TOKLAT RIVER CHUM SALMON STOCK IDENTIFICATION; SAMPLE COLLECTION AND GENETIC ANALYSES, 1985-1994

By

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EXECUTIVE SUMMARY

* Genetic characteristics of eleven sets of tissue collections from spawning chum salmon of the Toklat River were studied by allozyme electrophoresis. Sample sizes ranged from 60 to 200 individuals and were collected from 1985 to 1994.

* Heterogeneity between collections was detected in five of the loci screened, *ALAT**, *ESTD**, *G3PDH2**, *MPI**, and *PEPLT**; being most pronounced in *PEPLT**, *ALAT**, and *MPI**.

* Higher frequencies of *PEPLT*85* were found in the two collections made near and within Geiger Creek. Spatial and/or temporal distinctions to this specific locality are considered likely explanations.

* A higher frequency of *ALAT*93* was found in the collection from 1987. The next nearest sampling location for which data of this loci were available, the 1990 group, had the next highest *ALAT*93* frequency. A localized spatial distinction is again considered a possibility. However, the USFWS laboratory collected data for these two collections, whereas the remainder of the *ALAT** data was collected in the ADF&G laboratory; the possibility of laboratory bias cannot be ruled out.

* Significant *MPI*90* frequency variation was found to be wide ranging throughout most of the collection comparisons. No associations were identified.

* Additional sampling and analysis is recommended to study possible temporal variation within year class for *PEPLT*85* near Geiger Creek and to confirm localized *ALAT*93* frequencies.

INTRODUCTION

The Toklat Springs area of the Toklat River is known to have chum salmon (*Oncorhyncus keta*) returning during the month of October to spawn. This area is centered just below the mouth of the Sushana River. A localized concentration of chum salmon occupy available spawning habitat of the lower few miles of the Sushana River, Geiger Creek, and the floodplain and sloughs of the mainstream Toklat River, from a few miles upstream of the Sushana R. mouth to a few miles downstream of the Geiger Cr. mouth (Figure 1).

Tissue samples for genetic analysis (protein electrophoresis) have been collected from spawning chum salmon of the Toklat Springs area during the past several years. The electrophoretic analyses have been performed by the Alaska Department of Fish and Game (ADF&G) Genetics Laboratory, Anchorage, the U.S. Fish and Wildlife Service (USFWS), and the Canadian Department of Fisheries and Oceans (CDFO). From the analyses, variation between years in allelic frequencies among some of the observed loci was found. This variation between years is not typical within a single spawning population of salmon.

During 1994, specific efforts were employed on a project to examine the possibility of genetically distinct populations spawning within the Toklat Springs area. The emphasis of this study was placed on examining variation in spawner composition between various spawner localities. Temporal variation was not addressed due to the current lack of knowledge regarding the existence of separate early- and late-runs to this area. It was beyond the scope of this project to attempt to adequately address both spatial and temporal variation.

METHODS

Eleven sample collections were made from the Toklat Springs area from 1985-1987 and 1990-1994 (Fig. 1). The Sushana River collections of 1992-1994 were made in conjunction with the State's Clear Hatchery egg-take project. To examine possible spatial differences in spawner compositions, four collections of 100 individuals were made in 1994: Sushana River mouth (1994SR), Geiger Creek (1994GC), upstream mainstream Toklat River (1994TRU), and downstream Toklat River slough (1994TRD).

Access to the Toklat Springs area was by helicopter. Chum salmon were captured by 40 ft. beach seine and/or spear directly on spawning grounds. Tissue samples were obtained on site following standard genetic sample collection techniques (Appendix A). Tissues were preserved on liquid nitrogen and/or dry ice. Gender of individual samples was recorded for the 1992-1994 collections. Analysis of the 1991-1994 sample sets was completed in January

1995. Laboratory results were photo documented. Analysis of the 1987 and 1990 sample sets was conducted by Wilmot et al. (1992) of USFWS, and the 1985 and 1986 sample sets were studied by Beacham et al. (1988) of CDFO. Allelic frequencies from these studies are used in comparisons to those of the 1991-1994 sample sets. Since loci studied are not entirely consistent between studies, separate analyses of common loci are made when applicable. Table 1 provides a summary of sampling locations, dates of sampling, number of samples, and the study that conducted the analyses.

Allozyme analyses were conducted using standard electrophoretic techniques (Harris and Hopkinson 1976; May et al. 1979; Aebersold et al. 1987). Up to 76 loci were screened. Due to advances in the field and slight practice variation between laboratories, the number of loci studied is not consistent throughout all sample sets.

RESULTS AND DISCUSSION

Sample Collection

At the time of sampling, spawners were very abundant and concentrated throughout the Toklat Springs area. They appeared to be somewhat evenly dispersed throughout the usable habitat of the area, centered mid way between the inflows of Sushana River and Geiger Creek. The concentration of chum salmon seemed quite localized, as the number observed dropped abruptly in aerial searches conducted both up and down river of this area. Additional details of sampling and field notes are provided in the Technical Notes of Sampling section (Appendix B).

Some differences in spawning stages of fish between locations. Generalizations of individuals of the four sample sets are as follows:

1994TRU-	some still green, no spawnouts.
1994TRD-	mostly ripe/ready to spawn.
1994GC-	general transition of old spawnouts to early-spawn fish sequentially through sampling; then transitioning back to an increased number of spawnouts.
1994SR-	from egg take. All ripe and ready to spawn.

Of particular interest is the generalization of the 1994GC set. During sampling, the first few seine sets (6-20 per set) consisted of a majority of fish that were very spawned out. As these were captured and cleared from the gravels of the sampling site, additional fish moved in to take advantage of the open and less congested habitat. These fish tended not to be spawned out, but instead were near the start of their spawn as several of the

females were still full of eggs. Towards the end of sampling (last 20 or so), fish were captured by spear and the catch then consisted of a mix of spawning stages.

With the variation of spawning stage of the fish represented by this sample set, it is possible that if an early and late run do exist, then this set could potentially contain an overlap of the two runs. Some individual sample numbers within the set do correspond to the sequence of capture, however; notes of spawning stage were not recorded by individual, and this trend of spawnout to green fish is a rather rough generalization and does not apply to all individuals.

Laboratory Analyses

Variation was observed in 25 of the loci studied by ADF&G throughout the 1991-1994 sets. Of these 25 polymorphic loci, *CKC2*105*, *EST2**, *bGLUA**, and *sMEP1*95* were not considered consistently or accurately resolvable and were excluded from all subsequent analyses of findings. Appendix C provides a list of monomorphic and polymorphic loci screened by ADF&G. Allelic frequencies of the remaining 21 polymorphic loci are provided in Appendix C.1.

Statistical Analyses

The 1991-1994 data were individually tested for conformance to random mating (Hardy-Weinberg) expectations using the log-likelihood method, with no significant findings in the overall tests of 51-52 loci ($P \geq 0.54$). Departures from Hardy-Weinberg within individual loci were found in the following of the 1991-1994 sets: 1992, *MPI**, $P = 0.01$; 1994GC, *mAAT2**, $P = 0.02$; 1994TRD, *ESTD**, $P = 0.02$, and *sMDHA1**, $P = 0.03$. Wilmot et al. (1992), using the chi-squared method, reports significant departure from Hardy-Weinberg expectations for the individual loci *ALAT** and *sIDHP2** of the 1987 collection.

Heterogeneity between collections was tested using G-Statistics. The results of these comparison analyses are provided throughout Appendix D as follows: 1991-1994 are shown in Appendix D.1, Appendix D.2 contains results of 1987-1994, and Appendix D.3 contains results of 1985-1994. Results of various combinations of collections are provided.

Throughout the G-Statistic tests, a *P*-Value of less than 0.05 was considered an indication of significant variation. In each comparison conducted, the *P*-Value for the overall G-Statistic testing of all loci combined was not indicative of variation ($P \geq 0.14$). However, five specific loci (*ALAT**, *ESTD**, *G3PDH2**, *MPI**, and *PEPLT**) produced *P*-Values below the 0.05 standard in various comparisons of collections.

