U. S. Fish and Wildlife Service
Federal Office of Subsistence Management
Federal Subsistence Fisheries Monitoring Program Report

GENETIC DIVERSITY OF DOLLY VARDEN POPULATIONS IN NORTON AND KOTZEBUE SOUNDS, AND OF ARCTIC CHAR POPULATIONS ON THE NOATAK NATIONAL PRESERVE

FINAL REPORT FOR STUDY 00-01

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March 2001

SUMMARY PAGE

Title: Genetic diversity of Dolly Varden populations in Norton and Kotzebue sounds, and of Arctic char populations in the Noatak National Preserve.

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Management Regions: Seward Peninsula (7) and Northwest Arctic (8)

Information Type: Stock Status and Trends

Issue Addressed: This project addresses the lack of stock composition information to support federal subsistence fishery management of char populations in northwestern Alaska.

Total Cost: $91,000. Of this, $46.1 was used for sample collection and field studies, and 45.0 transferred directly to the U. S. Fish and Wildlife Service's Fish Genetics Laboratory in Anchorage for genetic analyses.

Project Dates: May 1, 2000– July 1, 2001

Abstract: Anadromous northern form Dolly Varden *Salvelinus malma* are common throughout most of northwestern Alaska and are an important component of subsistence harvests. This species has complex migratory patterns involving annual summer feeding migrations to sea and annual fall movements back to freshwater rivers where they remain during the winter. Subsistence harvests are primarily taken from mixed stock wintering aggregations during fall seining, winter jigging, and spring gill netting. This project was a first step in achieving the goal of estimating stock contribution to mixed-stock subsistence harvests in northwestern Alaska. Fin tissue was collected from known stock Dolly Varden populations in streams used for spawning both north and south of the Bering Strait. Populations were sampled in the Kugururok, Kaluktavik and Nimiuktuk rivers of the Noatak River drainage and in the Wulik and Kivalina rivers draining into the Chukchi Sea. Five lakes were also sampled for the presence of Arctic char *S. alpinus*, but only Dolly Varden were found and sampled from two of these lakes. A total of 112 clones were sequenced and 34 appeared suitable for primer development. These collections will be coupled with future collections to create a stock specific genetic base line for anadromous Dolly Varden in northwestern Alaska.

Key Words: Dolly Varden, *Salvelinus malma*, genetic diversity, stock composition, DNA, micro-satellites, northwestern Alaska, Kotzebue Sound, Norton Sound.

Data Information: *Description*- Data for this study consisted of tissue samples and processed DNA samples from char captured. Information collected in association with data collections included location, number, length, and sex of fish from which tissue samples were obtained. *Format*- Tissue samples are in long-term storage at –20° C, genetic data and AWL information

are stored in Microsoft EXCEL worksheets. *Custodians*- Genetic samples and data are archived at the U.S. Fish and Wildlife Service, Fish Genetics Laboratory, 1011, East Tudor Rd., Anchorage, AK 99503. Spreadsheets, with AWL and location data on samples, are maintained at Alaska Department of Fish and Game, Sport Fish Division, 1300 College Road, Fairbanks, Alaska 99701. *Availability*- Access to samples and data is available upon request of the custodians.

Citation: DeCicco, A. L. and W. Spearman 2001. Genetic stock composition of anadromous Dolly Varden populations in Norton and Kotzebue Sounds. Federal Subsistence Fishery Monitoring Program, Final Report for Study 00-01. U. S. Fish and Wildlife Service, Office of Subsistence Management, Fishery Information, Services Division, Anchorage, Alaska.

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EXECUTIVE SUMMARY

Anadromous northern form Dolly Varden, *Salvelinus malma* are common throughout most of northwestern Alaska and are an important component of the annual subsistence harvests in this region, particularly in the communities of Kivalina, Noatak and Kotzebue. This species has complex migratory patterns involving annual summer feeding migrations to sea and annual fall movements back to freshwater rivers where they remain during the winter. Most spawn during late summer and remain in freshwater nearly two years during the spawning cycle. Fish return to their home stream to spawn, but spend the winter in mixed-stock over-wintering aggregations in spring fed areas that provide suitable habitat throughout the winter. In arctic areas, these habitats are critical to this species since the fish cannot remain in salt water for extended periods, a strategy common to many other salmonids.

Subsistence harvests are primarily taken from mixed stock over-wintering aggregations during fall seining, winter jigging, and spring gill netting. Earlier studies have shown that mixed stock over-wintering aggregations, from which major harvests are taken, are comprised of stocks ranging throughout northwest Alaska, Norton Sound and even the Russian Far East. The relative contribution of stocks over this wide geographic area is unknown, and the effects of this harvest on any specific spawning stock or stock-unit group cannot presently be determined. Other studies have provided evidence that stock specific genetic analysis of mitochondrial DNA and nuclear DNA microsatellites may provide a useful tool to estimate stock contribution to mixed stock fisheries.

This project was the first step in achieving the goal of estimating stock contribution to mixed-stock Dolly Varden subsistence harvests in northwestern Alaska. Such estimates will serve as a substitute for composition estimates of the major over-wintering populations. The project supported tissue collections from known stock Dolly Varden populations from streams used for spawning both north and south of the Bering Strait. These collections will be coupled with additional future collections and used to create a stock specific genetic base line for anadromous Dolly Varden in northwestern Alaska. The base line will be used in conjunction with future mixed stock samples from subsistence harvests to estimate stock contribution to these harvests.

This project also served to partially fund the development of a genetic library for Alaskan Dolly Varden in order to expedite the genetic reactions necessary for data analysis for this and future Dolly Varden and Arctic char genetic studies. The project was initially funded for one year to start work on this problem as federal subsistence research funds first became available. It is really the first part of a multi-year project that is extended through project FIS 01-136. As such, its findings are not complete but serve as the foundation for the continuation of genetic analyses to address the problem. Additional stock specific tissue collections are planned from north and south of the Bering Strait, and mixed stock tissue collections will also occur in the future so that estimates of stock contributions in the Noatak and Wulik river drainages may be calculated.

INTRODUCTION

Dolly Varden, and Arctic char are members of the Arctic char complex (McPhail 1961; Behnke 1980, 1984; Savvaitova 1980, 1995). Arctic char has a continuous circumpolar distribution in the Arctic (Johnson 1980), while Dolly Varden are found only in the North Pacific basin. Two major subspecies of Dolly Varden are thought to occur in North America. The northern form, *S. malma malma*, is distributed from the north side of the Alaska Peninsula to the Mackenzie River in Canada, while the southern form, *S. malma lordi*, is distributed from the Alaska Peninsula south to Washington (Behnke 1980, 1984, Morrow 1980). The common anadromous char in northwestern Alaska is the northern form Dolly Varden while Arctic char are only known to be present as lake residents. The taxonomic status of Arctic char populations in Alaska is poorly understood.

