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Length Composition of Rainbow Trout Populations of the Negukthlik and Ungalikthluk Rivers, Togiak National Wildlife Refuge, Alaska, 2003

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Length Composition of Rainbow Trout Populations of the Negukthlik and Ungalikthluk Rivers, Togiak National Wildlife Refuge, Alaska, 2003

Dan Gwinn

Abstract

Concerns over the potential impacts of fishing pressure on the rainbow trout population within the Ungalikthluk and Negukthlik Rivers have been expressed by state and federal biologists. In an effort to monitor the rainbow trout population, length frequency measurements were compared over time. One hundred and forty-three rainbow trout were measured on the Negukthlik River and 45 were measured on the Ungalikthluk River. The mean length of fish measured was 337 mm (SD = 74.57) on the Negukthlik River and 502 mm (SD = 84.96) on the Ungalikthluk River. Comparisons of 2003 length distributions with 1989 and 1990 length distributions revealed a significant difference. Between 1989 and 2003 there was a relative decrease in fish > 400 mm on the Negukthlik River and relative decrease in fish > 500 mm on the Ungalikthluk River. There were no fish detected over 600 mm on the Negukthlik River in 2003, although this size class was represented in 1989. Although these data indicate a shift in the length composition of rainbow trout within the study area, whether or not the cause is selective harvest of larger fish, differential mortality among size classes, or natural variation is unknown.

Introduction

Concerns over the potential impacts of subsistence and sport fishing pressure on the rainbow trout population within the Ungalikthluk and Negukthlik Rivers have been expressed by state and federal biologists. These concerns exist because informal surveys and biological data from the mid-1980s and early 1990s suggested that this population was small and vulnerable to over harvest. These concerns resulted in harvest restrictions. An up-to-date assessment of the rainbow trout population is needed to determine if past management actions have been successful and to further assess the effects of future management actions.

The Ungalikthluk and Negukthlik Rivers have experienced fishing pressure from guided fishing tours since the late 1970s. In the mid-1980s the use of the rivers increased over previous years (USFWS 1991). During the mid-1980s several sport fish guides received permits to conduct fly-in day use and utilize one base camp, which provided overnight accommodations and motorboat access on the rivers. Guides reported a mean of 300 angler days from 1986 to 1994 with a peak in 1987 of 500 angler days (Togiak National Wildlife Refuge files). Currently, two guiding outfits use the river, one of which uses a semi-permanent base camp, but angling data after 1994 is incomplete because as of then guides were no longer required to report angling information.

In addition to the guided fishing pressure, the rivers sustained heavy unguided fishing pressure and harvest in 1984 and 1985, when commercial herring fishermen were idle, waiting for

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commercial openings, and ascended the rivers (Minard 1987). Over limits of sport caught rainbow trout and netting of the fish in the lower river were rumored to have occurred. The Alaska Board of Fisheries enacted an emergency closure to angling during the spawning season the rivers in 1987. Subsequent action taken by ADFG and the Board of Fisheries has made the spawning season closure, from 10 April to 07 June, permanent by regulation.

To address concerns about the Ungalikthluk and Negukthlik Rivers' rainbow trout populations, a study was conducted by the US Fish and Wildlife Service in 1989 and 1990 (Lisac 1996). The objectives of this study were to document the age, weight and length composition of the rainbow trout population in the lower reaches of the Ungalikthluk and Negukthlik Rivers and to document movements of rainbow trout within the Ungalikthluk and Negukthlik Rivers and determine spawning and over-wintering habitat areas. Data from this study provided evidence that rainbow trout in these systems become densely concentrated in the Negukthlik River during the spring spawning season and are potentially vulnerable to over-harvest in this area. This study also provided a baseline description of the length structure of the rainbow trout.

In 2003, the Federal Subsistence Board (FSB) adopted regulations liberalizing subsistence rod and reel harvest regulations for rainbow trout in the Bristol Bay Region. Previously, subsistence harvest of rainbow trout with rod and reel in this region was regulated by the state sport fishing laws. Under this system, harvest and possession limits varied among different drainages. Before the 2003 regulation change, the Negukthlik and Ungalikthluk River drainage was closed to all fishing from 10 April through 07 June. From 08 June through 31 Oct, no rainbow trout could be retained and from 01 November through 09 April the daily limit was five per day and five in possession. With the new bag limits, two rainbow trout may be taken per day and two may be in possession during 10 April through 31 October and five may be taken and five may be in possession during 01 November through 09 April. This increases the daily legal take of rainbow trout from zero to two during the spawning season when fish are aggregated and are most vulnerable to over harvest. Information needed to monitor the results of these changes includes the current length structure of the rainbow tout in the entire reach of the Ungalikthluk and Negukthlik Rivers.

Objectives

1. Estimate the length composition of rainbow trout within the lower 8.5 river miles of the Negukthlik River and within the lower 9.5 river miles of the Ungalikthluk River.
2. Test the hypothesis that the length frequency of rainbow trout in 2003 is the same as the length frequency of rainbow trout in 1989 and 1990.
3. Estimate the length composition of rainbow trout within the entire floatable portion of the Ungalikthluk and Negukthlik Rivers.

Study Area

The Ungalikthluk and Negukthlik Rivers are located within the Togiak National Wildlife Refuge, approximately 12 miles southeast of the villages of Togiak and Twin Hills between the Togiak and Kulukak Rivers (Figure 1). The Negukthlik River flows south from the tundra headwaters for approximately 7 miles into two shallow lakes interconnected by a 0.25 mile section of the river. The river then continues south for approximately 12 miles joining the Ungalikthluk River approximately 2 miles upstream of Togiak Bay.