*ALAT*93* frequency variation is specifically related to the 1987 sample set. The frequency 0.155 of the variant allele in this set ranges from 1.8 to 2.6 times that seen in the other eight collections of 1990-1994 for which this loci was studied, and is 2.2 times the mean 0.070 of these other eight collections. In the G-Statistic comparisons of the 1987-1994 collections, the *ALAT* P*-Value increases from 0.007 for all collections to 0.975 for the comparison excluding the 1987 set. The sample sets collected nearest in locality to the 1987 set were 1985 and 1986. The Beacham et al. (1988) study of these two sets reports no frequencies for this locus; comparisons could not be made to investigate a localized, spatial correlation for this *ALAT*93* variation. However, the next nearest sampling location, collected in 1990, did have the next highest *ALAT*93* variant frequency of 0.088.

*ESTD*91* and *G3PDH2*90* frequency variation showed in certain combinations of the 1994 sampling locations, but was not apparent in larger group size comparisons. No conclusions were drawn.

Significant *MPI*90* frequency variation was found to be wide ranging throughout most of the collection comparisons. *P*-Values of the comparisons made were as low as 0.01 which was calculated from the combination of the nine collections from 1987-1994. Sub-standard *MPI*90* frequency variation was not found among the 1994 set locations. However, in the comparison of 1994GC and 1994TRD the P-Value was near standard, at *P*= 0.06.

*PEPLT*85* frequency variation was found only in set comparisons that included the 1994GC or the 1991 sets. The respective variant allele frequencies for these sets are 0.045 and 0.058, which are 3.5 to 4.5 times the mean 0.013 of the seven other sets of 1987-1994 (these set frequencies ranged from 0.008 to 0.023). In the G-Statistic comparisons of the 1987-1994 collections, the *PEPLT P*-Value increased from 0.04 for all collections to 0.84 for the comparison excluding the 1991 and 1994GC sets. It is particularly interesting to note that the 1991 set was collected in the Sushana River just above the mouth of Geiger Creek and none of the other sets are from this relative proximity.

An additional note regarding *PEPLT*85* frequency variation of the 1994GC set may relate to the previously mentioned spawning stage/sequence of capture trend. In the raw data, a rough clustering of allele variants was observed among the sequence of individuals. Considering the different spawning stage of fish noted in the field, there is a possibility that this allele variation pattern relates to a temporal, genetic distinction. Further inference from this observed pattern is not possible since field observations of spawning stage were not recorded by individual. However, this temporal possibility combined with the observed spatial trend does, perhaps, support the existence of genetic distinction within the area.

G-Statistic testing was also conducted between and among sexes for the 1992-1994 collections (Appendix E). Several comparisons did produce notable *P*-Values; however, results are inconclusive at this stage.

RECOMMENDATIONS

This study reveals several indicators of genetic distinction between some of the groups of chum salmon collected. However, these indicators are not extreme and their associations are complex. Further investigation of genetic composition is advised. Current plans for further statistical analysis include testing for gametic disequilibrium.

Additional sampling and analysis are recommended. It appears particularly important to examine temporal variation within year class and to obtain samples from a site similiar to that of the 1987 collection (to confirm possible *ALAT*93* correlation). For the temporal study, aerial scout trips may be necessary to monitor and evaluate early and late spawner activity in the area. Early and late collections from the Geiger Creek area are a likely target because of the *PEPLT** heterogeneity. A similar paired collection set could be made from another location, if spawners are found. Methods similar to those of this study should be effective. A total of three to five additional collections are recommended.

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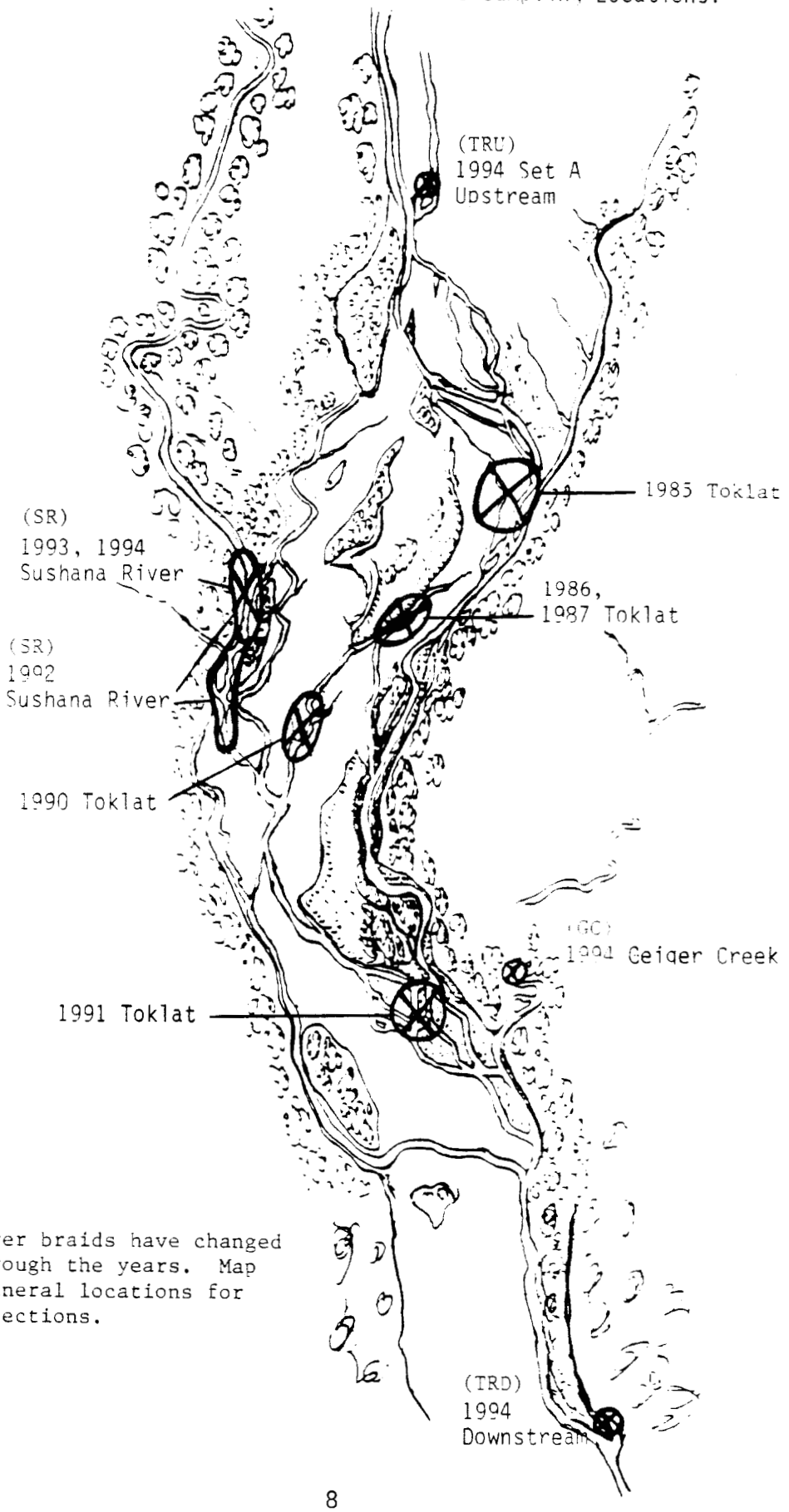
TABLE 1. Toklat River Chum Salmon GSI Collections.

YEAR	LOCATION	DATE	N	LABORATORY
1985	Western Floodplain Slough	1985	120	Beacham et al. (1988)
1986	Central Floodplain	1986	124	Beacham et al. (1988)
1987	Central Floodplain	10/19	135	Wilmot et al. (1992)
1990	Central Floodplain	10/25	75	Wilmot et al. (1992)
1991	Wolf Slough	10/17	60	This Study
1992	Sushana River	10/13-15	155	This Study
1993	Sushana River	10/13-15	200	This Study
1994	Sushana River (SR)	10/11-12	100	This Study
1994	Geiger Creek (GC)	10/13	100	This Study
1994	Upstream Main Toklat (TRU)	10/12	100	This Study
1994	Downstream Toklat Slough (TRD)	10/13	100	This Study

Figure 1. Map of Toklat River Chum Salmon GSI Sampling Locations.



