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Preliminary assessment of the salmon stocks of the Innoko and Dishna rivers, Innoko National Wildlife Refuge, Alaska, 1993

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ABSTRACT.— A general decline in Yukon River chum salmon population has increased the need for baseline information on stocks within the drainage. Gill nets were used to evaluate run timing and strength of chum salmon in the Innoko and Dishna rivers on the Innoko National Wildlife Refuge. Nets were run during July 1993 and salmon and resident species were enumerated and released. A total of 339 chum salmon were caught in the mainstem Innoko River with 121 hours of effort. Chum salmon were present in the Innoko River throughout the sampling period, with run strength apparently peaking between July 13 - 23. A total of 34 chum salmon were captured in the Dishna River with 50.2 hours of effort. No clear peak in run strength was determined for the Dishna River. Genetic stock analysis samples were collected from 88 chum salmon. A compilation of past reports of salmon use of the Innoko River drainage is included. Recommendations for monitoring salmon escapement in the Innoko River drainage include aerial surveys, telemetry studies, and direct enumeration techniques in the event substantial stocks of chum salmon exist in the system.

In light of the requirements set forth in Section 302(3)(B) of the Alaska National Interest Land Conservation Act (1980), the U.S. Fish & Wildlife Service (Service) is obligated to conserve the natural diversity of the fish and wildlife resources present on National Wildlife Refuge lands. Within this broad guideline, a high priority for the USFWS is protecting the native salmon stocks within the Yukon River drainage. While evidence suggests that the wild salmon population is currently decreasing throughout the Yukon River drainage, relatively little is known about specific stocks. Many of these stocks use drainages either wholly or partially within National Wildlife Refuge boundaries, including the Innoko River drainage. The Innoko River and its major tributaries (the Iditarod, Dishna, Yetna, and Mud rivers to the south, and Magitchlie Creek and Hather Creek to the north) drain the majority of the 3.8-million-acre Innoko National Wildlife Refuge which borders the Yukon River between the villages of Anvik and Kaltag. Significant numbers of three Pacific salmon species (chum salmon *Onchorhynchus keta*, chinook salmon *O. tshawytscha*, and coho salmon *O. kisutch*) have been reported in the Innoko River system from various surveys conducted between 1974 and 1987 (Alt 1983; Barton 1984; Rost 1988). These

surveys and sampling efforts have been inadequate, however, for describing run timing and approximate run size of the salmon stocks. Verbal accounts by nearby village residents indicate spawning populations of chum, chinook, and coho salmon are present in the headwaters of the Innoko and Iditarod rivers (Alt 1983). As such, the Innoko River drainage may encompass significant spawning and rearing habitat for chinook, chum, and coho salmon stocks affected by the Yukon River mixed-stocked fishery. Sockeye salmon have also been captured in the drainage, but are believed to be a minor component of the local fish fauna. A spawning population of sockeye salmon in the Innoko River drainage may represent the only such stock in the Yukon River drainage (W. Arvey, Alaska Dept. Fish and Game; personal communication).

Those salmon escaping to the upper Innoko River and tributaries are relatively unexploited by sport and subsistence fishing. Residents of the nearby villages of Holy Cross, Anvik, and Shageluk are reported to concentrate their chinook salmon harvest efforts in the mainstem of the Yukon River, while harvest of summer chum may come from the lower Innoko River (USFWS 1987). The latter is particularly true for Shageluk residents, as the village is located on the Innoko River proper, south of the southern Innoko Refuge boundary. Residents of Ophir may harvest those salmon reaching the headwaters of the Innoko River, plus Ganes Creek and Beaver Creek. Sport fishing for salmon in the Innoko drainage is reported to be minimal, probably due to the overall remoteness of the system coupled with a chinook salmon stock of uncertain size. There is evidence of a significant run of coho salmon in the Innoko River drainage, although specific spawning areas remain uncertain (K. Alt, Alaska Dept. of Fish and Game; personal communication).

The Service's Fishery Management Plan (FMP) for the Southern Unit of the Innoko National Wildlife Refuge provides specific concerns and strategies for the management and conservation of the fishery resources using the Refuge (USFWS 1993). A high priority concern identified for the Innoko River system is the lack of baseline data for salmon stocks within the Refuge, including run timing and size, plus the risk of overharvesting Innoko Refuge stocks (among others) in the mixed-stock fisheries occurring offshore and in the lower Yukon River. In the future, timely evaluations of escapement for selected salmon stocks may be necessary for both stock preservation and implementation of prudent management decisions. Baseline evaluation of these salmon stocks is needed to efficiently direct these future monitoring efforts. Objective I-C of the Innoko FMP calls for test netting and assessing the feasibility of more sophisticated enumeration techniques (weirs, sonar) in the Innoko River as needed for monitoring salmon stock escapements (USFWS 1993). Additional objectives explicit within the FMP include the identification of spawning and rearing areas for chinook, coho, and chum salmon, plus determining the location and size of chinook salmon spawning populations within the Innoko River and its tributaries. The results of this project, coupled with similar studies, will assist prioritization and allocation of future effort and funds towards monitoring spawning escapement and protecting habitat for selected salmon stocks in the Yukon River drainage.