Anadromous Dolly Varden in northwestern Alaska have complex life history and movement patterns (DeCicco 1985, 1989, 1997). They spawn in freshwater streams where young fish remain for three to five years before first traveling to salt water. After migrating to sea, fish feed entirely in marine waters during the summer and return to fresh water in the fall to spend the winter. Dolly Varden home for spawning, but fish from various stocks commonly mix in rivers used for overwintering. The sexually mature portion of the population is comprised of summer and fall spawning components. Most summer spawners remain in fresh water during the year that they spawn. If prespawners wintered in their natal river system, rather than moving seaward in the spring, they move upstream to spawning areas where they spawn during July or August. Spent fish descend to lower river overwintering areas where they join non-spawners returning from summer marine feeding areas and remain for a second winter. This group remains in fresh water without feeding for approximately 20 months during the spawning cycle. If summer spawners have wintered in a non-natal river system, they move to sea with non-spawners in June, travel directly to their home river and move upstream during July to join other summer spawners already on spawning grounds. Fall spawners feed at sea during summer, enter rivers in August and travel directly to spring areas in headwaters where they spawn and remain throughout the winter. Dolly Varden in northwestern Alaska have been recorded to move vast distances in association with spawning or feeding. Non-spawning Dolly Varden tagged in the Wulik River have been recovered in the Noatak, Kobuk, Wulik and Kivalina rivers; near Teller on the Seward Peninsula; near Unalakleet in Norton Sound; on St. Lawrence Island and at several locations in the Russian Far East. Documented movements to Russia (over 1,000 miles) are the first record of a fish moving between the fresh waters of North America and Asia, and the longest movement of a Dolly Varden or Arctic char ever recorded (DeCicco 1989).

Northwestern Alaska Dolly Varden are harvested in subsistence and sport fisheries and taken incidentally in the Kotzebue based commercial chum salmon fishery. The first documentation of subsistence fishing activities and harvests of northwestern Alaska Dolly Varden was conducted from 1959 to 1961 in studies carried out in relation to Project Chariot (Wilimovsky and Wolfe 1966). A chapter by Sarrio and Kessel (1966) in this summary volume provides a detailed description of fall subsistence fishing activities in the village of Kivalina and a chapter by Foote and Williamson (1966) documents harvests in Noatak. Sarrio and Kessel estimated Kivalina's

fall seine harvests of Dolly Varden at 85,600 pounds in 1959, and 124,300 pounds in 1960. Ernest Burch (1985) participated in the Project Chariot studies at Kivalina and continued detailed subsistence research in the village during the mid 1960's and in the early 1980's. During 1982 and 1983 he found that 76% of Kivalina's char harvest was taken during the fall by seining while 6% was taken in the winter by under ice hooking and 17% was taken in the spring by hooking and gill net. The remaining 1% was taken in summer. His total annual harvest estimate (June-July) for 1964/65 was 33,845 fish and for 1965/66 was 14,087 fish. His estimate for 1982/83 of 28,900 fish fell within the range of harvests previously reported. Yoshihara (1973) estimated the fall seine harvest of char in the Wulik River at 29,281 in 1971 and 35,733 in 1972. DeCicco (1982, 1984, and 1985) estimated the fall seine harvest of char in the Wulik River at 14,600 for 1979, 15-18,000 for 1981, 16,270 for 1983 and 12,000 for 1984. Foote and Williamson (1966) estimated Noatak's 1960-1961 winter fish harvest at 10,500 pounds. The harvest was comprised mostly of "trout" (Dolly Varden) hooked through the ice, and included 200 pounds of trout harvested from the Wulik River. They stated that residents of Noatak highly regarded the "trout" from the Wulik River because they lacked the salmon taste that "trout" acquire in the Noatak River. More recent subsistence harvests in Noatak have ranged form 3,872 in 1998 to 5,762 in 1995. Dolly Varden are the most important subsistence fish resource to the village of Kivalina comprising 80% to 98% of their annual fish harvest (Burch 1985), and second only to chum salmon in the village of Noatak.

Most sport fishing for Dolly Varden in northwestern Alaska occurs in the Noatak, Wulik and Kivalina rivers. Harvests of Dolly Varden in these sport fisheries have averaged 1,269 fish annually since 1977 (Mills 1978 –1994, Howe et al. 1995-1999, Appendix A1).

Incidental harvests of Dolly Varden have occurred in the Kotzebue based commercial chum salmon fishery since its inception in the early 1960's. Recorded annual harvests have averaged 1,798 over the past 10 years (Brennan et al 2001, Appendix A2), but records are limited to those years in which a market for char existed. In years with no market, harvest records do not exist although it is likely that fish were harvested and used locally to satisfy subsistence needs.

Stocks have been monitored using aerial survey techniques since the late 1970's with a few surveys dating back to the late 1960's. Surveys have been conducted on mixed stock overwintering aggregations in the Wulik River and on spawners in the major tributary streams of the Noatak River. Spawning streams surveyed include the Kelly, Kugururok and Nimiuktuk rivers (Figure1). Counts of overwintering Dolly Varden in the Wulik River have ranged from 5,590 in 1986 to 144,138 in 1993; in the Noatak River from 6,500 in 1995 to 12,184 in 1996; and in the Kivalina River from 3,859 in 1999 to 45,355 in 1981 (Appendix A3). Since stocks of Dolly Varden are mixed in overwintering areas, and fish may overwinter in a number of streams on both sides of the Chukchi Sea, these counts serve more as a general index of overall stock condition than as a stock specific tracking of population abundance. Although it is known from tagging studies that Dolly Varden from the local area mix in overwintering areas with fish from south of the Bering Strait and from Asia (DeCicco 1992, 1997), the proportional representation of stocks is not known. Since Dolly Varden home to spawn, surveys of spawners provide a population-by-population index of the sexually mature fish and may serve as an index of annual production. Dolly Varden do not spawn annually, and it is likely that the proportion of a

population spawning in a given year is related to the condition of fish within the population, that in turn, is related to the quality of marine feeding conditions.

