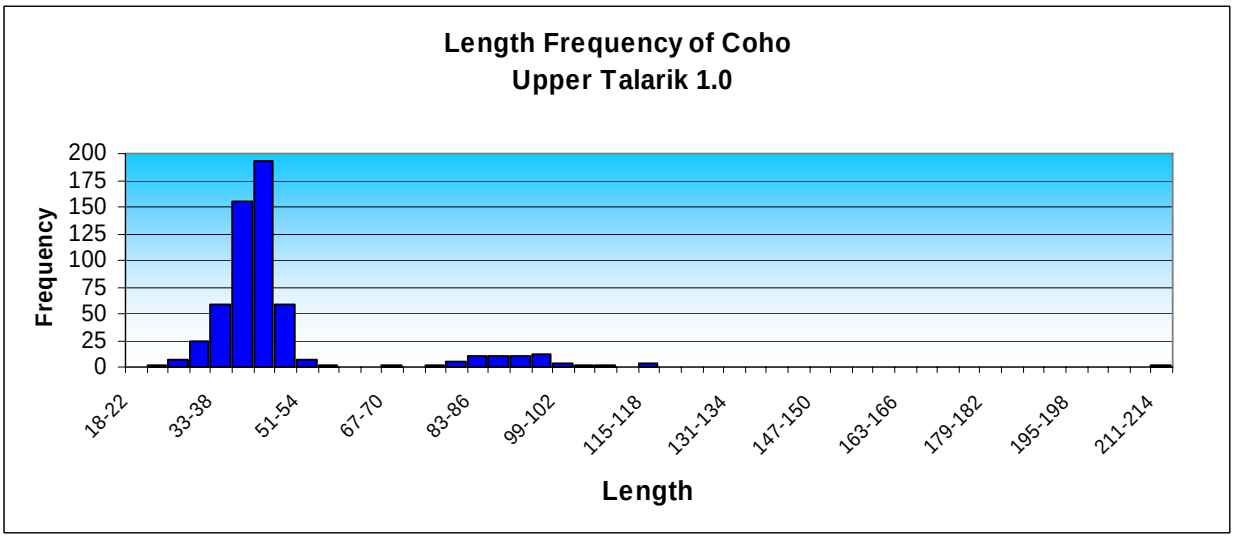

Length Frequency of Dolly Varden
SFK 1.240
Frequency
1.5
1
0.5
0
46-49
54-57
62-65
70-73
78-81
86-89
94-97
102-105
110-113
118-121
126-129
134-137
Length

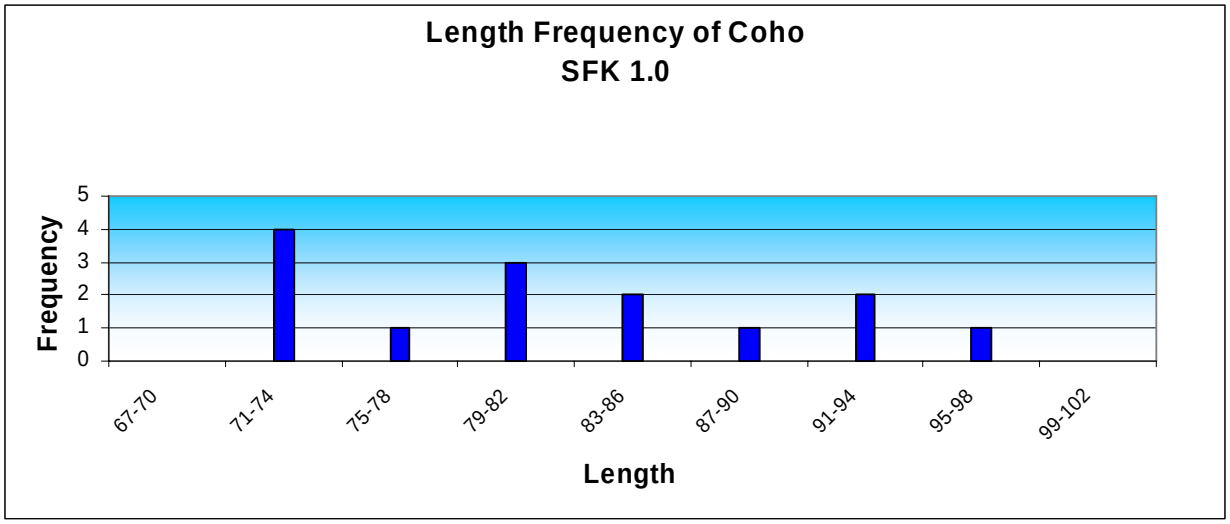

Length Frequency of Dolly Varden
Upper Talarik 1.0
Frequency
2.5
2
1.5
1
0.5
0
63-66
71-74
79-82
87-90
95-98
103-106
111-114
119-122
127-130
135-138
143-146
151-154
159-162
167-170
Length

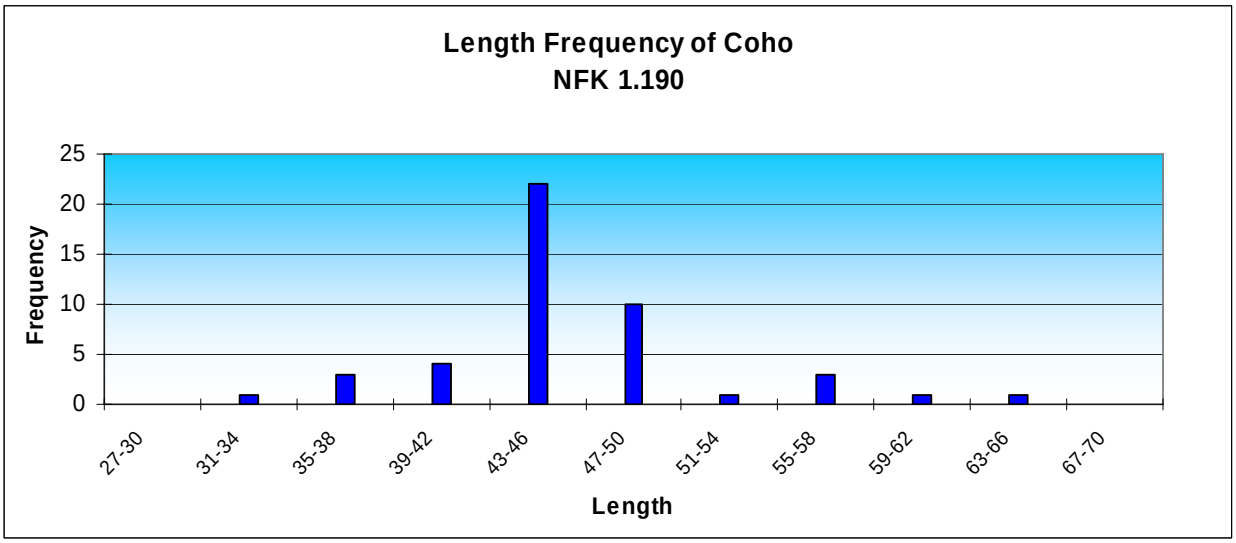

Length Frequency of Northern Pike
SFK 1.0
Frequency
0
1
2
3
4
5
6
65-68
77-80
89-92
101-104
113-116
123-128
137-140
149-152
161-164
173-176
Length

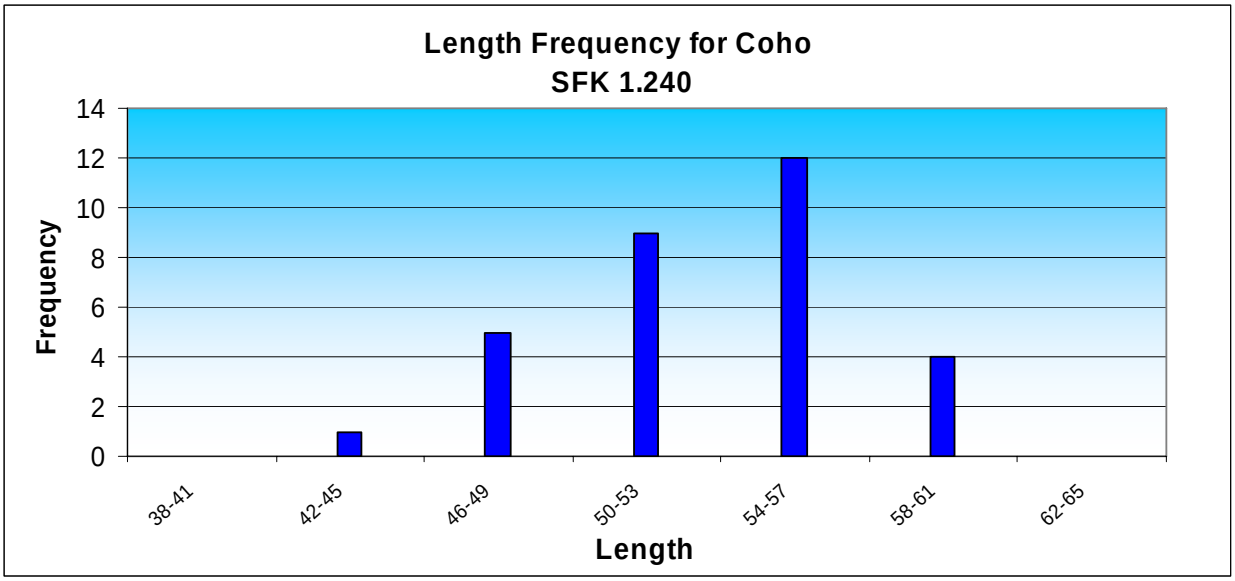

Length Frequency of Northern Pike
SFK 1.0 Below Frying Pan Lake
Frequency
0
1
2
3
4
5
6
55-58
69-70
79-82
91-94
103-106
115-118
127-130
Length

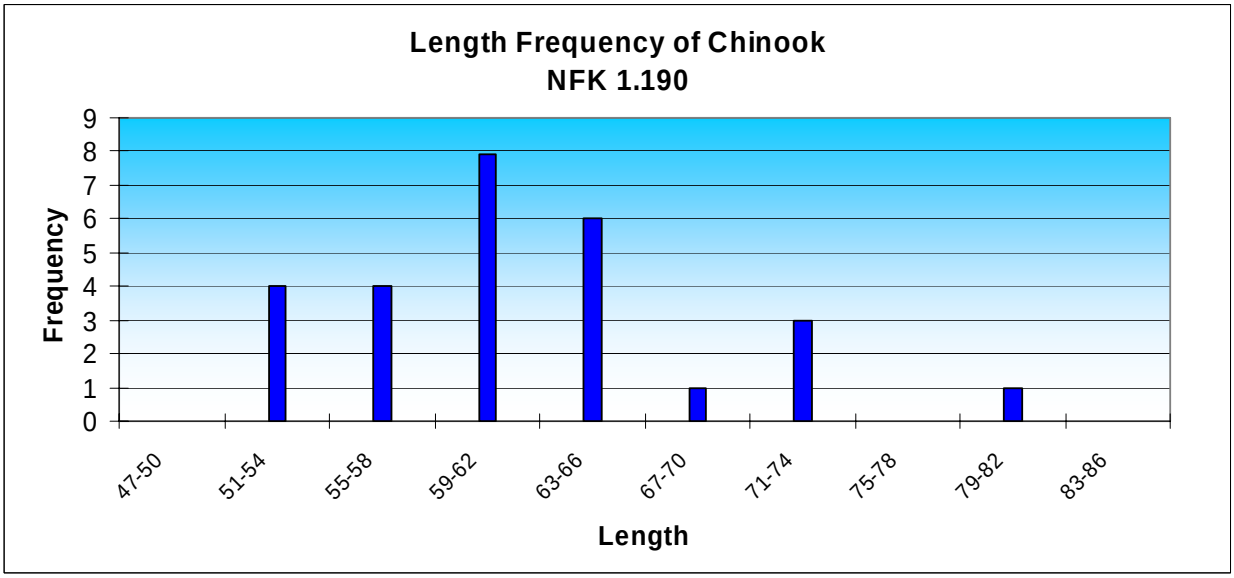

Length Frequency of Coho
SFK 1.0 Below Frying Pan Lake
Frequency
15
10
5
0
35-38
39-42
43-46
47-50
51-54
55-58
Length


Length Frequency of Coho
Upper Talarik 1.0
Frequency
200
175
150
125
100
75
50
25
0
18-22
33-38
51-54
67-70
83-86
99-102
115-118
131-134
147-150
163-166
179-182
195-198
211-214
Length

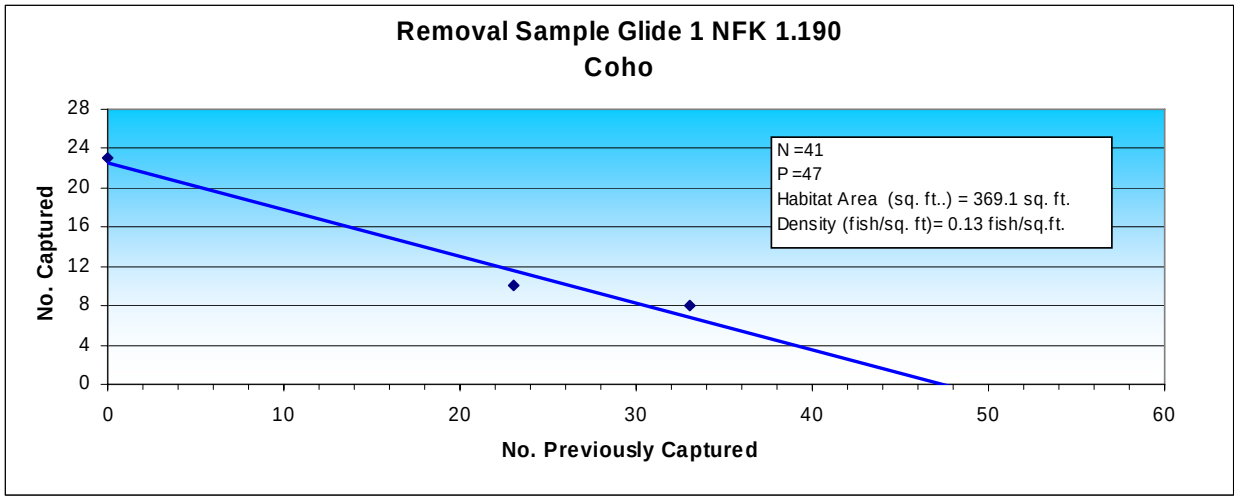

Length Frequency of Coho
SFK 1.0
Frequency
5
4
3
2
1
0
67-70
71-74
75-78
79-82
83-86
87-90
91-94
95-98
99-102
Length

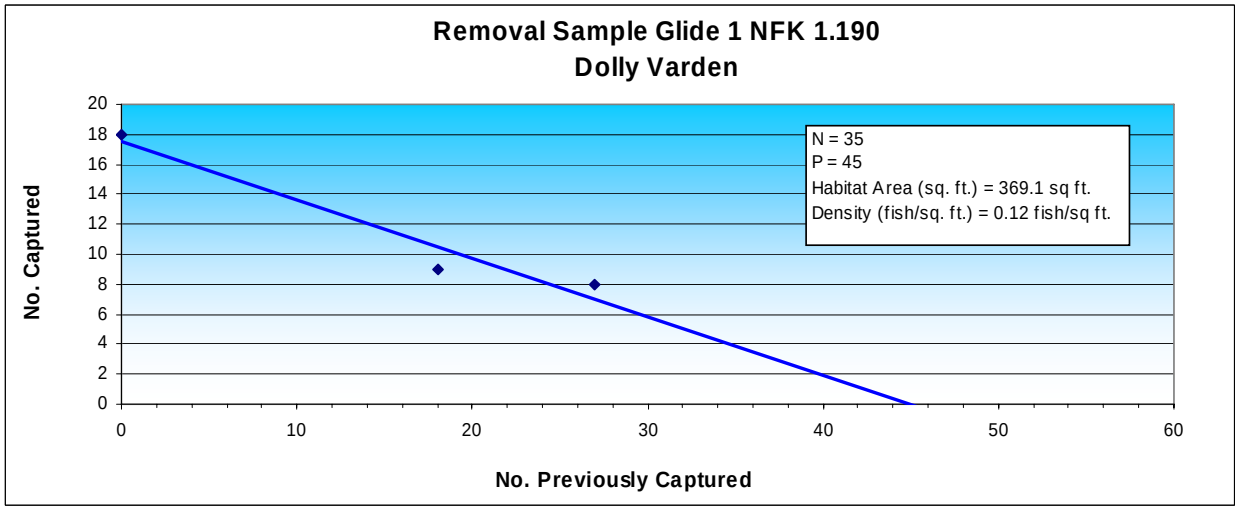

Length Frequency of Coho
NFK 1.190
Frequency
25
20
15
10
5
0
27-30
31-34
35-38
39-42
43-46
47-50
51-54
55-58
59-62
63-66
67-70
Length

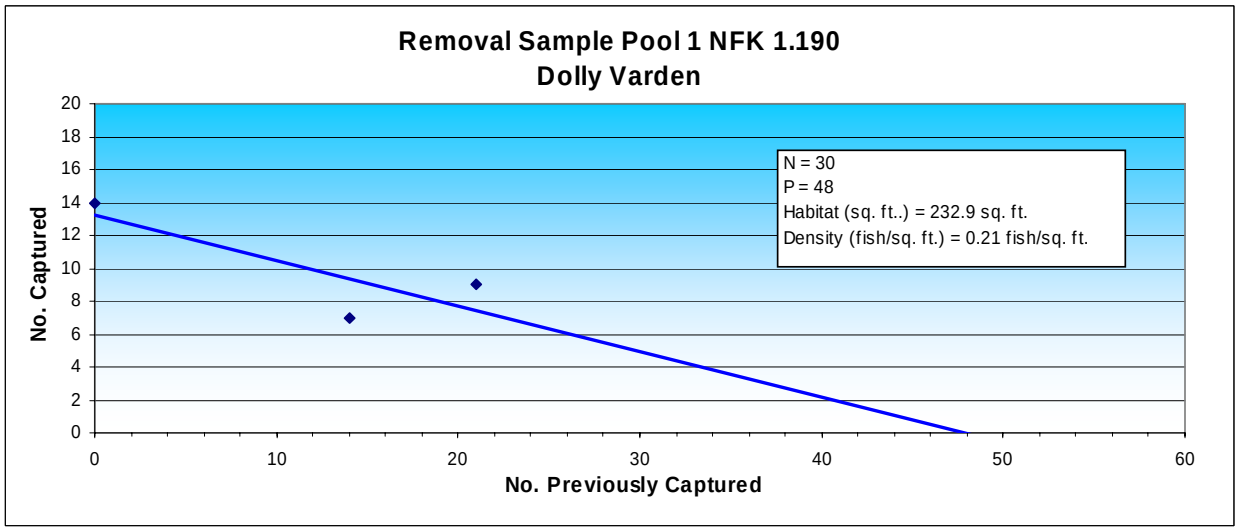

Length Frequency for Coho
SFK 1.240
Frequency
14
12
10
8
6
4
2
0
38-41
42-45
46-49
50-53
54-57
58-61
62-65
Length

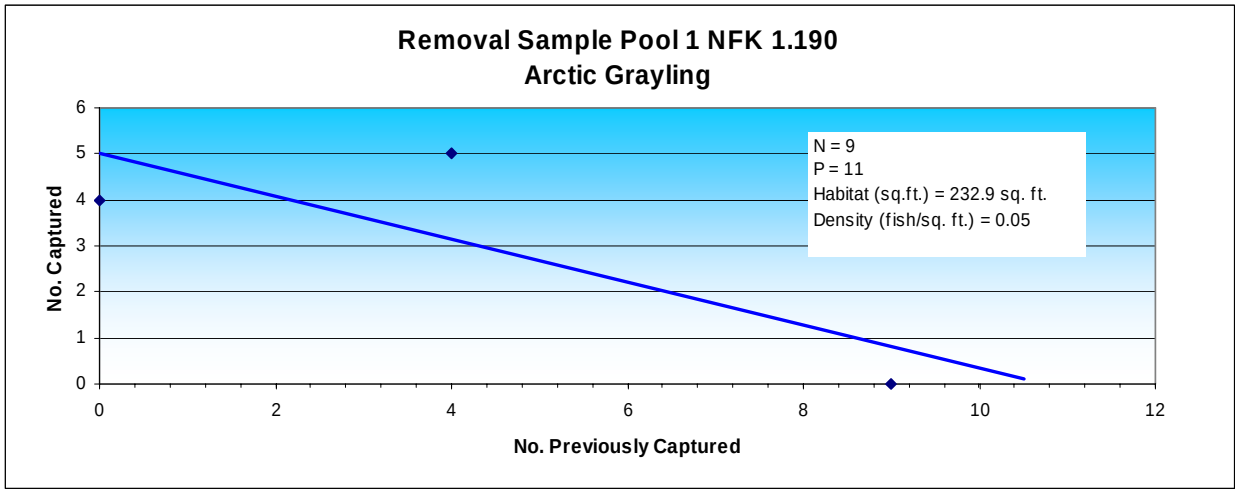

Length Frequency of Chinook
NFK 1.190
Frequency
9
8
7
6
5
4
3
2
1
0
47-50
51-54
55-58
59-62
63-66
67-70
71-74
75-78
79-82
83-86
Length

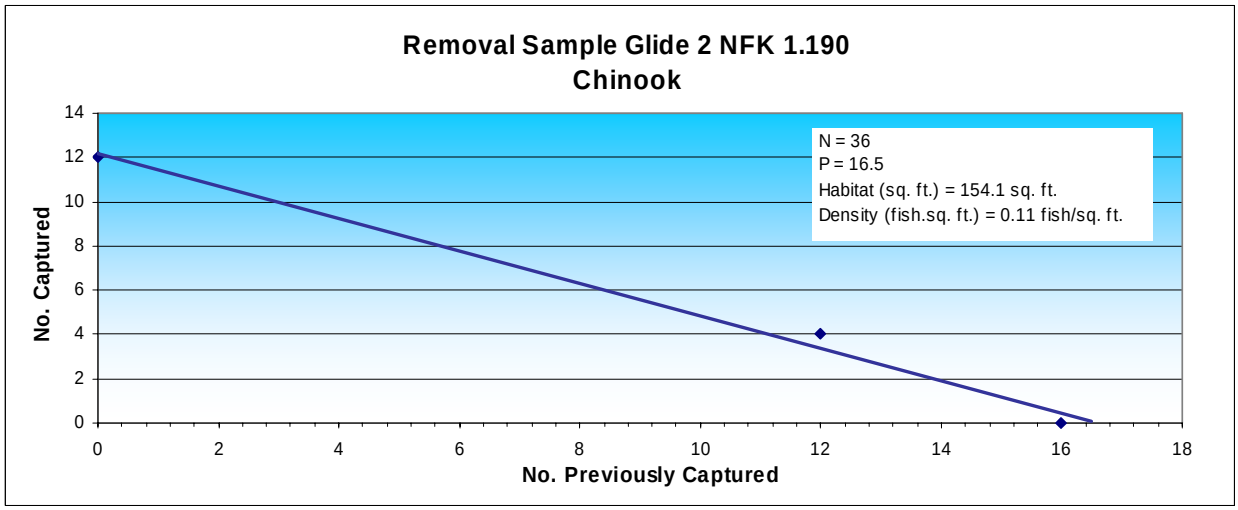
APPENDIX 11-D
Fish Density per Habitat Unit

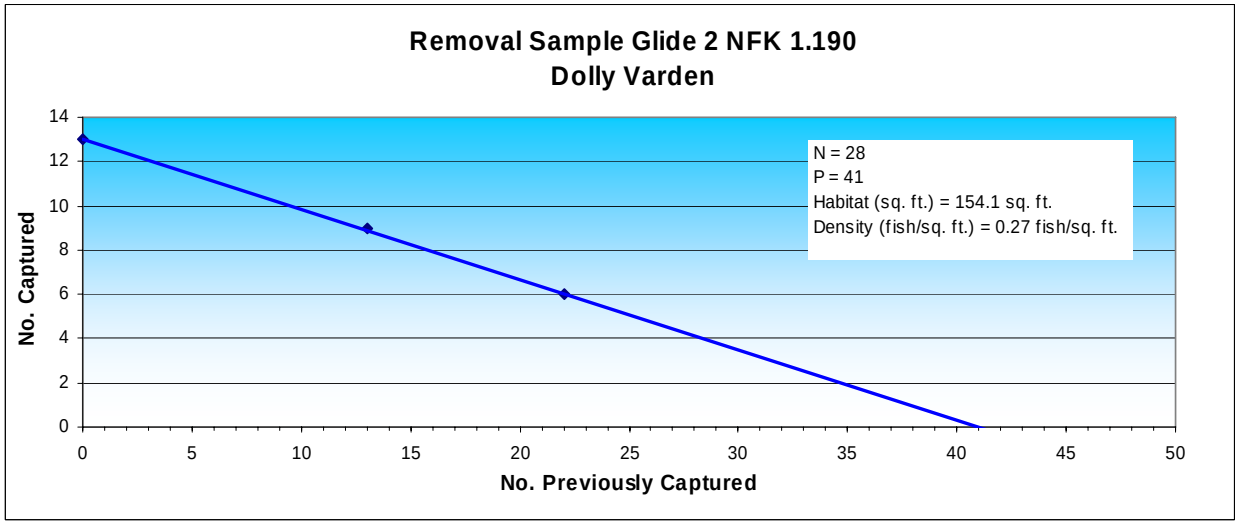

Removal Sample Glide 1 NFK 1.190
Coho
N =41
P =47
Habitat Area (sq. ft..) = 369.1 sq. ft.
Density (fish/sq. ft)= 0.13 fish/sq.ft.
No. Captured
No. Previously Captured
0
4
8
12
16
20
24
28
0
10
20
30
40
50
60

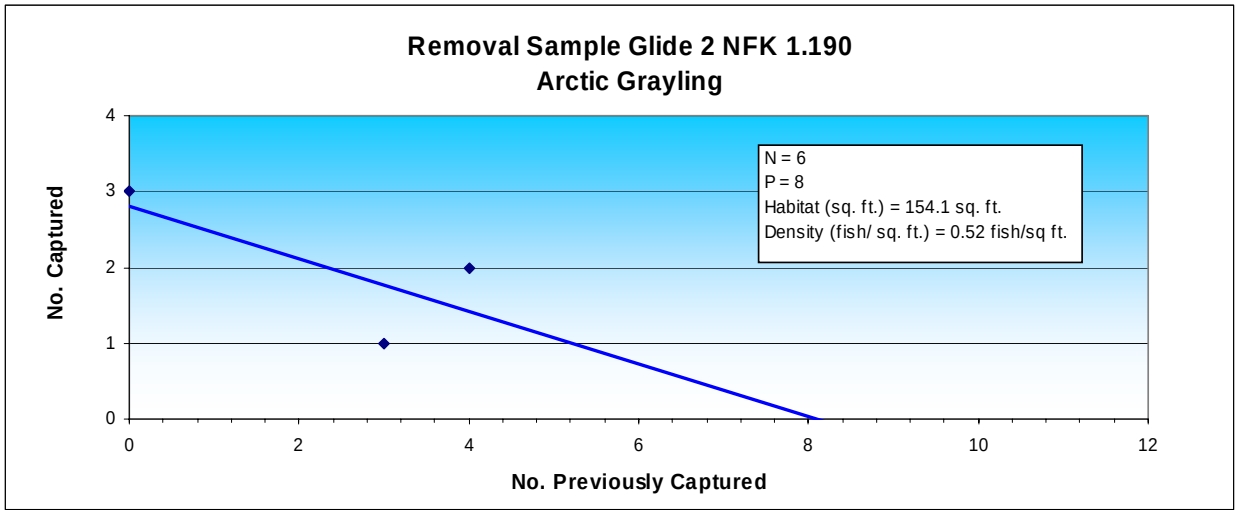

Removal Sample Glide 1 NFK 1.190
Dolly Varden
N = 35
P = 45
Habitat Area (sq. ft.) = 369.1 sq ft.
Density (fish/sq. ft.) = 0.12 fish/sq ft.
No. Captured
No. Previously Captured
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60

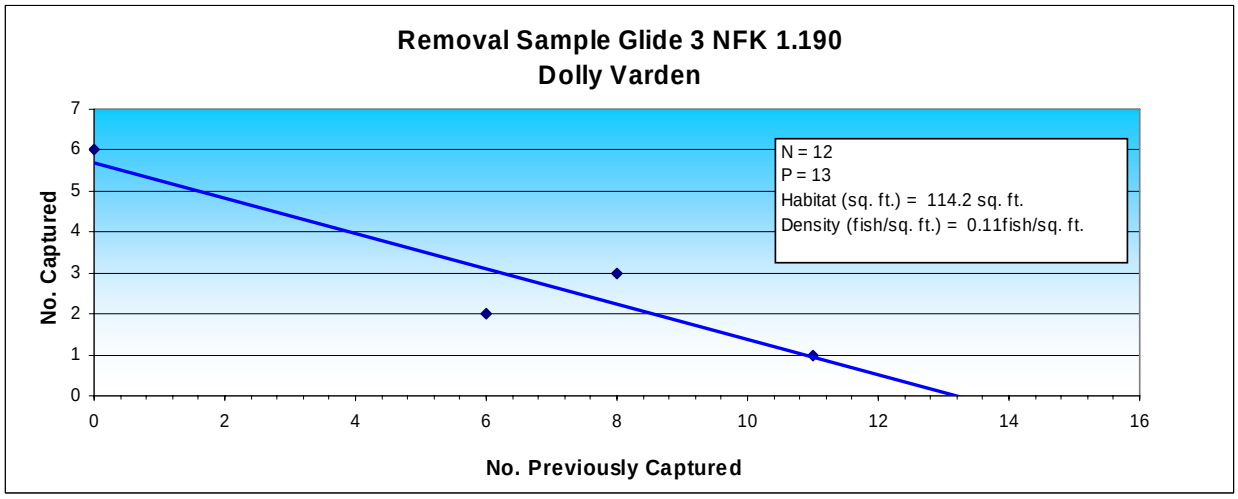

Removal Sample Pool 1 NFK 1.190
Dolly Varden
N = 30
P = 48
Habitat (sq. ft..) = 232.9 sq. ft.
Density (fish/sq. ft.) = 0.21 fish/sq. ft.
No. Captured
No. Previously Captured
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60