Objectives

This study was designed to provide baseline data on Innoko River chum salmon. In particular, this study addressed the following objectives:

1. verify the presence of chum salmon in the upper Innoko River and a major tributary, the Dishna River; determine a qualitative index of chum salmon abundance based on CPUE, characterize length trends in the sampled population, and recommend a plan for future salmon investigations in the drainage

2. collect genetic stock identification samples from summer chum salmon entering the Dishna River and the upper Innoko River (upstream from mouth of Dishna River)

3. record presence of resident fish species captured coincident with salmon sampling efforts in the upper Innoko River and the Dishna River

4. compile, update, and synthesize all available literature concerning salmon in the Innoko River system.

Methods

Objective 1.— A base camp was maintained near confluence of the Dishna and Innoko rivers from July 10 to July 31. This location permitted test-netting at two sites: (1) the Dishna River, and (2) the mainstem Innoko River upstream from the Dishna River confluence (Figure 1). Results from this sampling were intended to provide some index of the relative run strengths for salmon entering the Dishna River drainage, and for those continuing into the upper Innoko River drainage. Test-netting consisted of deployment of multifilament gillnets. A single 100 ft gillnet (5⅞" stretch mesh) was used to assess presence/absence and relative run strength of chum salmon at each site. The Innoko River mainstem net effectively sampled approximately a third of the river channel, while the Dishna River set sampled approximately half of the cross-channel distance. Nets were deployed a minimum of 6 hours per 24 hour period, generally from 1800 to 2400 nightly on the Innoko River and every other night on the Dishna River. Salmon were counted, measured (mideye-fork length), and released away from the net. Nets were continuously monitored in an effort to minimize fish mortality. Mixed small gravel and sand was the predominant substrate at the Innoko River sampling site, while substrate at the Dishna River site consisted mainly of sand and mud.