In order to assess the impacts of subsistence harvests to the anadromous Dolly Varden stocks in northwestern Alaska, data on the stock composition in overwintering areas are needed since major harvests occur there. This project will focus on the development and testing of a genetic baseline to characterize population structure and perform mixed stock assessments. Evidence from studies of Dolly Varden in other regions suggests that Dolly Varden in the study area probably do not form a single, large population, but are subdivided into multiple populations. For example, a genetic survey of Dolly Varden in Beaufort Sea drainages in Alaska and Canada demonstrated that Dolly Varden in that region form multiple populations generally defined by separate river systems (Everett et al. 1997). Evidence suggested that some river systems supported more than one population. The genetic baseline constructed in that study was used to assess patterns of stock composition in coastal waters (Krueger et al. 1999). Significant trans-boundary movements of U. S. and Canadian origin Dolly Varden were documented based on genetic information. Those studies demonstrate the utility and value of developing genetic baselines for Dolly Varden to satisfy management needs.

Arctic char are known to be present in some lakes within the Noatak National Preserve. They have been reported from lakes in the Kelly River drainage (Phil Driver, personal communication), and from a single high elevation lake in the Kugururok River drainage (Frederick Paillet, USGS, personal communication). Alt (1978) surveyed 13 lakes in the Noatak River drainage and found Arctic char in only one, a small lake in the Cutler River drainage. It is likely that Arctic char are present in more lakes in the drainage, but their distribution and taxonomic status are poorly understood. This component to the project will characterize genetic diversity and the geographic distribution of Arctic char in the Noatak National Preserve.

OBJECTIVES

While work in 2000 focused on collection of tissue samples and development of genetic markers, I also wanted to locate a site in a Noatak River tributary for future study of a Dolly Varden spawning stock.

Specific objectives of this study were to:

1. Collect fin clips from Dolly Varden in 8 streams supporting northern form Dolly Varden populations - four collections each from north and south of the Bering Strait;
2. Collect fin clips from four lake populations of Arctic char;
3. Collect basic limnological data on lakes sampled for the presence of Arctic char; and,
4. Design a suite of genetic markers specifically for Dolly Varden.

METHODS

Sample Collection, Dolly Varden

Dolly Varden tissue samples for genetic assays (fin clips about 6 mm^2) were taken from prespawning Dolly Varden captured in the Kugururok, Kaluktavik, and Nimiuktuk rivers. Recently emerged young-of-the-year, Dolly Varden were collected near spawning areas in and in Chukchi Sea drainages including the Wulik and Kvialina rivers (Figure 1), and in Norton Sound, where the Nome, Solomon, Tisuk, Sinuk, Cripple and Penny rivers (Figure 2) were sampled.

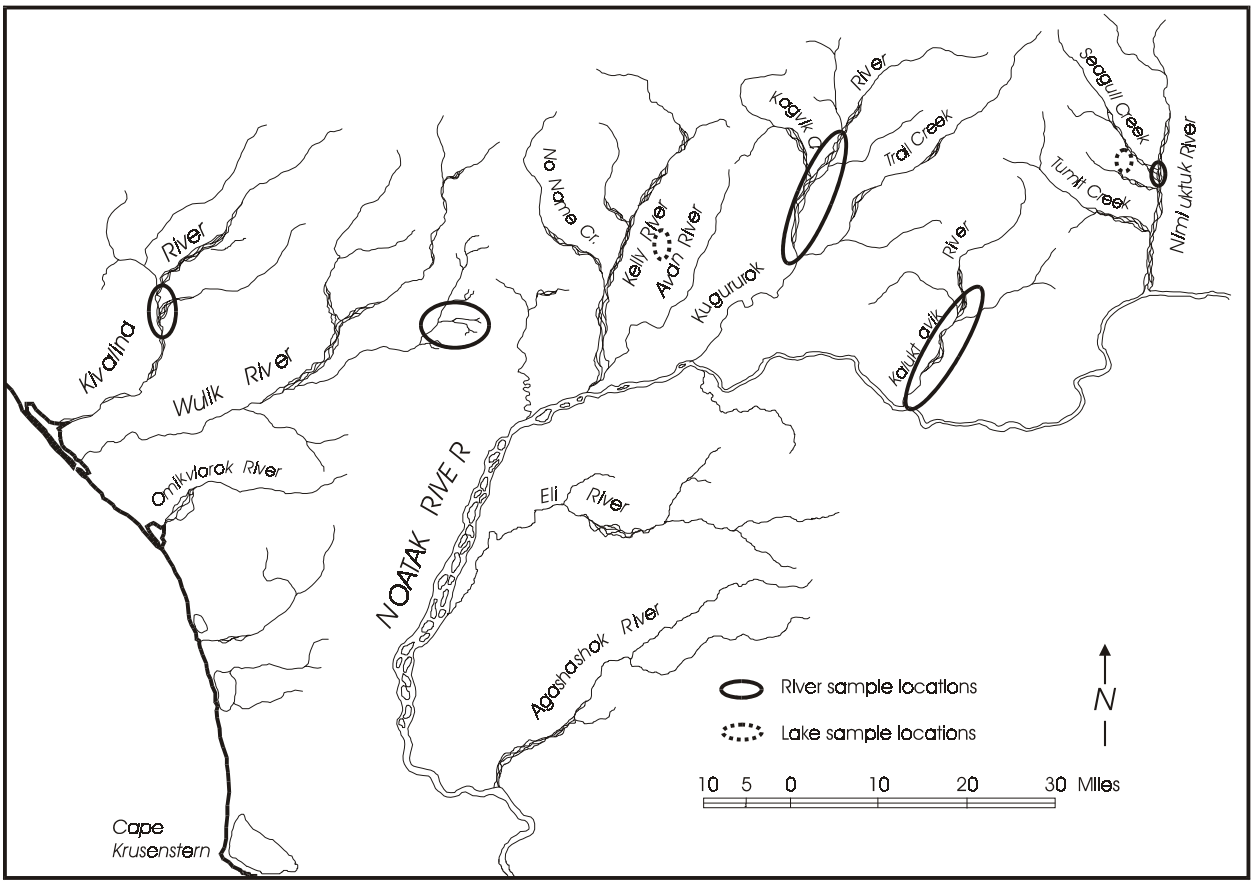

Figure 1. The Wulik, Kivalina, and Noatak rivers with locations of samples taken in 2000.