Note: River braids have changed course through the years. Map depicts general locations for early collections.

Appendix A. 25 May 1993

Collection of Genetic Samples

ADF&G Genetics Laboratory, Anchorage

I. General info

We use tissue samples from muscle, liver, heart, and eye from individual fish to determine the genetic characteristics and profile of a particular run or stock of fish. The most important thing to remember in collecting samples is that tissues need to be as fresh and as cold as possible at all times.

II. Sample size

A sample size of 50-100 adult fish is preferred for the baseline electrophoretic study. Samples of juveniles are statistically less desirable and sample sizes will need to be larger than for adults; generally a sample size of 150-200 juveniles is necessary.

III. Tissue sampling

A. General set up

We use four tissues (muscle, liver, eye, and heart) for protein electrophoresis. Working fast is necessary, so it is best to try to get set up in as comfortable a place as possible. You might use a portable table, piece of plywood, or anything to give you a surface at a good height. Before sampling (night before?), label tubes with the adhesive labels provided in sampling kit. Place the prepared tubes in the racks provided. Four separate tubes, corresponding to the four tissues, should be labeled for each individual.

B. Use of liquid nitrogen

We will be using a liquid nitrogen container to immediately freeze the tissues. Inside the liquid nitrogen container are 6 cylindrical canisters. We have shipped special test tubes called "cryotubes" in which to place the samples. These cryotubes have plastic seals and screw on caps to withstand liquid nitrogen storage. Five to six tubes are stored in a cane.

-Continued-

The working time of the liquid nitrogen container under normal conditions is 81 days (35VHC) or 50 days (18VHC). To prolong the liquid nitrogen, samples can be pre-frozen (if a freezer or dry ice is available) and added in a group to minimize the number of times the container is opened. The liquid nitrogen level can be checked periodically with a flashlight or actually measured with a stick (2.3 liters/inch in 35VHC; 1.25 liters/inch in 18VHC).

"Large" 35VHC container:
30 canes will fit in each of the six canisters. 5 cryovials will fit on a cane comfortably or 6 in a pinch. Total capacity is 900 - 1080 tubes.

"Small" 18VHC container:
17 canes will fit in each of the six canisters. 5 to 6 cryovials will fit on a cane. The total capacity is 510 - 612 Nalgene tubes.

Safety with liquid nitrogen:

1. Wear gloves, protective eyewear, and protective footwear when placing samples in container. Liquid nitrogen boils at -196°, and it will spit and boil when samples are added.

2. Do not tip the tank over as it does not seal.

3. Keep lid on liquid nitrogen container at all times when you are not placing samples in it.

4. Use a small cooler with ice, snow, or blue ice to hold canes until an adequate number are collected to be put in liquid nitrogen container. Depending on the conditions and the speed of sampling, place samples in liquid nitrogen within about one hour of sampling.

5. Use liquid nitrogen only in well ventilated areas (usually not a problem in the field). Avoid directly breathing the vapor.

6. Hazardous Materials Forms need to be filled out when shipping a filled liquid nitrogen container by air cargo.

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B. Actual sampling

Please take samples from freshly killed fish. We find it easiest to set up four canes simultaneously and organize the samples in canes by tissue. Thus, muscle tissue from fish 1-5 would all be in one cane.

Fill the tubes approximately 3/4 full or to the 1.8 ml mark, leaving air space at the top. Overfilling the tubes can cause them to burst when frozen. Please minimize the amount of blood, dirt, skin, and fat in the sample.

Once tubes have been filled, place them in liquid nitrogen within 20 minutes of sampling.

Be sure to wipe your knife off with a paper towel before sampling the next fish.

1. Muscle

Muscle samples should be "white" muscle, not muscle from along the lateral line. Use a piece of muscle dorsal to the lateral line. If you have trouble getting the tissue into the tubes, cut it into smaller pieces.

2. Liver

The liver is (generally) located on the fish's left side, just behind the pectoral fin. An L-shaped incision slicing down ventrally behind the pectoral fin then caudally along the belly works well. Please do not include the gall bladder (the small green/yellow sac of fluid attached to the liver).

3. Heart

Once you have taken the liver, it is easy to get the heart by just opening the belly incision towards the head.

4. Eye

There are two ways to take the eyes. If the eyes are small enough (juveniles), they can be placed intact into a cryotube. This is the easiest method. If they are too large, you

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must pipette out the liquid and black retinal fluid. Using a sharp scalpel, cut a small slit in the surface of the eye, then insert a pipette into the slit and suck out the fluid and black retinal material. Scraping the tip of the pipette around the eye helps to mix up the fluid making it easier to suck the fluid out. Squirt this into the cryotube.

C. Data to Record.

We would like sex of the fish recorded. Data forms will be included in the sampling kit for this purpose. However, if your project includes taking scales, and recording age and length and you are using data sheets of your own, if you would prefer to photocopy your own data sheets and send us a copy once back from the field, this will be fine.

We appreciate your help with the sampling. If you have any questions, please give us a call.

Lisa Seeb	Jim Seeb	Penny Crane
267-2249	267-2385	267-2140

Laboratory 267-2247

Appendix B. Technical Notes of Sampling.

GC- Toklat River, Geiger Creek, 1994

Date Sampled: 10/13/94
Individuals Collected: 100
Computer Database Code: CMTOKG94
Set Code Label: Toklat94, Geiger Cr.
GPS Coordinates of Sampling Site:
N64 09.84' W150 00.65'
Est.Avg.Peak Esc.(from stream survey database):
Min. Desired= 33,000 for Springs area.
Est.Number Chum in drainage at time of sampling:
8,000 in Geiger. Rough est. of 80-100,000 in springs area.

Notes on Drainage, Sampling Site, and Methods:
The earlier fish sampled (lower numbered individuals) were mostly spawned out. After sampling about 40 fish, we started catching an increased number of fish which moved in to fill the vacated and thus less congested spawning gravels at our sampling site. The difference in spawning stage between some of these individuals was likely 2-3 weeks. If an early and late run do exist, then this sample set could potentially contain an overlap of the two runs.

Run Timing:
We were probably near peak.

Tissue Preservation/Quality Notes:
Samples kept on dry ice 6 hours, then placed in LN2.

Gender by sample number:

1-10.	F,F,F,F,F,F,F,F,F,F.
11-20.	F,F,F,F,F,F,F,F,F,F.
21-30.	F,F,F,F,F,F,F,F,F,M.
31-40.	M,M,M,M,M,M,M,M,M,M.
41-50.	M,M,M,M,F,F,F,F,F,F.
51-60.	F,F,F,F,F,F,F,F,F,F.
61-70.	F,F,F,F,F,F,F,F,F,F.
71-80.	F,F,F,M,M,M,M,M,M,M.
81-90.	M,M,M,M,M,M,M,M,M,M.
91-100.	M,F,F,F,F,M,M,M,M,M.

Females=62%
Males=38%

Appendix B. Technical Notes of Sampling. (cont'd.)

TRU- Toklat River, Upstream, 1994

Date Sampled: 10/12/94
Individuals Collected: 100
Computer Database Code: CMTOKA94
Set Code Label: Toklat94, Main Set A
GPS Coordinates of Sampling Site:
N64 08.46' W149 59.79'

Est.Avg.Peak Esc.(from stream survey database):
Min. Desired= 33,000 for Springs area.
Est.Number Chum in drainage at time of sampling:
Rough est. of 80-100,000 in springs area.

Notes on Drainage, Sampling Site, and Methods:
Sampled in mainstream Toklat R., approximately 3 miles upstream of Sushana R.

Run Timing:
We were probably near peak for the springs area, but this set of fish sampled were all very fresh and mostly just beginning to spawn, some still green, no spawnouts.

Tissue Preservation/Quality Notes:
Samples kept on dry ice 6 hours, then placed in LN2.

Gender by sample number:

1-10.	M,M,M,M,M,M,M,M,M,M.
11-20.	M,M,M,M,M,M,M,M,M,M.
21-30.	F,F,F,F,F,F,F,F,M,M.
31-40.	M,M,M,M,M,M,M,M,M,M.
41-50.	M,M,M,M,M,M,M,M,M,M.
51-60.	M,M,M,M,M,M,M,M,M,M.
61-70.	M,M,M,M,M,M,M,M,M,M.
71-80.	M,M,F,F,F,F,F,F,F,F.
81-90.	F,F,F,F,M,M,M,M,M,M.
91-100.	M,M,M,M,M,M,M,M,M,M.