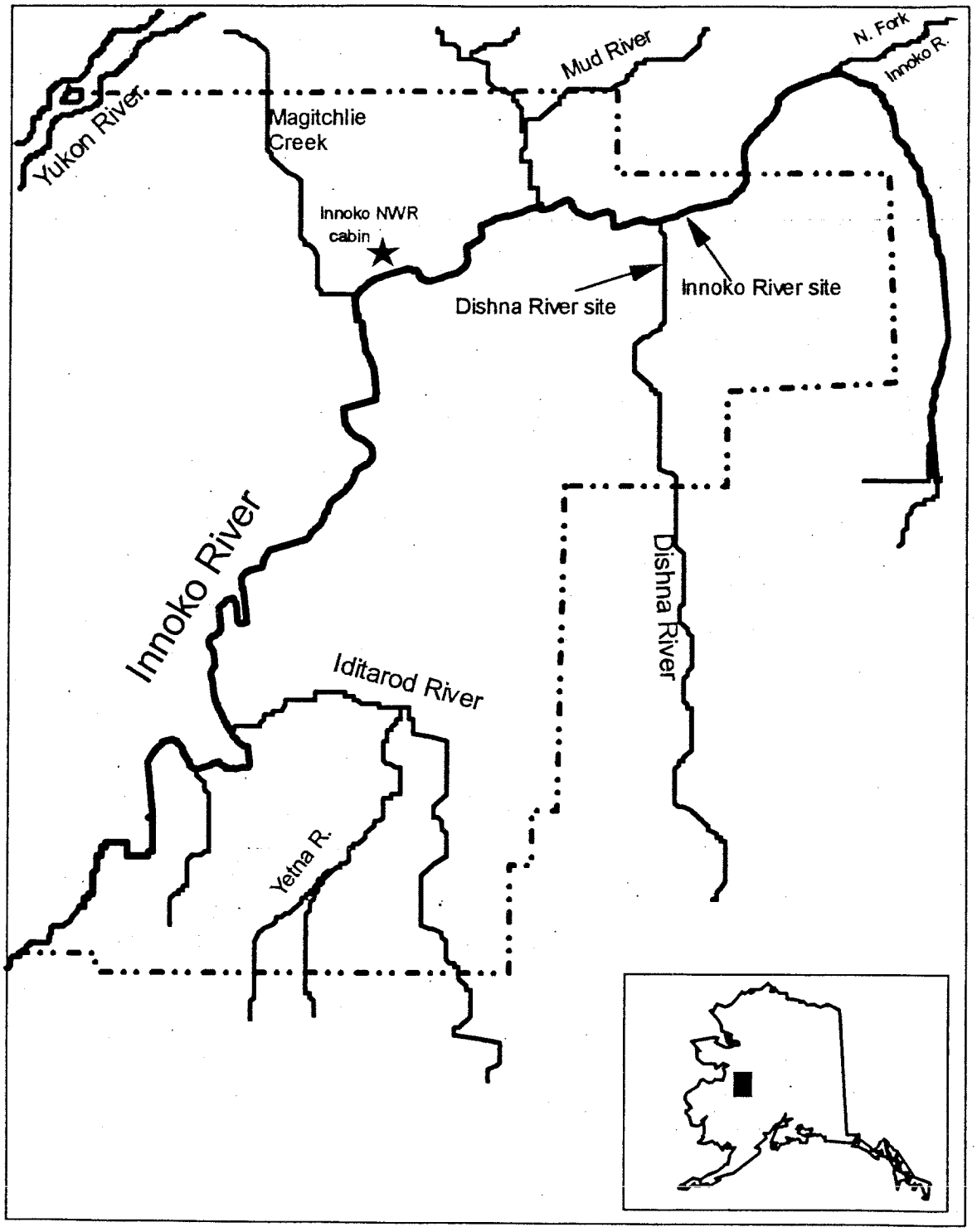

Figure 1. Study sites for preliminary chum salmon stock assessment on the Innoko National Wildlife Refuge, July 1993.

Objective 2.— Genetic stock identification tissue samples from summer chum salmon were collected from the mainstem Innoko River, upstream of the Dishna River confluence, as per the protocol established by Everett (AFWRC 1989). Sample preservation and transport materials were provided by the Alaska Fish and Wildlife Research Center, Anchorage. The tissue samples were turned over to the Alaska Department of Fish and Game for genetic analysis and presentation of results.

Objective 3.— Resident fish species captured in the gillnets were identified and released. Qualitative beach seine (10 m long, 6mm bar mesh) hauls were also employed twice weekly in shoal areas (< 1 m depth) near gillnet sites to assess presence/absence of juvenile fish species. The seine was hauled for approximately 10 meters for each sample.

Objective 4.— Available state and federal reports concerning salmon surveys in the Innoko River drainage were summarized and tabulated. This tabulation serves as a reference source for available salmon literature pertaining to Innoko River drainage.

Results

Innoko River.— Test gillnetting for chum salmon in the Innoko River mainstem was conducted during 19 evenings in July, 1993. A suitable net site was established approximately two kilometers upstream from the Dishna River confluence. No fish were caught during initial gillnetting efforts conducted during the day (0900-1500 hrs). As such, subsequent sampling effort was allocated exclusively to evening periods. A total of 121 hours of gillnet effort resulted in 320 male chum salmon and 19 female chum salmon, with an overall mean CPUE of 2.8 fish/hr (Table 1). Chum salmon were present at the initial sampling on July 8 and remained present through July 31, the end of sampling. A graph of CPUE over time suggests that the chum salmon run strength in the mainstem Innoko River peaked between July 13 and 23 in 1993, with diminishing catch rates occurring near the end of July (Figure 2).

The overall mean mideye - fork length (MFL) was 555 mm for males and 550 mm for females. A regression of MFL versus time for male chum salmon detected a significant decrease in MFL (b = -0.13; $P < 0.001$) during the July sampling period (Figure 3).

Chum salmon were captured in Finland Creek (5 individuals) and Scandinavian Creek (2 individuals) on July 29, approximately one kilometer upstream from their respective confluences with the Innoko River. While spawning was not observed in these latter systems, the live fish were in advanced stages of deterioration.

In addition to chum salmon, 4 chinook salmon, 13 northern pike (*Esox lucius*), 2 inconnu (*Stenodus leucichthys*), and 1 least cisco (*Coregonus sardinella*) were captured by gillnet in the mainstem Innoko River. One of the inconnu (107 cm total length) was captured in the mainstem approximately 6 km upstream of the Dishna River confluence. Several pond smelt (*Hypomesus olidus*) were captured by beach seine near the Innoko River site, representing an apparent range extension for this species.

Table 1. Catch and CPUE for chum salmon in the Innoko National Wildlife Refuge, 1993. [ML = mean mideye-to-fork length (cm); CPUE = fish/h.]

Mainstem Innoko River

	Males			Females		
Date	N	ML	CPUE	N	ML	CPUE
8-Jul-93	14	56.1	3.33	1	57.50	0.24
9-Jul-93	10	57.7	3.33	1	54.00	0.33
10-Jul-93	10	57.0	2.63	1	56.50	0.26
11-Jul-93	14	57.0	2.30	0		0.00
12-Jul-93	23	55.8	3.77	0		0.00
13-Jul-93	29	56.7	4.60	0		0.00
14-Jul-93	9	56.1	1.50	0		0.00
15-Jul-93	18	55.5	0.96	2	58.30	0.11
19-Jul-93	24	55.1	4.00	1	55.00	0.17
20-Jul-93	24	55.9	4.07	2	57.00	0.34
21-Jul-93	24	54.9	3.93	1	52.00	0.16
22-Jul-93	21	55.0	3.50	2	55.50	0.33
23-Jul-93	26	55.7	4.48	1	50.50	0.17
26-Jul-93	21	53.1	3.82	2	55.50	0.36
27-Jul-93	15	54.2	2.42	1	50.00	0.16
28-Jul-93	19	54.5	3.06	2	53.30	0.32
29-Jul-93	4	57.0	0.67	1	55.50	0.17
30-Jul-93	6	55.5	0.86	0		0.00
31-Jul-93	9	53.2	1.50	1	57.00	0.17