Fin clips were taken from adult spawners (N=100 fish; Wood et al. 1987) at locations where prespawning fish were available. Adult fish were captured using rod and reel. When adult Dolly were not available, presmolt Dolly Varden (N=200), usually young-of-the-year, were captured using baited minnow traps or small dip nets. Stock specific samples were obtained by collecting newly emerged young-of-the-year fish near spawning areas, or resident presmolt prior to their first ocean migration that were rearing in the small streams flowing directly to the sea (Norton Sound only) or from adult spawners in streams. Fin clips (or whole fish in the case of newly emerged fry) were stored in individual vials of 90% ethanol. Each sample was assigned a unique alphanumeric identifier to maintain sample identity throughout the project and link the sample to other project data. Samples were delivered to the U.S. Fish and Wildlife Service, Fish

Genetics Laboratory, 1011 East Tudor Road, Anchorage, for genetic analysis. Access to streams was by the road system, fixed wing aircraft, raft or helicopter.

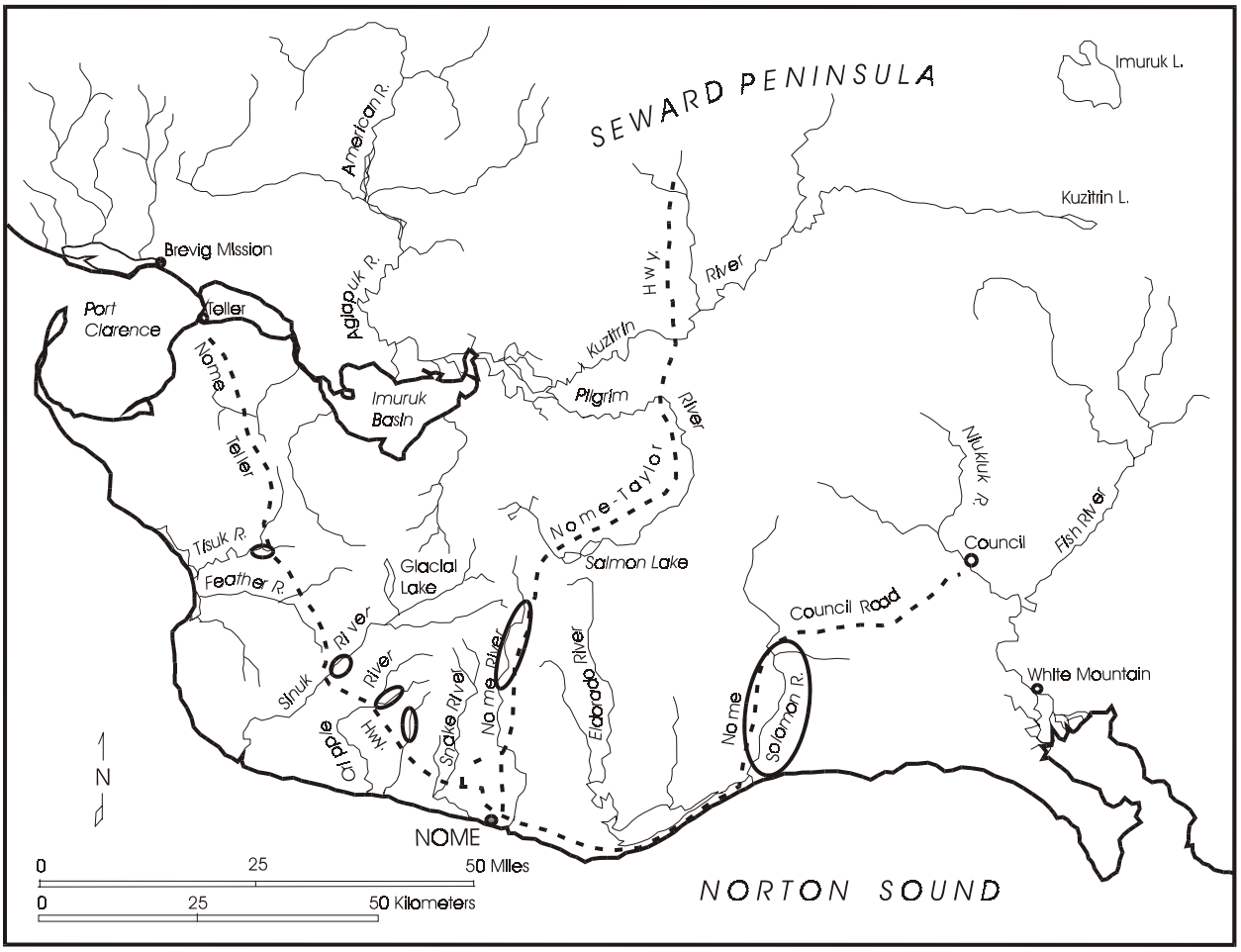

Figure 2. Southern Seward Peninsula with areas sampled during 2000.

These collections will be used to assess population structure within and between the Norton and Kotzebue Sound regions and form the foundation for a regional genetic baseline. DeCicco and Reist (1999) presented information supporting two general groupings of Dolly Varden in northwestern Alaska. One group, the provisional "Bering Sea form" dominates in North American waters from the Alaska Peninsula northward to the Bering Strait, while the provisional "Chukchi Sea or Beringian form" dominates north of the Bering Strait.

Life History Study Site Selection

The Kugururok and Kaluktavik rivers were floated in a raft in order to collect genetic samples and to evaluate potential trap sites for the multi-year spawning stock assessment. These two streams have been selected as candidates for the future life history study because they support runs of both summer and fall spawners (DeCicco 1985). Kagvik Creek, a tributary of the Kugururok River was also investigated during the Kugururok River trip. Stream characteristics including stream width, bottom contour, substrate size, and flow were measured at potential sites. An adjacent area suitable for a seasonal camp, and ease of access via boat or aircraft for resupply were additional attributes considered in the final site selection.

Arctic Char Collections

Six lakes in the Noatak National Preserve were investigated, and five were sampled in 2000 using baited minnow traps and gill nets with variable mesh ranging from 25 mm to 64 mm bar measure (Figure 3 and 4). Gill nets were checked at 30-min intervals to minimize mortality of fish. All live fish were sampled for species, measured (fork length). Fin clips were collected from all char captured. Gill raker and pyloric caeca counts
were obtained from all char killed. Data collected from lakes included: depth profile transects, water clarity (secchi disk), description of inlets, outlets and observable bottom type. Additional water quality data were not collected because equipment for this purpose did not arrive in Kotzebue in time for use.

Laboratory Processing

Fin and DNA samples were inventoried, and stored at -20 ^{o} C. A subsample of tissue from each fish was used for DNA extraction using a standard Puregene® protocol designed for fish tissue.