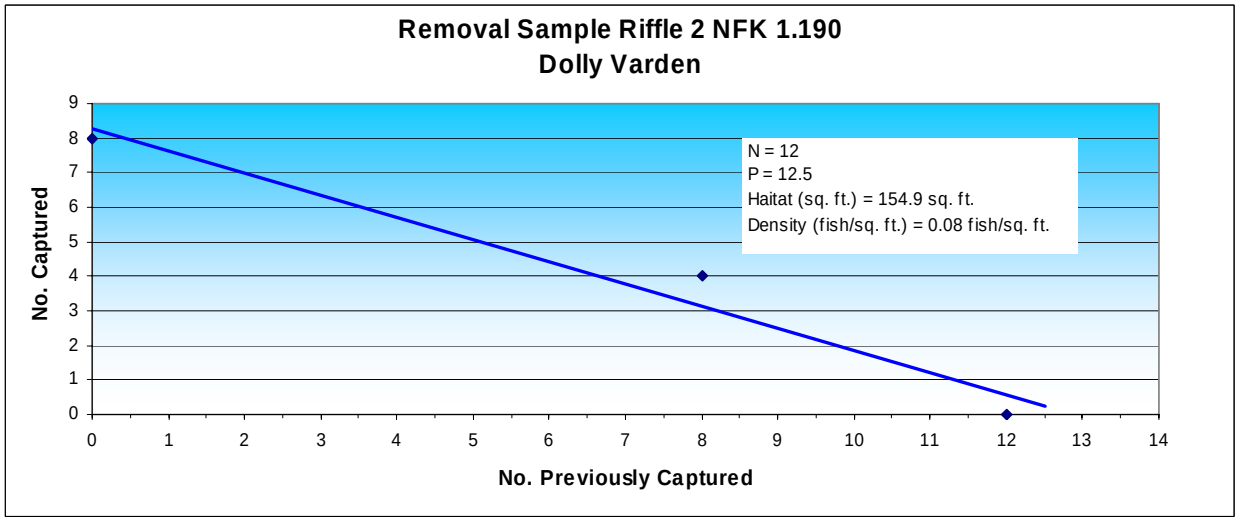

Removal Sample Pool 1 NFK 1.190
Arctic Grayling
N = 9
P = 11
Habitat (sq.ft.) = 232.9 sq. ft.
Density (fish/sq. ft.) = 0.05
No. Captured
No. Previously Captured
0
1
2
3
4
5
6
0
2
4
6
8
10
12

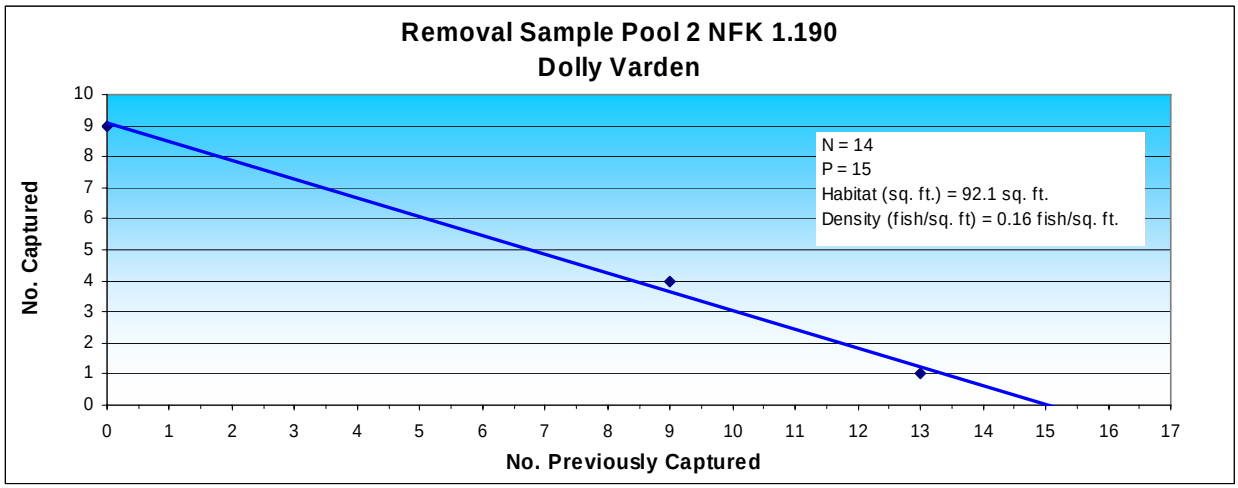

Removal Sample Glide 2 NFK 1.190
Chinook
N = 36
P = 16.5
Habitat (sq. ft.) = 154.1 sq. ft.
Density (fish.sq. ft.) = 0.11 fish/sq. ft.
No. Captured
No. Previously Captured
0
2
4
6
8
10
12
14
0
2
4
6
8
10
12
14
16
18

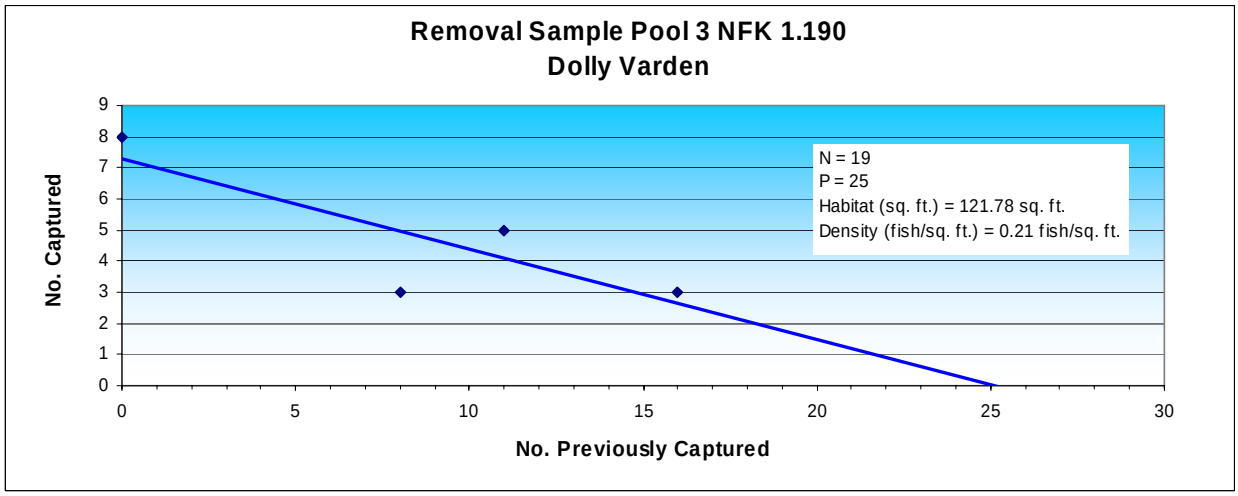

Removal Sample Glide 2 NFK 1.190
Dolly Varden
N = 28
P = 41
Habitat (sq. ft.) = 154.1 sq. ft.
Density (fish/sq. ft.) = 0.27 fish/sq. ft.
No. Captured
No. Previously Captured
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
50

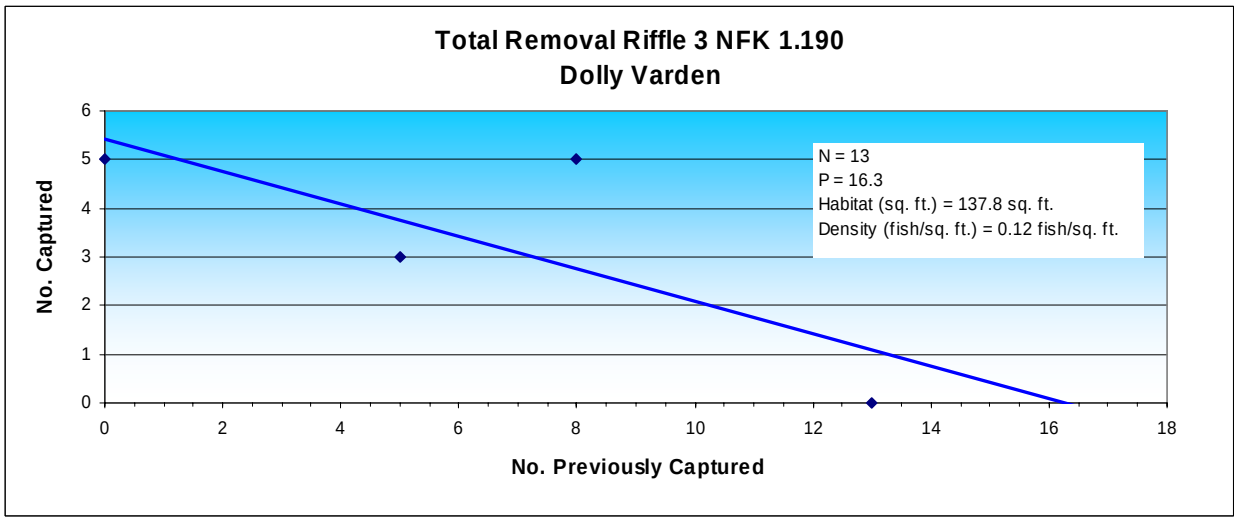

Removal Sample Glide 2 NFK 1.190
Arctic Grayling
N = 6
P = 8
Habitat (sq. ft.) = 154.1 sq. ft.
Density (fish/ sq. ft.) = 0.52 fish/sq ft.
No. Captured
No. Previously Captured
0
1
2
3
4
0
2
4
6
8
10
12

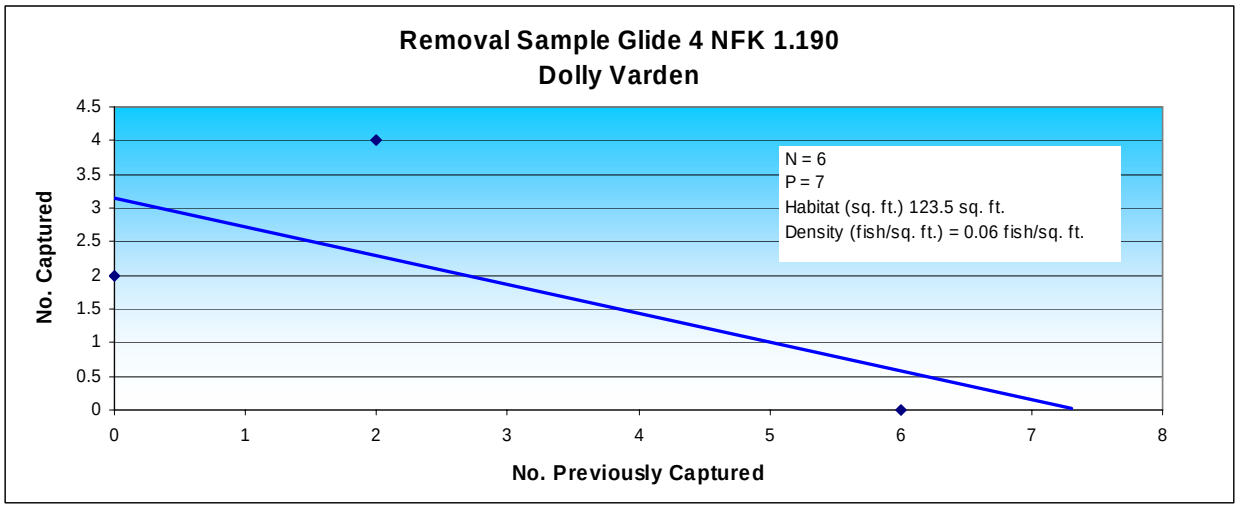

Removal Sample Glide 3 NFK 1.190
Dolly Varden
N = 12
P = 13
Habitat (sq. ft.) = 114.2 sq. ft.
Density (fish/sq. ft.) = 0.11fish/sq. ft.
No. Captured
No. Previously Captured
0
1
2
3
4
5
6
7
0
2
4
6
8
10
12
14
16

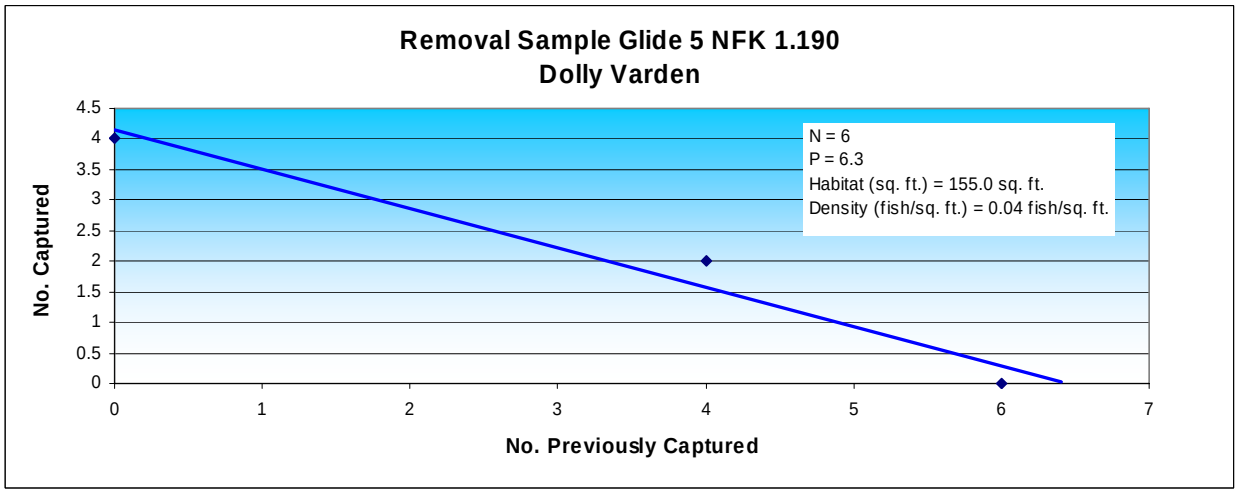

Removal Sample Riffle 2 NFK 1.190
Dolly Varden
N = 12
P = 12.5
Haitat (sq. ft.) = 154.9 sq. ft.
Density (fish/sq. ft.) = 0.08 fish/sq. ft.
No. Captured
No. Previously Captured
0
1
2
3
4
5
6
7
8
9
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14

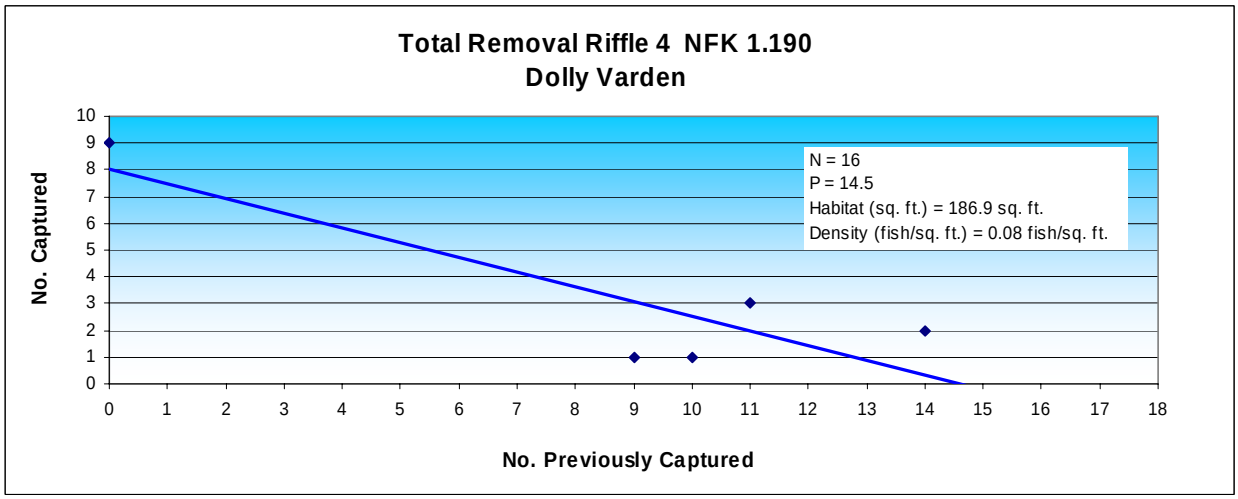

Removal Sample Pool 2 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 14
P = 15
Habitat (sq. ft.) = 92.1 sq. ft.
Density (fish/sq. ft) = 0.16 fish/sq. ft.

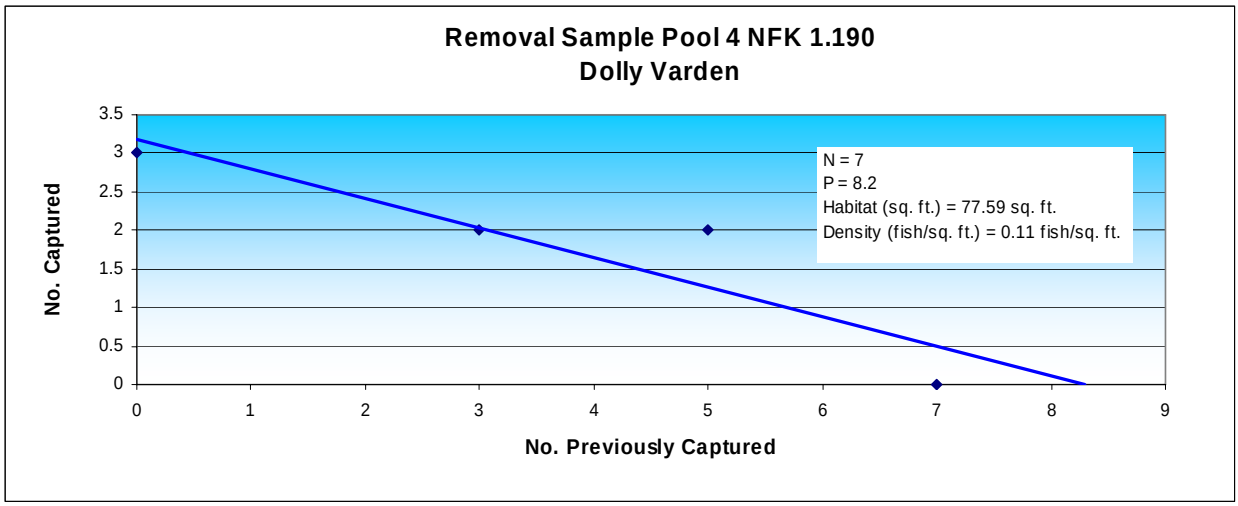

Removal Sample Pool 3 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 19
P = 25
Habitat (sq. ft.) = 121.78 sq. ft.
Density (fish/sq. ft.) = 0.21 fish/sq. ft.

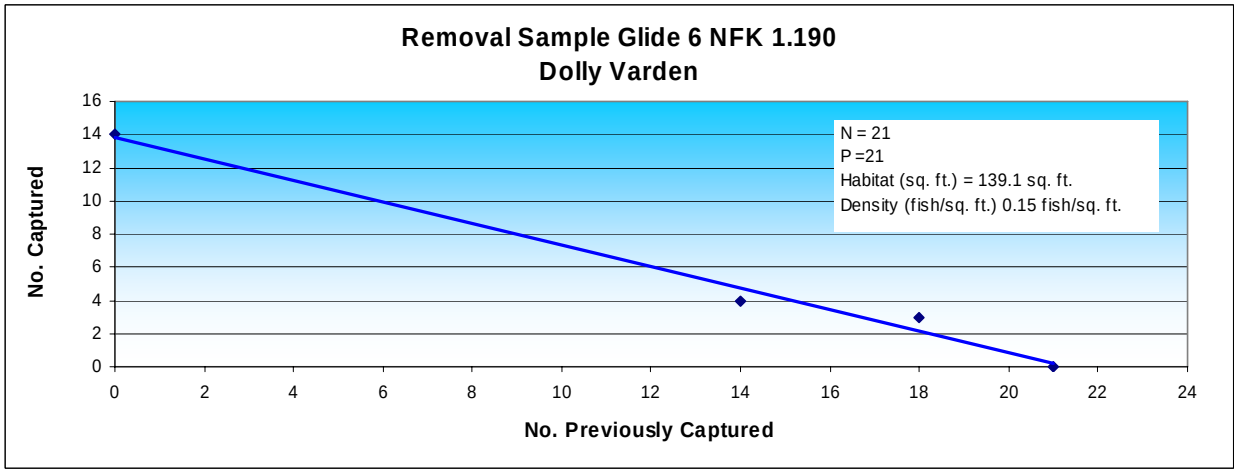

Total Removal Riffle 3 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 13
P = 16.3
Habitat (sq. ft.) = 137.8 sq. ft.
Density (fish/sq. ft.) = 0.12 fish/sq. ft.

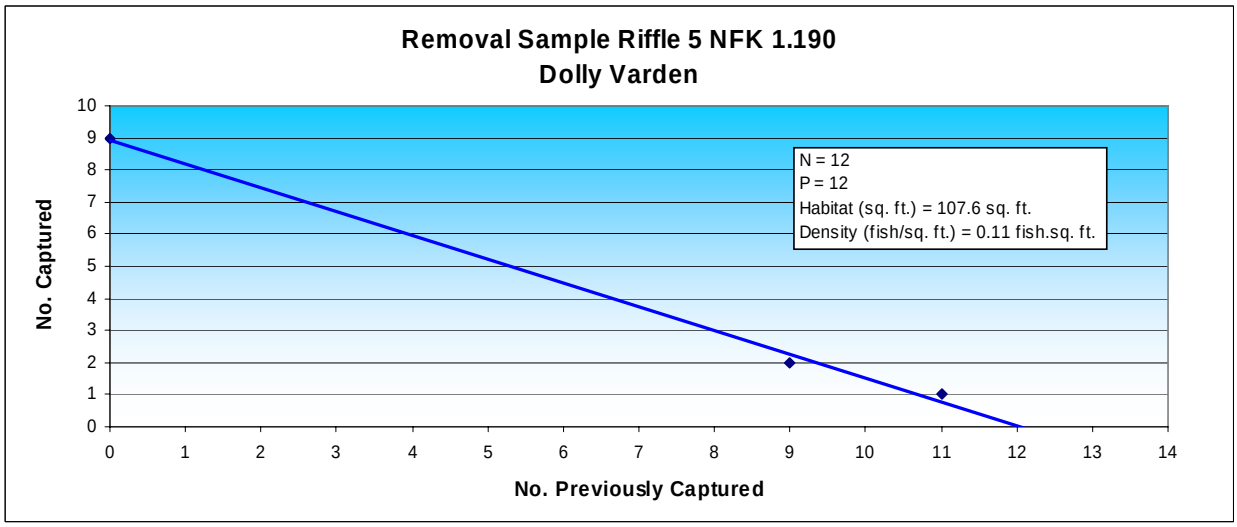

Removal Sample Glide 4 NFK 1.190
Dolly Varden
N = 6
P = 7
Habitat (sq. ft.) 123.5 sq. ft.
Density (fish/sq. ft.) = 0.06 fish/sq. ft.
No. Captured
No. Previously Captured

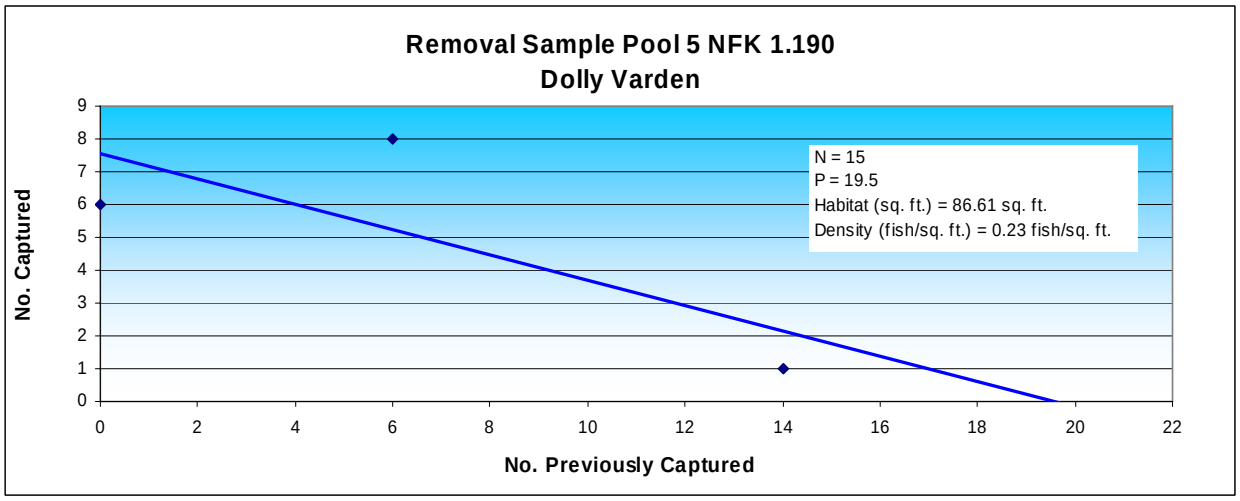

Removal Sample Glide 5 NFK 1.190
Dolly Varden
N = 6
P = 6.3
Habitat (sq. ft.) = 155.0 sq. ft.
Density (fish/sq. ft.) = 0.04 fish/sq. ft.
No. Captured
No. Previously Captured

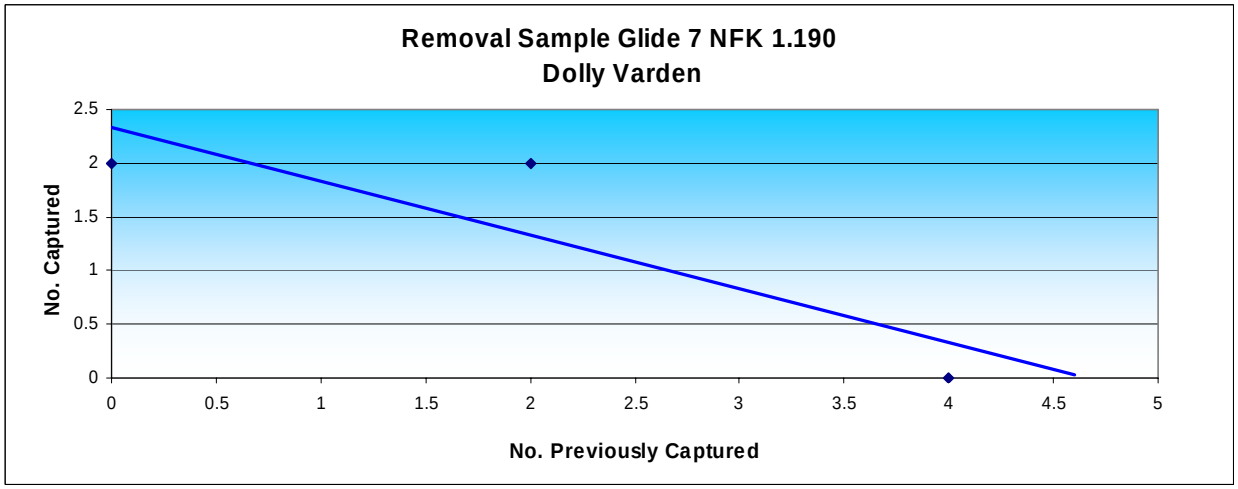

Total Removal Riffle 4 NFK 1.190
Dolly Varden
N = 16
P = 14.5
Habitat (sq. ft.) = 186.9 sq. ft.
Density (fish/sq. ft.) = 0.08 fish/sq. ft.
No. Captured
No. Previously Captured

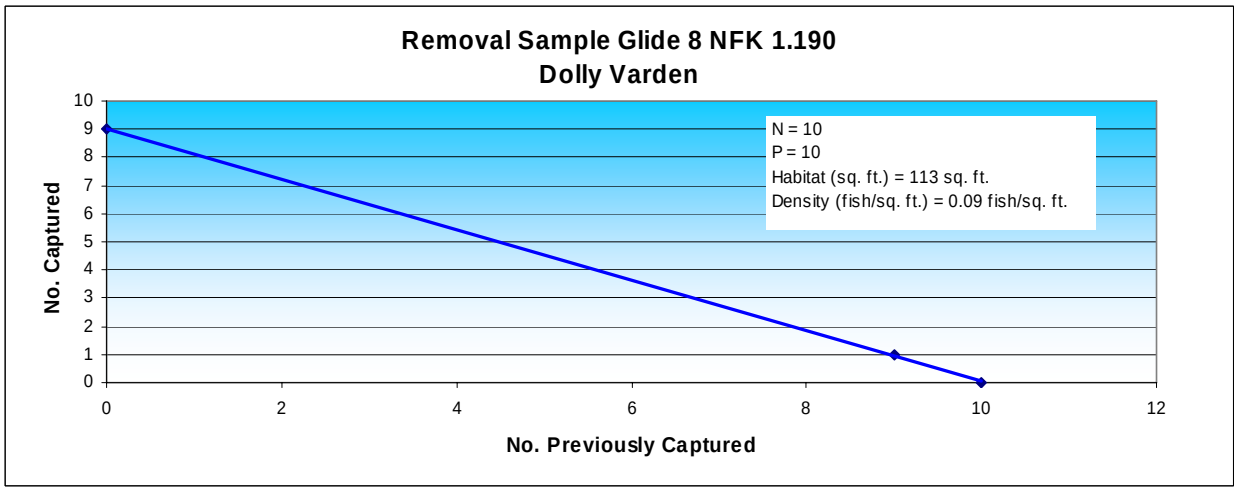

Removal Sample Pool 4 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 7
P = 8.2
Habitat (sq. ft.) = 77.59 sq. ft.
Density (fish/sq. ft.) = 0.11 fish/sq. ft.