Dishna River

	Males			Females		
Date	N	ML	CPUE	N	ML	CPUE
10-Jul-93	1	51.5	0.26	1	61.00	0.26
12-Jul-93	3	56.2	0.55	0		0.00
14-Jul-93	2	56.0	0.33	0		0.00
19-Jul-93	6	55.3	1.09	1	55.00	0.18
21-Jul-93	5	56.8	0.94	1	50.00	0.19
23-Jul-93	3	53.5	0.50	0		0.00
27-Jul-93	7	55.4	1.17	0		0.00
30-Jul-93	2	54.5	0.33	1	53.00	0.17
31-Jul-93	5	53.7	0.83	1	50.50	0.17

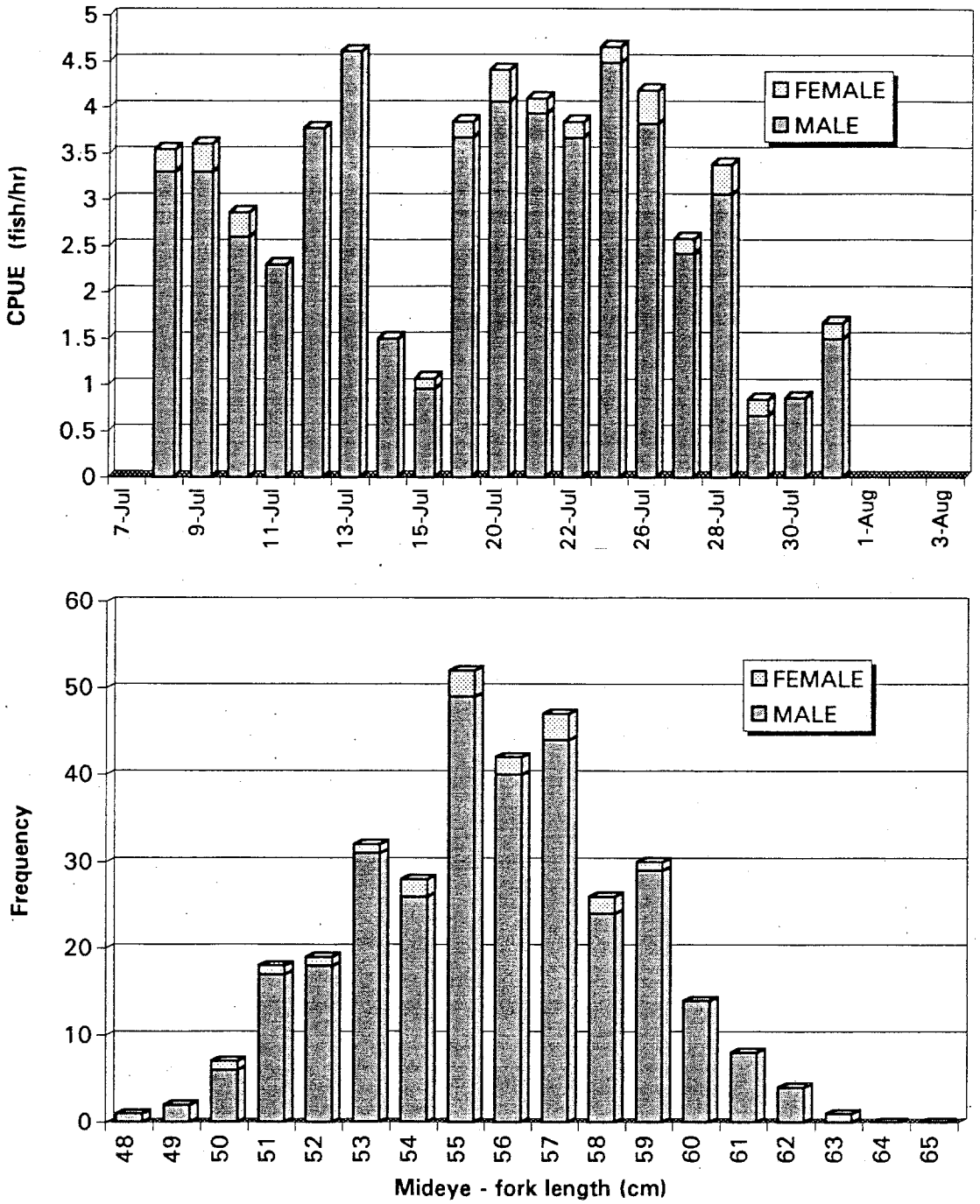

Figure 2. Catch per unit effort (top) and length frequencies (bottom) for chum salmon from the Innoko River, July 1993.