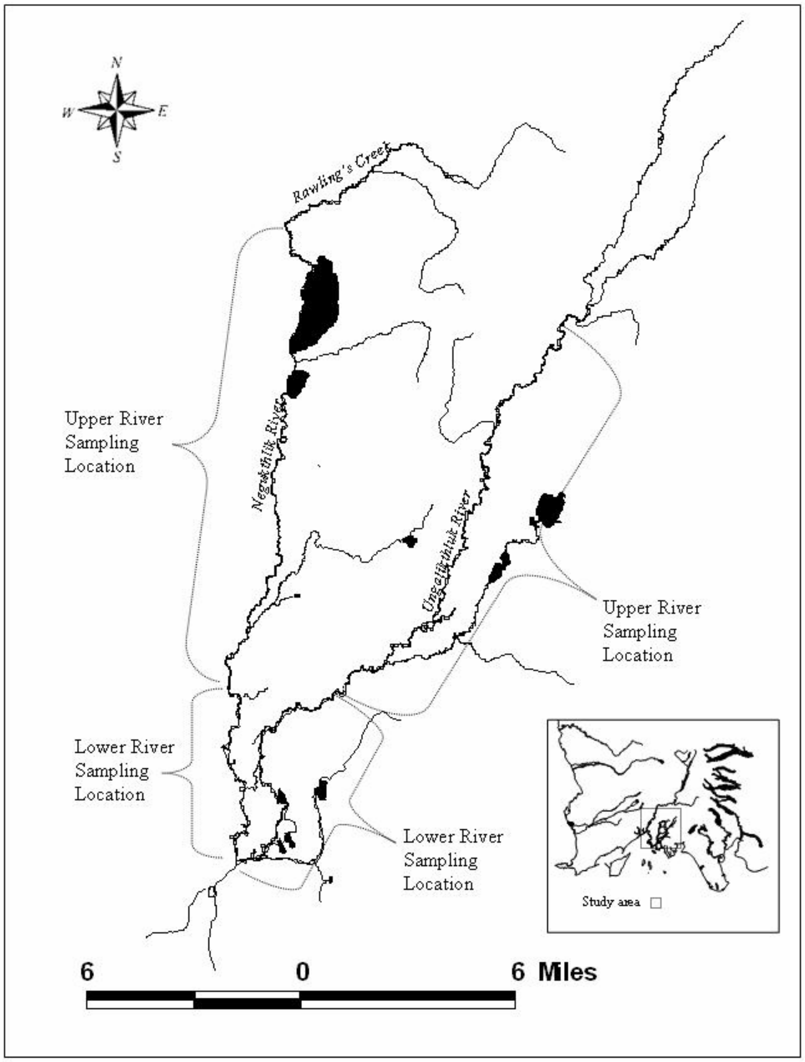

Figure 1. Negukthlik and Ungalikthluk Rivers and study area.

The Ungalikthluk River originates in the mountains between the Togiak River and Kulukak River drainages and flows south for approximately 22 miles before being joined by the Negukthlik River. All five Pacific salmon species utilize both rivers for spawning and rearing. Estimates of sockeye salmon escapements for 2001 were 2,220 and 4,680 for the Negukthlik and Ungalikthluk, respectively; estimates of Chinook salmon escapements for 2001 were 603 and 185 for the Negukthlik and Ungalikthluk, respectively; and estimates of chum salmon escapements for 2001 were 550 and 10,960 for the Negukthlik and Ungalikthluk, respectively. Other fish that inhabit the Ungalikthluk and Negukthlik Rivers include Dolly Varden (*Salvelinus malma*), northern pike (*Esox lucius*), Arctic grayling (*Thymallus arcticus*), and round white fish (*Prosopium cylindraceum*).

Methods

The study area within each river was divided into two sections (Figure 1): upper river and lower river. The Negukthlik upper river section originated at the most upstream point where an inflatable boat could navigate and ran downstream to river mile 8.5. The Negukthlik lower river section extended from river mile 8.5 to the confluence of the Ungalikthluk River. The

Ungalikthluk upper river section originated at the most upstream point where an inflatable boat could navigate and ran downstream to river mile 9.5. The Ungalikthluk lower river section extended from river mile 9.5 to the confluence of the two rivers. The lower river sections were accessed via 16' jon boat with a 50-horsepower jet-drive outboard motor by a crew of two to three researchers. The upper sections of the rivers were sampled via float trips, which included one raft with a crew of three researchers. Float parties were inserted by helicopter. A crew of three on each river then waded and floated downstream, sampling fish until the confluence of the Negukthlik and the Ungalikthluk Rivers was reached.

Fish were collected with conventional angling techniques. Only single hook flies and lures of similar size and type to those used by Lisac (1996) were utilized for sampling. The fork length (FL, from tip of snout to the fork of the tail) of all rainbow trout captured was measured to the nearest millimeter. Date, time, and location of capture were recorded for each capture event. A genetic sample, consisting of a small pelvic fin clip, was taken from each captured fish. Fish captured greater than 250mm FL were tagged with alphanumeric visible implant (VI) tags on the left side in the periocular (adipose eyelid) tissue. Tag number was recorded at the time of initial attachment and upon the time of proceeding recaptures. The pelvic fin clip served as a secondary mark to document VI tag loss. All fish captured were released alive.