Females=20%
Males=80%

Appendix B. Technical Notes of Sampling. (cont'd.)

TRD- Toklat River, Downstream, 1994

Date Sampled: 10/13/94
Individuals Collected: 100
Computer Database Code: CMTOKB94
Set Code Label: Toklat94, Main Set B
GPS Coordinates of Sampling Site:
N64 10.68' W150 01.19'

Est.Avg.Peak Esc.(from stream survey database):
Min. Desired= 33,000 for Springs area.
Est.Number Chum in drainage at time of sampling:
300 within 100 ft. in slough. Rough est. of 80-100,000 in springs area.

Notes on Drainage, Sampling Site, and Methods:
Sampled from a slough of spawners, connected and within 100 yards of main Toklat, 1 mile downstream of Geiger Creek. Most of these fish were ripe and ready to spawn, a few were spawned out.

Run Timing:
We were probably near peak for the spring area, but prior to peak for this slough.

Tissue Preservation/Quality Notes:
Samples kept on dry ice 4 hours, then placed in LN2.

Gender by sample number:

1-10.	F,F,F,F,F,F,F,F,F,F.
11-20.	F,F,F,F,F,F,F,F,F,F.
21-30.	F,F,F,F,F,F,F,F,F,F.
31-40.	F,F,F,F,F,F,F,F,F,F.
41-50.	F,F,F,F,F,F,F,F,F,F.
51-60.	M,M,M,M,M,M,M,M,M,M.
61-70.	M,M,M,M,M,M,M,M,M,M.
71-80.	M,M,M,M,M,M,M,M,M,M.
81-90.	M,M,M,M,M,M,M,M,M,M.
91-100.	M,M,M,M,M,M,M,M,M,M.

Females=50%
Males=50%

Appendix B. Technical Notes of Sampling. (cont'd.)

SR- Toklat River, Sushana River (egg take), 1994

Date Sampled: 10/12/94
Individuals Collected: 100
Computer Database Code: CMTOKS94
Set Code Label: Toklat94, Sushana R.
GPS Coordinates of Sampling Site:
N64 09.30' W149 59.50'

Est.Avg.Peak Esc.(from stream survey database):
Min. Desired= 33,000 for Springs area.
Est.Number Chum in drainage at time of sampling:
10,000 in Sushana. Rough est. of 80-100,000 in Toklat Springs area.

Notes on Drainage, Sampling Site, and Methods:
All fish were from egg take. Ripe and ready to spawn.

Run Timing:
We were probably near peak.

Tissue Preservation/Quality Notes:
Samples kept on dry ice 4 hours, then placed in LN2.

Gender by sample number:

1-10.	F,F,F,F,F,F,F,F,F,F.
11-20.	F,F,F,F,F,F,F,F,F,F.
21-30.	F,F,F,F,F,F,F,F,F,F.
31-40.	F,F,F,F,F,F,F,F,F,F.
41-50.	F,F,F,F,F,F,F,F,F,F.
51-60.	F,F,F,F,F,F,F,F,F,F.
61-70.	F,F,F,F,F,F,F,F,F,F.
71-80.	F,F,F,F,F,F,F,F,F,F.
81-90.	M,M,M,M,M,M,M,M,M,M.
91-100.	M,M,M,M,M,M,M,M,M,M.

Appendix B. Technical Notes of Sampling. (cont'd.)

Toklat River, Sushana River (egg take), 1992

Date Sampled: 10/13-15/92
Individuals Collected: 155

Gender by sample number:

1-10.	F,F,F,F,F,F,F,F,F,F.
11-20.	F,F,F,F,F,F,F,F,F,F.
21-30.	F,F,F,F,F,F,F,F,F,F.
31-40.	F,F,F,F,F,F,F,F,F,F.
41-50.	F,F,F,F,F,F,F,F,F,F.
51-60.	F,F,F,F,F,F,F,F,F,F.
61-70.	M,M,M,M,M,M,M,M,M,M.
71-80.	F,F,F,F,F,F,F,F,F,F.
81-90.	M,M,M,M,M,M,M,M,M,M.
91-100.	M,M,M,M,M,M,M,M,M,M.
101-110.	F,F,F,F,F,F,F,F,F,F.
111-120.	M,M,M,M,M,M,M,M,M,M.
121-130.	F,F,F,F,F,F,F,F,F,F.
131-140.	(131-155 NOT RECORDED).
141-150.	
151-155.	

Appendix C. Loci Screened and Allelic Frequencies.

Loci screened by ADF&G in Toklat River chum salmon collections:

Monomorphic

1991-1994:
mAH1,2, mAH4, sAAT2, sAH, CKA1, CKA2, CKB, CKC1, FH, GAPDH1, GAPDH2, GAPDH3, G3PDH1, G3PDH3, GPIA, GPIB1,2, HAGH, mIDHP2, sIDHP1, LDHA2, LDHB1, LDHB2, LDHC, mMDH1, sMDHA1, sMDHA2, sMDHB2, mMEP1, PEPA, PEPD1, PGM1, PGM2, TPI1, TPI2, TPI3, TPI4.

1991-1992 additional screening:
ACP1, ADA2, FBALD1, FBALD2, FBALD3, FBALD4, GAPDH5, GUS, IDDH1, IDDH2, sMEP2, SOD, XO.

Polymorphic

(listed with relative mobilities observed)

*ALAT*93, mAAT1*-70, mAAT2*-145, *-90, sAAT1*65, *120, sAAT3*90, *110, mAH3*124, CKC2*105, ESTD*91, EST2*87, bGALA*74, bGLUA*15, G3PDH2*90, mIDHP1*60, *85, sIDHP2*35, *85, LDHA1*50, LDHB2*60, MPI*90, sMDHA1*200, sMDHB1*72, mMEP2*122, sMEP1*95, PEPB1*-146, *-126, PEPLT*85, PGDH*88, PGMR*0.*

Appendix C.1. Allelic Frequencies for Polymorphic Loci, Toklat River Chum Salmon, 1985-1994.

	Heterozygosity		sAAT-1,2				sAAT-3			
Population	Obs.	Exp.	N	100	120	65	N	100	90	110
Toklat River 1985										
Toklat River 1986										
Toklat River 1987			133	0.9192	0.0808	0.0000				
Toklat River 1990			74	0.9291	0.0709	0.0000				
Toklat River 1991	0.0858	0.0891	60	0.9250	0.0750	0.0000	60	0.4000	0.6000	0.0000
Toklat River 1992	0.0878	0.0874	153	0.9232	0.0752	0.0016	153	0.3497	0.6503	0.0000
Toklat River 1993	0.0812	0.0834	200	0.9400	0.0600	0.0000	197	0.3274	0.6701	0.0025
Toklat Upstream 1994	0.0894	0.0855	100	0.9350	0.0650	0.0000	100	0.3650	0.6350	0.0000
Toklat Downstream 1994	0.0873	0.0852	100	0.9550	0.0450	0.0000	100	0.3800	0.6200	0.0000
Toklat/Gieger 1994	0.0856	0.0876	100	0.9425	0.0575	0.0000	100	0.3750	0.6200	0.0050
Toklat/Sushana 1994	0.0787	0.0803	100	0.9400	0.0600	0.0000	100	0.3350	0.6650	0.0000

	mAH-3			mAAT-1			mAAT-2			
Population	N	100	124	N	-100	-70	N	-100	-145	-90
Toklat River 1985										
Toklat River 1986										
Toklat River 1987				69	0.9275	0.0725				
Toklat River 1990				74	0.8919	0.1081				
Toklat River 1991	58	0.6983	0.3017	60	0.9417	0.0583	60	0.6083	0.3833	0.0083
Toklat River 1992	150	0.7300	0.2700	154	0.9091	0.0909	151	0.6887	0.3046	0.0066
Toklat River 1993	195	0.7564	0.2436	200	0.9025	0.0975	198	0.6439	0.3535	0.0025
Toklat Upstream 1994	100	0.6950	0.3050	100	0.9000	0.1000	99	0.7020	0.2929	0.0051
Toklat Downstream 1994	98	0.7194	0.2806	100	0.9100	0.0900	100	0.6900	0.3050	0.0050
Toklat/Gieger 1994	100	0.7100	0.2900	100	0.9050	0.0950	100	0.6800	0.3100	0.0100
Toklat/Sushana 1994	100	0.7500	0.2500	100	0.9000	0.1000	100	0.7200	0.2700	0.0100

Appendix C.1. Allelic Frequencies for Polymorphic Loci, Toklat River Chum Salmon, 1985-1994. (continued).