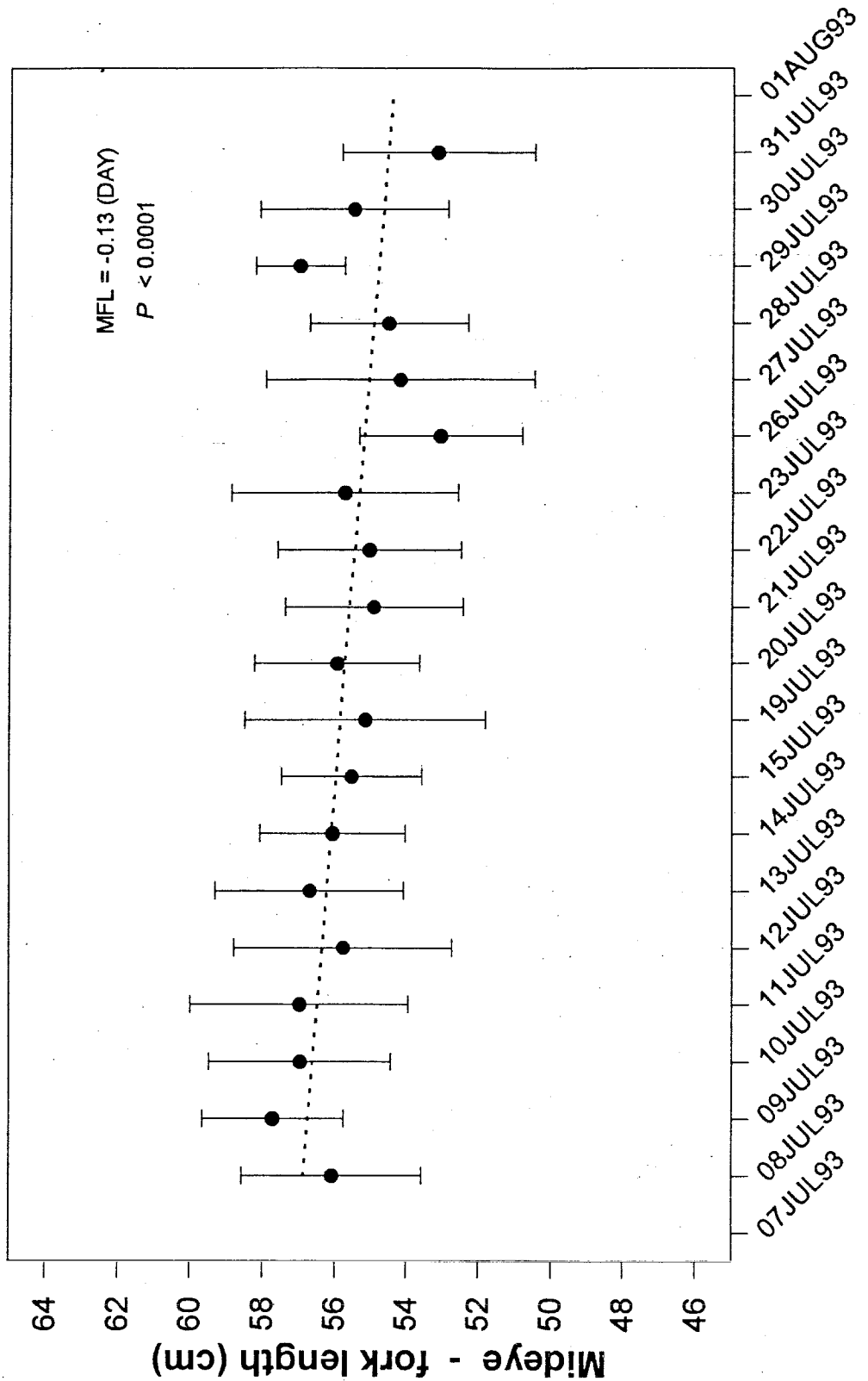

Figure 3. Lengths of male chum salmon from the mainstem Innoko River, during July, 1993. Equation describes significant negative slope of regression line; error bars represent (+/-) one standard deviation around mean daily sample length .

Juvenile longnose suckers (*Catostomus catostomus)* were abundant in the backwaters and nearshore areas throughout the study area. Beach seining over gravel and sand substrate consistently captured in excess of 100 individuals per haul. Juvenile Arctic grayling (*Thymallus arcticus*) were commonly captured in association with the longnose suckers, with approximately 3-5 individuals occurring per 10 m haul.

Dishna River.— Gillnet samples were taken in the Dishna River during nine evenings in July, approximately three kilometers upstream from the confluence with the Innoko River. A total of 50.2 hours of sampling effort resulted in 34 male chum salmon and 5 female chum salmon, for an overall mean CPUE of 0.68 fish/hr (Table 1). While chum salmon were present in the Dishna River throughout the month of July, the small number of captured salmon precluded reliable detection of increasing or decreasing trends in daily CPUE (Figure 4). The mean mideye - fork length of male chum salmon from the Dishna River was 550 mm.

One chinook salmon and one northern pike were also captured by gillnet at the Dishna River site. Similar to the Innoko River mainstem site, qualitative seining indicated that juvenile longnose suckers and Arctic grayling were abundant in slack water zones.