Cumulative length frequency distributions were generated with 10 mm length categories for the rainbow trout sampled in each section of each river. For further comparison, length categories of Stock, Quality, Preferred, Memorable, and Trophy were adapted from Gabelhouse (1984) for the Ungalikthluk and Negukthlik Rivers as follows: Stock <299 mm; Quality 300-399 mm; Preferred 400-499 mm; Memorable 500-599 mm; Trophy >600 mm. Relative stock density was estimated (Wagner 1991, Lisac 1996) for rainbow trout by dividing the number of individuals in a length category by the sum of all individuals in all length categories for each section of each river. To maintain unbiased length structure comparisons among years, data were spatially and temporally standardized. Only fish sampled from the section of the rivers that extend from the confluence of the Negukthlik and Ungalikthluk Rivers to 8.5 river miles upstream on the Negukthlik River and 9.5 river miles upstream on the Ungalikthluk were used in the yearly comparisons. In addition, only samples collected in May, June and August were included in yearly comparisons. With these data adjustments, the 1989, 1990, and 2003 data sets were considered statistically comparable. Length data collected from individuals sampled in the lower river sections during comparable times in 2003 were compared to those generated in 1989 and 1990 (Lisac 1996). A Kolmogorov-Smirnov two sample test (NCSS 2001) was utilized to determine differences in length frequency among years. Relative stock densities of 2003 were compared to relative stock densities of 1989-1990 with Chi-square analysis. Cumulative length frequency distributions were generated from data collected during float trips, combining the upper and lower river sections of each river to provide a more complete length structure description. Length data collected from individuals sampled in the lower river sections were compared to length data collected from individuals sampled in the upper river sections with a Kolmogorov-Smirnov two sample test (NCSS 2001). Relative stock densities of upper river locations were compared to relative stock densities of lower river locations with Chi-square analysis. Differences were considered significant at an α level of 0.05.

Results

Rainbow trout were sampled on the Negukthlik and Ungalikthluk River from 29 May 2003 to 9 August 2003. Float trips occurred on three separate occasions on the Negukthlik River (5/29/03

– 6/01/03, 6/23/03 -6/26/03, and 8/05/03 – 8/09/03) and two separate occasions on the Ungalikthluk River (6/24/03 – 6/26/03, and 8/05/03 – 8/09/03). The mean length of fish caught in the lower section of the Negukthlik River in 2003, 1990 and 1989 was 337 mm (SD = 74, n = 143), 363 mm (SD = 112, n = 192), and 416 mm (SD = 125, n = 253), respectively (Figure 2). Mean length of rainbow trout sampled from the lower section of the Negukthlik River in 2003 was approximately 79 mm less than the mean length of rainbow trout sampled from the same area in 1989 and approximately 26 mm less than those sampled from the same area in 1990. The maximum length of rainbow trout sampled from the lower section of the Negukthlik River in 2003 (595 mm) was 82 mm less than the maximum length rainbow trout captured from the same area in 1989 (677 mm) and 105 mm less than that captured from the same area in 1990 (700 mm). Cumulative length frequency distributions showed that rainbow trout sampled from the lower portion of the Negukthlik River in 2003 were significantly different from those sampled in 1989 and 1990 (Figure 3, Table 1). The relative stock density shows a relative increase in Stock and Quality fish, a relative decrease in Preferred, and Memorable fish, and a complete lack of Trophy fish in 2003 (Figure 4). The hypothesis of relative stock density equality among years was rejected (Chi = 62.154, df = 4, $P<0.001$).

The mean length of fish caught in the lower section of the Ungalikthluk River in 2003, 1990, and 1989 was 502mm (SD = 85, n = 45), 578mm (SD = 79, n = 32), and 589mm (SD = 76, n = 26), respectively (Figure 5). Mean length of rainbow trout sampled from the lower section of the Ungalikthluk River in 2003 was approximately 87 mm less than the mean length of rainbow trout sampled from the same area in 1989 and approximately 76 mm less than those sampled from the same area in 1990. The maximum length of rainbow trout sampled from the lower section of the Ungalikthluk River in 2003 (678 mm) was 42 mm less than the 1989 maximum length rainbow trout captured from the

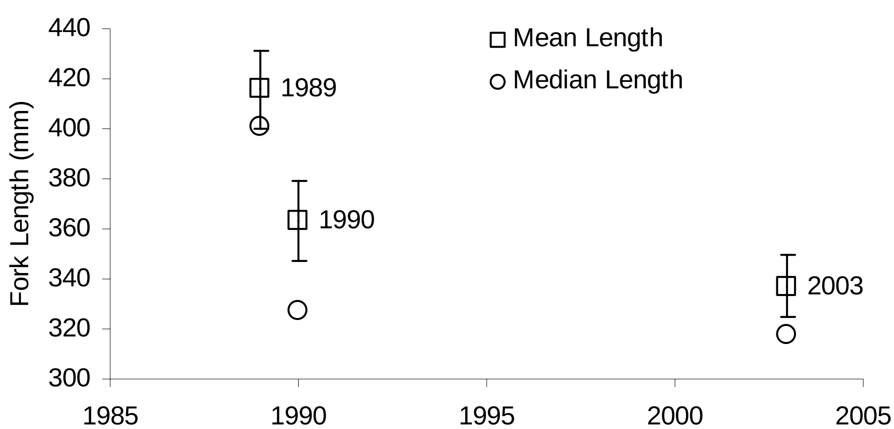

Figure 2. Mean (with 95% C.I.) and median length of rainbow trout from the lower Negukthlik River, 1989, 1990, and 2003.

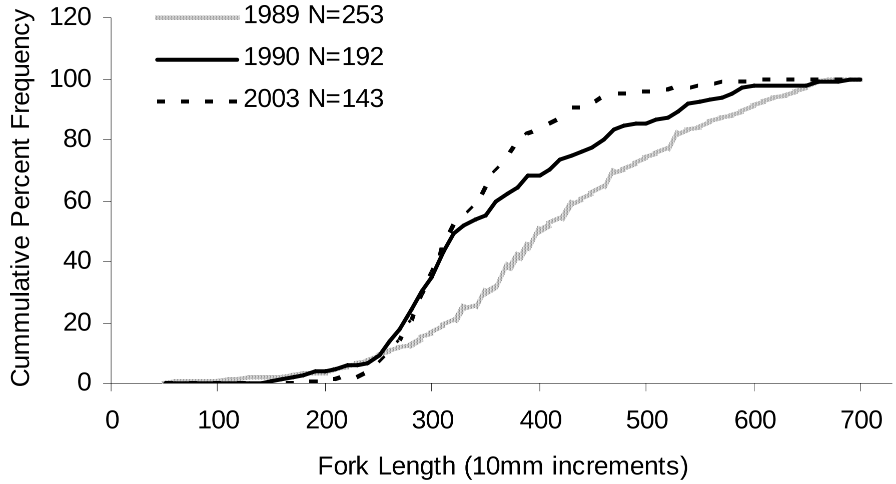

Figure 3. Cumulative percent fork length frequency of rainbow trout from the lower Negukthlik River, 1989, 1990, and 2003.