	ALAT			ESTD			G3PDH-2		
Population	N	100	93	N	100	91	N	100	90
Toklat River 1985							112	0.8482	0.1518
Toklat River 1986							111	0.8333	0.1667
Toklat River 1987	132	0.8447	0.1553	135	0.2704	0.7296	134	0.7873	0.2127
Toklat River 1990	74	0.9122	0.0878	74	0.2838	0.7162	73	0.8356	0.1644
Toklat River 1991	60	0.9250	0.0750	60	0.2667	0.7333	59	0.8220	0.1780
Toklat River 1992	153	0.9379	0.0621	155	0.2613	0.7387	153	0.8464	0.1536
Toklat River 1993	200	0.9300	0.0700	198	0.2626	0.7374	200	0.8425	0.1575
Toklat Upstream 1994	100	0.9300	0.0700	100	0.2700	0.7300	100	0.8100	0.1900
Toklat Downstream 1994	100	0.9250	0.0750	100	0.2000	0.8000	100	0.8000	0.2000
Toklat/Gieger 1994	100	0.9400	0.0600	100	0.3150	0.6850	100	0.7950	0.2050
Toklat/Sushana 1994	100	0.9400	0.0600	100	0.2700	0.7300	100	0.8750	0.1250

	mIDHP-1				sIDHP-2			
Population	N	100	60	85	N	100	35	85
Toklat River 1985	120	0.9458	0.0542	0.0000	120	0.5792	0.3500	0.0708
Toklat River 1986	124	0.9516	0.0484	0.0000	124	0.5121	0.3992	0.0887
Toklat River 1987	135	0.9556	0.0444	0.0000	135	0.6333	0.3037	0.0630
Toklat River 1990	74	0.9527	0.0473	0.0000	74	0.6149	0.3378	0.0473
Toklat River 1991	60	0.9250	0.0750	0.0000	60	0.5750	0.3833	0.0417
Toklat River 1992	155	0.9774	0.0226	0.0000	155	0.5387	0.4161	0.0452
Toklat River 1993	200	0.9500	0.0475	0.0025	200	0.5950	0.3400	0.0650
Toklat Upstream 1994	100	0.9500	0.0500	0.0000	99	0.5556	0.3737	0.0707
Toklat Downstream 1994	100	0.9600	0.0400	0.0000	100	0.5800	0.3550	0.0650
Toklat/Gieger 1994	100	0.9600	0.0400	0.0000	100	0.5950	0.3500	0.0550
Toklat/Sushana 1994	100	0.9500	0.0450	0.0050	100	0.6050	0.3300	0.0650

Appendix C.1. Allelic Frequencies for Polymorphic Loci, Toklat River Chum Salmon, 1985-1994. (continued).

	LDH-A1			LDH-B2			PEPB-1			
Population	N	100	50	N	100	60	N	-100	-146	-126
Toklat River 1985							120	0.8083	0.1583	0.0333
Toklat River 1986							122	0.8525	0.1189	0.0287
Toklat River 1987	135	0.7556	0.2444				135	0.7889	0.1815	0.0296
Toklat River 1990	72	0.7569	0.2431				74	0.7568	0.2162	0.0270
Toklat River 1991	60	0.7833	0.2167	60	1.0000	0.0000	59	0.7797	0.1780	0.0424
Toklat River 1992	154	0.7110	0.2890	155	1.0000	0.0000	152	0.7829	0.1941	0.0230
Toklat River 1993	200	0.7950	0.2050	200	0.9975	0.0025	197	0.8046	0.1701	0.0254
Toklat Upstream 1994	100	0.7650	0.2350	100	1.0000	0.0000	100	0.8350	0.1400	0.0250
Toklat Downstream 1994	100	0.7500	0.2500	100	1.0000	0.0000	100	0.7450	0.2300	0.0250
Toklat/Gieger 1994	100	0.7600	0.2400	100	1.0000	0.0000	100	0.8200	0.1550	0.0250
Toklat/Sushana 1994	100	0.7700	0.2300	100	1.0000	0.0000	100	0.8100	0.1850	0.0050

	PEPLT			sMDH-A1			sMDH-B1,2		
Population	N	100	85	N	100	200	N	100	72
Toklat River 1985									
Toklat River 1986									
Toklat River 1987	126	0.9921	0.0079	135	0.9296	0.0704	135	0.9926	0.0074
Toklat River 1990	74	0.9865	0.0135	74	0.9392	0.0608	74	1.0000	0.0000
Toklat River 1991	52	0.9423	0.0577	60	0.9583	0.0417	60	1.0000	0.0000
Toklat River 1992	155	0.9774	0.0226	155	0.8968	0.1032	155	0.9984	0.0016
Toklat River 1993	200	0.9850	0.0150	199	0.9523	0.0477	200	0.9962	0.0038
Toklat Upstream 1994	100	0.9850	0.0150	100	0.9400	0.0600	100	0.9950	0.0050
Toklat Downstream 1994	100	0.9900	0.0100	100	0.9400	0.0600	100	0.9975	0.0025
Toklat/Gieger 1994	100	0.9550	0.0450	100	0.9050	0.0950	100	0.9975	0.0025
Toklat/Sushana 1994	100	0.9900	0.0100	100	0.9400	0.0600	100	1.0000	0.0000

Appendix C.1. Allelic Frequencies for Polymorphic Loci, Toklat River Chum Salmon, 1985-1994. (continued).

	mMEP-2			MPI			PGDH		
Population	N	100	122	N	100	94	N	100	88
Toklat River 1985	120	0.8875	0.1125	120	0.9167	0.0833	120	0.9708	0.0292
Toklat River 1986	124	0.9113	0.0887	124	0.8831	0.1169	123	0.9756	0.0244
Toklat River 1987	135	0.8778	0.1222	135	0.9370	0.0630	135	0.9593	0.0407
Toklat River 1990	73	0.9315	0.0685	75	0.9400	0.0600	74	0.9865	0.0135
Toklat River 1991	60	0.9167	0.0833	59	0.8475	0.1525	60	0.9833	0.0167
Toklat River 1992	154	0.9091	0.0909	151	0.8642	0.1358	155	0.9806	0.0194
Toklat River 1993	200	0.8975	0.1025	199	0.9146	0.0854	200	0.9800	0.0200
Toklat Upstream 1994	100	0.9050	0.0950	100	0.9200	0.0800	100	0.9750	0.0250
Toklat Downstream 1994	100	0.8950	0.1050	100	0.8800	0.1200	100	0.9900	0.0100
Toklat/Gieger 1994	100	0.8950	0.1050	100	0.9350	0.0650	100	0.9700	0.0300
Toklat/Sushana 1994	100	0.9250	0.0750	100	0.9200	0.0800	100	0.9700	0.0300

	PGMr			bGALA		
Population	N	100	0	N	100	74
Toklat River 1985						
Toklat River 1986						
Toklat River 1987						
Toklat River 1990						
Toklat River 1991	59	0.9492	0.0508			
Toklat River 1992	149	0.9396	0.0604			
Toklat River 1993	200	0.9350	0.0650	195	0.9282	0.0718
Toklat Upstream 1994	100	0.9000	0.1000	100	0.9350	0.0650
Toklat Downstream 1994	100	0.9000	0.1000	99	0.9495	0.0505
Toklat/Gieger 1994	100	0.9200	0.0800	100	0.9300	0.0700
Toklat/Sushana 1994	100	0.9500	0.0500	100	0.9350	0.0650

Appendix D.1. G-Statistic Comparison Analyses, 1991-1994.

(All collections.)