Genetic Stock Identification.— On July 15-16, 88 chum salmon were collected from the mainstem Innoko River and sacrificed for retrieval of tissue samples for genetic stock identification (GSI) analysis. Eye, heart, liver, and cheek muscle tissue samples from each fish were flash-frozen on site and delivered to the Alaska Department of Fish and Game Genetics Laboratory (Anchorage) for analysis.

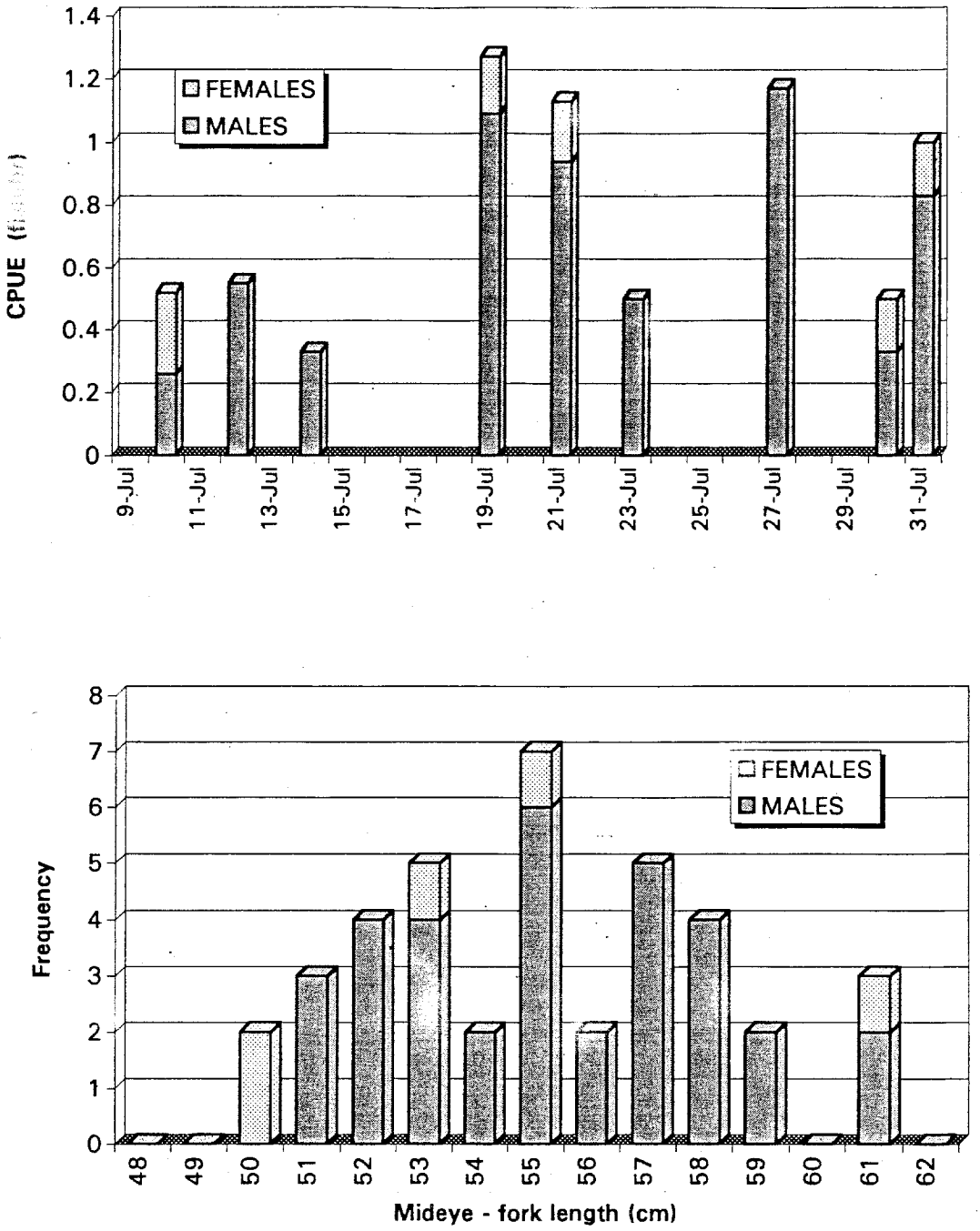

Figure 4. Catch per unit effort (top) and length frequencies (bottom) for chum salmon from the Dishna River, 1993.

Historical Salmon References for Innoko NWR.

Chum salmon

1.) 339 chum salmon gillnetted between July 8 - 31, 1993, in Innoko River, 2 km upstream from confluence with Dishna River.
Source: this study.

2.) 39 chum salmon gillnetted between July 10 - 31 in Dishna River, 3 km upstream from confluence with Innoko River.
Source: this study.

3.) 2000 chum salmon were reported by aerial survey, August 1, 1975, on Dishna River between Porcupine and Windy creeks.
Source: Barton 1984.

4.) 500 chum salmon were reported by aerial survey, August 1, 1975, on Tolstoi Creek (Dishna River tributary).
Source: Barton 1984.