Table 1. Kolmogorov-Smirnov two-sample P value for rainbow trout captured in 1989, 1990, and 2003 on the lower Negukthlik River.

	Year	
Year	1989	1990
1990	0.000	
2003	0.000	0.021

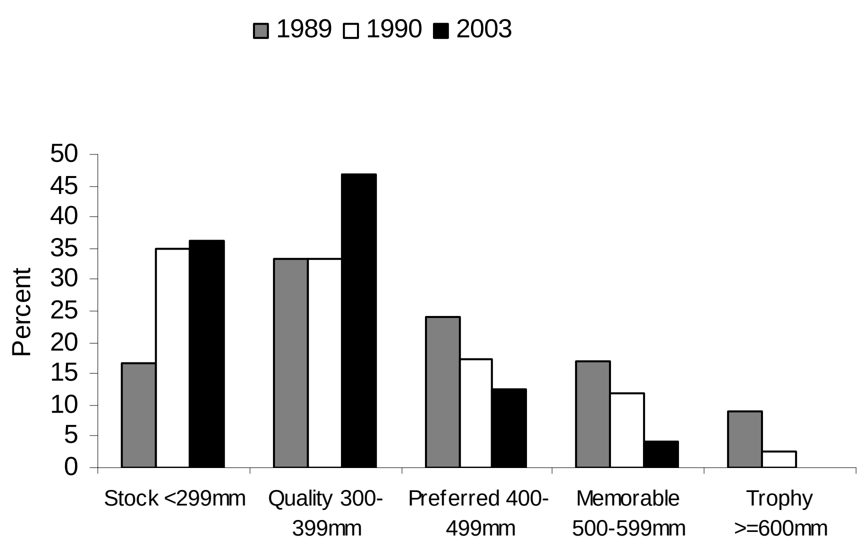

Figure 4. Relative stock density (%) of rainbow trout sampled from the lower Negukthlik River, 1989, 1990, and 2003.

same area in 1989 (720 mm) and 20 mm less than that in 1990 (698 mm). Cumulative length frequency distributions showed that rainbow trout sampled from the lower section of the Ungalikthluk River in 2003 were significantly different from those sampled in 1989 and 1990 (Figure 6, Table 2). The relative stock density shows a relative decrease in Trophy, and Memorable fish, a relative increase in Preferred and Quality fish, and a complete lack of Stock fish in 2003 (Figure 7). The hypothesis of relative stock density equality among years was rejected (Chi = 19.888, df = 4, P = 0.003).

Cumulative length frequency distributions and stock density plots of rainbow trout sampled from the entire floatable portion of the Negukthlik and Ungalikthluk Rivers were established from the data acquired solely from float trips (Figures 8, 9, 10 and 11). Fish sampled in the upper section of the Negukthlik River had a significantly different (P<0.001) cumulative length distribution than rainbow trout sampled in the lower section of the Negukthlik River (Figure 12). Fish sampled in the upper river section had mean length of 333 mm (SD = 110) while fish sampled in the lower river section had a mean length of 351 mm (SD = 71). In addition, Chi-square analysis revealed a significant relationship (Chi = 28.42, df = 4, P<0.001) between stock density and location of fish sampled (upper vs. lower river, Figure 13). The upper sections of the Negukthlik River had higher proportions of Stock, Memorable, and Trophy fish, while the lower sections of the Negukthlik River contained higher proportions of Quality and Preferred fish and lacked Trophy fish. The Kolmogorov-Smirnov two-sample test did not detect a difference between the cumulative length distributions of fish sampled in the upper river location of the Ungalikthluk River and the lower Ungalikthluk River location (Figure 14). Fish sampled in the upper river location had mean length of 519 mm (SD = 83) while fish sampled in the lower river location had a mean length of 485 mm (SD = 89). Fish sampled in the upper Ungalikthluk River had a greater proportion of Preferred, Memorable, and Trophy fish and a lower proportion of Quality fish than fish sampled in the lower Ungalikthluk River (Figure 15). Although these length class differences were observed, the hypothesis of relative stock density equality among years could not be rejected (Chi = 3.183, df = 3, P = 0.364).

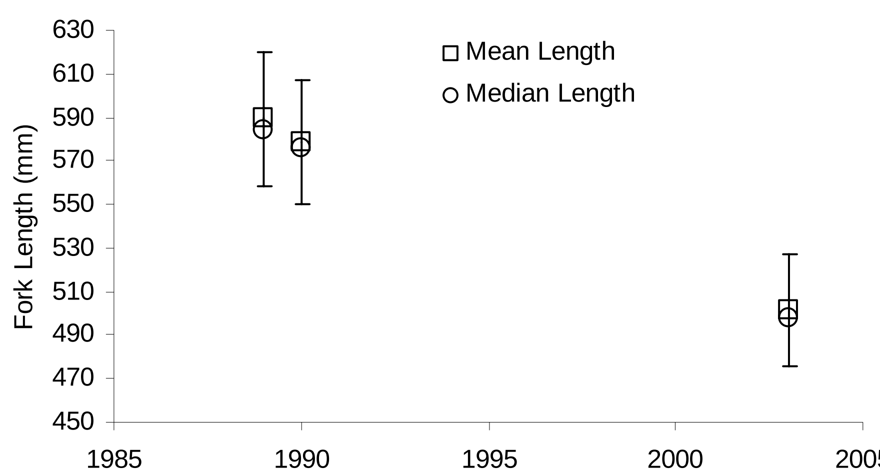

Figure 5. Mean (with 95% C.I.) and median length of rainbow trout from the lower Ungalikthluk River, 1989, 1990, and 2003.