Populations:
Toklat River 1991
Toklat River 1992
Toklat River 1993
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Geiger Cr. 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.85	6	0.9908
mAAT1	2.31	6	0.8886
mAAT2	9.70	12	0.6421
sAAT1	8.20	12	0.7691
sAAT3	7.96	12	0.7883
mAH3	4.10	6	0.6625
ESTD	7.14	6	0.3082
G3PDH2	7.63	6	0.2668
mIDHP1	11.02	12	0.5274
sIDHP2	8.15	12	0.7735
LDHA1	7.25	6	0.2982
LDHB2	2.81	6	0.8321
MPI	13.86	6	0.0312
sMDHA1	12.35	6	0.0545
sMDHB1	4.63	6	0.5915
mMEP2	1.96	6	0.9233
PEPB1	13.01	12	0.3685
PEPLT	12.96	6	0.0437
PGDH	3.16	6	0.7886
PGMR	7.83	6	0.2511
Total	146.88	156	0.6874

Appendix D.1. continued.

(Without 1991 and GC.)

Populations:
Toklat River 1992
Toklat River 1993
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.56	4	0.9671
mAAT1	0.26	4	0.9923
mAAT2	6.50	8	0.5914
sAAT1	6.98	8	0.5392
sAAT3	4.37	8	0.8224
mAH3	3.04	4	0.5515
ESTD	4.01	4	0.4047
G3PDH2	5.48	4	0.2414
mIDHP1	7.44	8	0.4904
sIDHP2	6.96	8	0.5413
LDHA1	6.91	4	0.1407
LDHB2	2.37	4	0.6673
MPI	7.62	4	0.1067
sMDHA1	8.73	4	0.0681
sMDHB1	3.41	4	0.4924
mMEP2	1.54	4	0.8199
PEPB1	10.39	8	0.2386
PEPLT	1.80	4	0.7716
PGDH	2.35	4	0.6713
PGMR	6.76	4	0.1489
Total	97.48	104	0.6611

Appendix D.1. continued.

Populations:
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Geiger Cr. 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.54	3	0.9093
mAAT1	0.16	3	0.9839
mAAT2	1.58	6	0.9541
sAAT1	1.67	3	0.6425
sAAT3	3.87	6	0.6937
mAH3	1.61	3	0.6562
ESTD	7.12	3	0.0681
G3PDH2	5.97	3	0.1131
bGALA	0.75	3	0.8625
mIDHP1	3.10	6	0.7957
sIDHP2	1.43	6	0.9640
LDHA1	0.24	3	0.9709
MPI	4.05	3	0.2561
sMDHA1	2.69	3	0.4426
sMDHB1	2.78	3	0.4272
mMEP2	1.45	3	0.6944
PEPB1	10.32	6	0.1117
PEPLT	7.50	3	0.0576
PGDH	2.71	3	0.4378
PGMR	4.75	3	0.1908
Total	64.31	75	0.8060

Appendix D.1. continued.

Populations:
Toklat R.,Downstream 1994
Toklat R.,Geiger Cr. 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.48	2	0.7854
mAAT1	0.12	2	0.9435
mAAT2	1.34	4	0.8549
sAAT1	1.04	2	0.5956
sAAT3	3.30	4	0.5093
mAH3	0.89	2	0.6419
ESTD	7.07	2	0.0292
G3PDH2	5.79	2	0.0553
bGALA	0.72	2	0.6974
mIDHP1	2.29	4	0.6826
sIDHP2	0.53	4	0.9704
LDHA1	0.22	2	0.8961
MPI	3.92	2	0.1411
sMDHA1	2.36	2	0.3075
sMDHB1	1.62	2	0.4441
mMEP2	1.45	2	0.4849
PEPB1	7.43	4	0.1148
PEPLT	7.14	2	0.0282
PGDH	2.70	2	0.2597
PGMR	3.72	2	0.1561
Total	54.11	50	0.3205

Appendix D.1. continued.

Populations:
Toklat R.,Upstream 1994
Toklat R.,Geiger Cr. 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.22	2	0.8952
mAAT1	0.04	2	0.9813
mAAT2	1.21	4	0.8766
sAAT1	0.20	2	0.9034
sAAT3	3.01	4	0.5558
mAH3	1.61	2	0.4463
ESTD	1.31	2	0.5188
G3PDH2	5.26	2	0.0721
bGALA	0.05	2	0.9738
mIDHP1	2.43	4	0.6565
sIDHP2	1.41	4	0.8422
LDHA1	0.06	2	0.9726
MPI	0.44	2	0.8016
sMDHA1	2.36	2	0.3075
sMDHB1	2.78	2	0.2494
mMEP2	1.14	2	0.5646
PEPB1	4.98	4	0.2895
PEPLT	5.93	2	0.0516
PGDH	0.12	2	0.9401
PGMR	3.72	2	0.1561
Total	38.29	50	0.8867

Appendix D.1. continued.

Populations:
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.37	2	0.8306
mAAT1	0.15	2	0.9257
mAAT2	1.03	4	0.9046
sAAT1	1.67	2	0.4337
sAAT3	0.91	2	0.6330
mAH3	1.52	2	0.4684
ESTD	3.60	2	0.1650
G3PDH2	4.86	2	0.0878
bGALA	0.51	2	0.7765
mIDHP1	2.43	4	0.6565
sIDHP2	1.03	4	0.9054
LDHA1	0.24	2	0.8879
MPI	2.43	2	0.2961
sMDHA1	0.00	2	1.0000
sMDHB1	2.78	2	0.2494
mMEP2	1.14	2	0.5646
PEPB1	9.12	4	0.0582
PEPLT	0.28	2	0.8702
PGDH	2.29	2	0.3186
PGMR	4.73	2	0.0939
Total	41.11	48	0.7490

Appendix D.1. continued.

Populations:
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Geiger Cr. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.37	2	0.8306
mAAT1	0.12	2	0.9435
mAAT2	0.64	4	0.9590
sAAT1	1.58	2	0.4541
sAAT3	2.31	4	0.6794
mAH3	0.29	2	0.8651
ESTD	7.07	2	0.0292
G3PDH2	0.15	2	0.9290
bGALA	0.72	2	0.6974
mIDHP1	0.31	2	0.8544
sIDHP2	0.85	4	0.9319
LDHA1	0.13	2	0.9384
MPI	3.92	2	0.1411
sMDHA1	2.36	2	0.3075
sMDHB1	0.47	2	0.7895
mMEP2	0.15	2	0.9289
PEPB1	6.30	4	0.1780
PEPLT	5.93	2	0.0516
PGDH	2.29	2	0.3186
PGMR	0.65	2	0.7242
Total	36.58	48	0.8856

Appendix D.1. continued.

Populations:
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.04	1	0.8471
mAAT1	0.12	1	0.7330
mAAT2	0.07	2	0.9660
sAAT1	1.55	1	0.2135
sAAT3	0.10	1	0.7564
mAH3	0.28	1	0.5939
ESTD	2.73	1	0.0983
G3PDH2	0.06	1	0.8007
bGALA	0.39	1	0.5349
mIDHP1	0.23	1	0.6292
sIDHP2	0.25	2	0.8832
LDHA1	0.12	1	0.7263
MPI	1.79	1	0.1811
sMDHA1	0.00	1	1.0000
sMDHB1	0.34	1	0.5592
mMEP2	0.11	1	0.7388
PEPB1	5.45	2	0.0656
PEPLT	0.20	1	0.6516
PGDH	1.35	1	0.2451
PGMR	0.00	1	1.0000
Total	15.18	23	0.8880

Appendix D.1. continued.

Populations:
Toklat R.,Upstream 1994
Toklat R.,Geiger Cr. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.16	1	0.6849
mAAT1	0.03	1	0.8661
mAAT2	0.50	2	0.7804
sAAT1	0.20	1	0.6582
sAAT3	1.45	2	0.4845
mAH3	0.11	1	0.7428
ESTD	0.98	1	0.3224
G3PDH2	0.14	1	0.7063
bGALA	0.04	1	0.8420
mIDHP1	0.23	1	0.6292
sIDHP2	0.82	2	0.6651
LDHA1	0.01	1	0.9065
MPI	0.34	1	0.5626
sMDHA1	1.73	1	0.1888
sMDHB1	0.34	1	0.5592
mMEP2	0.11	1	0.7388
PEPB1	0.18	2	0.9140
PEPLT	3.23	1	0.0722
PGDH	0.09	1	0.7596
PGMR	0.49	1	0.4842
Total	11.17	24	0.9877

Appendix D.1. continued.