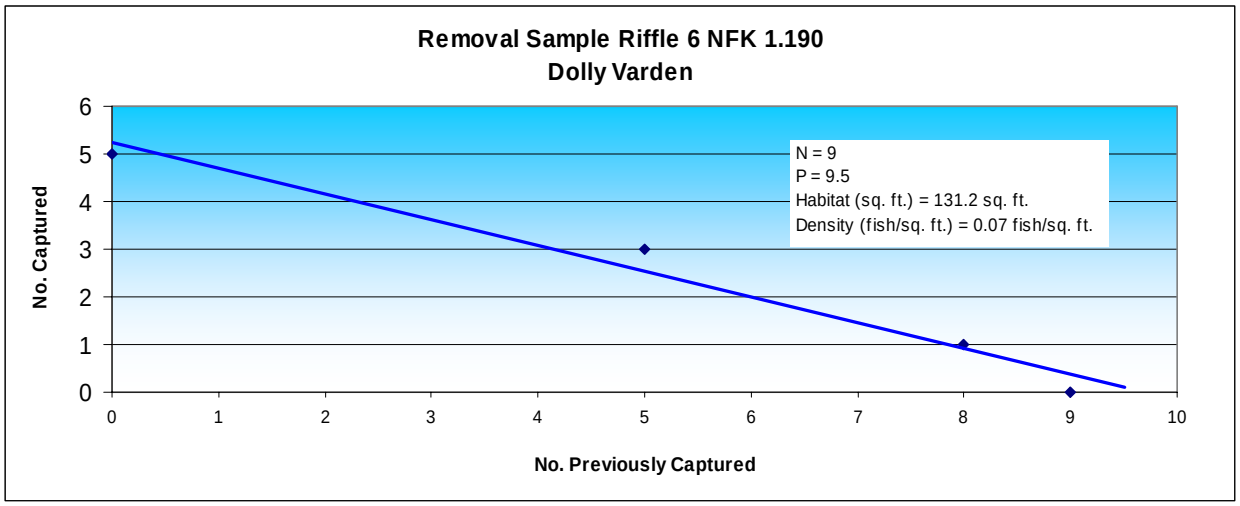

Removal Sample Glide 6 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 21
P =21
Habitat (sq. ft.) = 139.1 sq. ft.
Density (fish/sq. ft.) 0.15 fish/sq. ft.

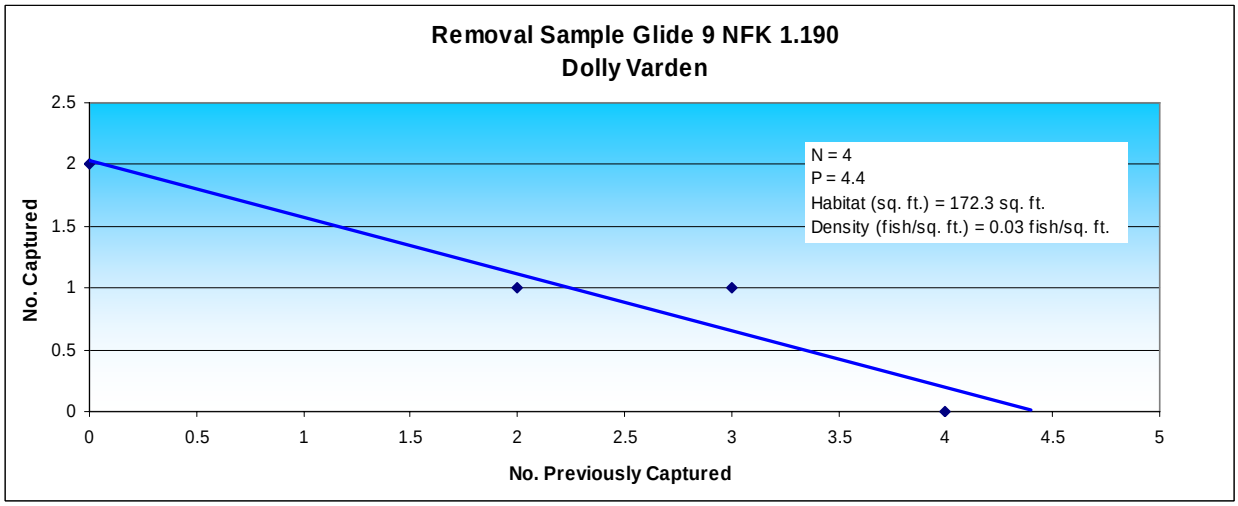

Removal Sample Riffle 5 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 12
P = 12
Habitat (sq. ft.) = 107.6 sq. ft.
Density (fish/sq. ft.) = 0.11 fish.sq. ft.

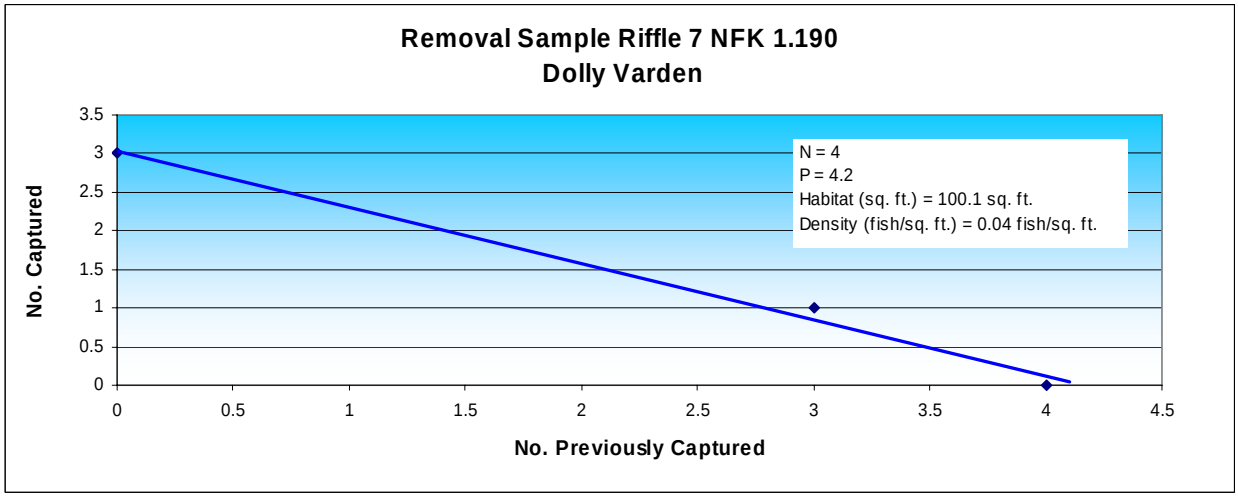

Removal Sample Pool 5 NFK 1.190
Dolly Varden
N = 15
P = 19.5
Habitat (sq. ft.) = 86.61 sq. ft.
Density (fish/sq. ft.) = 0.23 fish/sq. ft.
No. Captured
No. Previously Captured
0
1
2
3
4
5
6
7
8
9
0
2
4
6
8
10
12
14
16
18
20
22

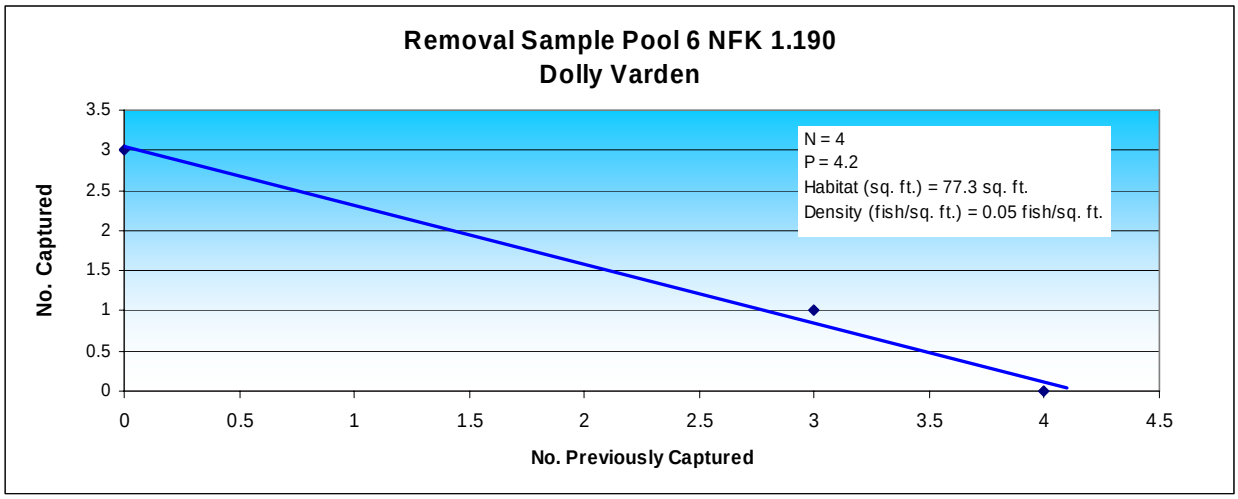

Removal Sample Glide 7 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

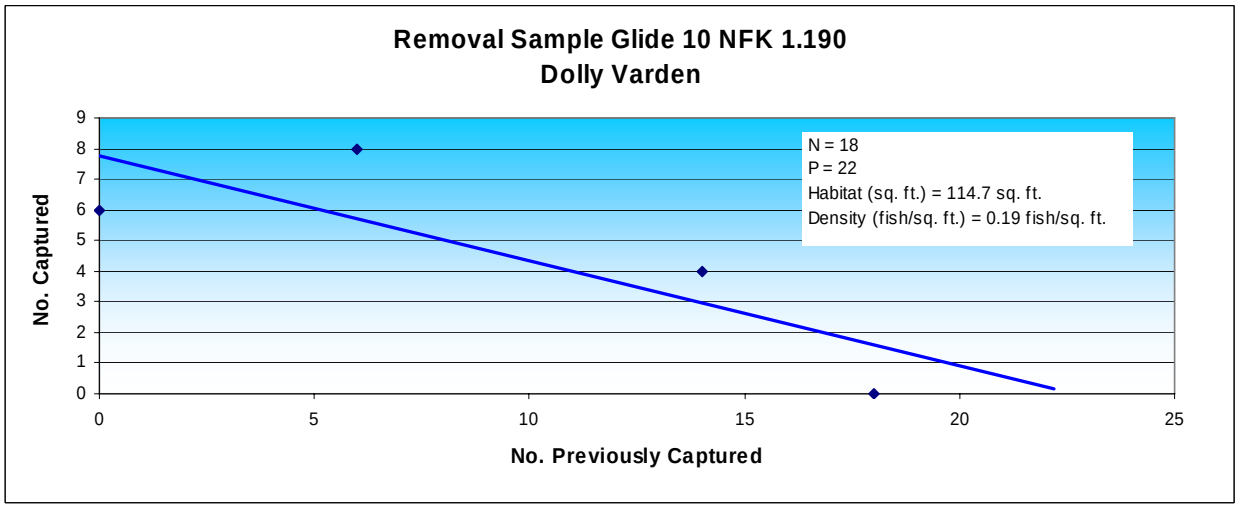

Removal Sample Glide 8 NFK 1.190
Dolly Varden
N = 10
P = 10
Habitat (sq. ft.) = 113 sq. ft.
Density (fish/sq. ft.) = 0.09 fish/sq. ft.
No. Captured
No. Previously Captured
0
1
2
3
4
5
6
7
8
9
10
0
2
4
6
8
10
12

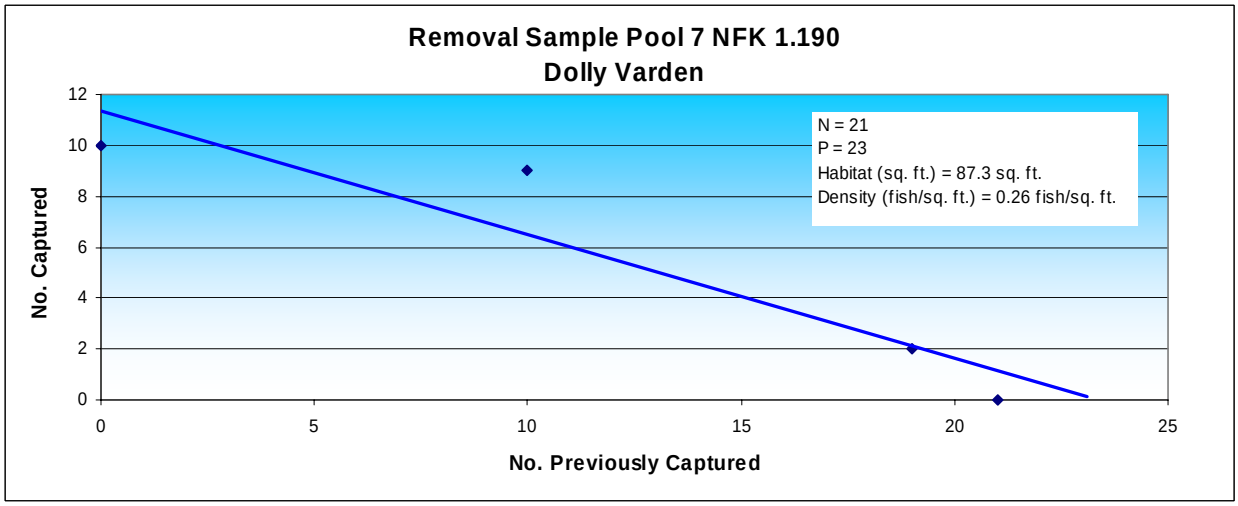

Removal Sample Riffle 6 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 9
P = 9.5
Habitat (sq. ft.) = 131.2 sq. ft.
Density (fish/sq. ft.) = 0.07 fish/sq. ft.

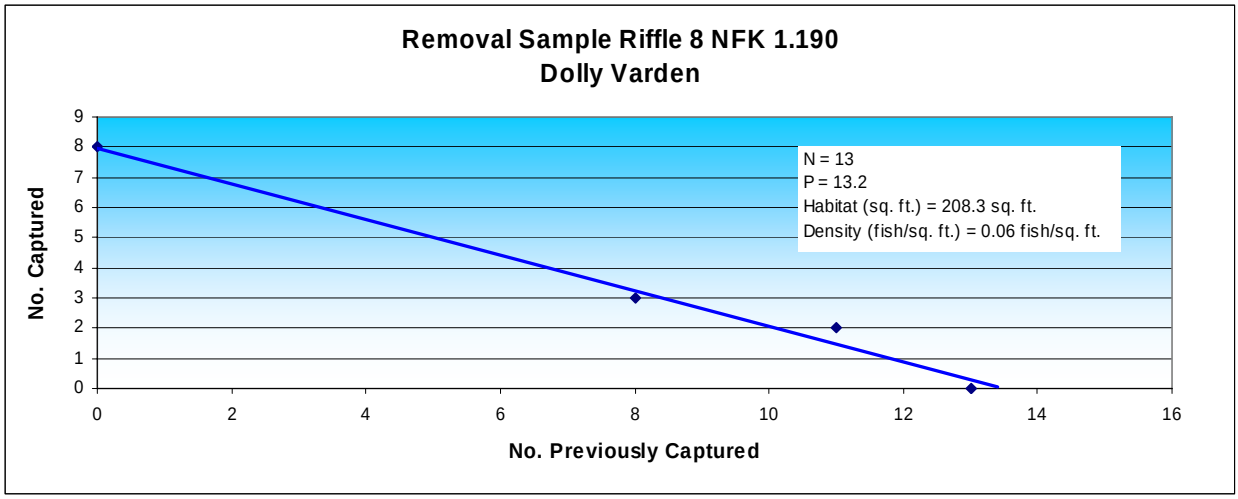

Removal Sample Glide 9 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 4
P = 4.4
Habitat (sq. ft.) = 172.3 sq. ft.
Density (fish/sq. ft.) = 0.03 fish/sq. ft.

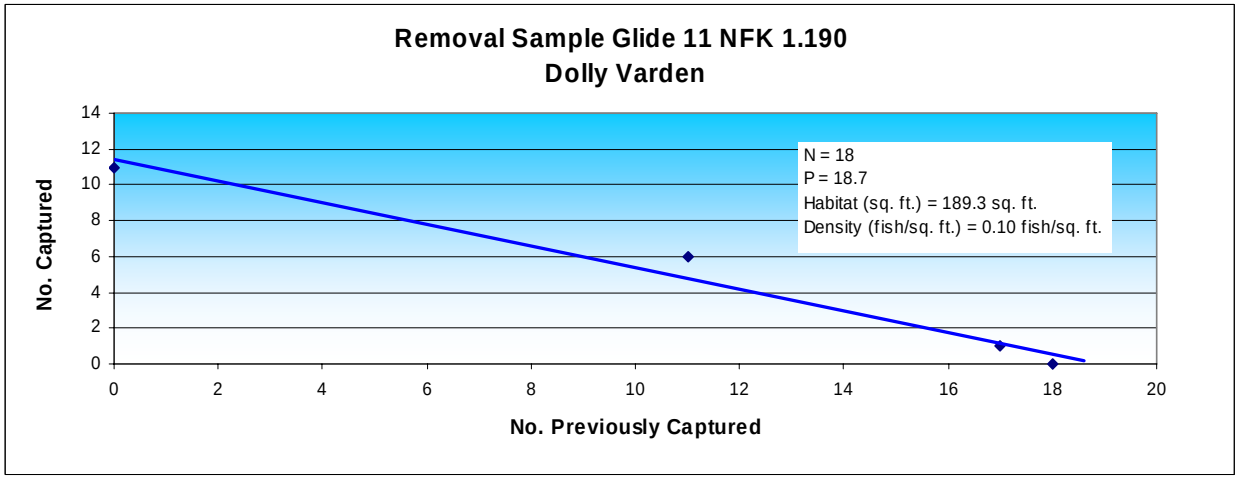

Removal Sample Riffle 7 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 4
P = 4.2
Habitat (sq. ft.) = 100.1 sq. ft.
Density (fish/sq. ft.) = 0.04 fish/sq. ft.

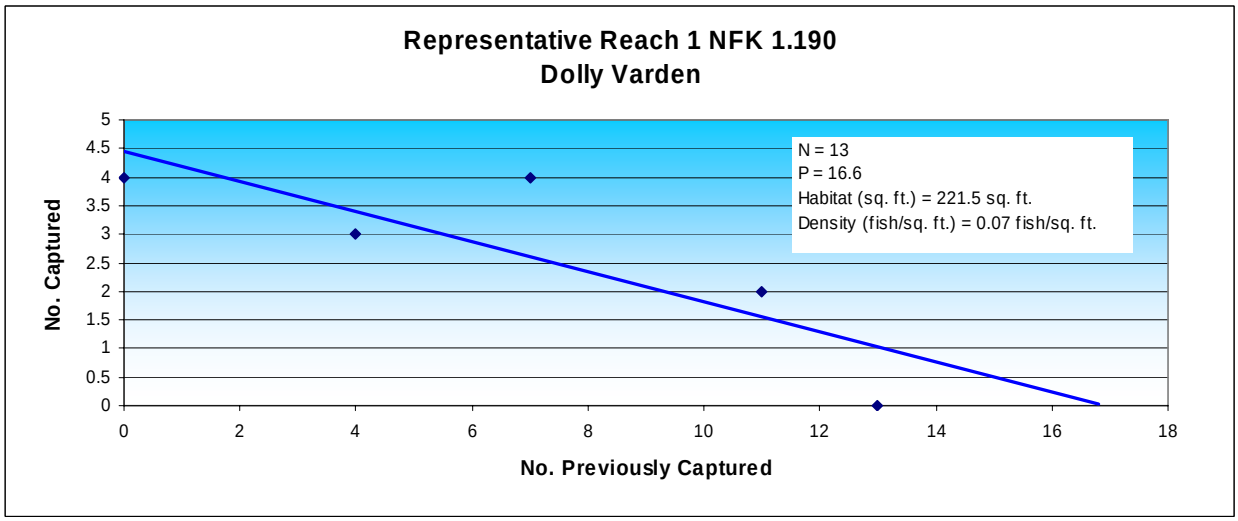

Removal Sample Pool 6 NFK 1.190
Dolly Varden
N = 4
P = 4.2
Habitat (sq. ft.) = 77.3 sq. ft.
Density (fish/sq. ft.) = 0.05 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

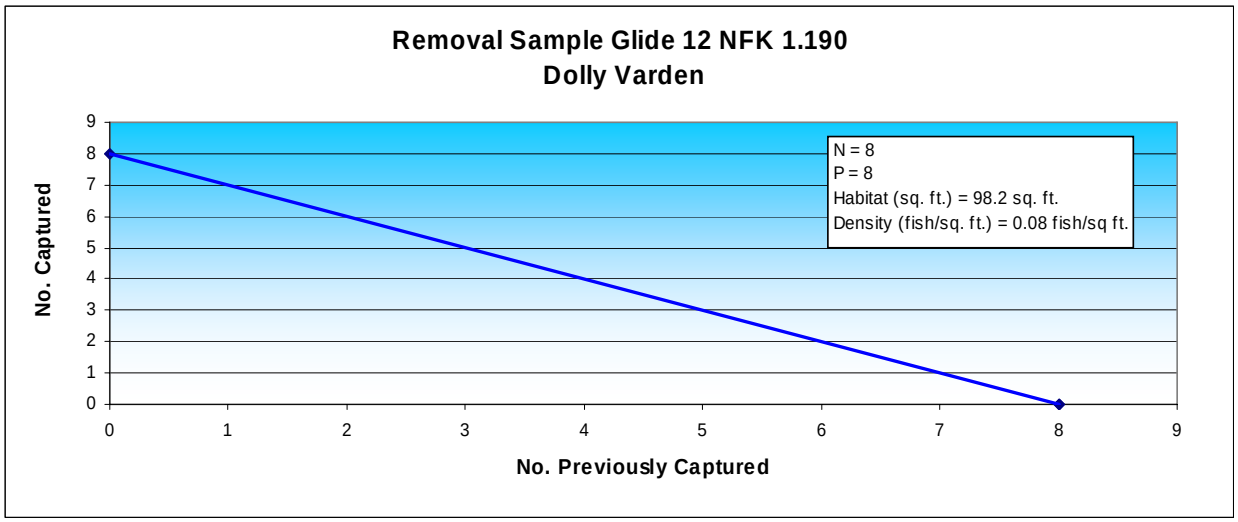

Removal Sample Glide 10 NFK 1.190
Dolly Varden
N = 18
P = 22
Habitat (sq. ft.) = 114.7 sq. ft.
Density (fish/sq. ft.) = 0.19 fish/sq. ft.
No. Captured
No. Previously Captured
0
1
2
3
4
5
6
7
8
9
10
15
20
25

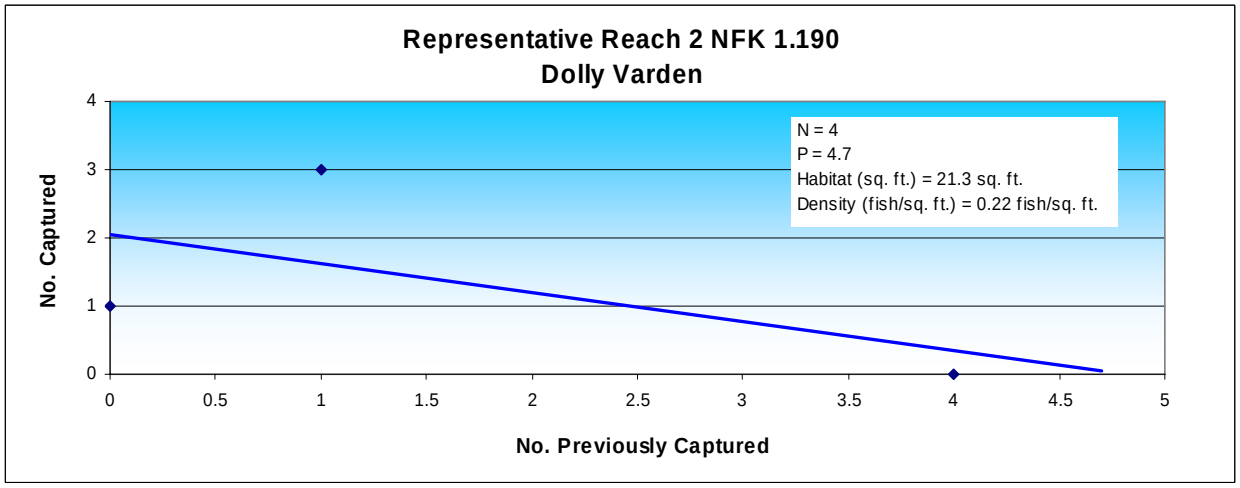

Removal Sample Pool 7 NFK 1.190
Dolly Varden
N = 21
P = 23
Habitat (sq. ft.) = 87.3 sq. ft.
Density (fish/sq. ft.) = 0.26 fish/sq. ft.
No. Captured
No. Previously Captured
0
2
4
6
8
10
12
5
15
20
25

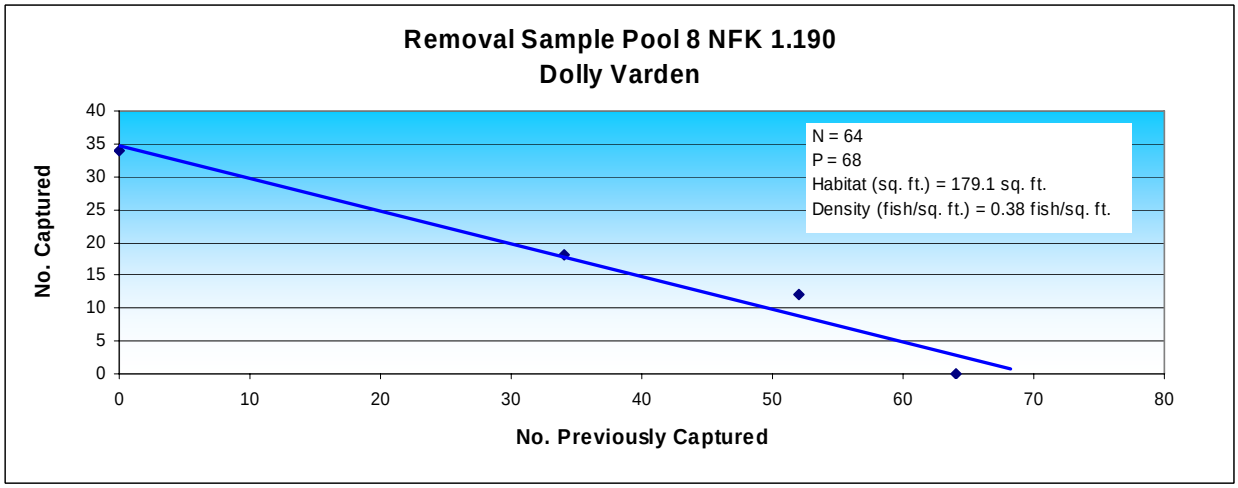

Removal Sample Riffle 8 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 13
P = 13.2
Habitat (sq. ft.) = 208.3 sq. ft.
Density (fish/sq. ft.) = 0.06 fish/sq. ft.

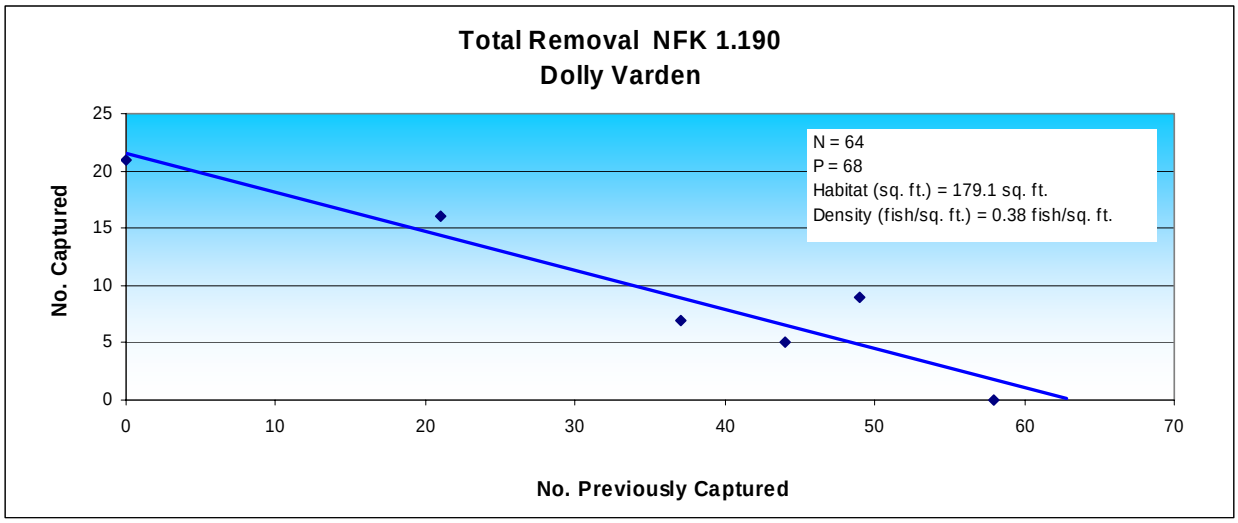

Removal Sample Glide 11 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 18
P = 18.7
Habitat (sq. ft.) = 189.3 sq. ft.
Density (fish/sq. ft.) = 0.10 fish/sq. ft.