5.) 1 chum salmon was reported from aerial survey, August 1, 1975, in Moose Creek (Windy Creek/Dishna River tributary).
Source: Barton 1984.

6.) 20 chum salmon gillnetted by Alt June 14-19, 1981, from Innoko River between village of Shageluk and mouth of Iditarod River.
Source: Barton 1984.

7.) 93 chum salmon were gillnetted/tagged from mainstem Innoko River (near Refuge field cabin) between July 10-21, 1987, by P. Rost, USFWS. Two tagged chum salmon were subsequently located $\approx$ 30 miles up the Dishna River on July 24, 1987.
Source: Rost 1988.

8.) 21 chum salmon reported by ADFG aerial survey (poor conditions) on July 29, 1988, in Reindeer Lake and River.
Source: Barton 1984 updates.

9.) 0 chum salmon reported by ADFG aerial survey (poor conditions) on July 30, 1992, in Iditarod River.
Source: Barton 1984 updates.

10.) Arvey and Mills (1991) report a sport harvest of 21 chum salmon from the Innoko River during 1989.

11.) Alt (1983) reports verbal accounts by residents/trappers of chum salmon spawning in Innoko River upstream of Ophir, including Ganes Creek (above Ophir), in Beaver Creek (just below Ophir), and in Dishna River.

12.) Residents of Flat report to ADFG that chum salmon are present in Iditarod River and Otter Creek (a tributary of the Iditarod River which runs through Flat).
Source: Alt 1983 - personal communication.

Chinook salmon

1). 4 chinook salmon gillnetted between July 12 - 15, 1993, in Innoko River, 2 km upstream from confluence with Dishna River.
Source: this study.

2.) 1 chinook salmon gillnetted on July 14 in Dishna River, 3 km upstream from confluence with Innoko River.
Source: this study.

1). 1 chinook salmon gillnetted by Alt between June 14-19, 1981, between Shageluk and the mouth of the Iditarod River.
Source: Barton 1984.

2.) 7 chinook salmon reported by ADFG aerial survey in Dishna River July 15, 1976. Estimate count to be 10% low due to turbid water.
Source: Barton 1984.

3.) 2 dead chinook salmon reported by ADFG aerial survey August 1, 1975, on Dishna River and Tolstoi Creek.
Source: Barton 1984.

4.) Arvey and Mills (1991) report sport harvest of 10 chinook salmon from Innoko River during 1989.

5.) Alt (1981) reports verbal accounts by local residents of chinook salmon seen in upper Innoko River, above Ophir.

Coho salmon

1.) 42 coho salmon gillnetted by Alt September 1-3, 1981, in Innoko River mainstem between mouths of Iditarod and Dishna rivers.
Source: Barton 1984.

2.) 34 coho salmon gillnetted by Alt September 6-9, 1981, in Innoko River mainstem between North Fork Innoko and Cripple Landing.
Source: Barton 1984.

3.) 43 coho salmon gillnetted by Alt September 10 - October 2, 1981, in Innoko River between Cripple Landing and Ophir (entering Beaver Creek).
Source: Barton 1984.

4.) 1 coho salmon gillnetted by Alt August 31, 1981, 2 miles up Iditarod River.
Source: Barton 1984.

5.) Arvey and Mills (1991) report sport harvest of 89 coho salmon from Innoko River during 1991.

6.) Alt (1981) reports verbal accounts by local residents of coho salmon present in upper Innoko River, above Ophir.

Sockeye salmon

1.) 1 sockeye salmon gillnetted by Alt September 8, 1981, in the North Fork Innoko River. Alt (1983) describes this fish as "probably a stray from another system".
Source: Alt 1983.

2.) Arvey and Mills (1991) report sport harvest of 72 sockeye salmon from Innoko River during 1991. [Note: This figure is improbable, and likely results from a statistical expansion employed in ADFG's sport fish survey methodology, or misidentification of species by reporting angler(s)].

The Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes.

The Alaska Department of Fish and Game has published a compilation of anadromous fish habitat as confirmed by either sightings and reports returned by their staff or contributions of external agencies (e.g. U.S. Fish and Wildlife Service). The level of documentation necessary for inclusion in the ADFG anadromous fish catalog has varied over the course of the catalog's development, such that confirmation, at this time, is often tenuous. Documentation for the more recent sightings and spawning/rearing designations are on file in ADFG's Anchorage office. The following reports of salmon species and drainages are extracted from the maps contained within this publication. Many of the sightings are based on the reports previously cited herein, whereas some appear to originate from personal reports or undocumented sources.