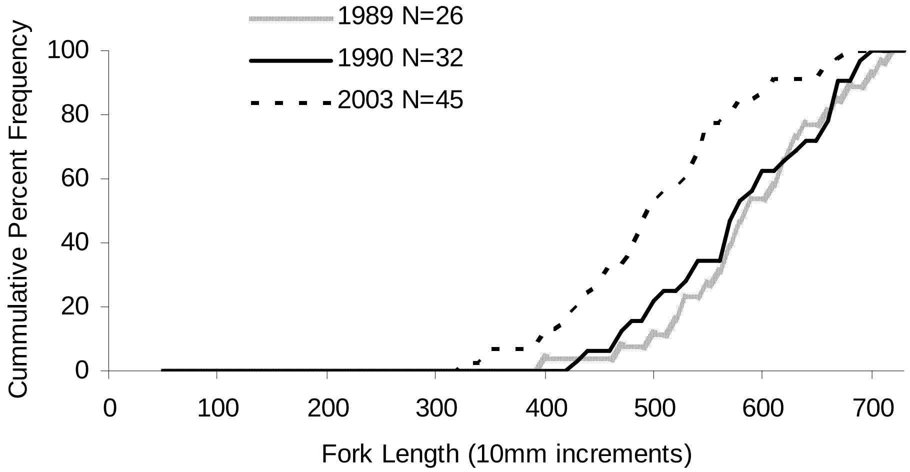

Figure 6. Cumulative percent fork length frequency of rainbow trout from the lower Ungalikthluk River, 1989, 1990, and 2003.

Table 2. Kolmogorov-Smirnov two sample P value for rainbow trout captured in 1989, 1990, and 2003 on the lower Ungalikthluk River.

	Year	
Year	1989	1990
1990	0.917	
2003	0.000	0.011

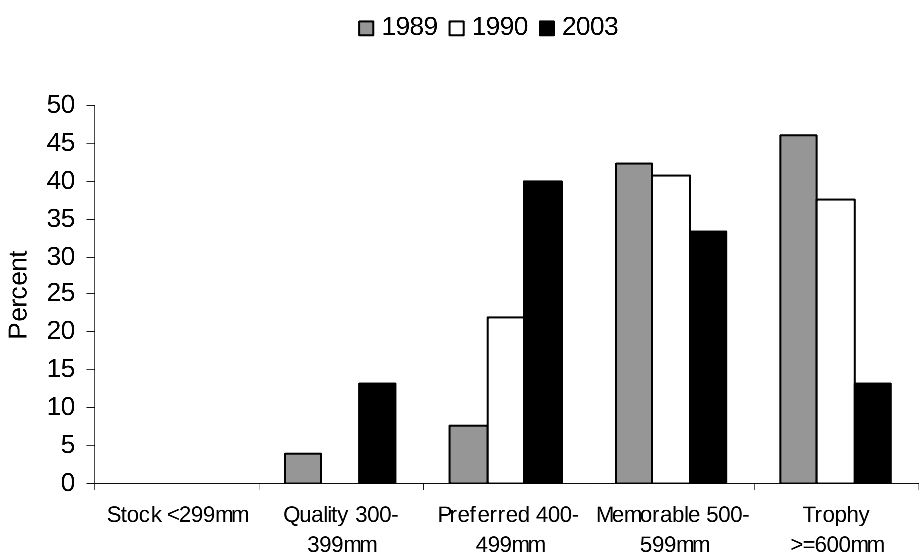

Figure 7. Relative stock density (%) of rainbow trout sampled from the lower Ungalikthluk River, 1989, 1990, and 2003.

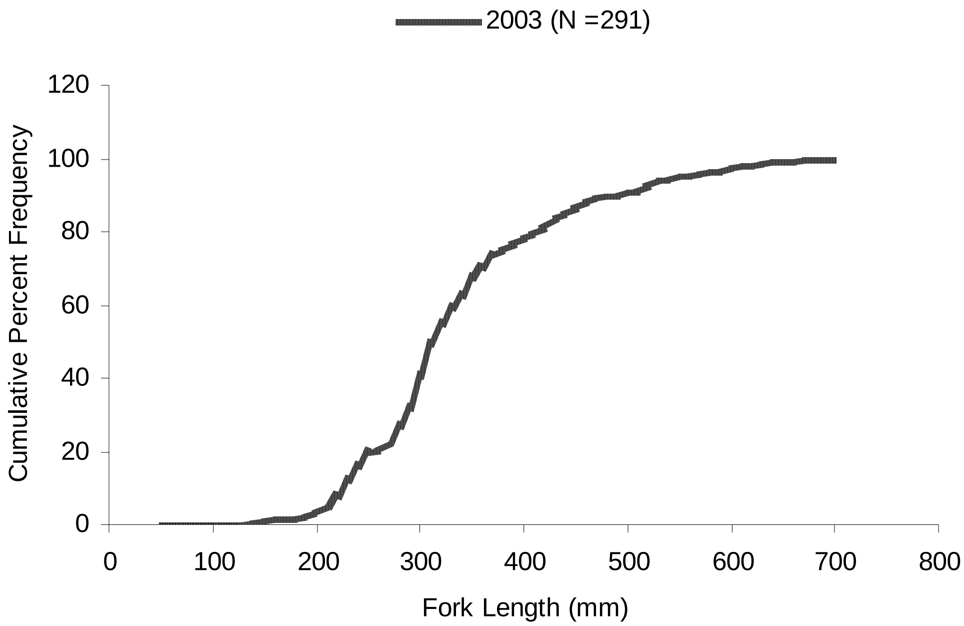

Figure 8. Cumulative percent fork length of rainbow trout from the lower and upper Negukthlik River, combined, 2003.