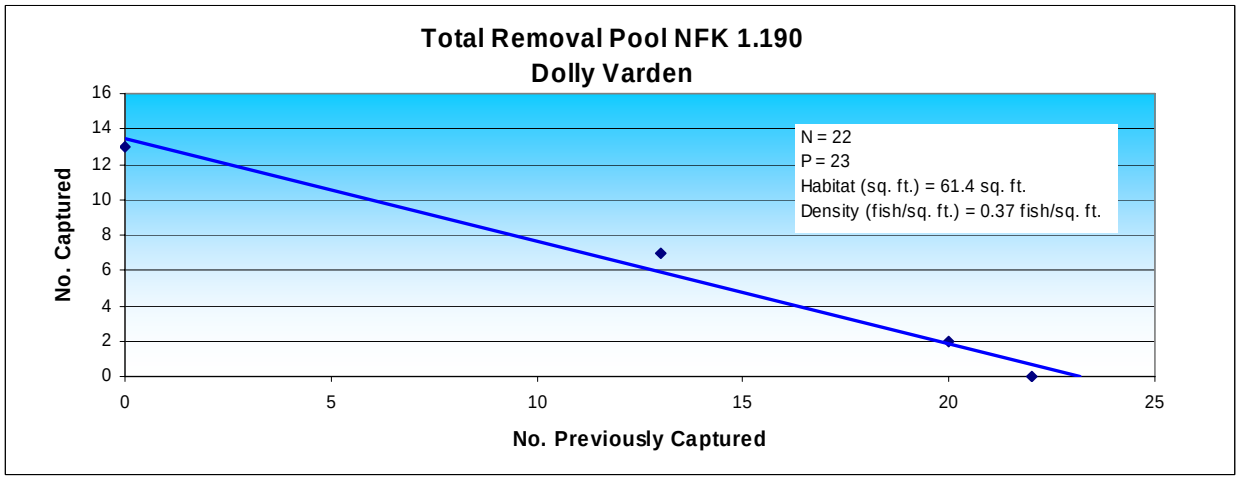

Representative Reach 1 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 13
P = 16.6
Habitat (sq. ft.) = 221.5 sq. ft.
Density (fish/sq. ft.) = 0.07 fish/sq. ft.

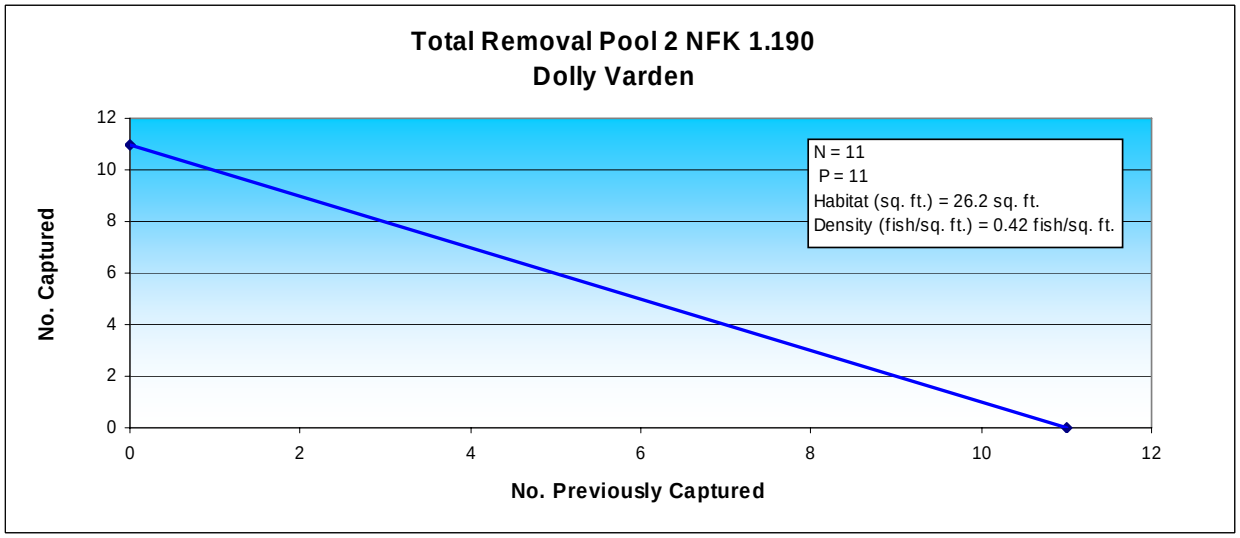

Removal Sample Glide 12 NFK 1.190
Dolly Varden
N = 8
P = 8
Habitat (sq. ft.) = 98.2 sq. ft.
Density (fish/sq. ft.) = 0.08 fish/sq ft.
No. Captured
No. Previously Captured
0
1
2
3
4
5
6
7
8
9

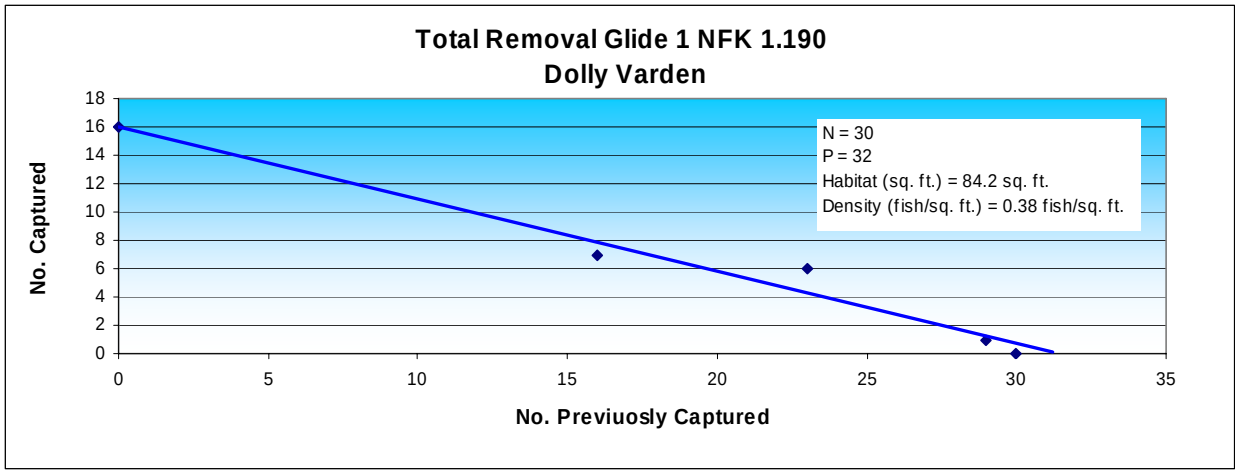

Representative Reach 2 NFK 1.190
Dolly Varden
N = 4
P = 4.7
Habitat (sq. ft.) = 21.3 sq. ft.
Density (fish/sq. ft.) = 0.22 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

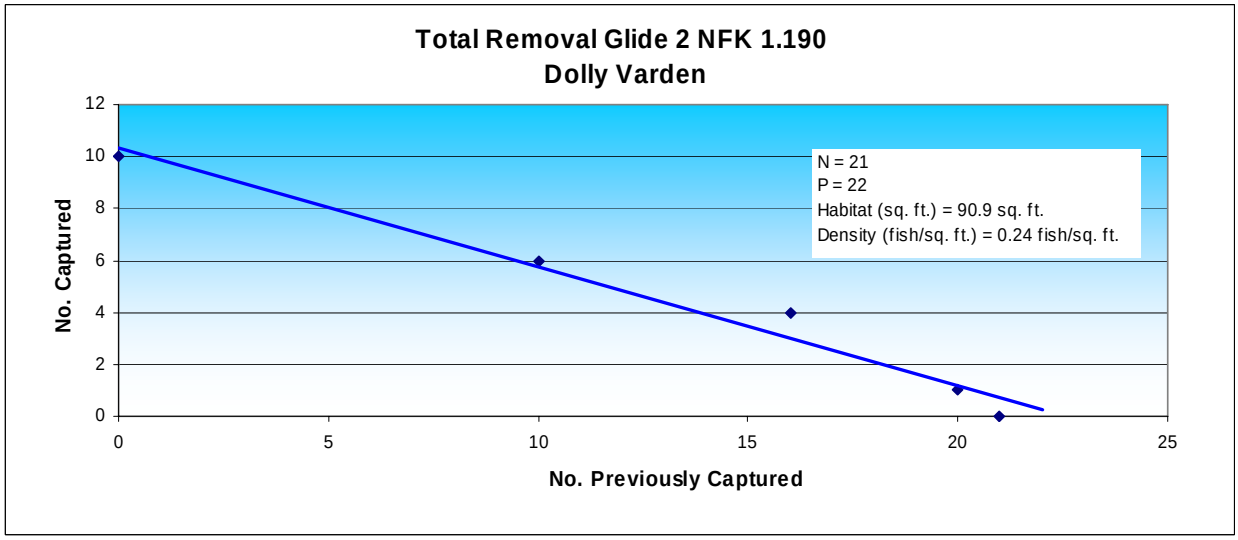

Removal Sample Pool 8 NFK 1.190
Dolly Varden
N = 64
P = 68
Habitat (sq. ft.) = 179.1 sq. ft.
Density (fish/sq. ft.) = 0.38 fish/sq. ft.
No. Captured
No. Previously Captured
0
5
10
15
20
25
30
35
40
50
60
70
80

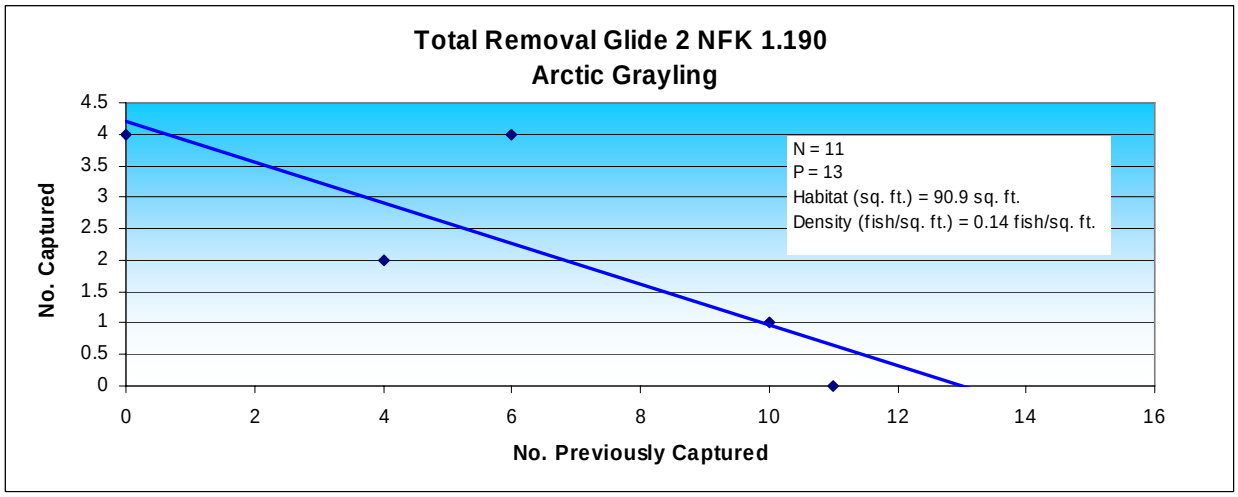

Total Removal NFK 1.190
Dolly Varden
N = 64
P = 68
Habitat (sq. ft.) = 179.1 sq. ft.
Density (fish/sq. ft.) = 0.38 fish/sq. ft.
No. Captured
No. Previously Captured
0
5
10
15
20
25
0
10
20
30
40
50
60
70

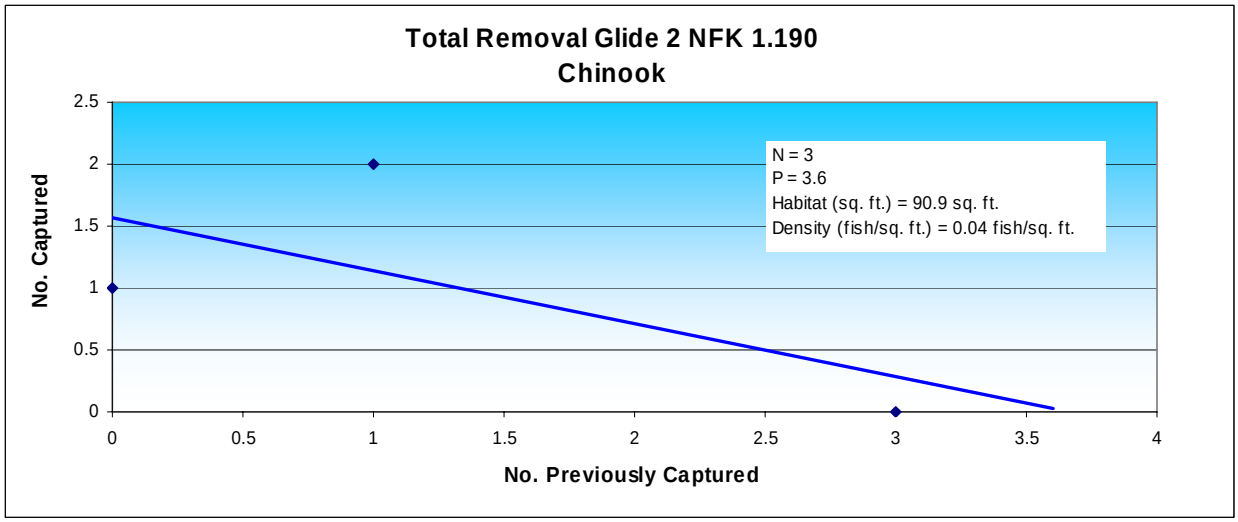

Total Removal Pool NFK 1.190
Dolly Varden
N = 22
P = 23
Habitat (sq. ft.) = 61.4 sq. ft.
Density (fish/sq. ft.) = 0.37 fish/sq. ft.
No. Captured
No. Previously Captured
0
2
4
6
8
10
12
14
16
0
5
10
15
20
25

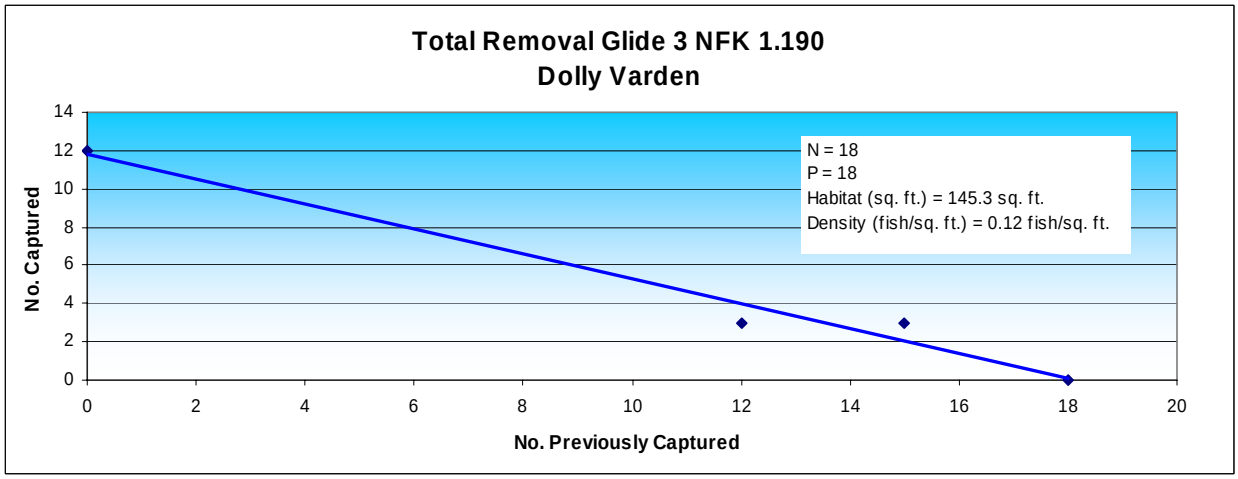

Total Removal Pool 2 NFK 1.190
Dolly Varden
N = 11
P = 11
Habitat (sq. ft.) = 26.2 sq. ft.
Density (fish/sq. ft.) = 0.42 fish/sq. ft.
No. Captured
No. Previously Captured
0
2
4
6
8
10
12
0
2
4
6
8
10
12

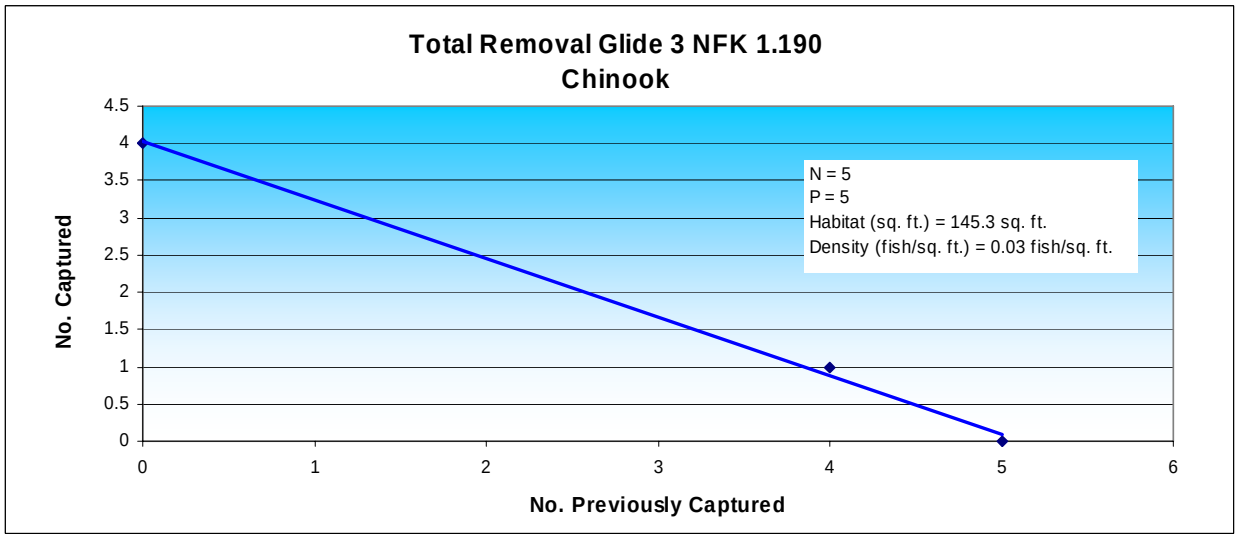

Total Removal Glide 1 NFK 1.190
Dolly Varden
No. Captured
No. Previuosly Captured
N = 30
P = 32
Habitat (sq. ft.) = 84.2 sq. ft.
Density (fish/sq. ft.) = 0.38 fish/sq. ft.
0
2
4
6
8
10
12
14
16
18
0
5
10
15
20
25
30
35

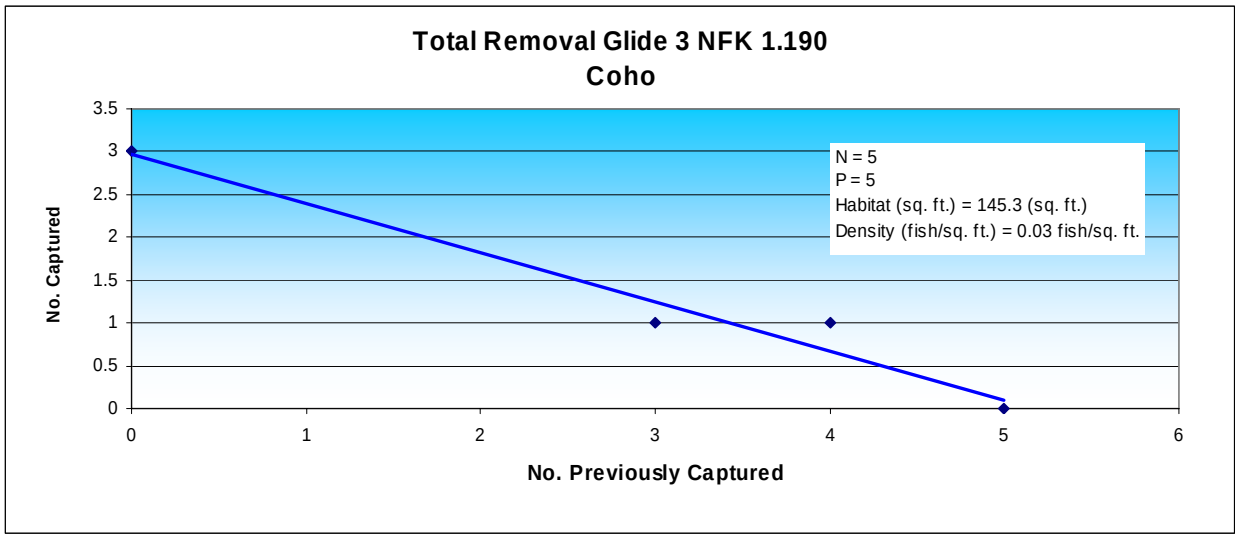

Total Removal Glide 2 NFK 1.190
Dolly Varden
No. Captured
No. Previously Captured
N = 21
P = 22
Habitat (sq. ft.) = 90.9 sq. ft.
Density (fish/sq. ft.) = 0.24 fish/sq. ft.
0
2
4
6
8
10
12
0
5
10
15
20
25

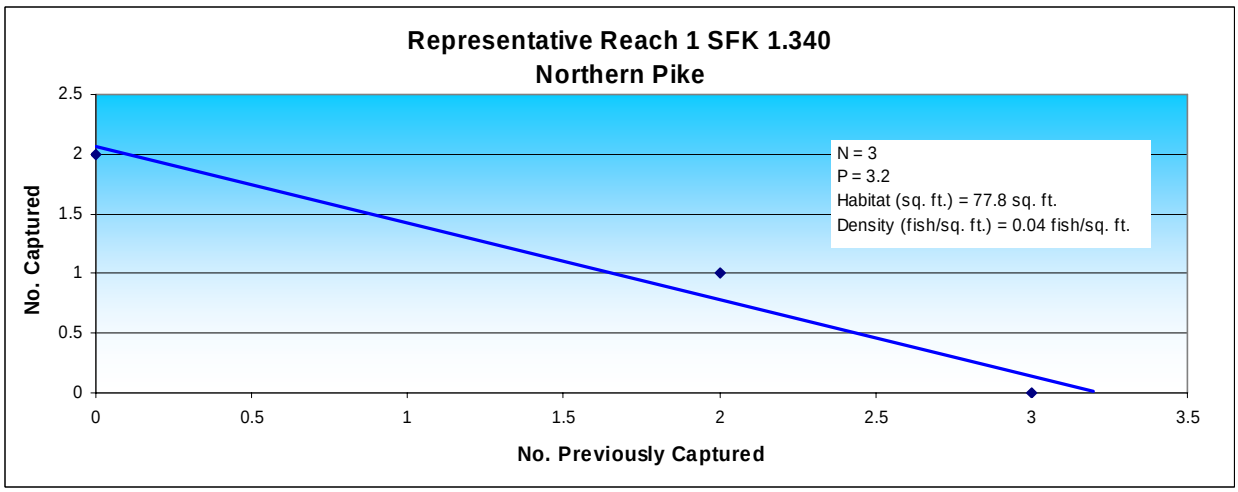

Total Removal Glide 2 NFK 1.190
Arctic Grayling
No. Captured
No. Previously Captured
N = 11
P = 13
Habitat (sq. ft.) = 90.9 sq. ft.
Density (fish/sq. ft.) = 0.14 fish/sq. ft.
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
2
4
6
8
10
12
14
16

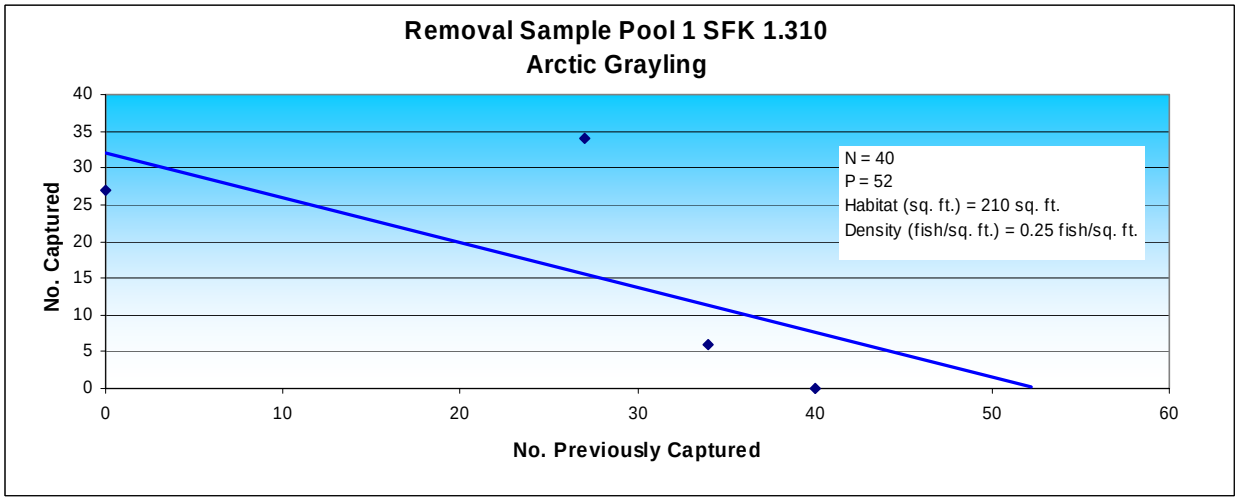

Total Removal Glide 2 NFK 1.190
Chinook
N = 3
P = 3.6
Habitat (sq. ft.) = 90.9 sq. ft.
Density (fish/sq. ft.) = 0.04 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
4

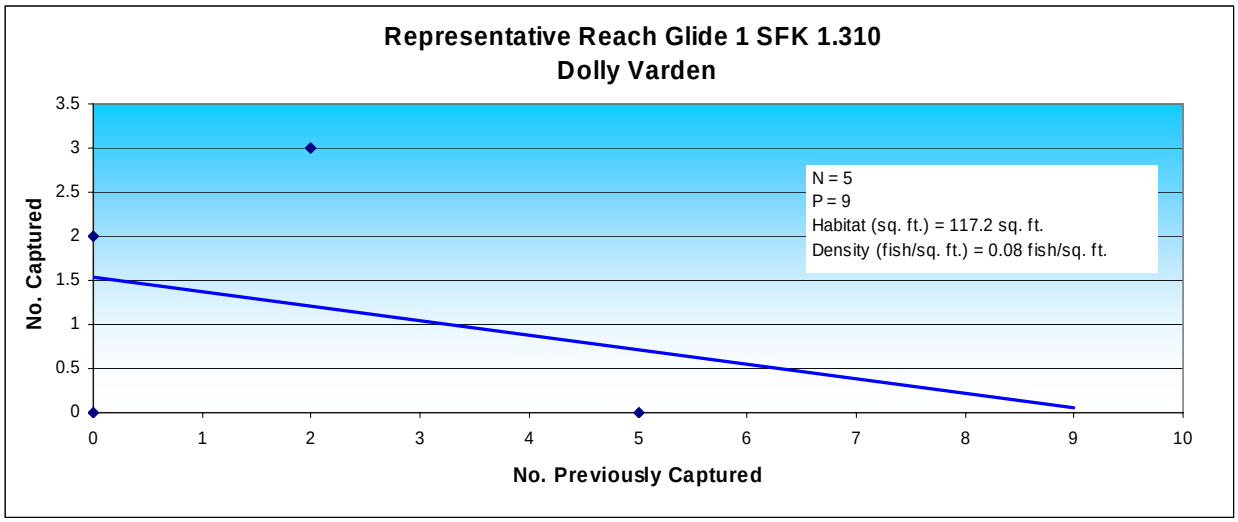

Total Removal Glide 3 NFK 1.190
Dolly Varden
N = 18
P = 18
Habitat (sq. ft.) = 145.3 sq. ft.
Density (fish/sq. ft.) = 0.12 fish/sq. ft.
No. Captured
No. Previously Captured
0
2
4
6
8
10
12
14
16
18
20

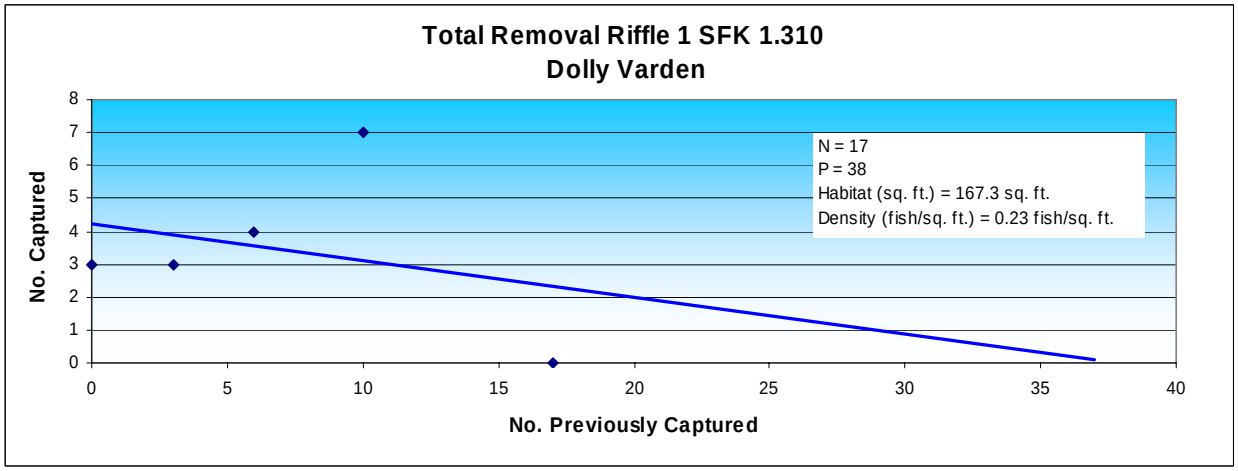

Total Removal Glide 3 NFK 1.190
Chinook
N = 5
P = 5
Habitat (sq. ft.) = 145.3 sq. ft.
Density (fish/sq. ft.) = 0.03 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
6