Chum salmon: Innoko River
- Iditarod River (spawning, rearing)
  - Yetna River
  - Otter Creek (spawning)
- Dishna River (spawning)
  - Tolstoi Creek (spawning)
  - California Creek
    - Windy Creek
- Hunch Creek

Chinook salmon: Innoko River
- Dishna River (spawning)
  - Windy Creek (spawning, rearing)
    - California Creek (spawning, rearing)
      - Billy Goat Creek (rearing)
- American Creek (rearing)
- Beaver Creek (rearing)

Coho salmon: Innoko River
Iditarod River (spawning, rearing)
Otter Creek (spawning, rearing)
N. Fork Innoko River
American Creek (rearing)
Beaver Creek (rearing)
Ganes Creek (rearing)

Sockeye salmon: Innoko River
N. Fork Innoko River

Discussion

The 1993 Arctic-Yukon-Kuskokwim (AYK) chum salmon return was disastrously low. Run strengths were approximately 80% below the 5-year average, and yielded the lowest commercial harvest since 1968. ADF&G biologists estimated 2.5 million chum salmon were missing from the expected AYK return. As a result, the baseline data collected in 1993 on chum salmon run timing and strength in AYK systems, e.g. the Innoko River drainage, may be proportionately biased. As such, the results of this study cannot be interpreted as a true representation of strength of the "normal" chum salmon run in the Innoko River. Also, the sampling period was too restricted to confidently assess the run timing. Salmon runs in large drainages are often characterized by multiple peaks, necessitating prolonged sampling to insure detection of all possible migration pulses in the system. The apparent numerical dominance of male chum salmon may also be misleading due to gear bias. Kype entanglement by male chum salmon rendered them much more susceptible to the gill nets, whereas females were observed to be captured only by the more traditional "gilling" process.

In spite of the above limitations, the capture of over 300 individuals in the mainstem Innoko River during a year of extremely low returns does suggest that a substantial number of summer-run chum salmon may exist in the drainage. As such, further monitoring of the Innoko River system should be directed towards developing an escapement index within the drainage and identifying potentially declining or threatened stocks. Headwaters of the Iditarod and Dishna rivers, plus the headwater drainages of the mainstem Innoko River, are regions of particular interest with respect to salmon spawning and rearing habitat.

Recommendations

Developing a program for monitoring escapement of Innoko River salmon stocks, as identified in the Innoko NWR Fishery Management Plan, should be a high priority of the Fish and Wildlife Service. This could best be addressed through continuing and expanding the cooperative effort between Innoko NWR and Fairbanks FRO personnel. Several options for expanding our capability for monitoring

salmon escapement are available and should be evaluated based on available funding. The following is a possible development plan for consideration for future funding allocation.

1. ***Aerial surveys.***— Low level aerial surveys of the headwaters of the mainstem Innoko and Dishna rivers could conceivably be accomplished with little extra operational commitment beyond current summertime procedures by Refuge staff. The Innoko River headwaters lie almost directly in the flight path between McGrath and the Refuge field cabin. Dishna River spawning areas (e.g Tolstoi Creek, Windy Creek) lie westward of the flight path. These drainages may be aerially surveyed at opportune times during the frequent flights between McGrath and the Innoko NWR field cabin. Merely noting the presence/absence of spawning redds, spawning fish, or post-spawning carcasses would add to our knowledge of the Innoko River system. In the future, as the observer became more experienced and spawning grounds were further delineated, numerical abundance indices may become more feasible.

2. ***Ground surveys.***— Gillnet sampling efforts similar to the 1993 program could be continued, with variable success, to further assess salmon run strength and timing. The cost-benefit aspect of these ground-based programs can be compromised by the requirements of operating a remote camp within the Refuge. Synoptic assessments of distantly separated tributary systems is unfeasible. Monitoring salmon stocks which may be simultaneously ascending separate stream reaches towards spawning grounds is virtually impossible with limited staffing resources. The effectiveness of monitoring the mainstem Innoko River is limited by gear constraints in conjunction with highly variable flow conditions. While ground-based sampling efforts with nets are an informative inventory and "immediate action" technique, they are ill-suited for long term monitoring of system-wide trends.

3. ***Telemetry Studies.***— Radiotelemetry of salmon ascending the Innoko River system will further assist the identification of spawning areas, plus the assessment of migration timing within the system and apportionment of escapement among major subdrainages. Telemetry has the potential to provide information on spawning habitat which may not be evident from aerial surveys, e.g. small stocks, or those using chronically turbid or stained waters. This could be applicable to chinook salmon stocks within the Innoko River drainage, the reported sockeye salmon stock from the North Fork Innoko River, or any stocks using waters affected by the mining activities prevalent southeast of the refuge. Large-scale telemetry programs also allow apportionment of the relative size of salmon stocks using the various spawning grounds within the system. Once the relative sizes of intradrainage stocks have been indexed, the question of whether or not (and if so, where) to pursue more quantitative enumeration methods can be better addressed.

4. ***Enumeration techniques.***— Direct enumeration of migrating salmon, via weir or ensonification, is the most dependable means of monitoring trends in escapement. However, the initial investment in money and personnel required by these techniques limits their applicability. Variable hydrologic regimes and channel morphology also affect the efficiency of these techniques. Whether or not this level of monitoring is warranted in the Innoko River drainage would depend on the results from preceding aerial, ground, and telemetry assessments.

Acknowledgements

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