Two classes of genetic markers, mtDNA and nucDNA microsatellites were evaluated for utility in characterizing population substructure. The marker development phase established a library of new genetic markers to be evaluated. The testing phase is currently in progress to identify those primer sets that consistently and reliably amplify the targeted segments of the char genome and reveal polymorphism. Markers selected from the testing phase will be used in the pilot phase. The most informative suite of markers identified in the pilot phase will be extended to the routine processing phase where all samples will be processed for those markers through the continuation of this work (study 01-136).

The Fish Genetics Laboratory will support the development of new primer sets for microsatellite loci specifically for Dolly Varden. At least 36 primer sets will be designed and tested with the expected result of identifying 8-16 primers sets that are polymorphic for characterizing population substructuring.

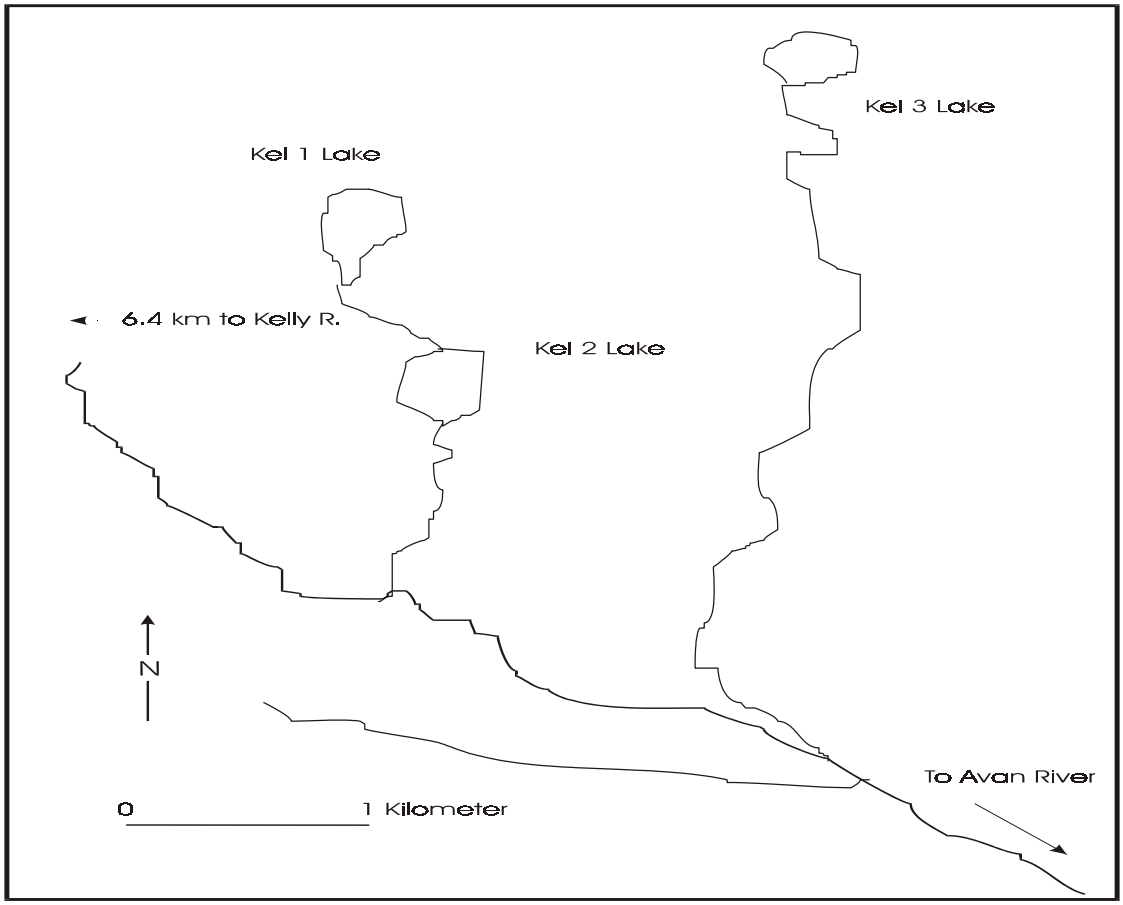

Figure 3. Kelly River drainage lakes sampled during 2000. (See Fig 1. for location.)

The genetic markers that are promising for Dolly Varden will be applied to a subset of 16 fish from each collection (site) to identify the most useful markers. At least 12 genetic markers will be selected for routine processing. Selection criteria include: 1) differential genetic variation across this range of Dolly Varden as determined by measures of genetic distance, and 2) robust processing conditions that yield reliable and consistent results, plus unambiguous genotypes. The genetic markers selected from the above subset will be applied to all samples from the remaining stocks in order to characterize the structuring. The analysis protocol and performance criteria described below will be used to assess the performance of the markers. If performance criteria are not met at this stage, additional loci will be evaluated.

Genetic Analyses

Genetic analyses will be conducted on the entire suite of samples as this project continues into the future (Project 01-136). These will include: 1. Tests to evaluate departure from Hardy–Weinberg (HW) equilibrium using GENEPOP 3.1d (an updated version of Raymond and Rousset 1995). 2. Tests of linkage disequilibria. 3. Genotypic variability among collections will