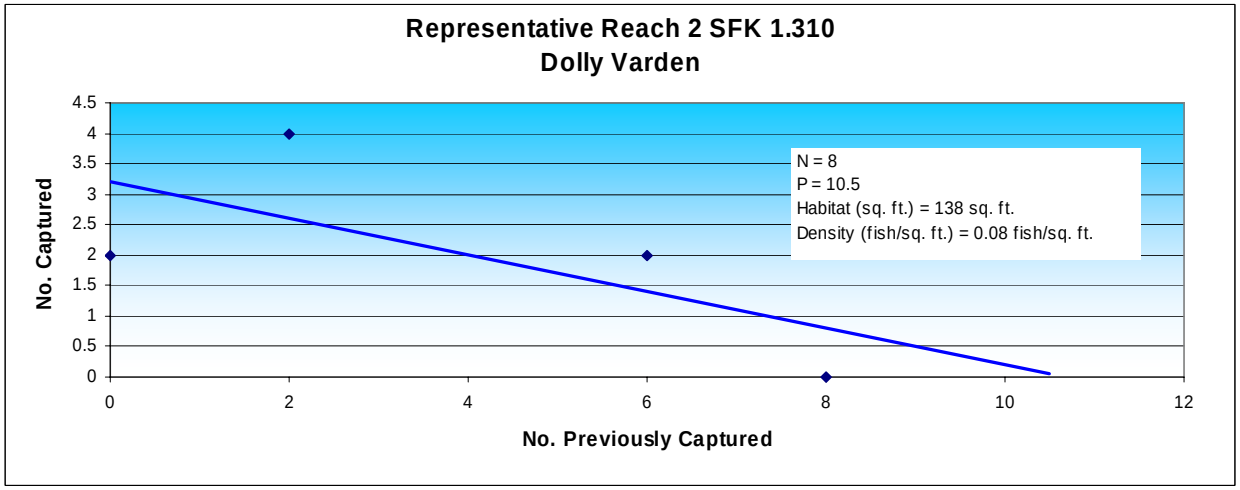

Total Removal Glide 3 NFK 1.190
Coho
N = 5
P = 5
Habitat (sq. ft.) = 145.3 (sq. ft.)
Density (fish/sq. ft.) = 0.03 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
0
1
2
3
4
5
6

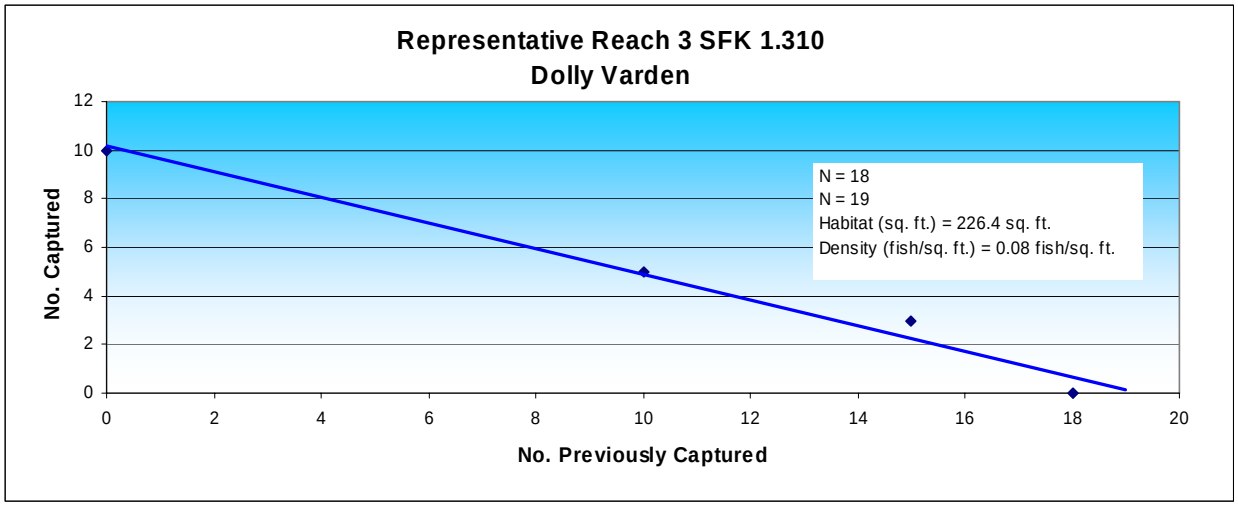

Representative Reach 1 SFK 1.340
Northern Pike
N = 3
P = 3.2
Habitat (sq. ft.) = 77.8 sq. ft.
Density (fish/sq. ft.) = 0.04 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
0
0.5
1
1.5
2
2.5
3
3.5

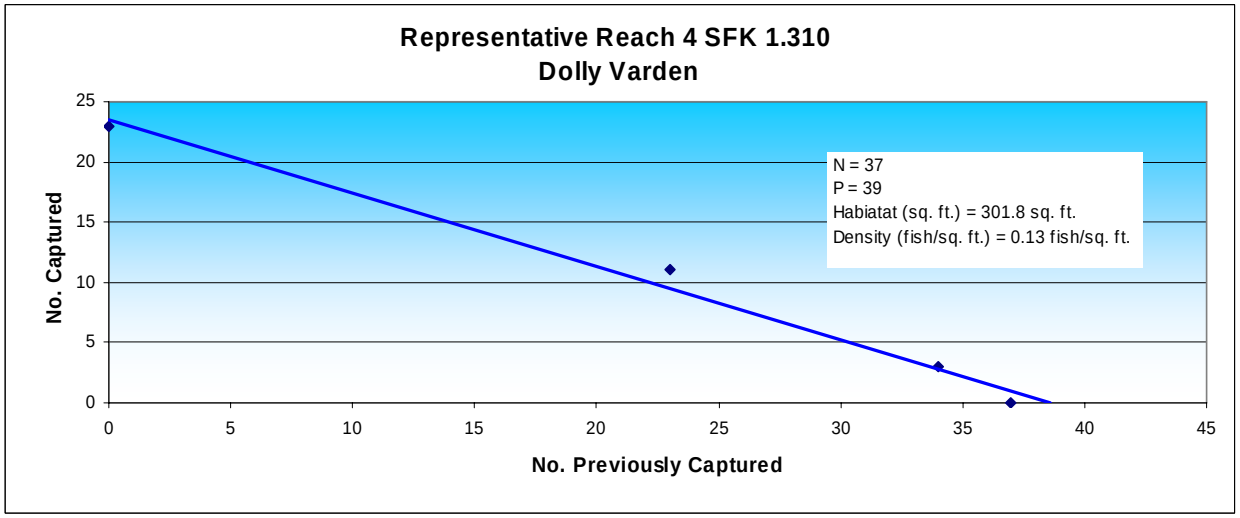

Removal Sample Pool 1 SFK 1.310
Arctic Grayling
N = 40
P = 52
Habitat (sq. ft.) = 210 sq. ft.
Density (fish/sq. ft.) = 0.25 fish/sq. ft.
No. Captured
No. Previously Captured
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60

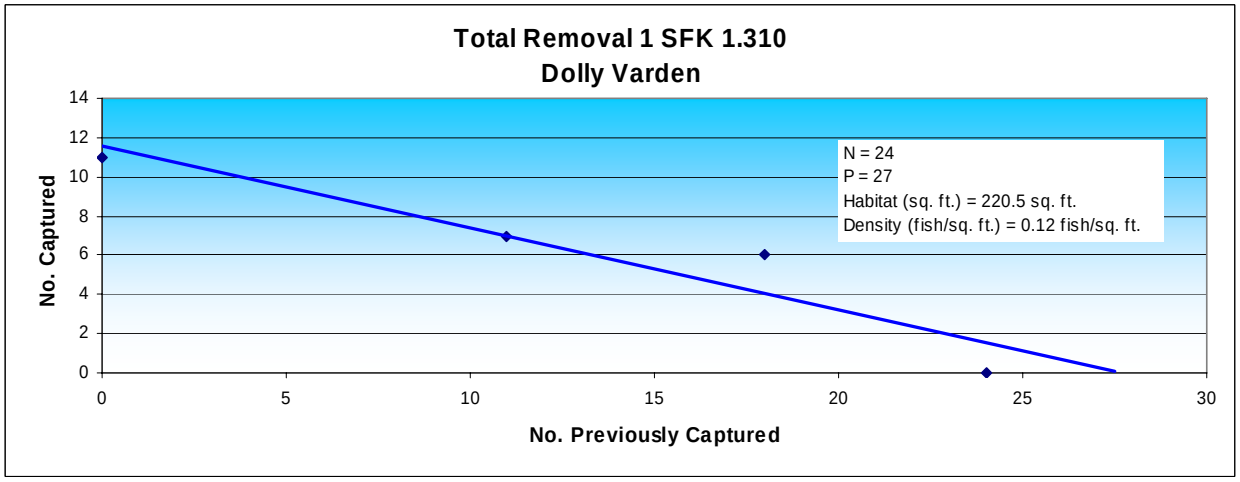

Representative Reach Glide 1 SFK 1.310
Dolly Varden
No. Captured
No. Previously Captured
N = 5
P = 9
Habitat (sq. ft.) = 117.2 sq. ft.
Density (fish/sq. ft.) = 0.08 fish/sq. ft.

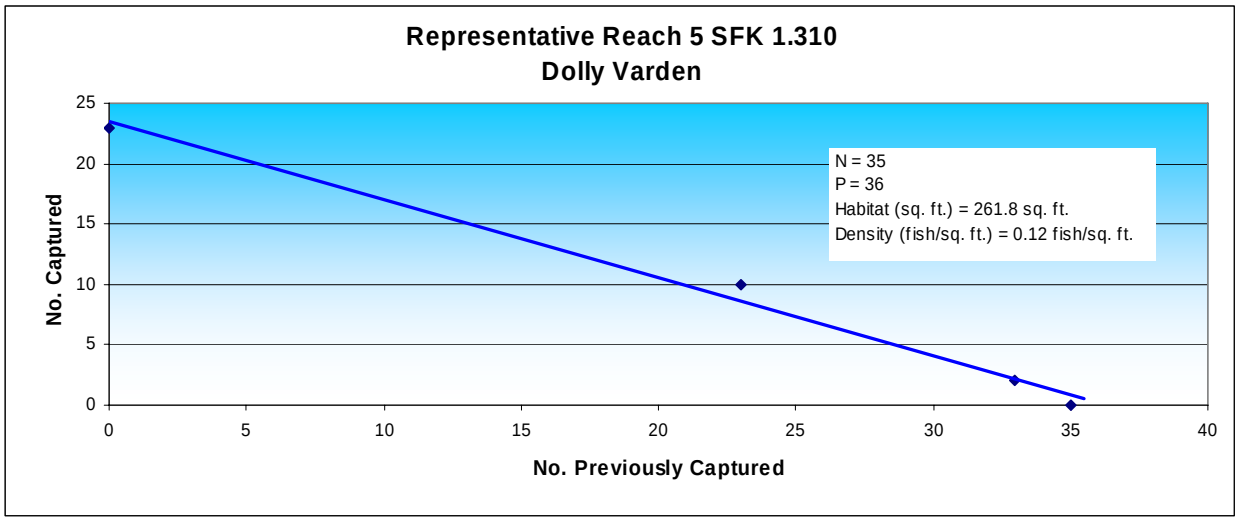

Total Removal Riffle 1 SFK 1.310
Dolly Varden
No. Captured
No. Previously Captured
N = 17
P = 38
Habitat (sq. ft.) = 167.3 sq. ft.
Density (fish/sq. ft.) = 0.23 fish/sq. ft.

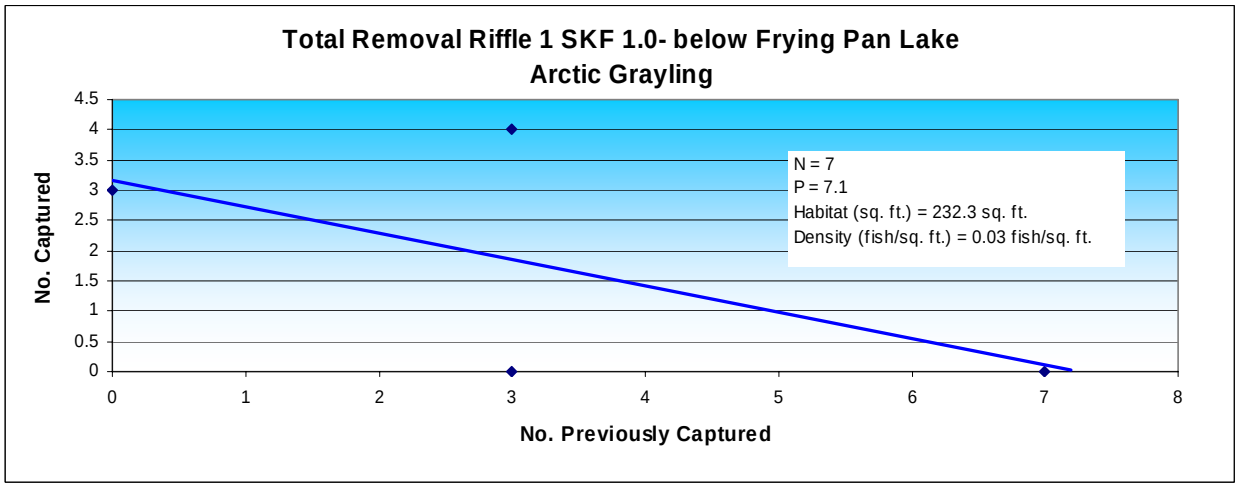

Representative Reach 2 SFK 1.310
Dolly Varden
No. Captured
No. Previously Captured
N = 8
P = 10.5
Habitat (sq. ft.) = 138 sq. ft.
Density (fish/sq. ft.) = 0.08 fish/sq. ft.

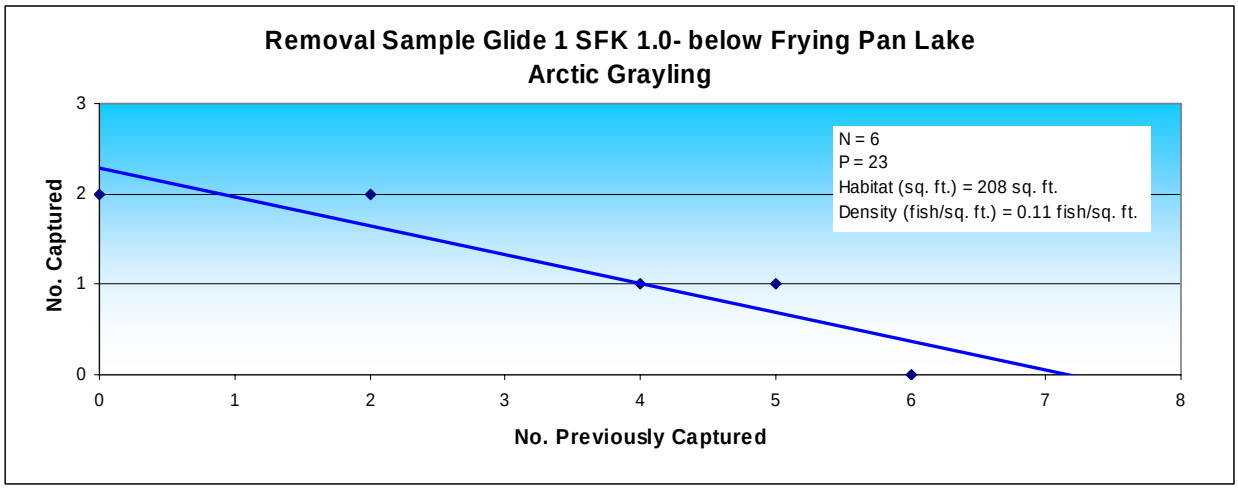

Representative Reach 3 SFK 1.310
Dolly Varden
No. Captured
No. Previously Captured
N = 18
N = 19
Habitat (sq. ft.) = 226.4 sq. ft.
Density (fish/sq. ft.) = 0.08 fish/sq. ft.

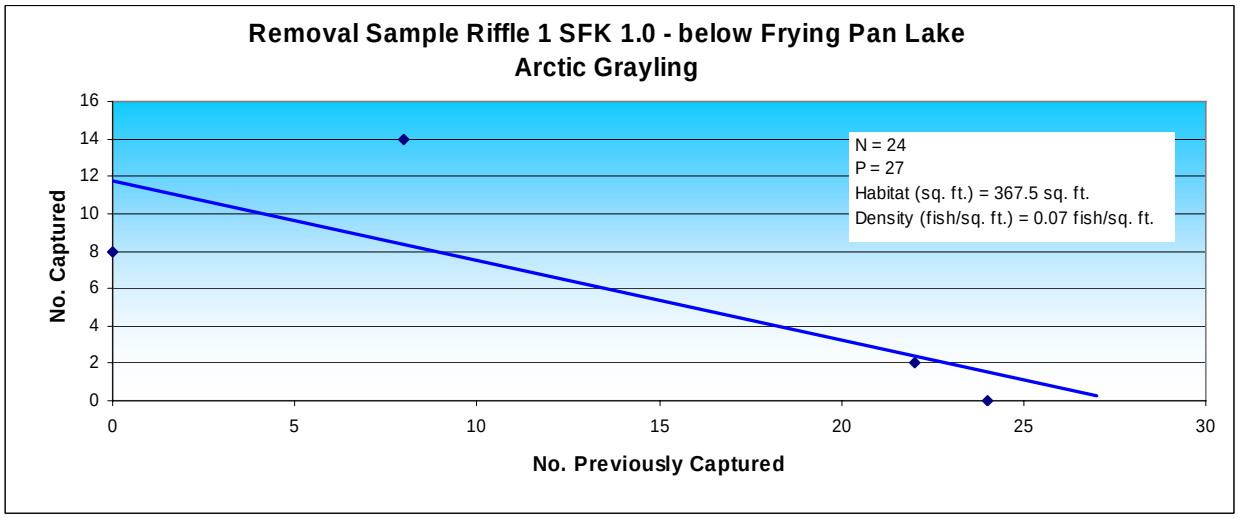

Representative Reach 4 SFK 1.310
Dolly Varden
No. Captured
No. Previously Captured
N = 37
P = 39
Habiatat (sq. ft.) = 301.8 sq. ft.
Density (fish/sq. ft.) = 0.13 fish/sq. ft.

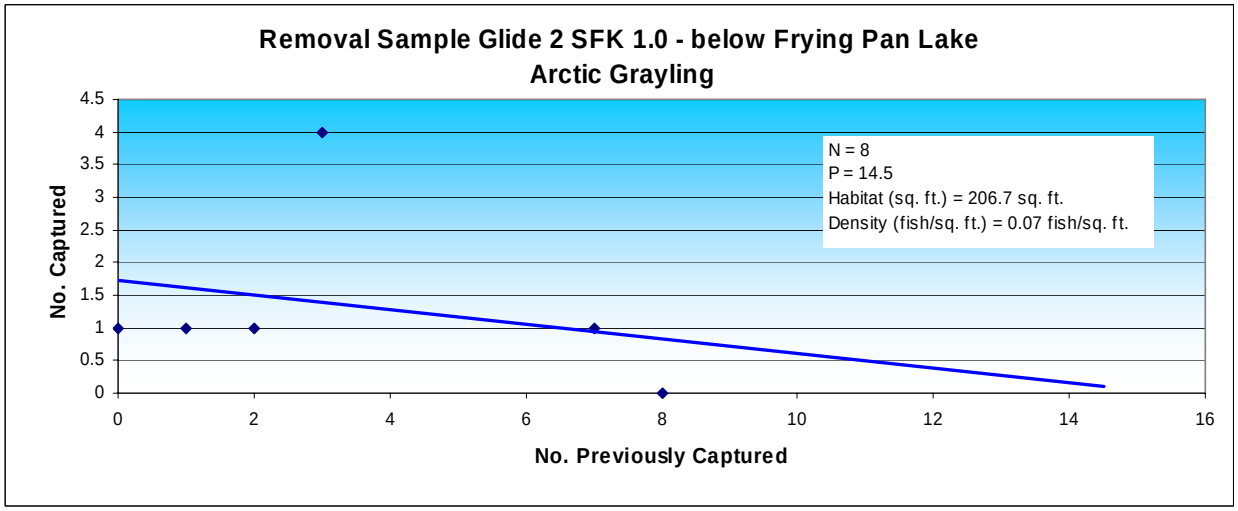

Total Removal 1 SFK 1.310
Dolly Varden
No. Captured
No. Previously Captured
N = 24
P = 27
Habitat (sq. ft.) = 220.5 sq. ft.
Density (fish/sq. ft.) = 0.12 fish/sq. ft.

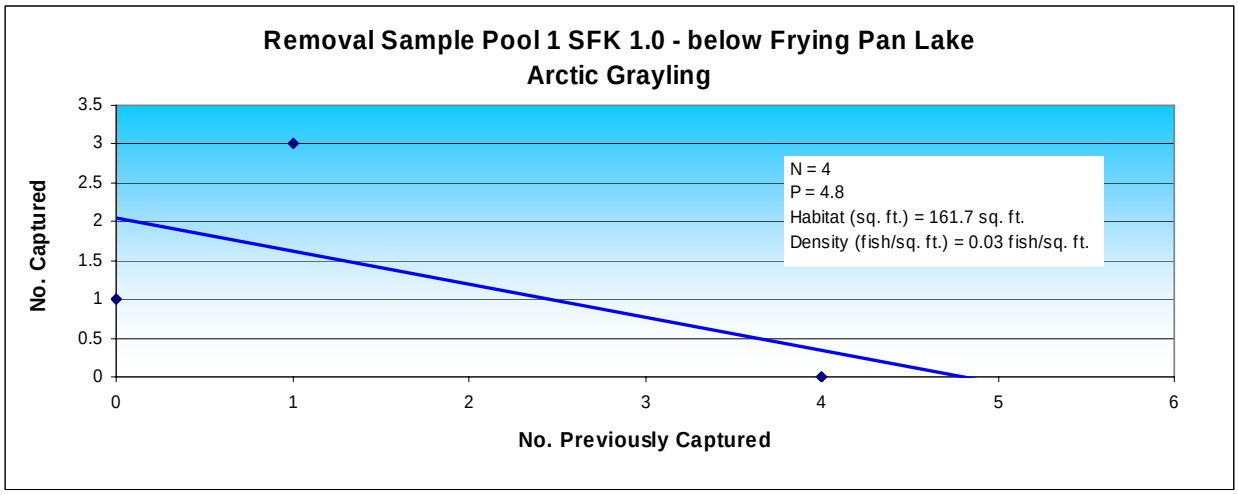

Representative Reach 5 SFK 1.310
Dolly Varden
No. Captured
No. Previously Captured
N = 35
P = 36
Habitat (sq. ft.) = 261.8 sq. ft.
Density (fish/sq. ft.) = 0.12 fish/sq. ft.
0
5
10
15
20
25
30
35
40

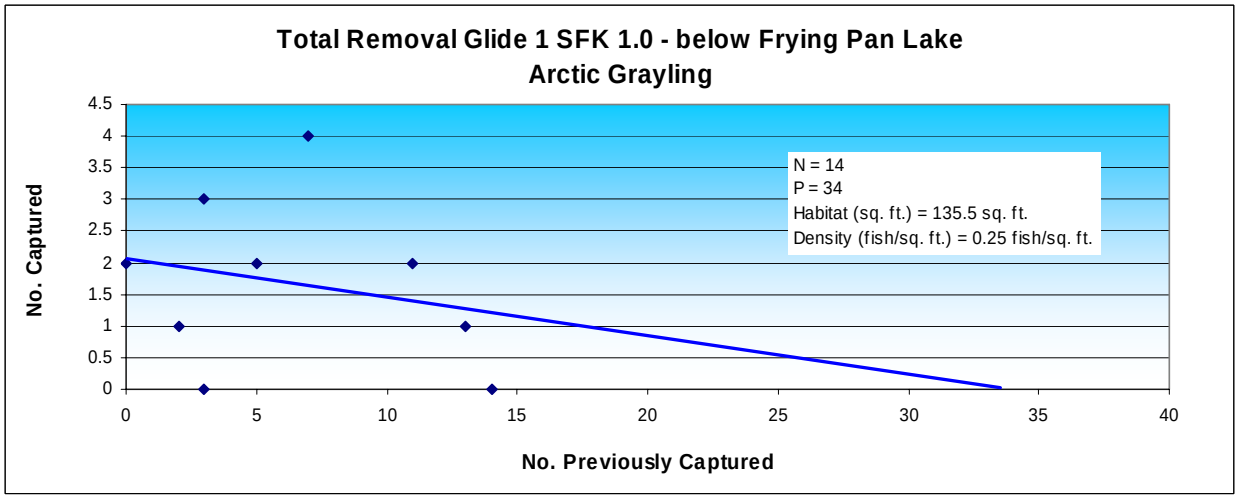

Total Removal Riffle 1 SKF 1.0- below Frying Pan Lake
Arctic Grayling
No. Captured
No. Previously Captured
N = 7
P = 7.1
Habitat (sq. ft.) = 232.3 sq. ft.
Density (fish/sq. ft.) = 0.03 fish/sq. ft.
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
6
7
8

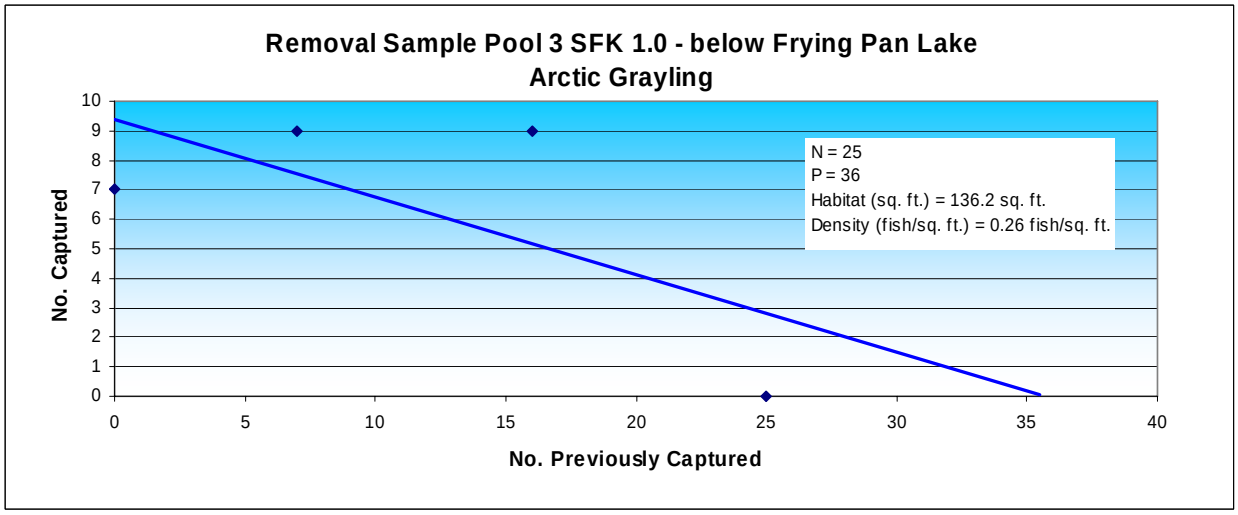

Removal Sample Glide 1 SFK 1.0- below Frying Pan Lake
Arctic Grayling
N = 6
P = 23
Habitat (sq. ft.) = 208 sq. ft.
Density (fish/sq. ft.) = 0.11 fish/sq. ft.
No. Captured
No. Previously Captured
0
1
2
3
4
5
6
7
8

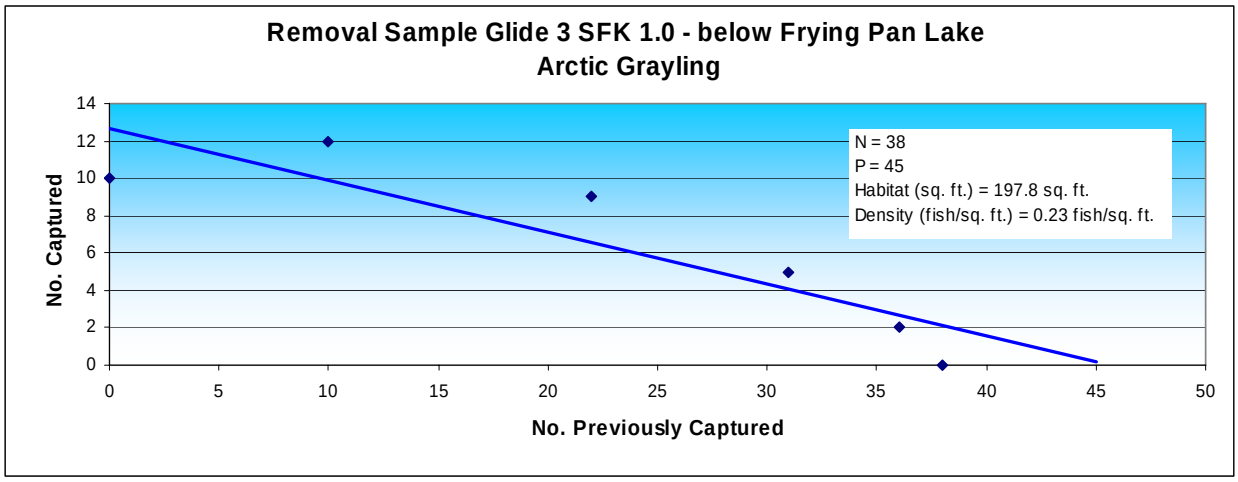

Removal Sample Riffle 1 SFK 1.0 - below Frying Pan Lake
Arctic Grayling
N = 24
P = 27
Habitat (sq. ft.) = 367.5 sq. ft.
Density (fish/sq. ft.) = 0.07 fish/sq. ft.
No. Captured
No. Previously Captured
0
2
4
6
8
10
12
14
16
5
15
20
25
30