Populations:
Toklat R.,Upstream 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.16	1	0.6849
mAAT1	0.00	1	1.0000
mAAT2	0.56	2	0.7554
sAAT1	0.09	1	0.7702
sAAT3	0.40	1	0.5293
mAH3	1.51	1	0.2190
ESTD	0.00	1	1.0000
G3PDH2	3.20	1	0.0735
bGALA	0.00	1	1.0000
mIDHP1	1.44	2	0.4870
sIDHP2	1.01	2	0.6040
LDHA1	0.01	1	0.9058
MPI	0.00	1	1.0000
sMDHA1	0.00	1	1.0000
sMDHB1	2.78	1	0.0956
mMEP2	0.52	1	0.4728
PEPB1	4.24	2	0.1202
PEPLT	0.20	1	0.6516
PGDH	0.09	1	0.7596
PGMR	3.67	1	0.0555
Total	19.88	24	0.7037

Appendix D.1. continued.

Populations:
Toklat R.,Downstream 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.36	1	0.5495
mAAT1	0.12	1	0.7330
mAAT2	0.89	2	0.6396
sAAT1	0.91	1	0.3408
sAAT3	0.88	1	0.3476
mAH3	0.48	1	0.4902
ESTD	2.73	1	0.0983
G3PDH2	4.16	1	0.0413
bGALA	0.39	1	0.5349
mIDHP1	1.46	2	0.4830
sIDHP2	0.29	2	0.8659
LDHA1	0.22	1	0.6395
MPI	1.79	1	0.1811
sMDHA1	0.00	1	1.0000
sMDHB1	1.39	1	0.2388
mMEP2	1.10	1	0.2935
PEPB1	4.43	2	0.1090
PEPLT	0.00	1	1.0000
PGDH	2.13	1	0.1441
PGMR	3.67	1	0.0555
Total	27.39	24	0.2864

Appendix D.1. continued.

Populations:
Toklat R.,Geiger Cr. 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.00	1	1.0000
mAAT1	0.03	1	0.8661
mAAT2	0.78	2	0.6768
sAAT1	0.02	1	0.8805
sAAT3	2.15	2	0.3409
mAH3	0.81	1	0.3674
ESTD	0.98	1	0.3224
G3PDH2	4.68	1	0.0304
bGALA	0.04	1	0.8420
mIDHP1	1.46	2	0.4830
sIDHP2	0.30	2	0.8602
LDHA1	0.06	1	0.8135
MPI	0.34	1	0.5626
sMDHA1	1.73	1	0.1888
sMDHB1	1.39	1	0.2388
mMEP2	1.10	1	0.2935
PEPB1	3.45	2	0.1779
PEPLT	4.94	1	0.0262
PGDH	0.00	1	1.0000
PGMR	1.49	1	0.2217
Total	25.76	25	0.4207

Appendix D.1. continued.

Populations:
Toklat R.,Downstream 1994
Toklat R.,Geiger Cr. 1994

Locus	G-Statistic	DF	P-Value
ALAT	0.36	1	0.5495
mAAT1	0.03	1	0.8630
mAAT2	0.36	2	0.8342
sAAT1	0.64	1	0.4222
sAAT3	1.39	2	0.4983
mAH3	0.04	1	0.8361
ESTD	6.96	1	0.0083
G3PDH2	0.02	1	0.9010
bGALA	0.67	1	0.4129
mIDHP1	0.00	1	1.0000
sIDHP2	0.21	2	0.8993
LDHA1	0.05	1	0.8161
MPI	3.65	1	0.0559
sMDHA1	1.73	1	0.1888
sMDHB1	0.00	1	1.0000
mMEP2	0.00	1	1.0000
PEPB1	3.66	2	0.1604
PEPLT	4.94	1	0.0262
PGDH	2.13	1	0.1441
PGMR	0.49	1	0.4842
Total	27.35	24	0.2883

Appendix D.2. G-Statistic Comparison Analyses, 1987-1994.

(All collections.)

Populations:
Toklat River 1987
Toklat River 1990
Toklat River 1991
Toklat River 1992
Toklat River 1993
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Geiger Cr. 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	21.19	8	0.0067
mAAT1	3.43	8	0.9045
sAAT1	11.20	16	0.7970
ESTD	7.47	8	0.4874
G3PDH2	10.61	8	0.2249
mIDHP1	12.00	16	0.7442
sIDHP2	12.56	16	0.7048
LDHA1	7.31	8	0.5036
MPI	20.21	8	0.0096
sMDHA1	12.50	8	0.1301
sMDHB1	9.23	8	0.3235
mMEP2	5.34	8	0.7210
PEPB1	14.66	16	0.5496
PEPLT	15.94	8	0.0433
PGDH	7.08	8	0.5275
Total	170.71	152	0.1423

Appendix D.2. continued.

(Without 1987.)

Populations:
Toklat River 1990
Toklat River 1991
Toklat River 1992
Toklat River 1993
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Geiger Cr. 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	1.70	7	0.9747
mAAT1	2.68	7	0.9133
sAAT1	8.69	14	0.8501
ESTD	7.43	7	0.3856
G3PDH2	7.65	7	0.3645
mIDHP1	11.42	14	0.6524
sIDHP2	9.06	14	0.8269
LDHA1	7.27	7	0.4015
MPI	16.72	7	0.0193
sMDHA1	12.48	7	0.0860
sMDHB1	6.03	7	0.5367
mMEP2	3.19	7	0.8671
PEPB1	14.35	14	0.4240
PEPLT	13.46	7	0.0617
PGDH	3.64	7	0.8206
Total	125.75	133	0.6597

Appendix D.2. continued.

(Without 1991 and GC.)

Populations:
Toklat River 1987
Toklat River 1990
Toklat River 1992
Toklat River 1993
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	19.80	6	0.0030
mAAT1	1.42	6	0.9644
sAAT1	10.08	12	0.6088
ESTD	4.76	6	0.5750
G3PDH2	9.21	6	0.1622
mIDHP1	8.75	12	0.7241
sIDHP2	11.42	12	0.4934
LDHA1	6.94	6	0.3267
MPI	13.87	6	0.0311
sMDHA1	8.88	6	0.1805
sMDHB1	7.72	6	0.2594
mMEP2	4.93	6	0.5532
PEPB1	12.13	12	0.4356
PEPLT	2.76	6	0.8382
PGDH	6.46	6	0.3732
Total	129.12	114	0.1576

Appendix D.2. continued.

(Without 1987, 1991, and GC.)

Populations:
Toklat River 1990
Toklat River 1992
Toklat River 1993
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
ALAT	1.37	5	0.9281
mAAT1	0.49	5	0.9925
sAAT1	7.53	10	0.6744
ESTD	4.58	5	0.4698
G3PDH2	5.48	5	0.3598
mIDHP1	8.01	10	0.6275
sIDHP2	8.03	10	0.6259
LDHA1	6.92	5	0.2269
MPI	10.50	5	0.0623
sMDHA1	8.81	5	0.1170
sMDHB1	4.91	5	0.4275
mMEP2	2.71	5	0.7447
PEPB1	11.59	10	0.3136
PEPLT	1.83	5	0.8716
PGDH	2.74	5	0.7406
Total	85.49	95	0.7473

Appendix D.3. G-Statistic Comparison Analyses, 1985-1994.

(1990-1994 collections.)

Populations:
Toklat River 1985
Toklat River 1986
Toklat River 1987
Toklat River 1990
Toklat River 1991
Toklat River 1992
Toklat River 1993
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Geiger Cr. 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
G3PDH2	11.40	10	0.3272
mIDHP1	13.44	20	0.8578
sIDHP2	19.29	20	0.5030
MPI	22.07	10	0.0147
mMEP2	6.18	10	0.7998
PEPB1	22.11	20	0.3345
PGDH	7.35	10	0.6917
Total	101.85	100	0.4297

Appendix D.3. G-Statistic Comparison Analyses, 1985-1994.