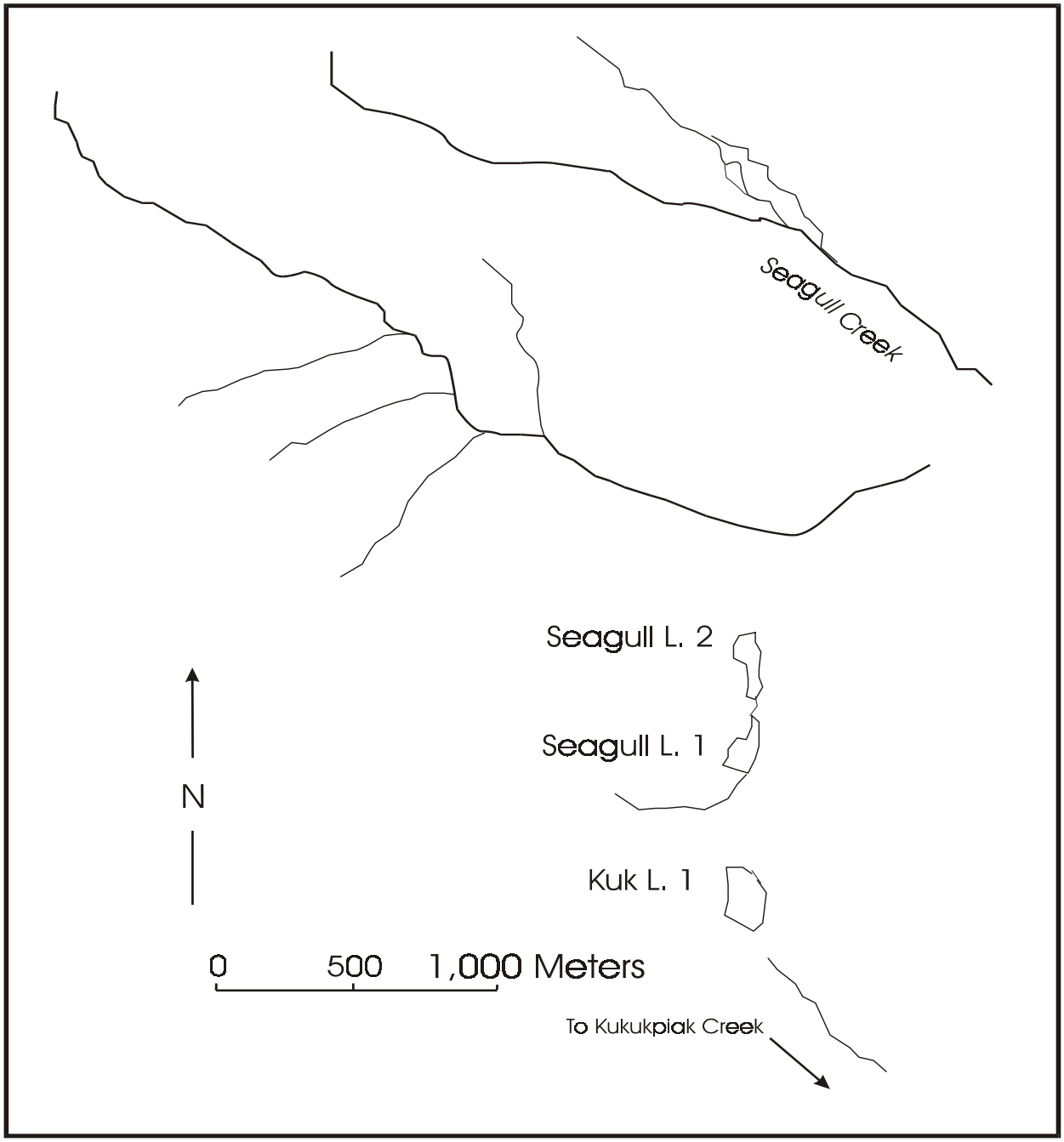

Figure 4. Seagull Lakes (Nimiuktuk River drainage) sampled in 2000. (See Fig. 1 for location.)

be partitioned with F-statistics (Wright 1965; Nei 1977). 4. Tests of heterogeneity will be performed for each locus to test the hypothesis that allelic frequencies are different among collections. 5. Genetic distances will be calculated between each pair of collections (chord distance; Cavalli-Sforza and Edwards 1967). 6. Patterns of misallocation among individual stocks will be used to test the performance of the baseline using the computer program

SIMSQRT (M. Masuda, Auke Bay Laboratory, National Marine Fisheries Service, Juneau, personal communication).

RESULTS

Dolly Varden Tissue Collections

Dolly Varden populations were sampled in the Kugururok, Kaluktavik and Nimiuktuk rivers of the Noatak River drainage and in the Wulik and Kivalina rivers draining into the Chukchi Sea (Figure 1). Tissue samples were collected from 100 prespawning Dolly Varden in the Kugururok River. Samples included 18 males and 82 females. Males averaged 688 mm in fork length (FL) and ranged in fork length from 473 mm to 835 mm while females averaged 633 mm FL and ranged from 530 mm to 792 mm (Figure 5). Tissue samples were collected from fish

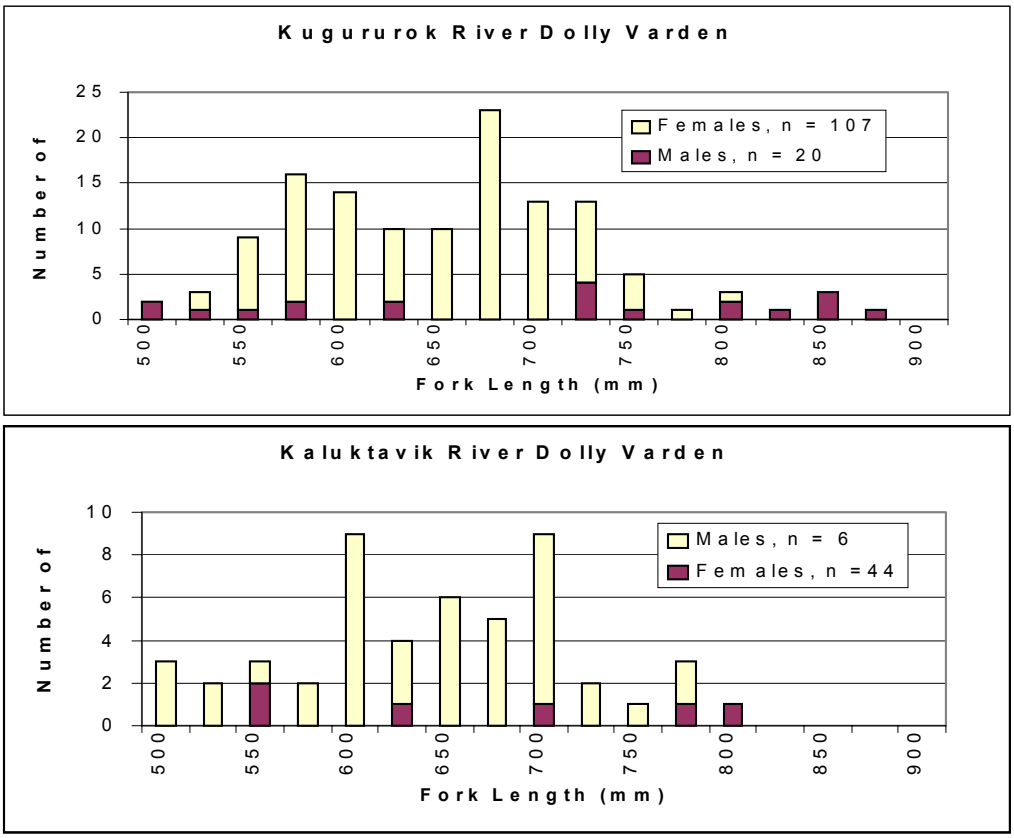

Figure 5. Length distribution of prespawning Dolly Varden sampled from the Kugururok and Kaluktavik rivers in 2000.