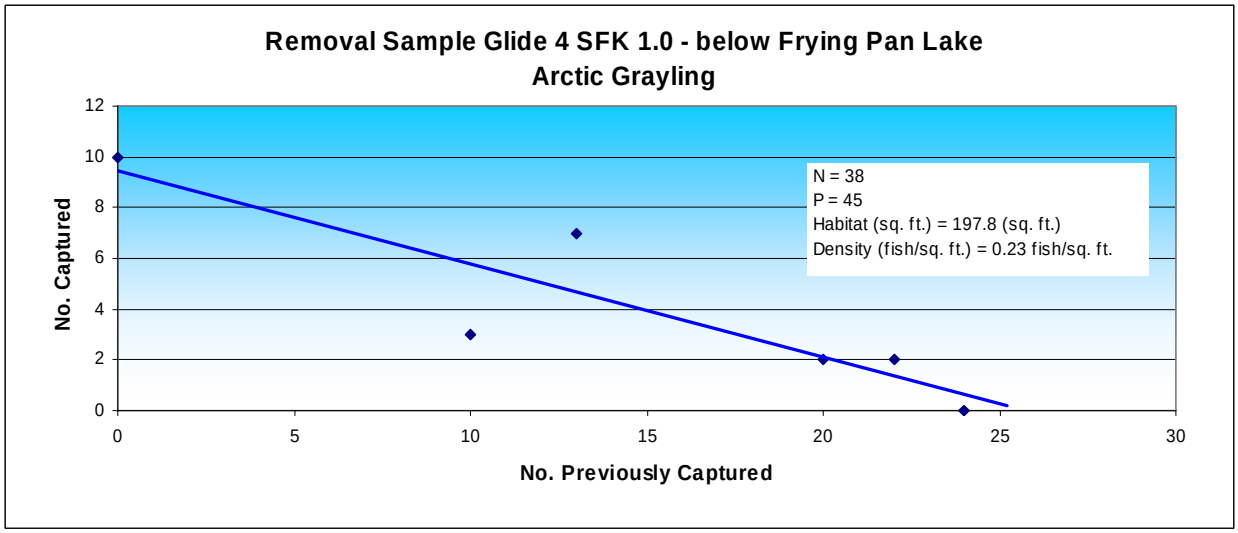

Removal Sample Glide 2 SFK 1.0 - below Frying Pan Lake
Arctic Grayling
N = 8
P = 14.5
Habitat (sq. ft.) = 206.7 sq. ft.
Density (fish/sq. ft.) = 0.07 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
6
8
10
12
14
16

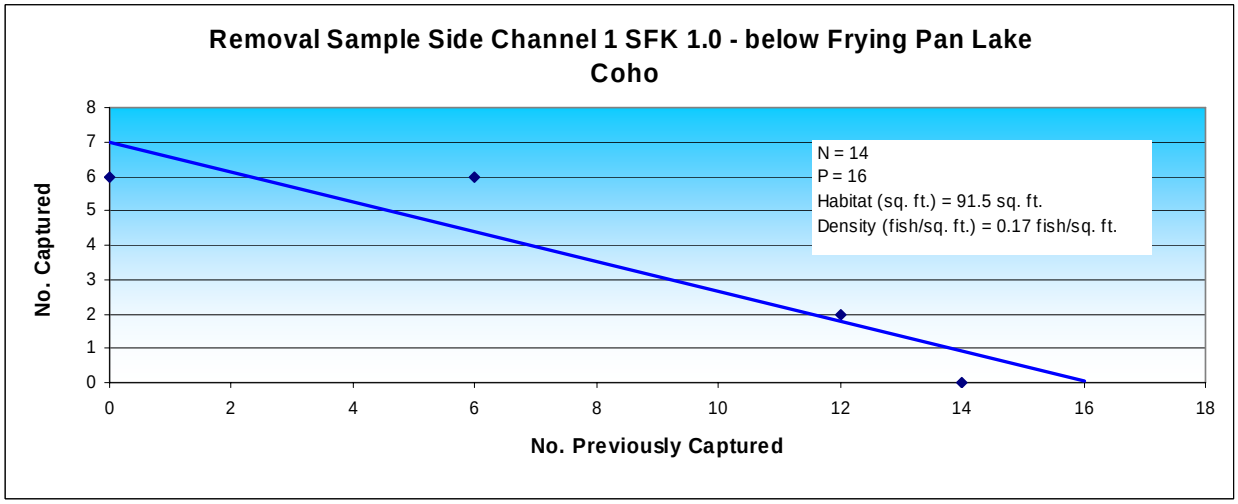

Removal Sample Pool 1 SFK 1.0 - below Frying Pan Lake
Arctic Grayling
No. Captured
No. Previously Captured
N = 4
P = 4.8
Habitat (sq. ft.) = 161.7 sq. ft.
Density (fish/sq. ft.) = 0.03 fish/sq. ft.

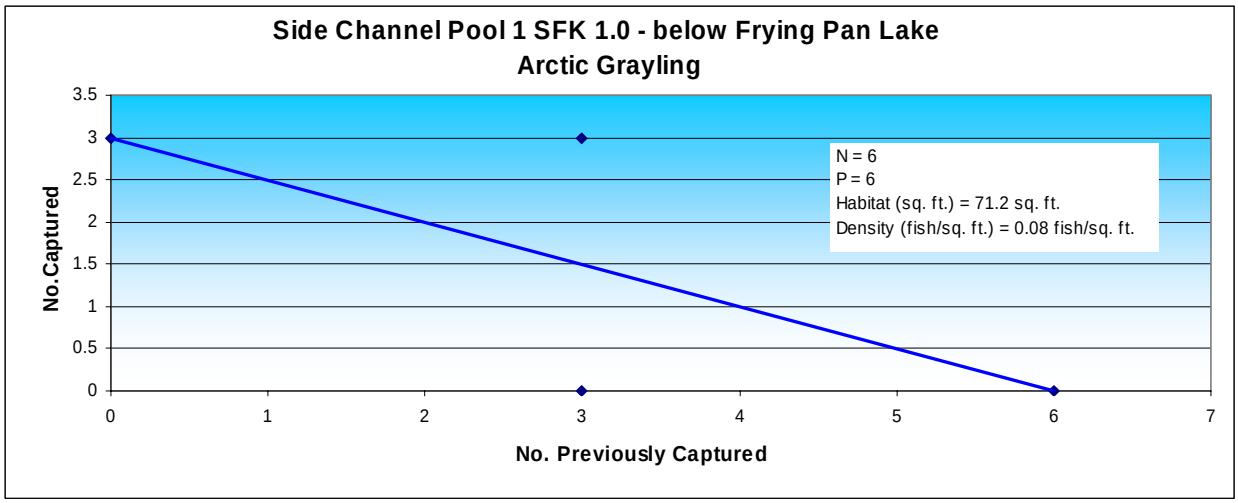

Total Removal Glide 1 SFK 1.0 - below Frying Pan Lake
Arctic Grayling
No. Captured
No. Previously Captured
N = 14
P = 34
Habitat (sq. ft.) = 135.5 sq. ft.
Density (fish/sq. ft.) = 0.25 fish/sq. ft.

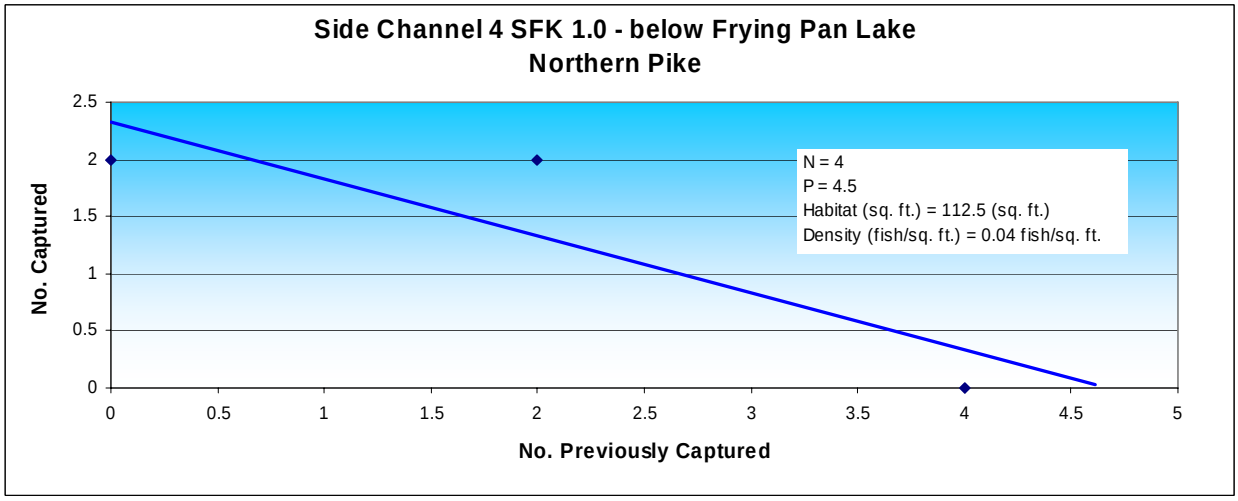

Removal Sample Pool 3 SFK 1.0 - below Frying Pan Lake
Arctic Grayling
No. Captured
No. Previously Captured
N = 25
P = 36
Habitat (sq. ft.) = 136.2 sq. ft.
Density (fish/sq. ft.) = 0.26 fish/sq. ft.

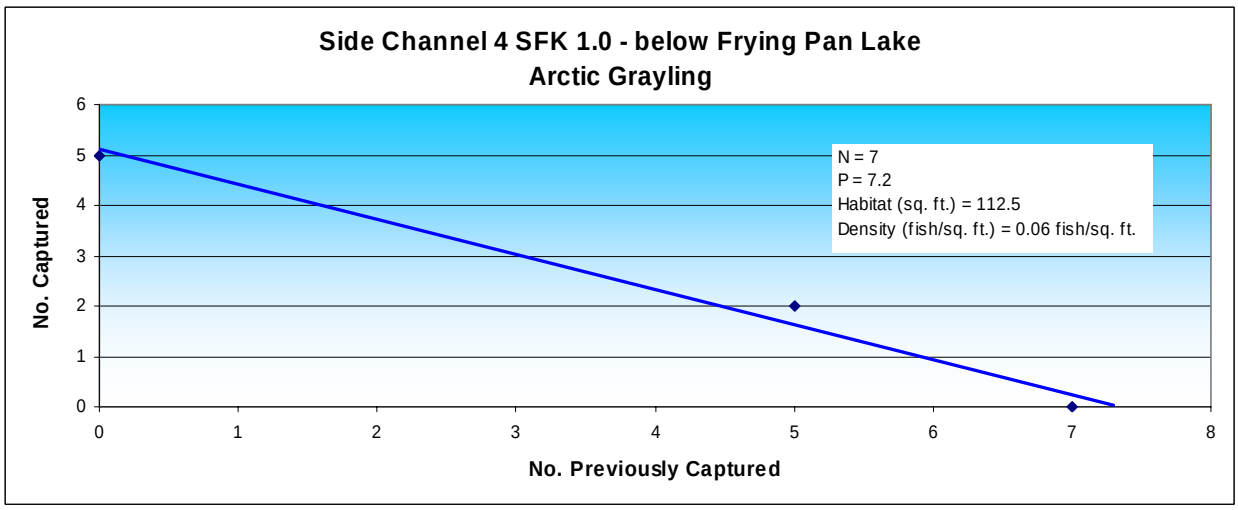

Removal Sample Glide 3 SFK 1.0 - below Frying Pan Lake
Arctic Grayling
N = 38
P = 45
Habitat (sq. ft.) = 197.8 sq. ft.
Density (fish/sq. ft.) = 0.23 fish/sq. ft.
No. Captured
No. Previously Captured
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
50

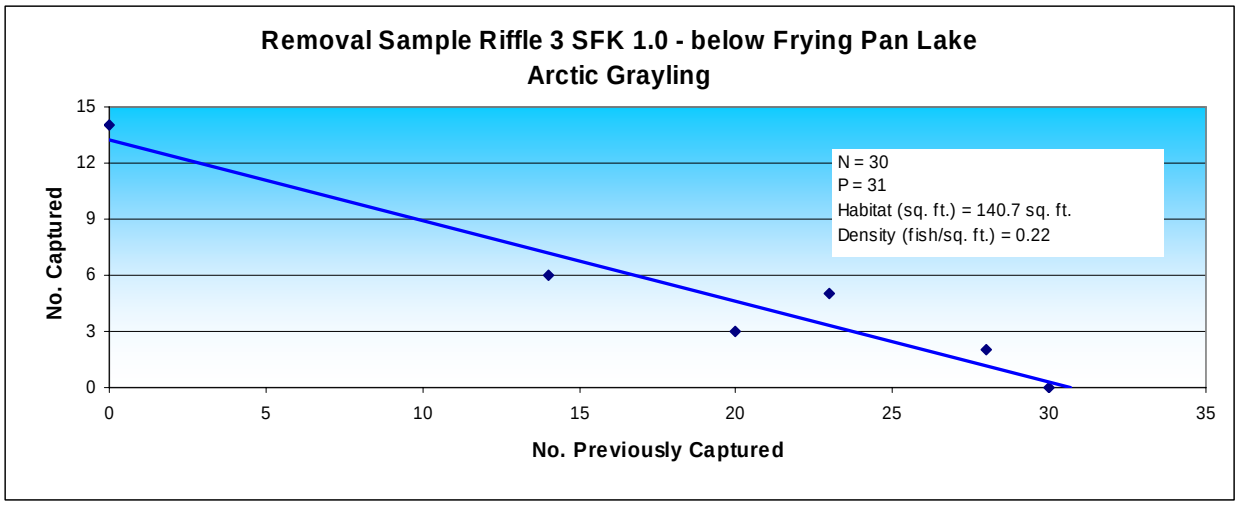

Removal Sample Glide 4 SFK 1.0 - below Frying Pan Lake
Arctic Grayling
N = 38
P = 45
Habitat (sq. ft.) = 197.8 (sq. ft.)
Density (fish/sq. ft.) = 0.23 fish/sq. ft.
No. Captured
No. Previously Captured
0
2
4
6
8
10
12
0
5
10
15
20
25
30

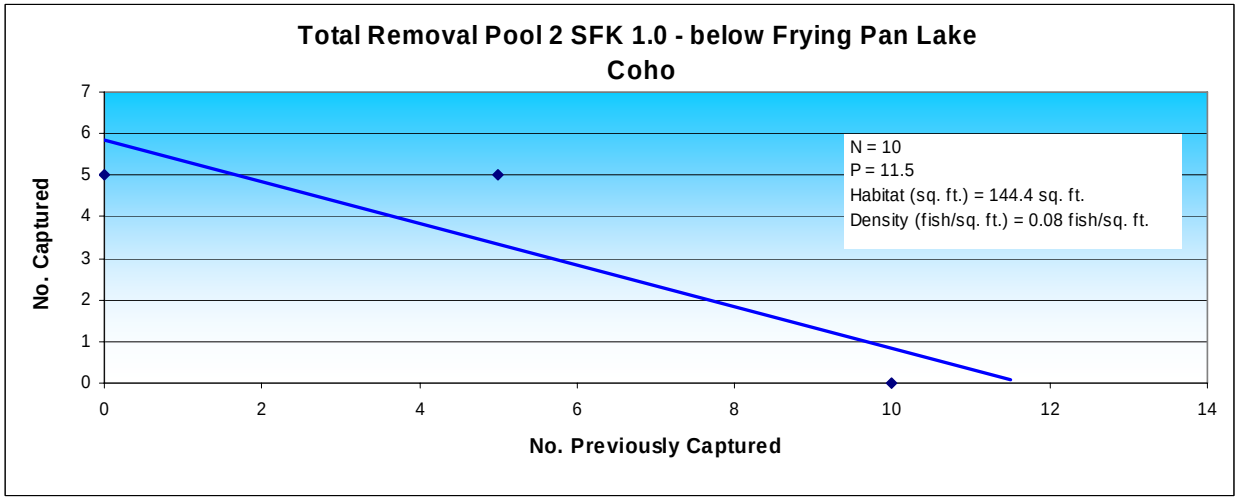

Removal Sample Side Channel 1 SFK 1.0 - below Frying Pan Lake
Coho
N = 14
P = 16
Habitat (sq. ft.) = 91.5 sq. ft.
Density (fish/sq. ft.) = 0.17 fish/sq. ft.
No. Captured
No. Previously Captured
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12
14
16
18

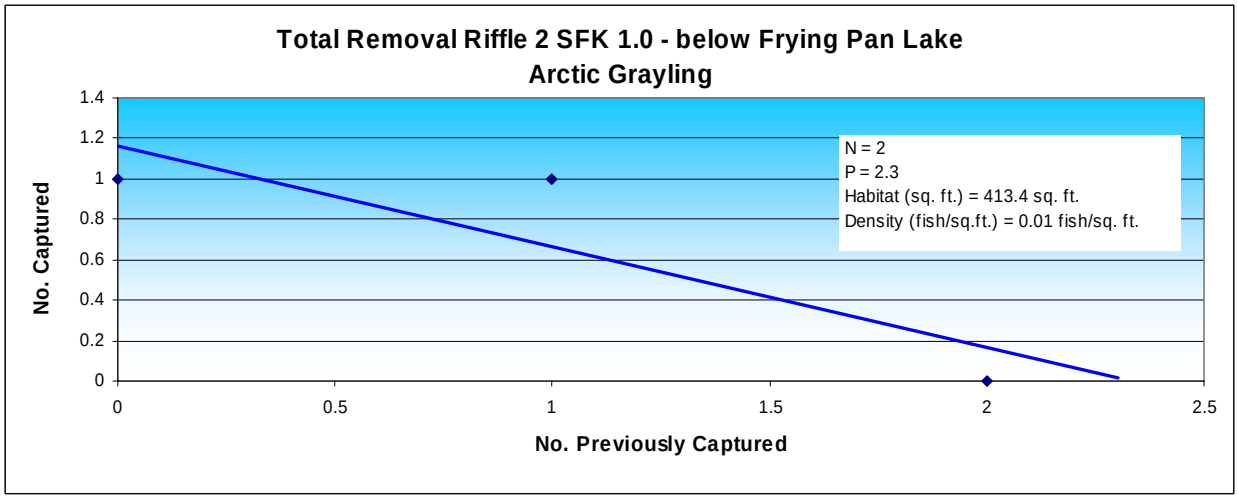

Side Channel Pool 1 SFK 1.0 - below Frying Pan Lake
Arctic Grayling
No.Captured
No. Previously Captured
N = 6
P = 6
Habitat (sq. ft.) = 71.2 sq. ft.
Density (fish/sq. ft.) = 0.08 fish/sq. ft.

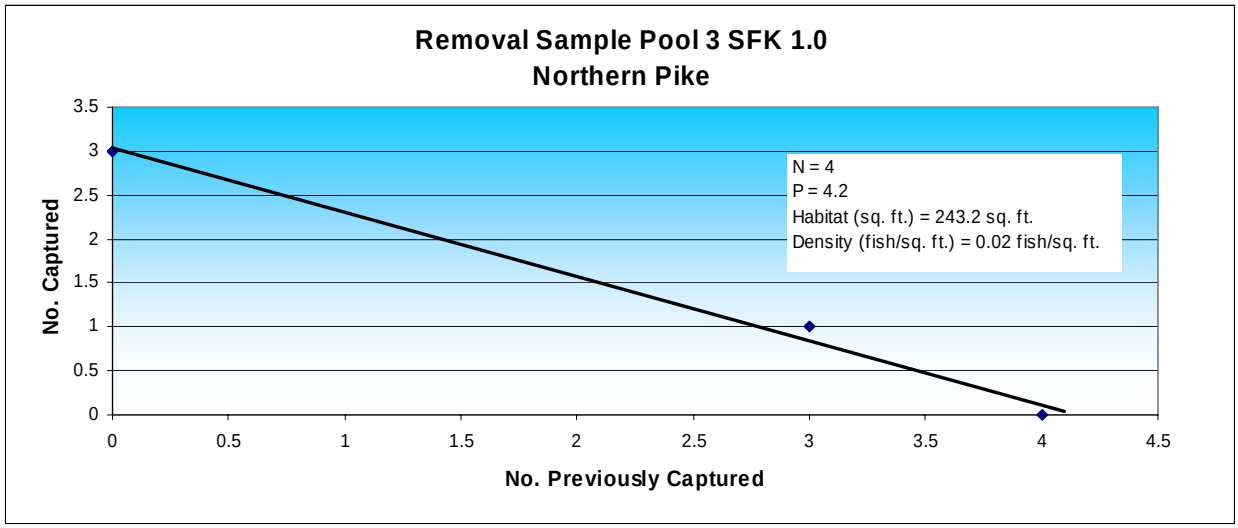

Side Channel 4 SFK 1.0 - below Frying Pan Lake
Northern Pike
No. Captured
No. Previously Captured
N = 4
P = 4.5
Habitat (sq. ft.) = 112.5 (sq. ft.)
Density (fish/sq. ft.) = 0.04 fish/sq. ft.

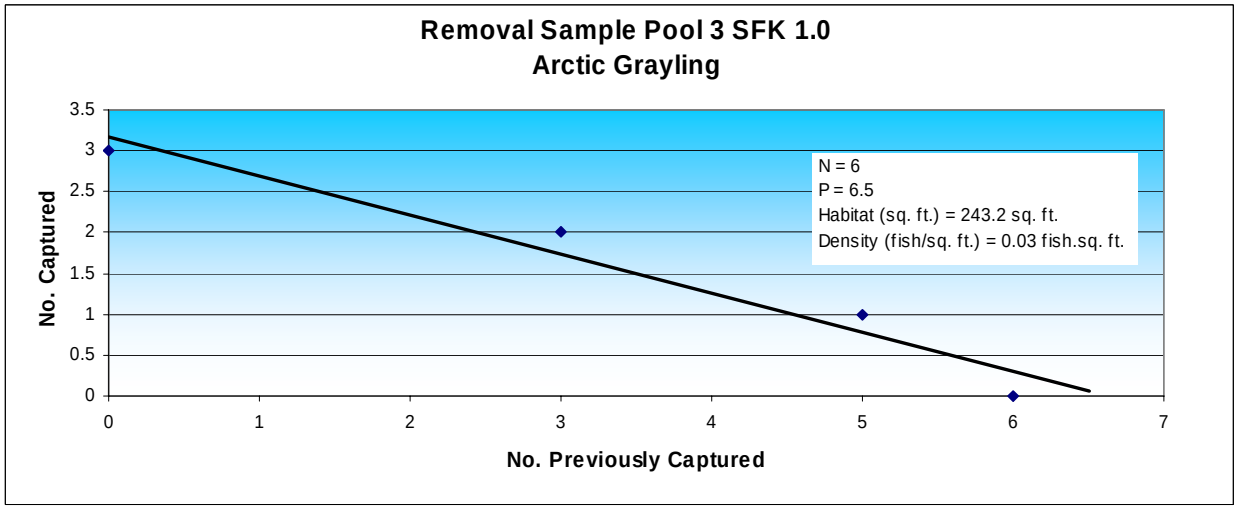

Side Channel 4 SFK 1.0 - below Frying Pan Lake
Arctic Grayling
No. Captured
No. Previously Captured
N = 7
P = 7.2
Habitat (sq. ft.) = 112.5
Density (fish/sq. ft.) = 0.06 fish/sq. ft.

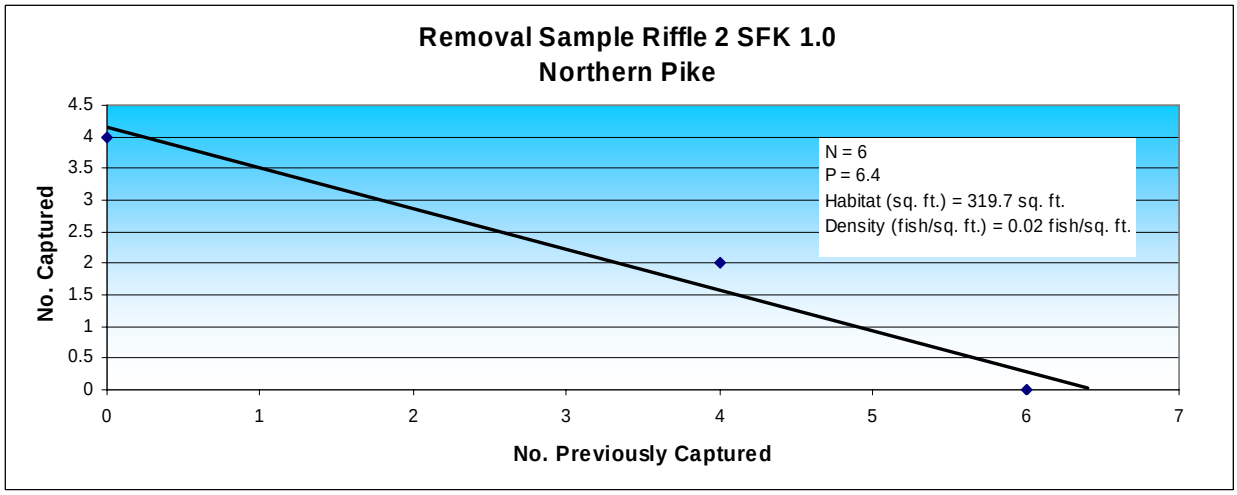

Removal Sample Riffle 3 SFK 1.0 - below Frying Pan Lake
Arctic Grayling
No. Captured
No. Previously Captured
N = 30
P = 31
Habitat (sq. ft.) = 140.7 sq. ft.
Density (fish/sq. ft.) = 0.22

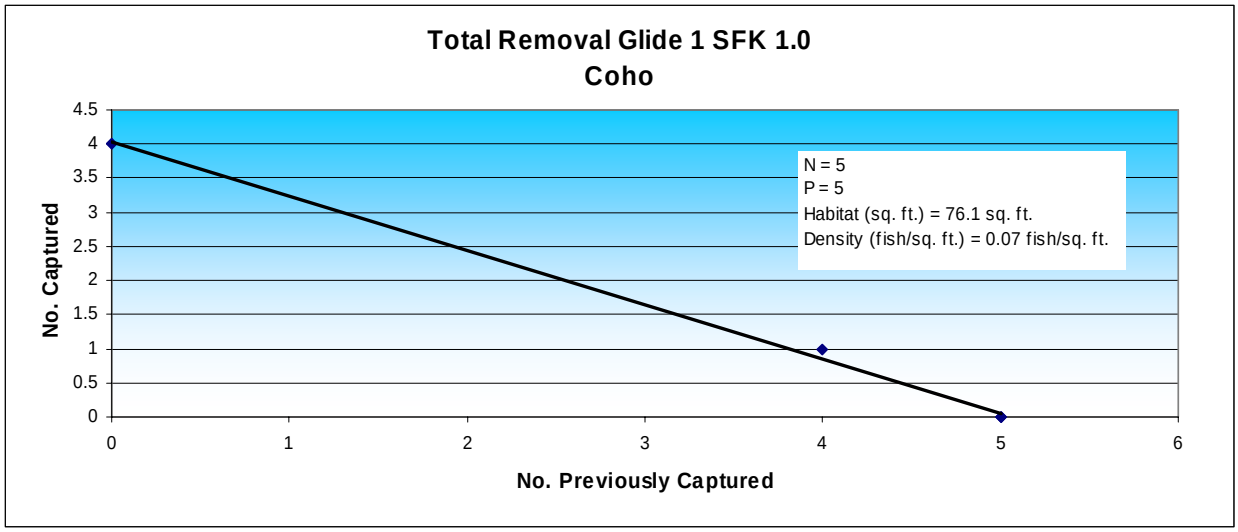

Total Removal Pool 2 SFK 1.0 - below Frying Pan Lake
Coho
No. Captured
No. Previously Captured
N = 10
P = 11.5
Habitat (sq. ft.) = 144.4 sq. ft.
Density (fish/sq. ft.) = 0.08 fish/sq. ft.

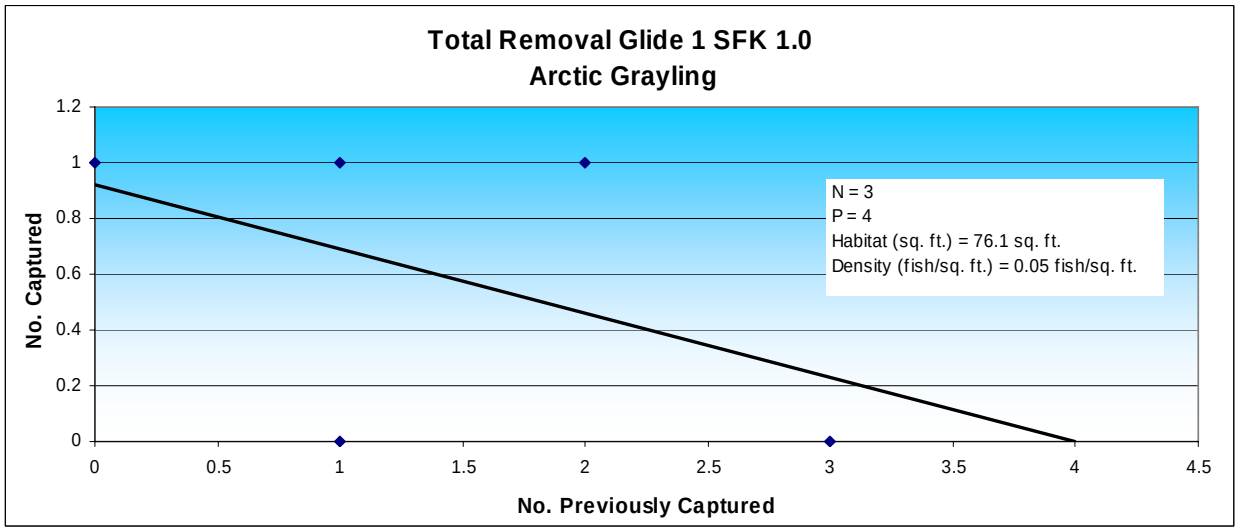

Total Removal Riffle 2 SFK 1.0 - below Frying Pan Lake
Arctic Grayling
No. Captured
No. Previously Captured
N = 2
P = 2.3
Habitat (sq. ft.) = 413.4 sq. ft.
Density (fish/sq.ft.) = 0.01 fish/sq. ft.