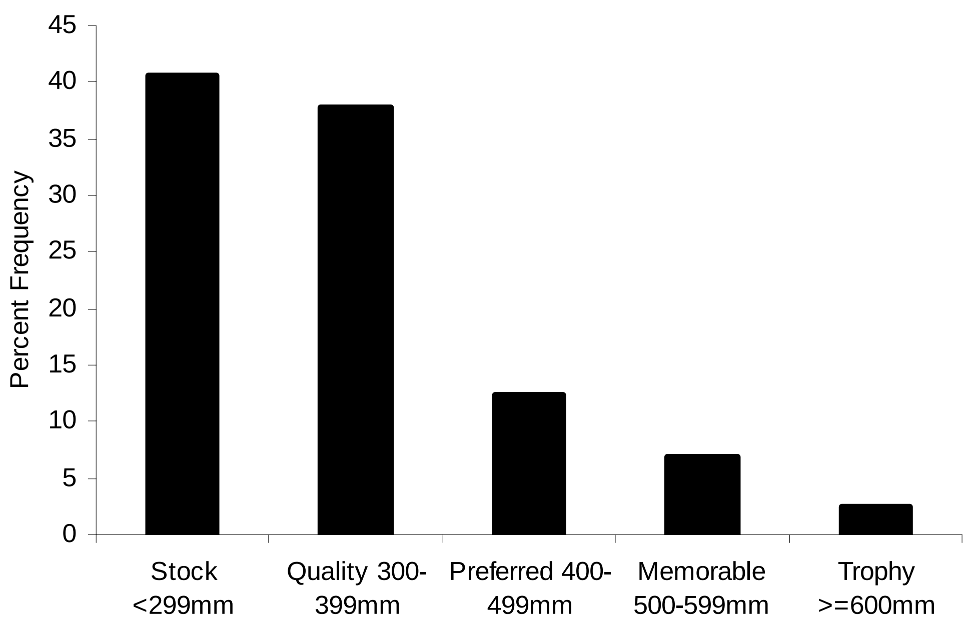

Figure 9. Relative stock density (%) of rainbow trout sampled from the lower and upper Negukthlik River, combined, 2003.

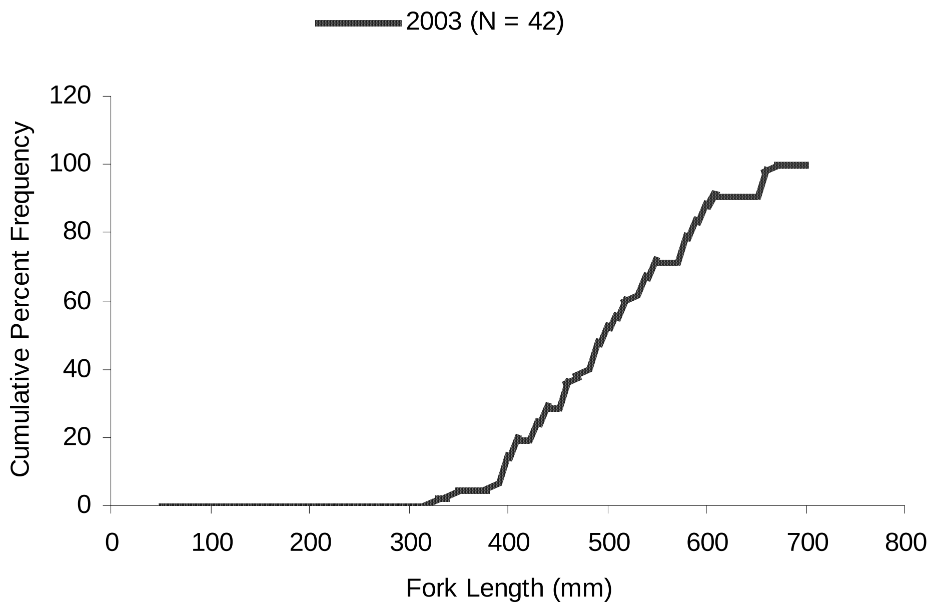

Figure 10. Cumulative percent fork length of rainbow trout from the lower and upper Ungalikthluk River, combined, 2003.

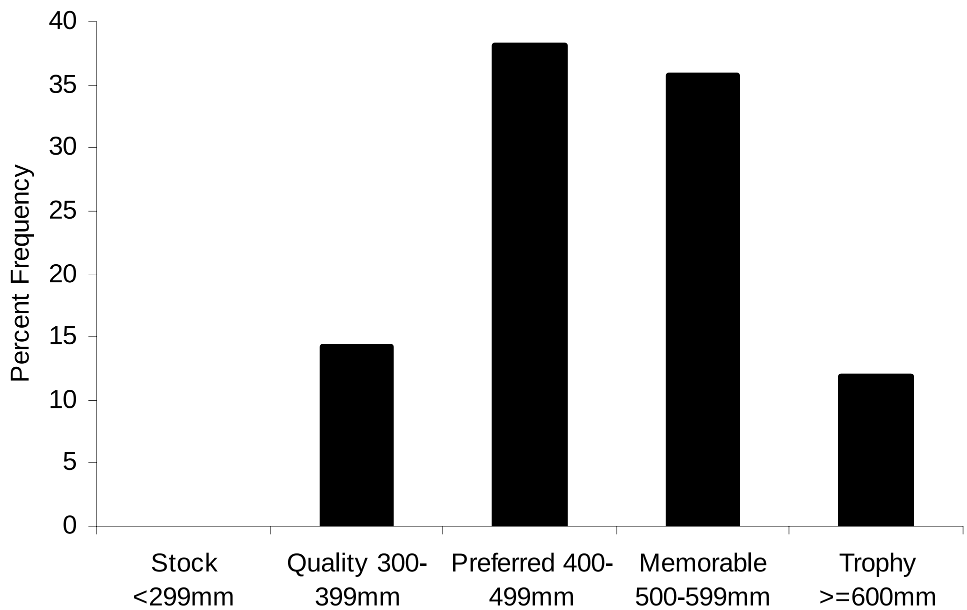

Figure 11. Relative stock density (%) of rainbow trout sampled from the lower and upper Ungalikthluk River, combined, 2003.