captured between the mouths of Nuniviksak and Trail Creeks. Tissue samples from 50 prespawning Dolly Varden in the Kaluktavik River were collected from just upstream from the mouth of Analak Creek downstream to the Noatak River. In addition, 100 newly emerged young-of-the-year fry were collected. Adult Dolly Varden samples consisted of 6 males and 44 females. Males averaged 651 mm FL and ranged from 536 to 777 mm while females averaged 628 mm FL and ranged from 488 to 765 mm (Figure 5). Fry were not individually sexed or measured, but ranged in length from about 50 mm to about 70 mm. Only Y-O-Y fry were collected from the Nimiuktuk and Kivalina rivers where 200 fish between 50 and 70 mm were sampled from each drainage. The sample from the Wulik River drainage contained 147 juvenile Dolly Varden rearing in nine different locations. These fish ranged from 73 to 211 mm FL . Collections in Northern Norton Sound drainages were obtained during September. Samples were taken from rivers accessible from the Nome road system. A sample of 23 juvenile Dolly Varden ranging in length from 65 to 144 mm were taken from the Cripple River, and 40 Dolly Varden ranging in length from 59 to 71 mm were captured from the Sinuk River. In the Penny River, 200 rearing Dolly Varden ranging in length from 54 to 150 mm were sampled. In the Nome River 135 rearing fish from 55 to 137 mm were sampled, and an additional 15 spawners ranging in FL from 425 to 524 mm were sampled for a total sample of 150 fish. In the Solomon River 197 rearing Dolly Varden from 36 to 165 mm in length were sampled, and three spawners from 461 to 492 mm FL were sampled. In the Tisuk River drainage, a Dolly Varden sample of 174 rearing and small resident adult fish was obtained from Eldorado Creek where fish ranged from 51 to 176 mm in length.

Genetic Libraries

This project provided partial funding for the development of a genetic library for northern form Dolly Varden. DNA from a male Dolly Varden was extracted and used to construct four microsatellite libraries enriched for the following DNA sequence motifs: CA, ATG, TAGA and CATC. The libraries were completed and aliquots of bacteria containing the libraries are stored at -80°C at the Fish Genetics Laboratory and at Genetic Identification Services (Chatsworth, CA). The libraries were screened and the CA, TAGA and CATC libraries were highly enriched for microsatellite-containing clones; enrichment in the ATG library was not successful so this library was discarded.

A total of 112 clones were sequenced. From these, 34 appeared suitable for primer development (i.e., had sufficient DNA flanking the microsatellites for primer design and had a minimum numbers of repeats). Further analyses indicated problems with secondary structure in seven of the 34 clones that would severely limit their utility. PCR primer pairs have been designed for only the other 27. The microsatellite loci have been designated *Sma* (*Salmo malma*)1-30. Optimization of PCR conditions is in progress. The following preliminary results have been obtained by amplifying DNA isolated from a single male and a single female each of Dolly Varden and Artic char using the first set of primer pairs evaluated:

Table 1. Summary of DNA amplifications for Dolly Varden and Arctic char using the first primer pair.

	Dolly Varden		Artic Char	
Locus	# alleles	Size range (nt)	# alleles	Size range (nt)
*Sma*1	2	100-150	3	180-200
*Sma*2	2	~100	4	110-200
*Sma*3	2	~120	2	100-180
*Sma*5	2	~90	1	~90
*Sma*6	1	~100	1	~110
*Sma*7	2 + 2	90-100 and 260-280	2	100-120
*Sma*8	many[a]		many[a]	
*Sma*9	3	120-140	4	100-120
*Sma*10	2	140-190	3	160-180
*Sma*11	2	~190	2	200-220
*Sma*12	many[a]		many[a]	

[a] Many fragments were amplified indicating further optimization will be required.

Arctic Char Sampling

Five lakes were sampled for the presence of Arctic char. Two were glacial cirques, Kel 1 and Kel 2, located in the upper Avan River drainage (Kelly River), and three lakes (Seagull 1, Seagull 2 and Kuk 1) were located in a small pass between Seagull and Kukukpilak Creeks in the Nimiuktuk river drainage (Figure 3). Arctic char were not found in any of these lakes, however, Dolly Varden were sampled from the lowest elevation lake in the Avan River drainage and in one of the lakes in the Nimiuktuk River. An additional lake in the Avan River drainage was visited and fished by angling. No fish were observed or captured. Slimy sculpin, Cottus cognatus, were found in two of the lakes and fairy shrimp were abundant in one of the Nimiuktuk lakes that contained no fish.

The surface of Lakes Kel 1 and Kel 2 were 615.2 m and 584.8m above sea level respectively. Kel 1 was pear shaped and deepest in the center at its largest width. The bottom was regular, inclining at a shallow angle to a maximum-recorded depth of 8.5 m. The secchi disk was visible to 5.32 m. A 0.5 m thick layer of glacial silt in partial suspension covered the bottom near shore. No fish were observed or captured in gill nets and minnow traps set overnight in this lake. The outlet stream from Kel 1 ran steeply for approximately 500 m dropping about 30 m in elevation to lake Kel 2. This lake was roughly circular with a regular bottom and a maximum depth of 11.25m. The Secchi disk was visible to 9.1 m. Five Dolly Varden were captured in gill nets in this lake, and no fish were captured in baited minnow traps. Genetic samples were obtained from the five captured fish. Of these, three were killed and included one male non-spawner 341 mm FL that weighed 550 g. This fish had an empty stomach, but was very fat. It had 26 pyloric caeca and 23 gill rakers. Two were female, one a prespawner, and one immature. The prespawnning female Dolly Varden was 487 mm FL and weighed 1,500 g. Its eggs were 3.4 mm in diameter on 19 July, 2000, and it had 23 pyloric caeca and 23 gill rakers. This fish was very

fat and its stomach was full of midge larvae The immature female was 352 mm FL and weighed 525 g. Its stomach was empty but the fish was very fat. It had 28 Pyloric caeca and 21 gill rakers. Gill raker and pyloric caeca counts in addition to body shape indicated that these fish were Dolly Varden, not Arctic char as would have been expected in a lake environment.