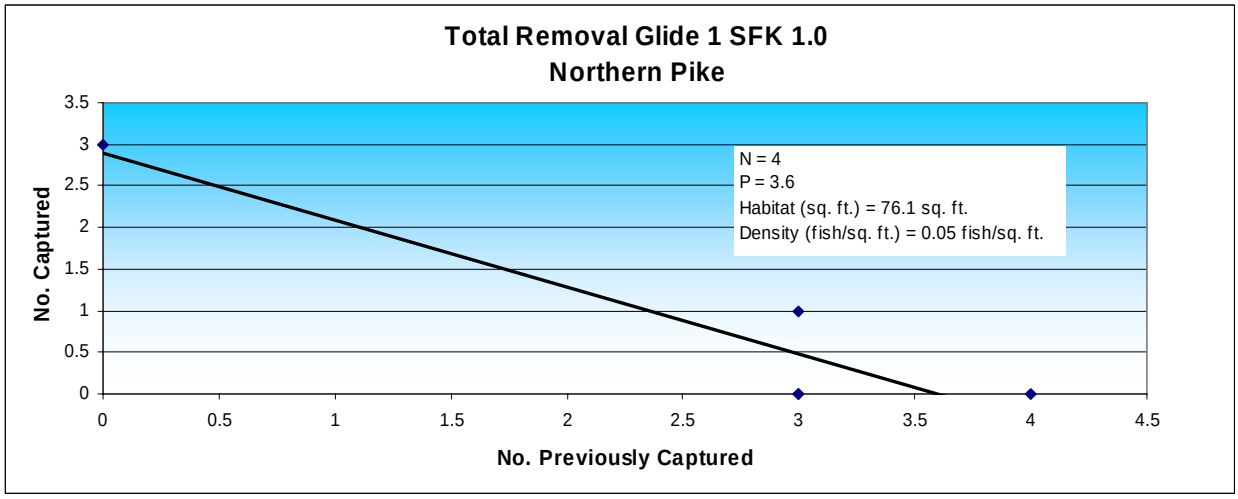

Removal Sample Pool 3 SFK 1.0
Northern Pike
N = 4
P = 4.2
Habitat (sq. ft.) = 243.2 sq. ft.
Density (fish/sq. ft.) = 0.02 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

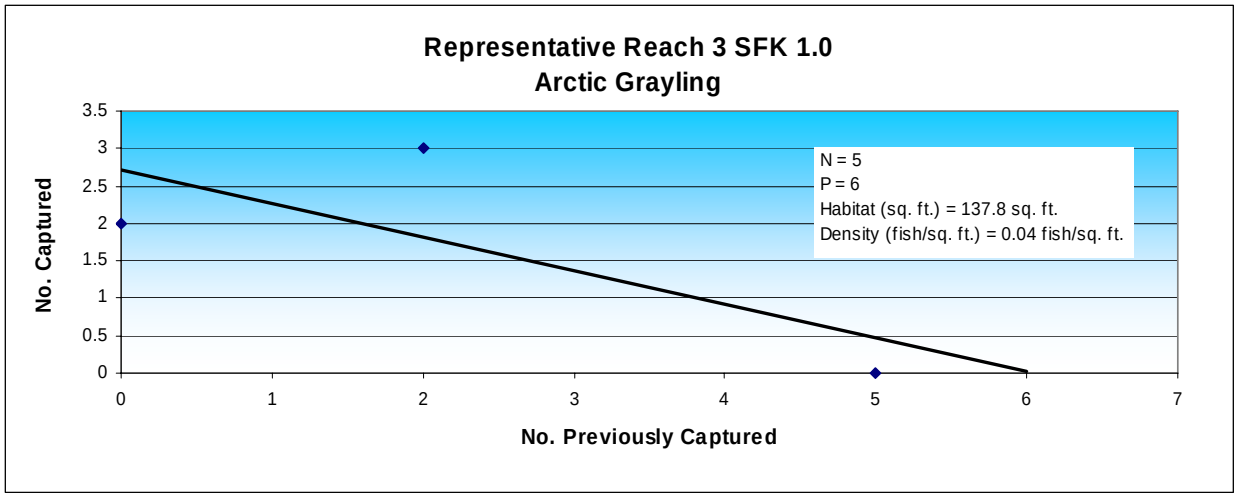

Removal Sample Pool 3 SFK 1.0
Arctic Grayling
N = 6
P = 6.5
Habitat (sq. ft.) = 243.2 sq. ft.
Density (fish/sq. ft.) = 0.03 fish.sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
4
5
6
7

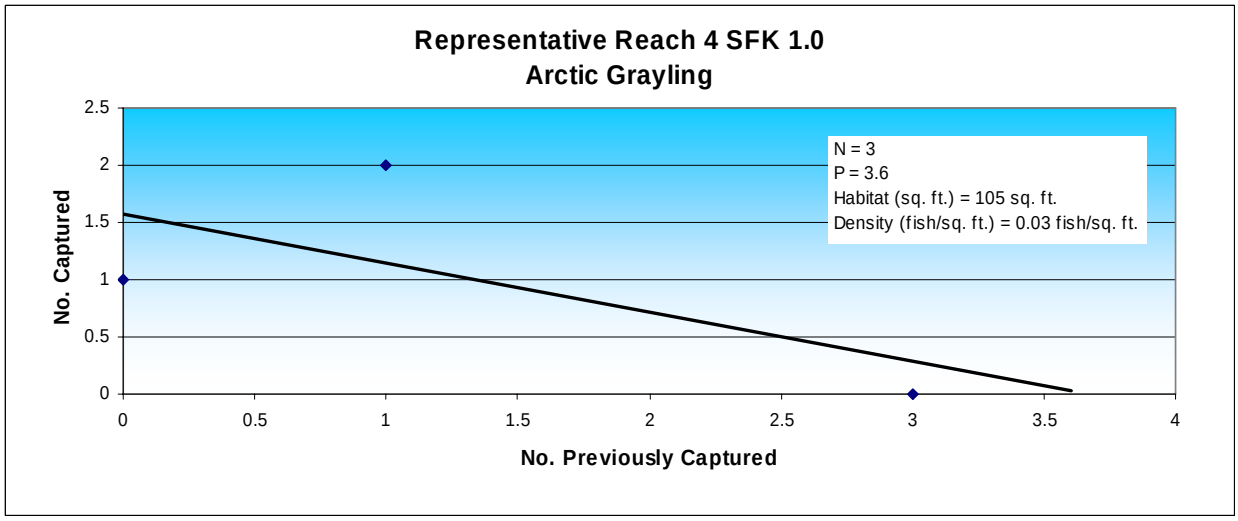

Removal Sample Riffle 2 SFK 1.0
Northern Pike
N = 6
P = 6.4
Habitat (sq. ft.) = 319.7 sq. ft.
Density (fish/sq. ft.) = 0.02 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
6
7

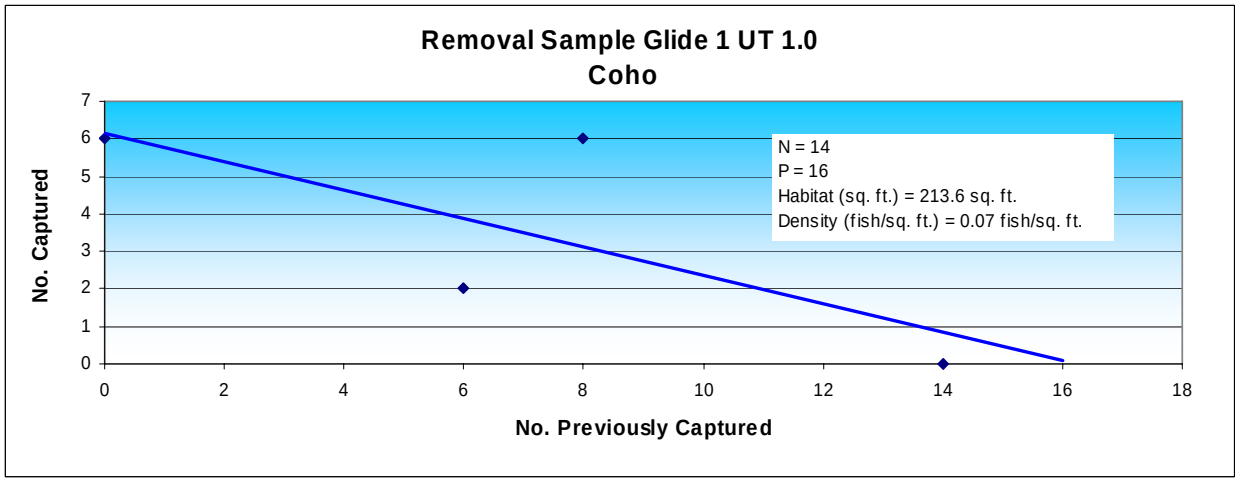

Total Removal Glide 1 SFK 1.0
Coho
N = 5
P = 5
Habitat (sq. ft.) = 76.1 sq. ft.
Density (fish/sq. ft.) = 0.07 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
1
2
3
4
5
6

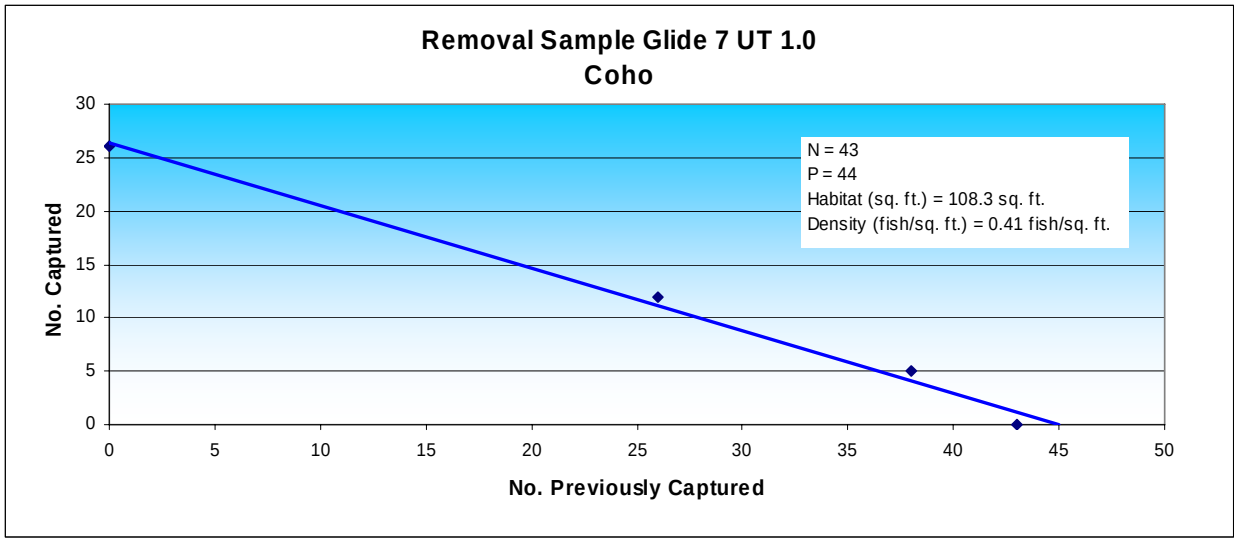

Total Removal Glide 1 SFK 1.0
Arctic Grayling
N = 3
P = 4
Habitat (sq. ft.) = 76.1 sq. ft.
Density (fish/sq. ft.) = 0.05 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.2
0.4
0.6
0.8
1
1.2
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

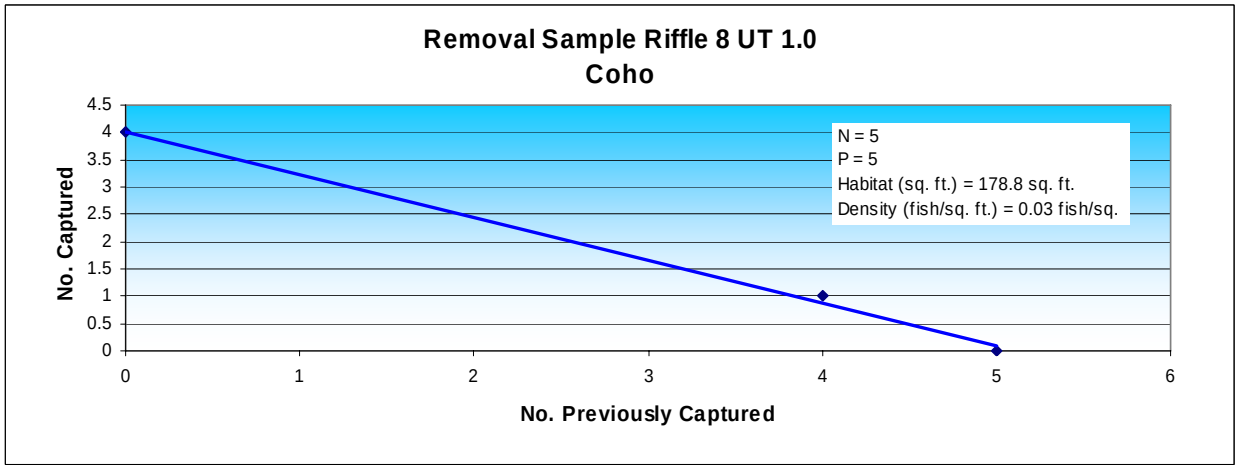

Total Removal Glide 1 SFK 1.0
Northern Pike
N = 4
P = 3.6
Habitat (sq. ft.) = 76.1 sq. ft.
Density (fish/sq. ft.) = 0.05 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

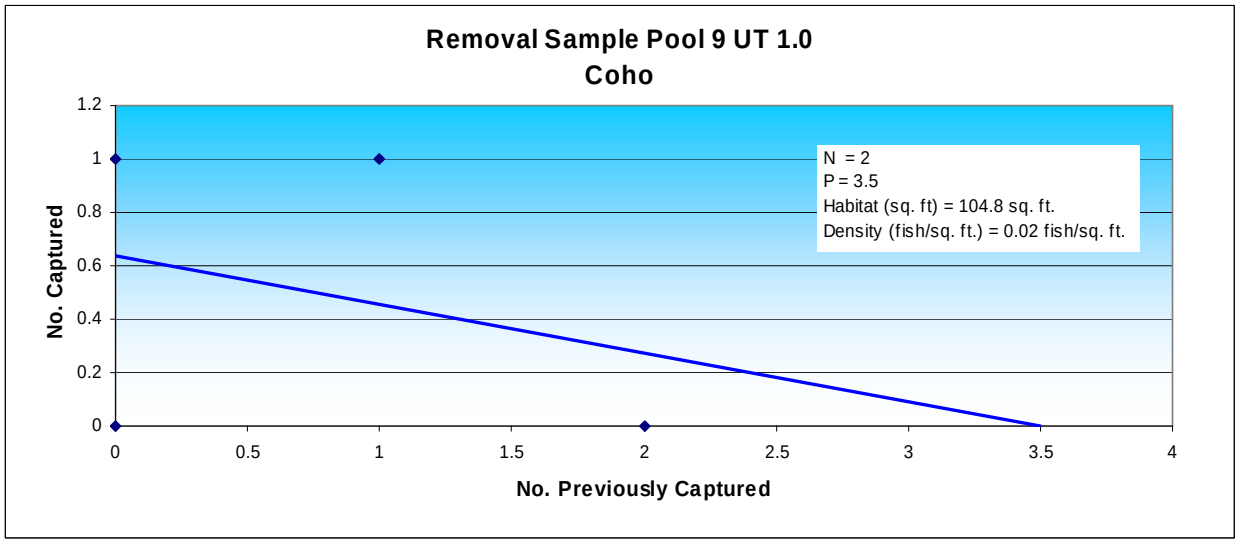

Representative Reach 3 SFK 1.0
Arctic Grayling
No. Captured
No. Previously Captured
N = 5
P = 6
Habitat (sq. ft.) = 137.8 sq. ft.
Density (fish/sq. ft.) = 0.04 fish/sq. ft.

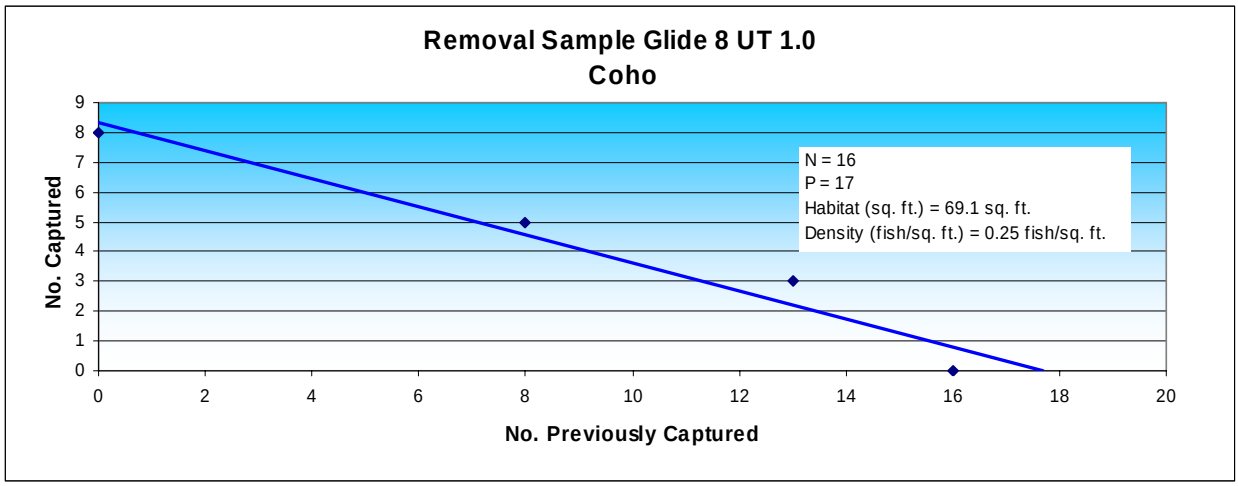

Representative Reach 4 SFK 1.0
Arctic Grayling
No. Captured
No. Previously Captured
N = 3
P = 3.6
Habitat (sq. ft.) = 105 sq. ft.
Density (fish/sq. ft.) = 0.03 fish/sq. ft.


Removal Sample Glide 1 UT 1.0
Coho
No. Captured
No. Previously Captured
N = 14
P = 16
Habitat (sq. ft.) = 213.6 sq. ft.
Density (fish/sq. ft.) = 0.07 fish/sq. ft.


Removal Sample Glide 7 UT 1.0
Coho
N = 43
P = 44
Habitat (sq. ft.) = 108.3 sq. ft.
Density (fish/sq. ft.) = 0.41 fish/sq. ft.
No. Captured
No. Previously Captured
0
5
10
15
20
25
30
35
40
45
50


Removal Sample Riffle 8 UT 1.0
Coho
N = 5
P = 5
Habitat (sq. ft.) = 178.8 sq. ft.
Density (fish/sq. ft.) = 0.03 fish/sq.
No. Captured
No. Previously Captured
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
6


Removal Sample Pool 9 UT 1.0
Coho
N = 2
P = 3.5
Habitat (sq. ft) = 104.8 sq. ft.
Density (fish/sq. ft.) = 0.02 fish/sq. ft.
No. Captured
No. Previously Captured
0
0.2
0.4
0.6
0.8
1
1.2
1.5
2
2.5
3
3.5
4


Removal Sample Glide 8 UT 1.0
Coho
No. Captured
No. Previously Captured
N = 16
P = 17
Habitat (sq. ft.) = 69.1 sq. ft.
Density (fish/sq. ft.) = 0.25 fish/sq. ft.
0
1
2
3
4
5
6
7
8
9
0
2
4
6
8
10
12
14
16
18
20

Appendix 11-E
Macroinvertebrate Graphs

Figure 11 E - 1: Pebble Project
Preliminary Summary of Taxa Richness by Site for ASCI Sampling Method

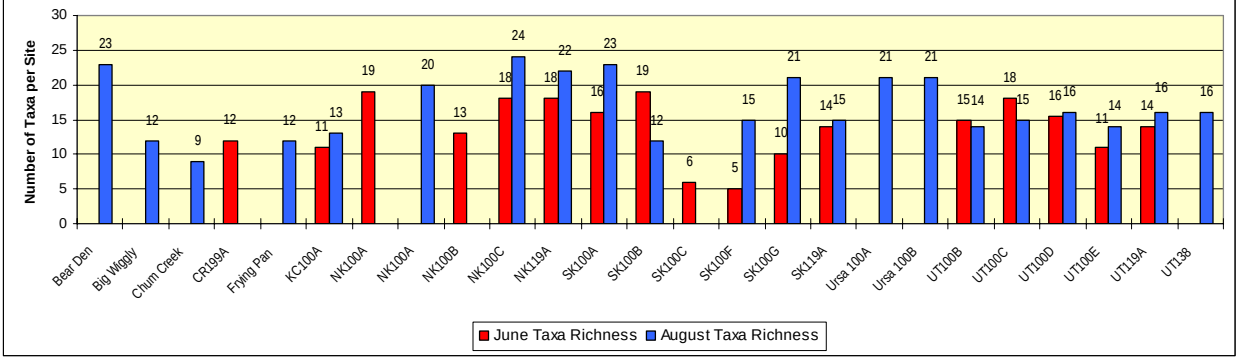
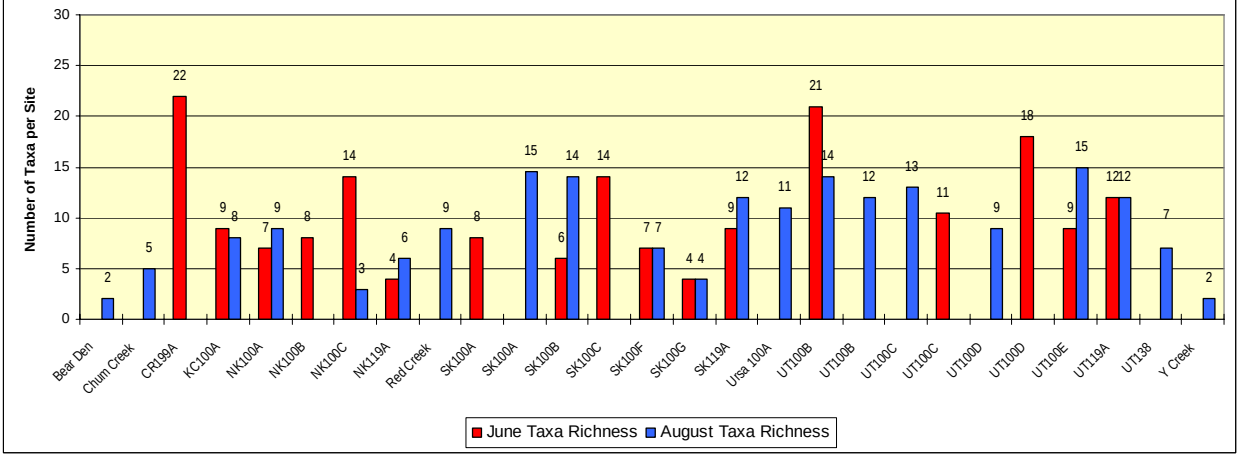
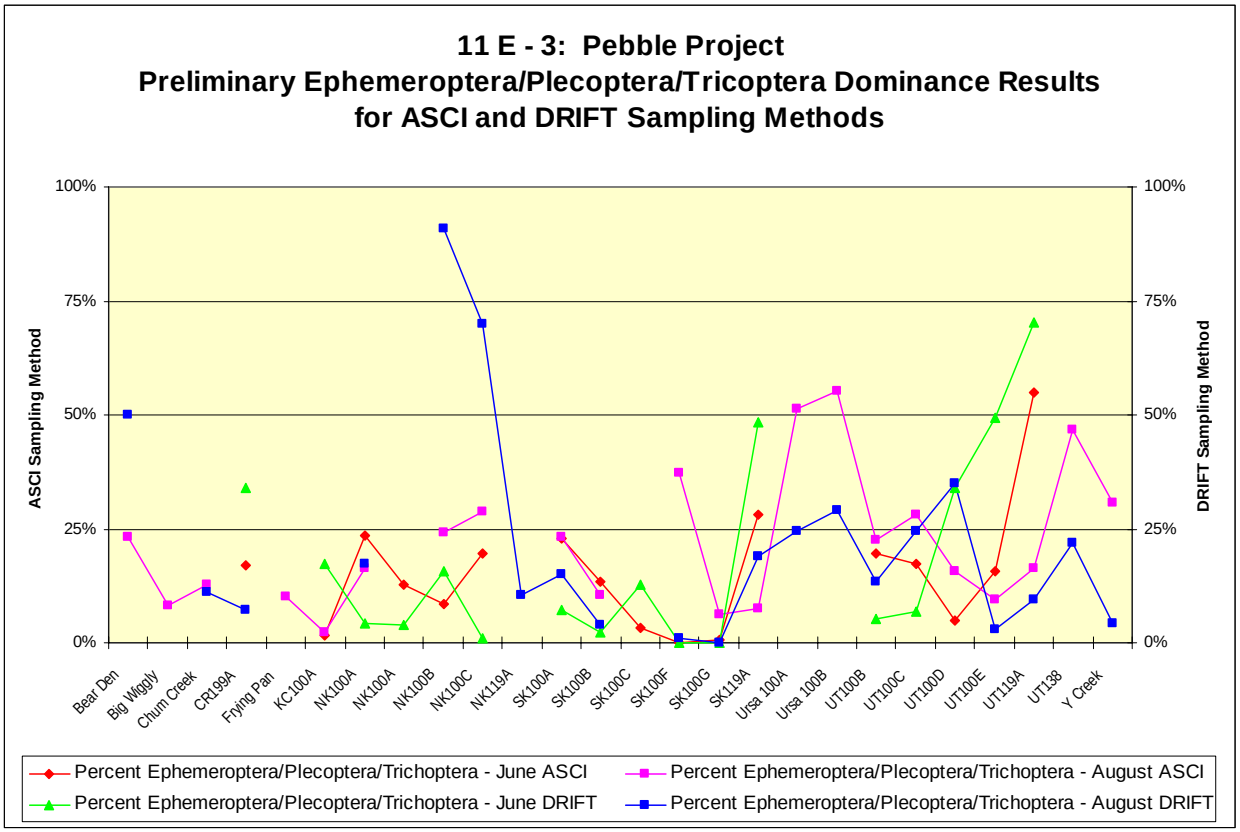
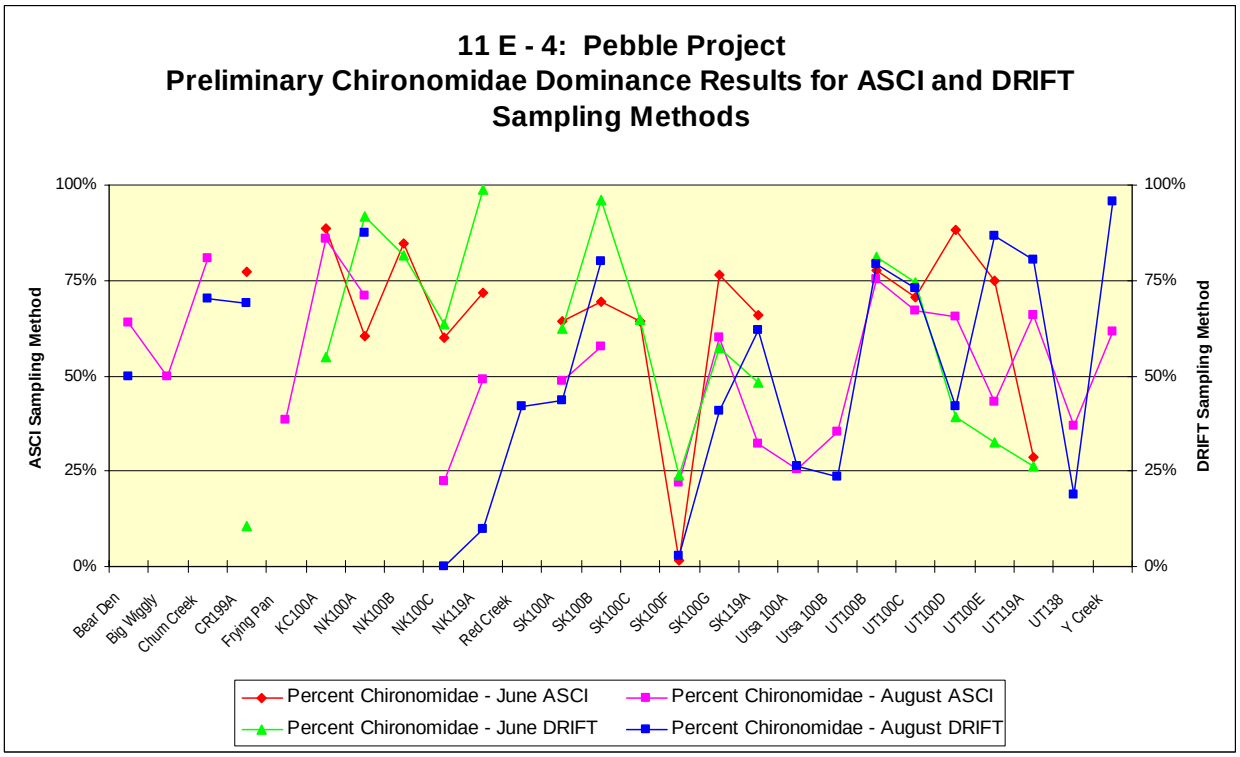
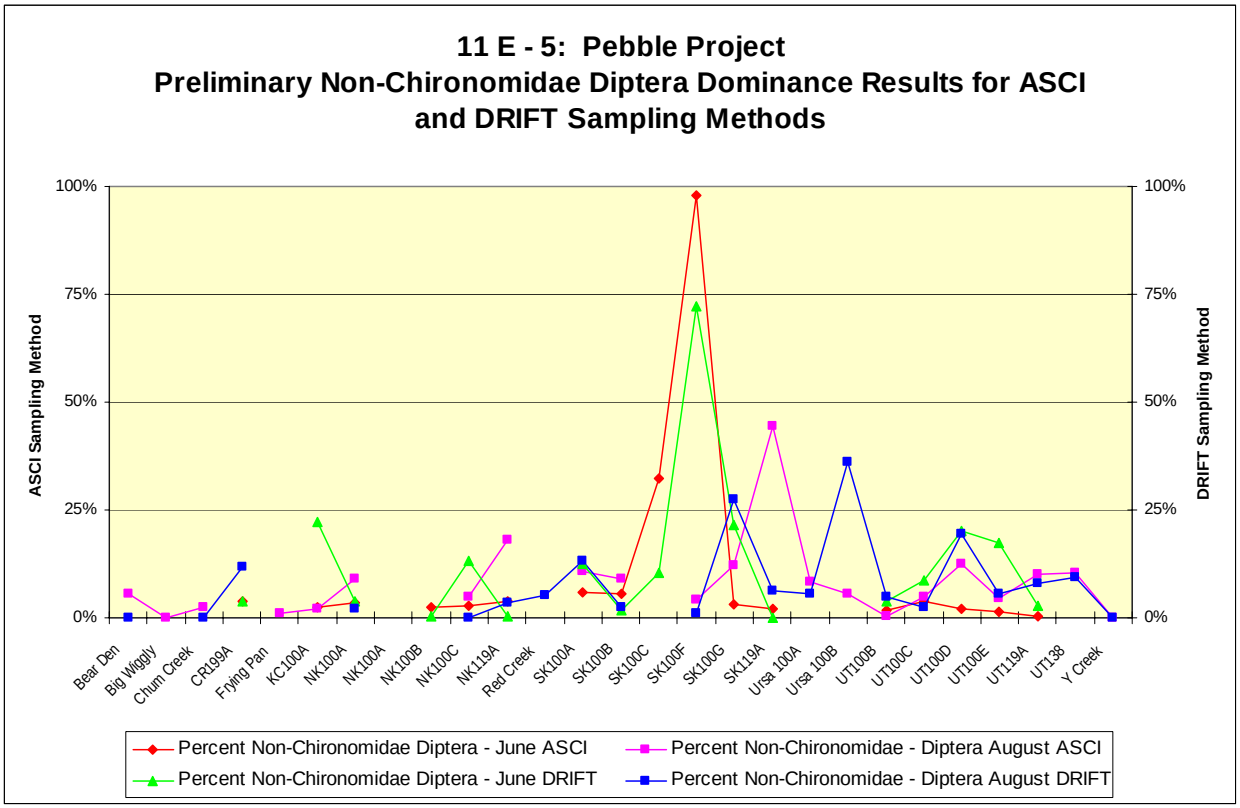