(1990-1994 collections.) continued.

Populations:
Toklat River 1985
Toklat River 1986
Toklat River 1990
Toklat River 1991
Toklat River 1992
Toklat River 1993
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Geiger Cr. 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
G3PDH2	8.07	9	0.5273
mIDHP1	12.99	18	0.7924
sIDHP2	15.21	18	0.6476
MPI	18.34	9	0.0314
mMEP2	4.23	9	0.8955
PEPB1	21.79	18	0.2415
PGDH	4.30	9	0.8908
Total	84.92	90	0.6315

Appendix D.3. continued.

Populations:
Toklat River 1985
Toklat River 1986
Toklat River 1987

Locus	G-Statistic	DF	P-Value
G3PDH2	3.36	2	0.1866
mIDHP1	0.25	2	0.8806
sIDHP2	7.89	4	0.0958
MPI	4.76	2	0.0927
mMEP2	1.59	2	0.4523
PEPB1	4.10	4	0.3925
PGDH	1.23	2	0.5404
Total	23.18	18	0.1839

Appendix D.3. continued.

Populations:
Toklat River 1990
Toklat River 1991
Toklat River 1992
Toklat River 1993
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Geiger Cr. 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
G3PDH2	7.65	7	0.3645
mIDHP1	11.42	14	0.6524
sIDHP2	9.06	14	0.8269
MPI	16.72	7	0.0193
mMEP2	3.19	7	0.8671
PEPB1	14.35	14	0.4240
PGDH	3.64	7	0.8206
Total	66.03	70	0.6124

Appendix D.3. continued.

Populations:
Toklat R.,Upstream 1994
Toklat R.,Downstream 1994
Toklat R.,Geiger Cr. 1994
Toklat R.,Sushana R. 1994

Locus	G-Statistic	DF	P-Value
G3PDH2	5.97	3	0.1131
mIDHP1	3.10	6	0.7957
sIDHP2	1.43	6	0.9640
MPI	4.05	3	0.2561
mMEP2	1.45	3	0.6944
PEPB1	10.32	6	0.1117
PGDH	2.71	3	0.4378
Total	29.04	30	0.5156

Appendix D.3. continued.

Populations:
Toklat River 1985
Toklat River 1986

Locus	G-Statistic	DF	P-Value
G3PDH2	0.19	1	0.6653
mIDHP1	0.09	1	0.7632
sIDHP2	2.28	2	0.3196
MPI	1.57	1	0.2099
mMEP2	0.78	1	0.3784
PEPB1	1.67	2	0.4348
PGDH	0.12	1	0.7313
Total	6.69	9	0.6692

Appendix E. G-Statistic Gender Comparisons, 1992-1994.

G-Statistics for populations:
Toklat River, 92 males
Toklat River, 92 females
Toklat River, 93 males
Toklat River, 93 females
Toklat Upstream, 94 males
Toklat Upstream, 94 females
Toklat Downstream, 94 males
Toklat Downstream, 94 females
Toklat/Gieger, 94 males
Toklat/Gieger, 94 females
Toklat/Sushana, 94 males
Toklat/Sushana, 94 females

Locus	G-Statistic	DF	P-Value
sAAT1,2	15.42	22	0.8437
sAAT3	13.32	22	0.9237
mAH3	11.35	11	0.4147
mAAT1	3.68	11	0.9784
mAAT2	20.15	22	0.5734
ALAT	7.14	11	0.7878
ESTD	22.53	11	0.0206
G3PDH2	13.46	11	0.2644
mIDHP1	26.43	22	0.2335
sIDHP2	19.53	22	0.6125
LDHA1	17.46	11	0.0949
LDHB2	4.61	11	0.9485
PEPB1	33.99	22	0.0492
PEPLT	15.51	11	0.1605
sMDHA1	13.34	11	0.2714
sMDHB1,2	8.87	11	0.6338
mMEP2	6.29	11	0.853
MPI	10.02	11	0.5286
PGDH	6.01	11	0.873
PGMR	19.85	11	0.0475
Total	288.96	286	0.4399

Appendix E. G-Statistic Gender Comparisons, 1992-1994. continued.

G-Statistics for populations:
Toklat Upstream, 94 males
Toklat Upstream, 94 females

Locus	G-Statistic	DF	P-Value
sAAT1,2	0.78	1	0.37
sAAT3	0.77	1	0.38
mAH3	0.47	1	0.49
mAAT1	0.33	1	0.56
mAAT2	0.68	2	0.71
ALAT	0.02	1	0.89
ESTD	0.75	1	0.38
G3PDH2	0.39	1	0.53
mIDHP1	0.00	1	1.00
sIDHP2	0.58	2	0.74
LDHA1	1.13	1	0.28
PEPB1	4.45	2	0.10
PEPLT	0.30	1	0.58
sMDHA1	0.19	1	0.66
sMDHB1,2	0.90	1	0.34
mMEP2	1.35	1	0.24
MPI	0.26	1	0.61
PGDH	0.00	1	1.00
PGMR	0.00	1	1.00
Total	13.31	22	0.92

Appendix E. G-Statistic Gender Comparisons, 1992-1994. continued.

G-Statistics for populations:
Toklat Downstream, 94 males
Toklat Downstream, 94 females

Locus	G-Statistic	DF	P-Value
sAAT1,2	0.94	1	0.33
sAAT3	0.08	1	0.77
mAH3	0.23	1	0.63
mAAT1	0.00	1	1.00
mAAT2	1.43	2	0.48
ALAT	1.83	1	0.17
ESTD	8.19	1	0.00
G3PDH2	0.50	1	0.47
mIDHP1	0.53	1	0.46
sIDHP2	4.30	2	0.11
LDHA1	0.43	1	0.51
PEPB1	1.32	2	0.51
PEPLT	2.79	1	0.09
sMDHA1	0.36	1	0.55
sMDHB1,2	1.39	1	0.23
mMEP2	0.05	1	0.81
MPI	0.76	1	0.38
PGDH	0.00	1	1.00
PGMR	0.89	1	0.34
Total	26.02	22	0.25

Appendix E. G-Statistic Gender Comparisons, 1992-1994. continued.

G-Statistics for populations:
Toklat/Gieger, 94 males
Toklat/Gieger, 94 females

Locus	G-Statistic	DF	P-Value
sAAT1,2	3.30	1	0.0692
sAAT3	3.31	2	0.1908
mAH3	0.01	1	0.9034
mAAT1	0.61	1	0.436
mAAT2	2.57	2	0.2763
ALAT	0.04	1	0.8457
ESTD	0.65	1	0.4207
G3PDH2	0.13	1	0.7214
mIDHP1	2.87	1	0.0901
sIDHP2	3.99	2	0.1362
LDHA1	9.34	1	0.0022
PEPB1	0.86	2	0.6498
PEPLT	0.13	1	0.7188
sMDHA1	0.04	1	0.8389
sMDHB1,2	0.99	1	0.3197
mMEP2	0.32	1	0.5702
MPI	0.29	1	0.5876
PGDH	0.09	1	0.7705
PGMR	1.52	1	0.2183
Total	31.06	23	0.1212

Appendix E. G-Statistic Gender Comparisons, 1992-1994. continued.

G-Statistics for populations:
Toklat/Sushana, 94 males
Toklat/Sushana, 94 females

Locus	G-Statistic	DF	P-Value
sAAT1,2	0.38	1	0.53
sAAT3	0.02	1	0.88
mAH3	0.69	1	0.40
mAAT1	0.37	1	0.54
mAAT2	3.18	2	0.20
ALAT	1.31	1	0.25
ESTD	4.04	1	0.04
G3PDH2	3.08	1	0.07
mIDHP1	6.26	2	0.04
sIDHP2	1.16	2	0.56
LDHA1	0.55	1	0.45
PEPB1	10.51	2	0.00
PEPLT	0.90	1	0.34
sMDHA1	1.31	1	0.25
mMEP2	0.42	1	0.51
MPI	0.68	1	0.41
PGDH	2.72	1	0.09
PGMR	0.00	1	1.00
Total	37.58	22	0.02