DISCUSSION

The primary objectives of this project were to collect tissue samples for genetic analysis and develop a genetic library in order to establish the relationship of populations of Dolly Varden in Northwestern Alaska. All genetic tissue sample objectives were exceeded, the genetic library was completed and the genetic analysis has begun. Additional sample collection is planned in the future, as is collection of tissues for mixed stock evaluation. Results from this project will not be available until the continuation of the project (FIS 01-136) is completed. The final report for study 01-136 will include all analyses of tissues collected during this, the first phase of the overall project.

CONSULTATION AND CAPACITY DEVELOPMENT

This project was developed in consultation with the National Park Service, the land manager in the area, and the U.S. Fish and Wildlife Service, Fish Genetics Laboratory in Anchorage, with the consent of the Kotzebue Regional Advisory Council, the mayor of Kivalina, and the Coastal Zone Management coordinator in Kotzebue.

As the project develops past its initial year, its potential for capacity building within the local Native community will become more evident. However, it is anticipated that four local technicians will be hired to actively participate in the spawning stock assessment project, a companion study to this project. It is hoped that local involvement in this project will stimulate interest in the community of Noatak and develop the interest of individuals hired that may lead to further employment opportunities in management of locally used subsistence resources. A discussion was held with Noatak IRA Council director, Ricky Ashby, in Noatak on April 10 to discuss this project. The IRA has served as a local job center for this project, advertising the positions, and collecting applications for technician positions for the 2001 season and forwarding applications to Alaska Department of Fish and Game. Interviews are scheduled to be held in Noatak on May 18, 2001. The rationale for this genetics project was also discussed at this conference in order to keep the people most affected by this work informed. Subsistence fishers will be contacted so they may be accompanied in the fall in order to collect mixed stock samples

CONCLUSIONS

Sample size objectives for tissue collections are reasonable and attainable. Capture methods employed to attain those objectives worked effectively and efficiently, and can be recommended for future projects. Whether sample sizes are adequate to achieve the discrimination necessary to separate stocks using mtDNA and microsatellite techniques will remain unknown until the genetic data analysis of the companion project FIS 01-136 has been completed.

RECOMMENDATIONS

1. Additional tissue samples from the Kivalina River (summer and fall spawners) and the Kelly River should be collected in order to allow more complete coverage of spawning populations in the Noatak River drainage.

2. Additional tissue samples from drainages of Norton Sound (Niukluk River) and Imruk Basin (Cobblestone River) should also be acquired so more stocks are represented in the base line genetic data. Additional stocks should be sampled in the future on an opportunistic basis, and added to the genetic database for Dolly Varden.

3. Large samples should be collected from subsistence harvests of Dolly Varden in the Noatak and Kivalina Rivers.

4. An effort should be made to add stock specific collections from the Russian Far East to the Alaska database for Dolly Varden.

ACKNOWLEDGEMENTS

I thank the U.S. Fish and Wildlife Service, Office of Subsistence Management for support and funding for this study under cooperative agreement 701810J241. I also thank the staff of the National Park Service, Noatak National Reserve and the U.S. Fish and Wildlife Service, Fairbanks Fishery Resources Office for advice and support. Finally, thanks to the field staff of the Alaska Department of Fish and Game for their hard work in helping to conduct this study.

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Appendix A1. Estimated sport fish harvests of Dolly Varden in the Kotzebue Sound and Chukchi Sea drainages of Alaska.

Kotzebue/Chukchi Sea					
Year	Number of Anglers	Effort Angler Days	Dolly Varden Harvest	Dolly Varden Catch	Percent Harvest
1977		3,487	469		
1978		4,997	199		
1979		2,593	1,772		
1980		3,841	301		
1981		5,284	1,177		
1982		6,906	1,531		
1983		7,963	2,192		
1984	696	7,791	3,804		
1985	1,788	6,701	1,557		
1986	1,570	6,313	1,300		
1987	2,090	9,288	1,072		
1988	959	5,279	983		
1989	1,028	4,932	999		
1990	991	3,782	806	3,747	22
1991	1,606	9,543	1,149	1,658	69
1992	1,421	6,145	582	7,054	8
1993	1,575	7,809	914	7,190	13
1994	1,100	6,036	2,365	10,733	22
1995	1,957	8,495	939	7,804	12
1996	1,501	7,763	528	3,075	17
1997	864	4,772	480	3,782	13
1998	903	4,342	441		
Average	1,398	6,177	1,269	6,364	20
87-97 Avg.	1,372	6,713	983	5,630	17
Recent 5 yr.	1,399	6,975	1,045	6,517	16

Appendix A2. Commercial harvests of chum salmon and incidental harvest of sheefish and Dolly Varden in the Kotzebue Sound commercial fishery, 1980-1999.

			Dolly Varden	
Year	Chum	Sheefish	Sold	Caught[a]
1980	367,284	1,175	3,049	
1981	677,239	278	3	
1982	417,790	2,629	3,447	
1983	175,762	1,424	190	845
1984	320,206	927	347	1,090
1985	521,406	342	454	3,600
1986	261,436	26	5	2,373
1987	109,467	670	1,261	
1988	352,915	943	752	
1989	254,617	2,335	3,093	
1990	163,263	687	604	
1991	239,923	852	6,136	
1992	289,184	289	1,977	
1993	73,071	210	76	
1994	153,452		149	
1995	290,730	226	2,090	
1996	82,110	308	188	
1997	142,720	731	3,320	
1998	55,709		349	
1999	136,626		1,502	
89-98 Avg.	174,478	564	1,798	
94-98 Avg.	144,944	248	1,219	

[a] Estimates of Dolly Varden caught but not sold.

Appendix A3. Aerial survey counts of Dolly Varden spawning in tributaries of the Noatak River and overwintering in the Wulik and Kivalina rivers.

	Spawners	Non-spawners	
Year	Noatak River	Wulik River	Kivalina River
1968		90,286	27,640
1969		297,257	
1976		68,300	12,600
1979		55,030	15,744
1980		113,553	39,692
1981	7,922	101,826	45,355
1982	8,275	65,581	10,932
1984	9,290	30,923	5,474
1985	11,073		
1986		5,590	5,030
1988		80,000	
1989		56,384	
1990	7,261		
1991	9,605	126,985	35,275
1992		135,135	
1993	9,560	144,138	16,534
1994		66,752	
1995	6,500	128,705	28,870
1996	12,184	61,005	
1997		95,412	
1998		104,043	
1999	9,636	70,704	3,859

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