Figure 11 E - 2: Pebble Project
Preliminary Summary of Taxa Richness by Site for DRIFT Sampling Method




11 E - 3: Pebble Project
Preliminary Ephemeroptera/Plecoptera/Tricoptera Dominance Results for ASCI and DRIFT Sampling Methods
ASCI Sampling Method
DRIFT Sampling Method
100%
75%
50%
25%
0%
Bear Den
Big Wiggly
Chum Creek
CR199A
Frying Pan
KC100A
NK100A
NK100A
NK100A
NK100B
NK100C
NK119A
SK100A
SK100B
SK100C
SK100F
SK100G
SK119A
Ursa 100A
Ursa 100B
UT100B
UT100C
UT100D
UT100E
UT119A
UT138
Y Creek
Percent Ephemeroptera/Plecoptera/Trichoptera - June ASCI
Percent Ephemeroptera/Plecoptera/Trichoptera - August ASCI
Percent Ephemeroptera/Plecoptera/Trichoptera - June DRIFT
Percent Ephemeroptera/Plecoptera/Trichoptera - August DRIFT


11 E - 4: Pebble Project
Preliminary Chironomidae Dominance Results for ASCI and DRIFT Sampling Methods
ASCI Sampling Method
DRIFT Sampling Method
100%
75%
50%
25%
0%
Bear Den
Big Wiggly
Chum Creek
CR199A
Frying Pan
KC100A
NK100A
NK100B
NK100C
NK119A
Red Creek
SK100A
SK100B
SK100C
SK100F
SK100G
SK119A
Ursa 100A
Ursa 100B
UT100B
UT100C
UT100D
UT100E
UT119A
UT138
Y Creek
Percent Chironomidae - June ASCI
Percent Chironomidae - August ASCI
Percent Chironomidae - June DRIFT
Percent Chironomidae - August DRIFT


11 E - 5: Pebble Project
Preliminary Non-Chironomidae Diptera Dominance Results for ASCI and DRIFT Sampling Methods
ASCI Sampling Method
DRIFT Sampling Method
100%
75%
50%
25%
0%
Bear Den
Big Wiggly
Chum Creek
CR199A
Frying Pan
KC100A
NK100A
NK100A
NK100B
NK100C
NK119A
Red Creek
SK100A
SK100B
SK100C
SK100F
SK100G
SK119A
Ursa 100A
Ursa 100B
UT100B
UT100C
UT100D
UT100E
UT119A
UT138
Y Creek
Percent Non-Chironomidae Diptera - June ASCI
Percent Non-Chironomidae - Diptera August ASCI
Percent Non-Chironomidae Diptera - June DRIFT
Percent Non-Chironomidae - Diptera August DRIFT

Appendix 11-F
Water-quality Graphs

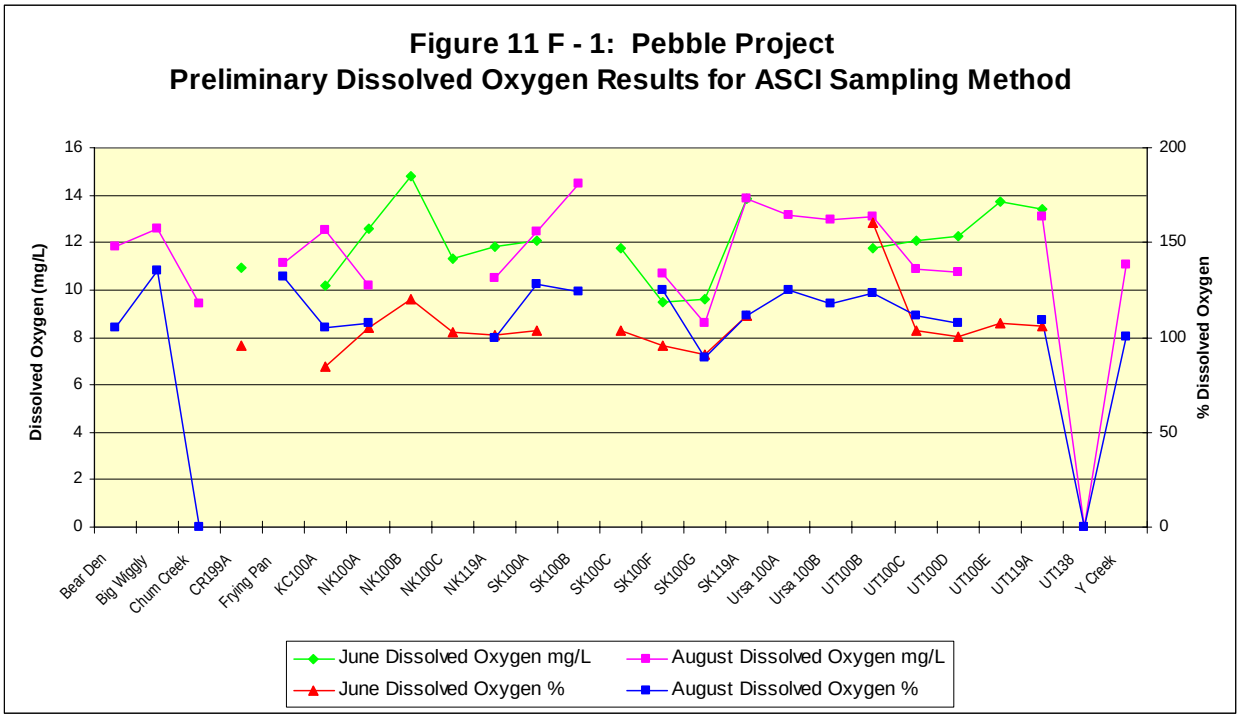


Figure 11 F - 1: Pebble Project
Preliminary Dissolved Oxygen Results for ASCI Sampling Method
Dissolved Oxygen (mg/L)
% Dissolved Oxygen
16
14
12
10
8
6
4
2
0
200
150
100
50
0
Bear Den
Big Wiggly
Chum Creek
CR199A
Frying Pan
KC100A
NK100A
NK100B
NK100C
NK119A
SK100A
SK100B
SK100C
SK100F
SK100G
SK119A
Ursa 100A
Ursa 100B
UT100B
UT100C
UT100D
UT100E
UT119A
UT138
Y Creek
June Dissolved Oxygen mg/L
August Dissolved Oxygen mg/L
June Dissolved Oxygen %
August Dissolved Oxygen %

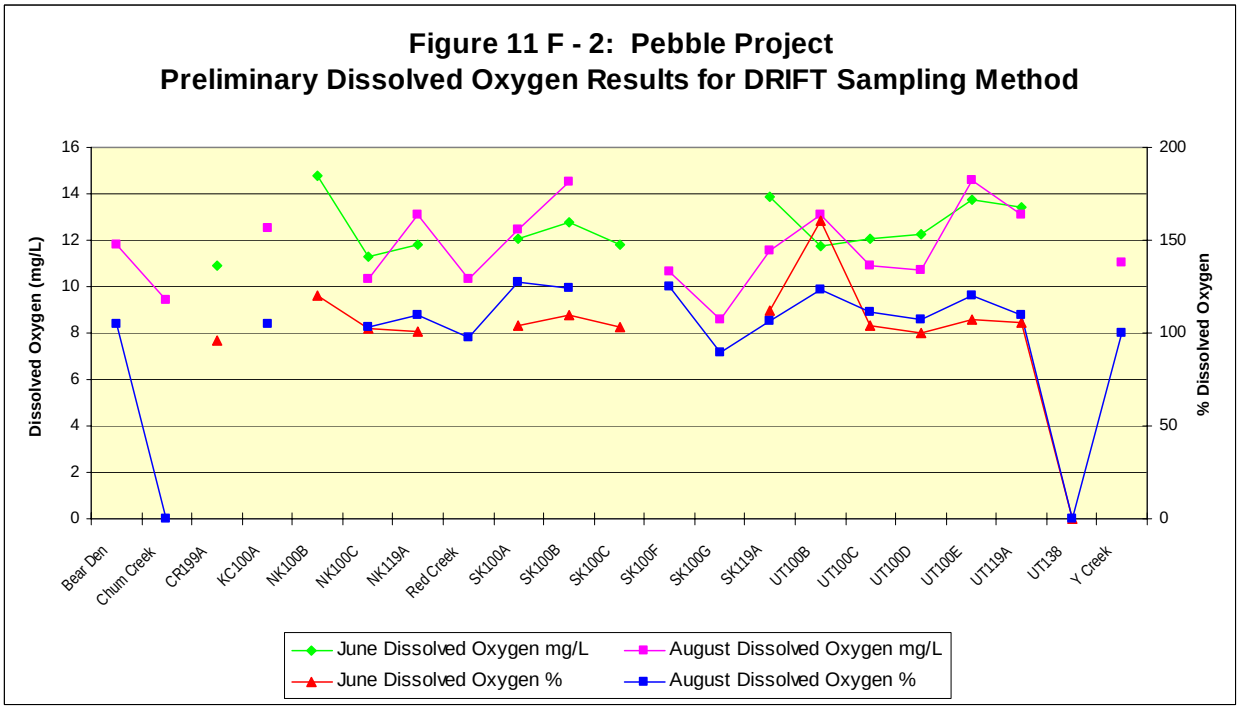


Figure 11 F - 2: Pebble Project
Preliminary Dissolved Oxygen Results for DRIFT Sampling Method
Dissolved Oxygen (mg/L)
% Dissolved Oxygen
16
14
12
10
8
6
4
2
0
200
150
100
50
0
Bear Den
Chum Creek
CR199A
KC100A
NK100B
NK100C
NK119A
Red Creek
SK100A
SK100B
SK100C
SK100F
SK100G
SK119A
UT100B
UT100C
UT100D
UT100E
UT119A
UT138
Y Creek
June Dissolved Oxygen mg/L
August Dissolved Oxygen mg/L
June Dissolved Oxygen %
August Dissolved Oxygen %

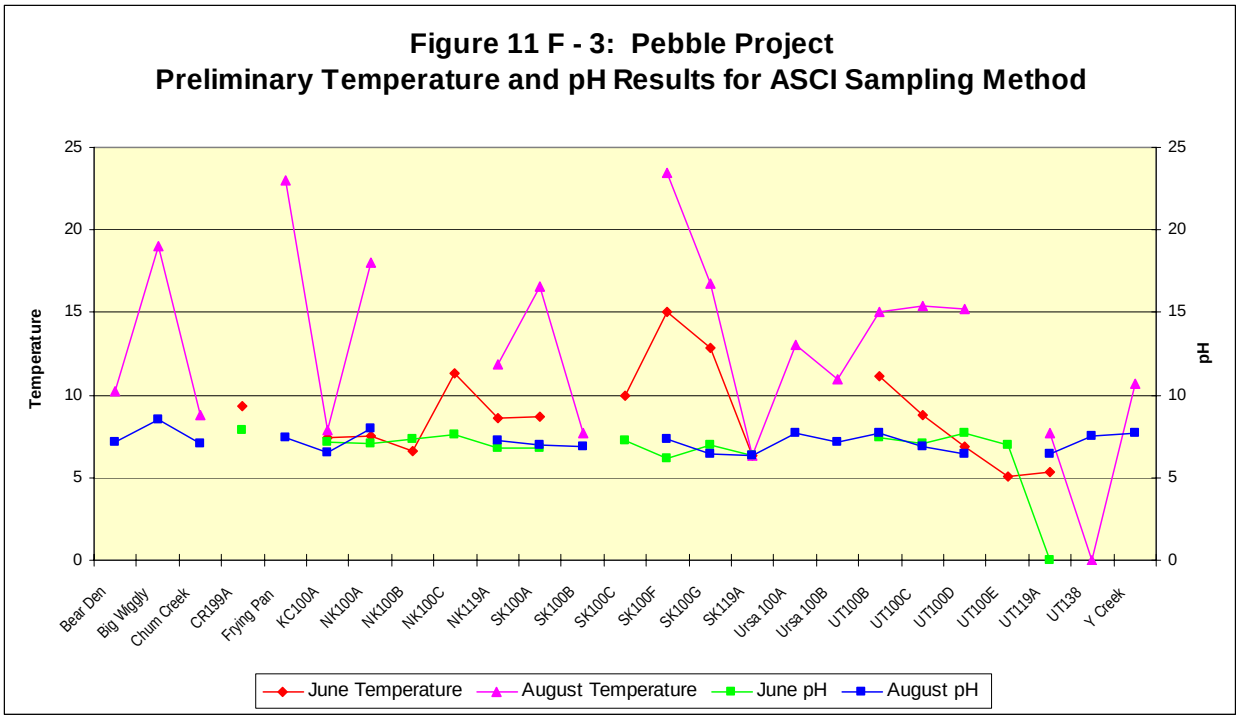


Figure 11 F - 3: Pebble Project
Preliminary Temperature and pH Results for ASCI Sampling Method
Temperature
pH
25
20
15
10
5
0
Bear Den
Big Wiggly
Chum Creek
CR199A
Frying Pan
KC100A
NK100A
NK100B
NK100C
NK119A
SK100A
SK100B
SK100C
SK100F
SK100G
SK119A
Ursa 100A
Ursa 100B
UT100B
UT100C
UT100D
UT100E
UT119A
UT138
Y Creek
June Temperature
August Temperature
June pH
August pH

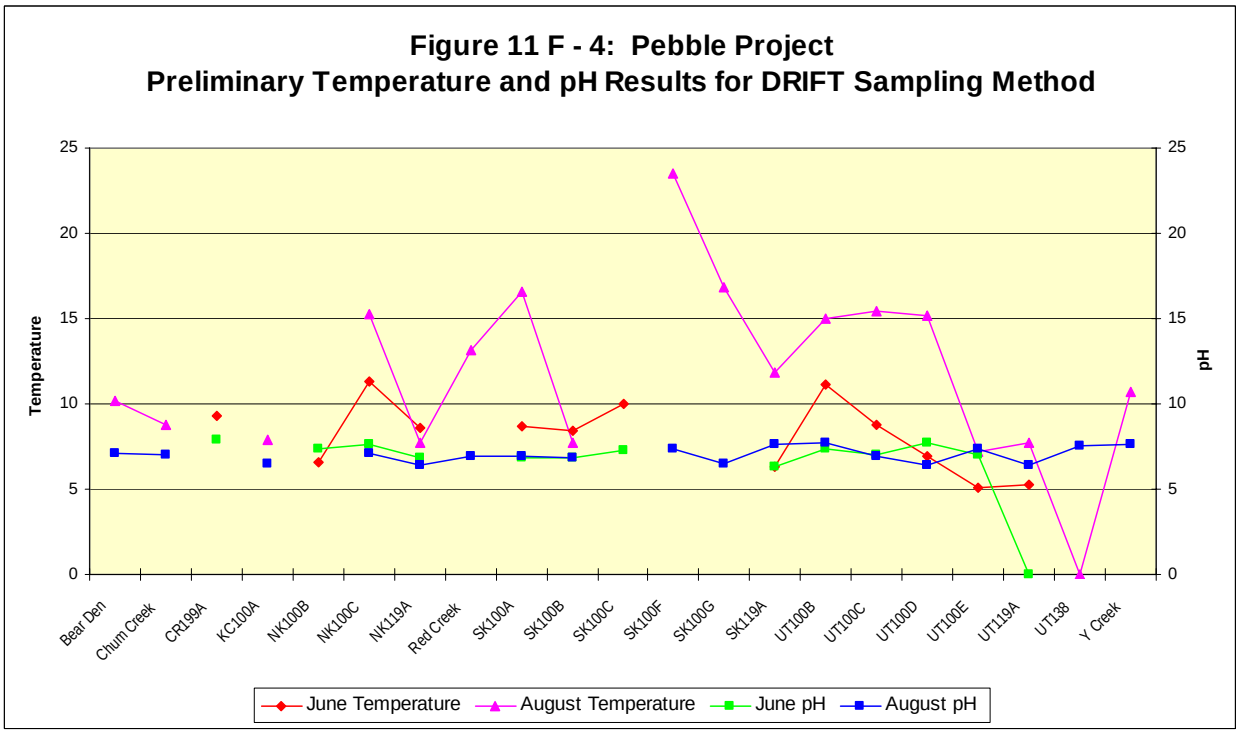


Figure 11 F - 4: Pebble Project
Preliminary Temperature and pH Results for DRIFT Sampling Method
Temperature
pH
25
20
15
10
5
0
Bear Den
Chum Creek
CR199A
KC100A
NK100B
NK100C
NK119A
Red Creek
SK100A
SK100B
SK100C
SK100F
SK100G
SK119A
UT100B
UT100C
UT100D
UT100E
UT119A
UT138
Y Creek
June Temperature
August Temperature
June pH
August pH

Figure 11 F - 5: Pebble Project
Preliminary Relative and Specific Conductivity Results for ASCI Sampling Method

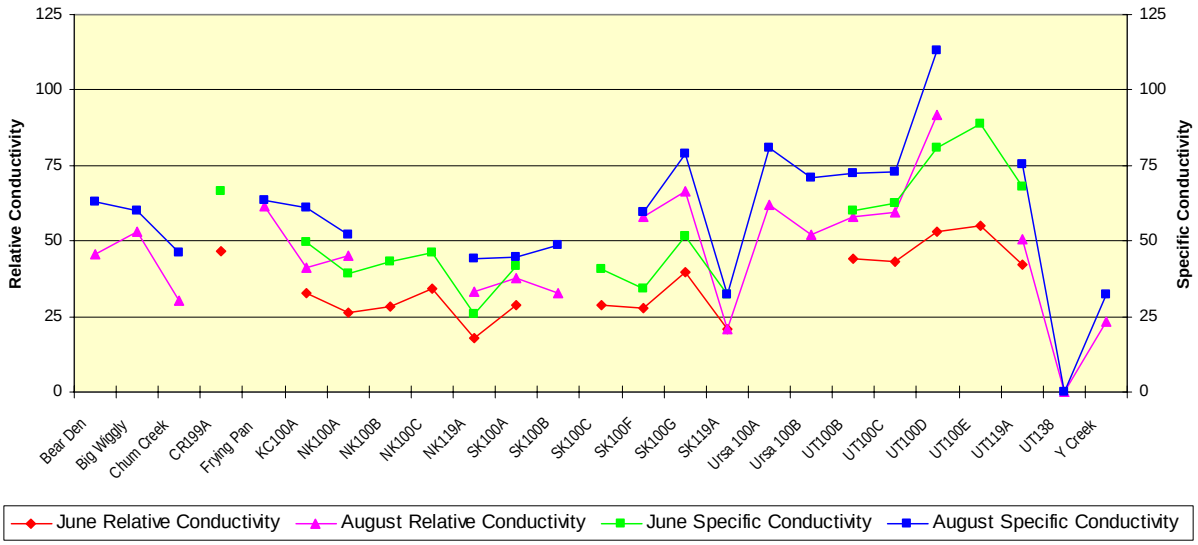
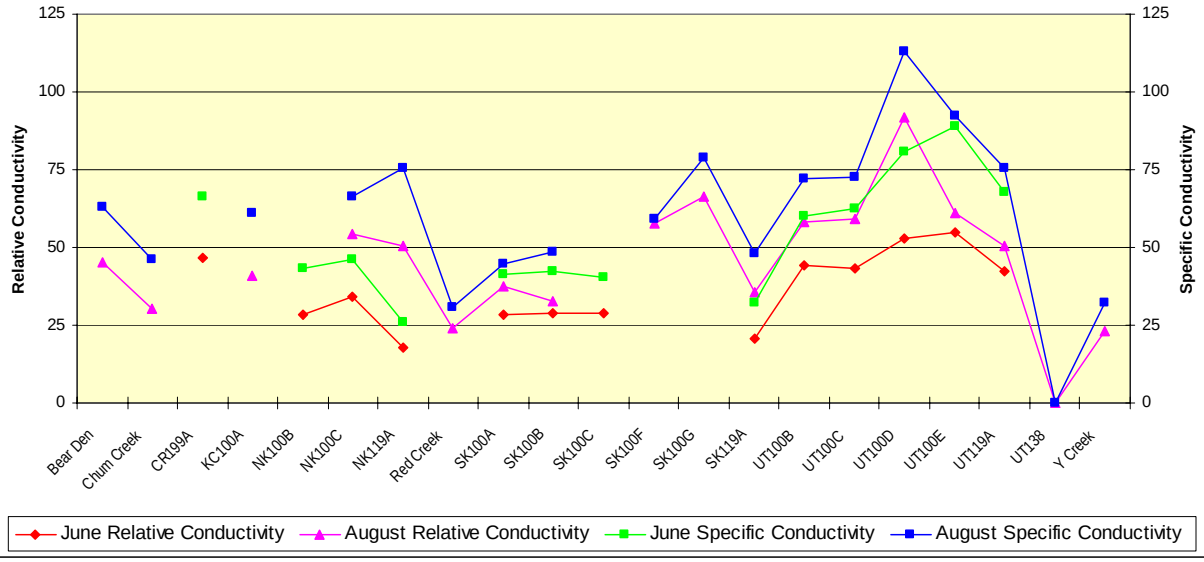


Figure 11 F - 6: Pebble Project
Preliminary Relative and Specific Conductivity Results for DRIFT Sampling Method



APPENDIX 11-G
Memorandum
2004 Diatom and Chironomidae Genus Data

To Ella Ede, Northern Dynasty Mines

From Andra Love, Jessica Manifold, Isaac Watkins
HDR Alaska, Inc.

Date 9/14/05

M e m o r a n d u m

Subject: 2004 Diatom and Chironomidae Genus Data.

Background

A Progress Report was completed in early 2005 that included macroinvertebrate identifications for all 2004 Pebble Project samples to genus with the exception of Chironomidae. At the time of the report, Chironomidae data were identified to family and diatom identification was still in progress. This memorandum documents the remainder of the work from the 2004 season and includes summary conclusions regarding the 2004 Chironomidae genus data and diatom data.

Diatoms

A total of 46 samples were processed from 25 different locations during June and August of 2004. An overall total of 26,736 diatoms in 38 genera were identified. The two most commonly found genera of diatoms were Achnanthidium (30.2%) and Fragilaria (28.7%). These taxa were identified at every location and made up approximately sixty percent of all diatoms identified.

Several genera were encountered, which together made up less than one percent of the total number of identified diatoms. These are listed in the following table:

Genus	***Location***	***Number Identified***
Amphipleura	UT100C (Aug.)	2
Asterionella	SK100B (June), NK100A (Aug.), KC100A (June)	4
Eucocconeis	Frying Pan Lake (Aug.)	2
Frustulia	UT138A (Aug.), BearDen (Aug.), ChumCr (Aug.)	4
Neidium	CR119A (June), KC100A (Aug.), NK100C (June)	4
Rhiocosphenia	SK100A (Aug.)	3
Stauroneis	BearDen (Aug.), SK100C (June), UT119A (June)	4
Stephanodiscus	SK100A (June), SK100G (Aug.)	5

The highest diatom diversity was found at Bear Den Creek during the August sampling event. A total of 22 different diatom genera were identified at this site. The lowest diversity was found at Y Creek during the August sampling event with 8 genera identified. The median number of genera per site was 17. Twenty-three samples had fewer than 17 genera, and 13 samples had more than 17 genera per sample.

Chironomidae

Samples were collected from 25 locations during the August and June sampling events for 2004. Including duplicate samples, an overall total of 2,030 Chironomidae larvae were identified from 81 collected samples. The most commonly identified Chironomidae were as follows:

Family And Genus	***Number of Samples***	***Total Number of Organisms***	***Percentage of Total***
Orthocladiinae Cricotopus	63	432	21.28%
Orthocladiinae Cricotopus/Orthocladius	46	276	13.60%
Tanytarsini Stempellina	23	176	8.67%
Diamesinae Pagastia	40	155	7.64%
Orthocladiinae Eukiefferiella	43	142	7.00%
Orthocladiinae Orthocladius	40	142	7.00%
Tanytarsini Tanytarsus	25	109	5.37%
Tanytarsini Micropsectra	31	83	4.09%
Diamesinae Diamesa	25	85	4.19%
Total:		1600	78.82%

Each of the following Chironomidae was identified in only one out of the 81 samples:

Family And Genus	***Site***	***Total Number of Organisms***	***Percentage of Total***
Chironomini Einfeldia	Big Wiggly (Aug.)	10	0.54%
Chironomini Endochironomus	Frying Pan Lake (Aug.)	1	0.05%
Chironomini Paracladopelma	KC100A (June)	1	0.05%
Chironomini Sergentia	UT100D (Aug.)	1	0.05%
Diamesinae Prodiamesa-Monodiamesa	UT100B (June)	1	0.05%
Diamesinae Prodiamesinae	UT100D (Aug.)	1	0.05%
Diamesinae Protanypus	Frying Pan Lake (Aug.)	2	0.10%
Diamesinae Pseudodiamesa	UT100E (Aug.)	3	0.15%
Diamesinae Syndiamesa	UT138 (Aug.)	1	0.05%
Tanypodinae Paramerina	SK100B (June)	1	0.05%
Tanypodinae Trissopelopia	NK100A (Aug.)	1	0.05%
Tanypodinae Zavrelimyia	UT100D (Aug.)	1	0.05%
Tanypodinae Zavrelimyia-Paramerina	SK119A (June)	1	0.05%
Orthocladiinae Halocladius	SK100C (June)	9	0.45%
Orthocladiinae Lopescladius	UT100C (June)	1	0.05%
Orthocladiinae Parorthocladius	Chum Creek (Aug.)	1	0.05%
Orthocladiinae Psectrocladius	Frying Pan Lake (Aug.)	1	0.05%
Orthocladiinae Rheosmittia	UT100B (June)	1	0.05%
Orthocladiinae Smittia	UT100B (June)	1	0.05%
Tanytarsini Sublettea	NK119A (June)	1	0.05%
Tanytarsini Zavrelia	UT100B (June)	1	0.05%
Totals		41	2.05%

Of the sites with Chironomidae present, the most diverse site was Frying Pan Lake (Aug. ASCI) with 22 different genera. The least diverse site was NK119A (Aug. Drift) which had only two specimens and one taxa represented. Average number of Chironomidae genera identified per sample was 7.4. The average number of organisms identified per sample was 25.

These results will be used with the 2005 data to establish trends in the project area. Data analyses will be presented in an environmental baseline document in 2006.