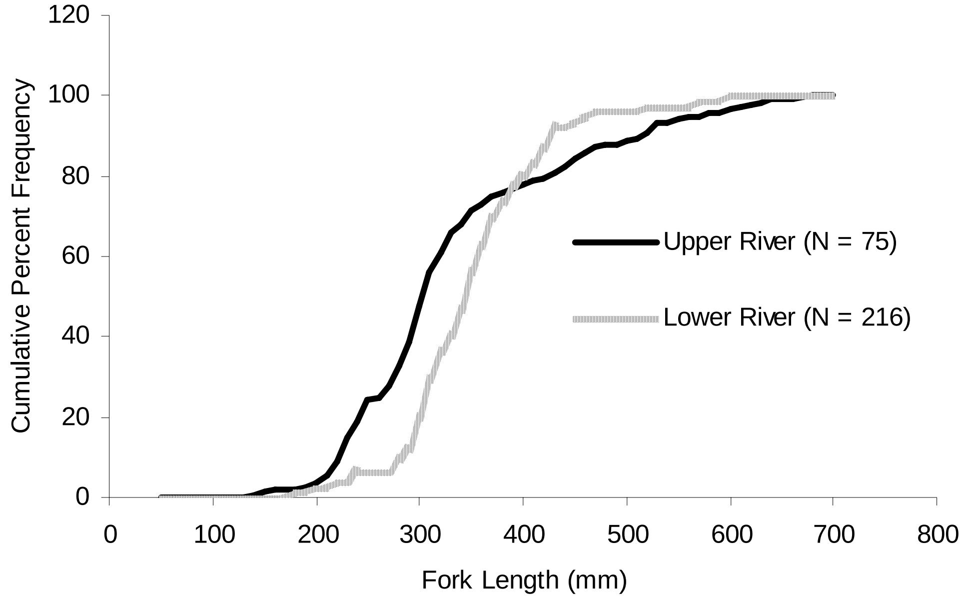

Figure 12. Cumulative percent fork length of rainbow trout from the lower and upper Negukthlik River, 2003.

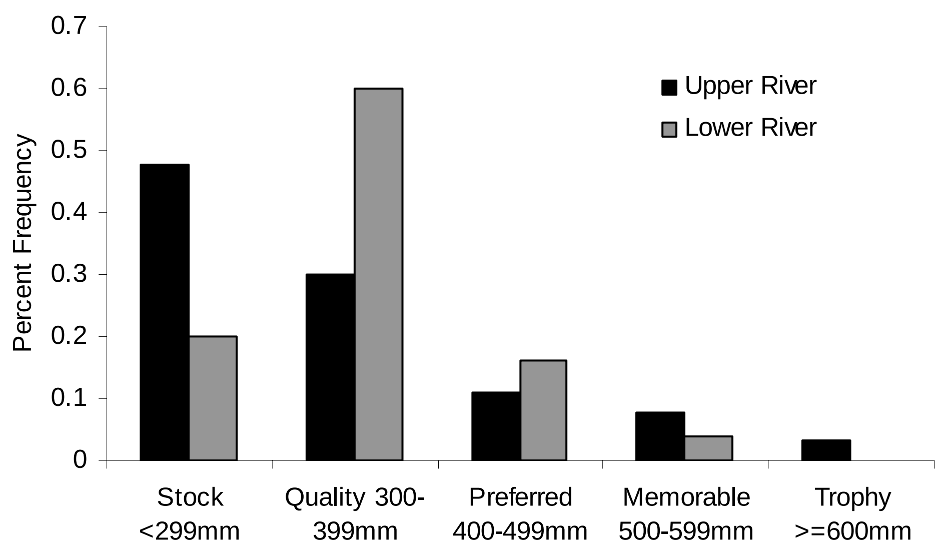

Figure 13. Relative stock density (%) of rainbow trout sampled from the lower and upper Negukthlik River, 2003.

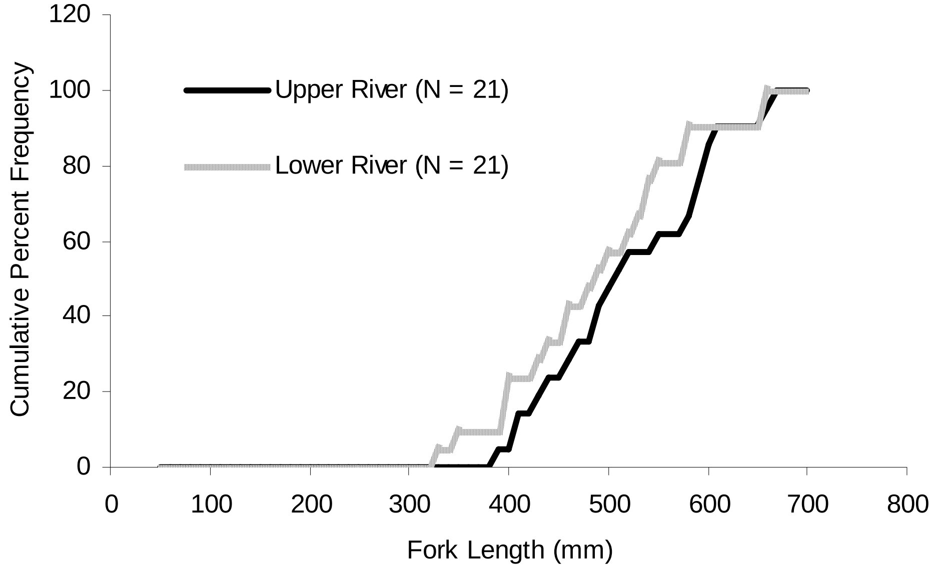

Figure 14. Cumulative percent fork length of rainbow trout from the lower and upper Ungalikthluk River, 2003.

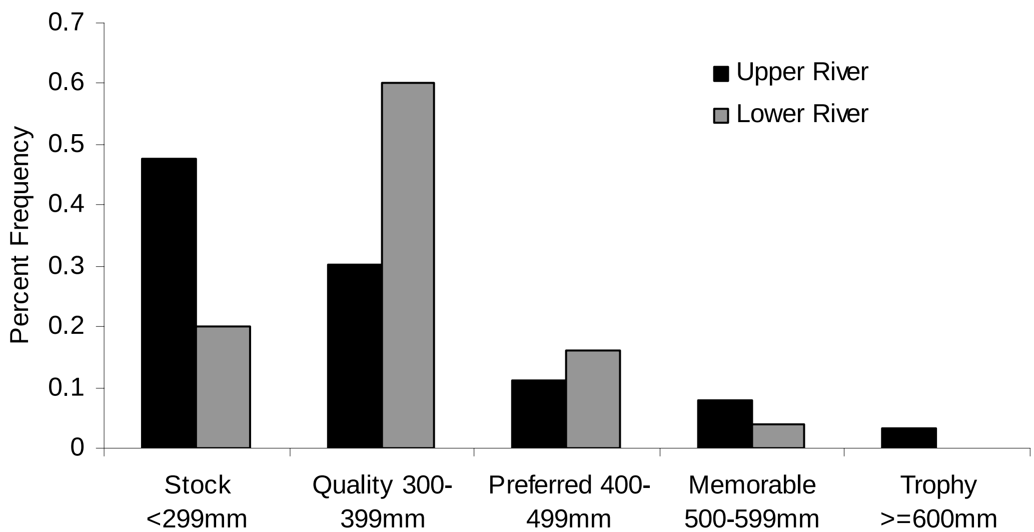

Figure 15. Relative stock density (%) of rainbow trout sampled from the lower and upper Ungalikthluk River, 2003.

Discussion

The significant difference between rainbow trout length distributions among years on the Negukthlik River appears to be mostly due to a relative decrease in the proportion of fish greater than 400 mm in length and a loss of fish greater than 600 mm in length in 2003. This change was first documented between 1989 and 1990 as a relative decrease in the proportion of fish 400 mm in length and appears to have continued into 2003. A similar but smaller pattern of change can also be observed in the Ungalikthluk River data. The 2003 rainbow trout length distribution from the Ungalikthluk River was significantly different from the 1989 and 1990 length distributions, but there was no significant difference between the 1989 and 1990 length distributions. This difference, observed in 2003 appears to be due to a relative decline in the proportion of fish greater than 500 mm in length.

The loss of larger, older fish is accepted as a possible indication of over-exploitation of fish populations, but is based on the premise that larger, older fish are selectively harvested, have a greater mortality rate in response to catch and release practices, and have a multiplicative probability of surviving multiple captures.

Larger, older fish are selectively targeted by both subsistence and sport users. Subsistence users infrequently practice catch and release angling. Instead, most fishing is done with gill nets, which tend to catch larger fish while smaller fish pass through the netting. At this time the subsistence harvest of rainbow trout in the Negukthlik and Ungalikthluk Rivers is unknown but is believed to be minimal due to the remote location of the system. Sport fishing users target larger fish through terminal tackle selection and sight fishing. There is one sport fish guiding operation on the Negukthlik and Ungalikthluk Rivers that, based on observations of refuge personnel in 2003, is believed to spend approximately 400-500 angler days on the rivers each year. In addition to this use, there is a second sport fish guiding operation that conducts float trips on the Negukthlik River.

The targeting of larger, older fish by sport fishing users is further compounded by differential effects of landing time on different size fish before release. Wydoski et al. (1976) observed a greater physiological response after 5 minutes of "playing" in larger hatchery rainbow trout than in smaller hatchery rainbow trout exposed to the same treatment. Furthermore, larger hatchery rainbow trout required twice the recovery time to return to a normal state than smaller hatchery rainbow trout. Nuhfer and Alexander (1992) observed a significant positive relationship between brook trout size and hooking mortality.

The loss of larger, older fish in a system can also be driven by the number of hooking events over the lifetime of fish. In theory, the probability of a fish surviving to a given age is partially a product of the probability of surviving each hooking event it is exposed to during the period of time up to that age. For example, if fish are exposed to 2 hooking events every year and each fish has a 90% chance of surviving each hooking event, then, under these assumptions, the probability of a given fish surviving to age 3 is 53% ($(0.9)^6=0.53$). Therefore, when a population of fish is exposed to catch and release angling or harvest, the probability of individual fish surviving to a given age decreases.

Although there is evidence supporting the loss of larger, older fish as a pattern expected of exploited fish populations (Willis et al. 1994, Webb and Ott 1991, Jennings et al. 1986), linking cause and effect is not possible. Long term patterns of fishing pressure can easily be confounded with other larger scale changes such as global climate change and decreased salmon escapements. Additionally, natural population fluctuations could result in changes in the estimated size structure. For example, a high recruitment year within the recent past could increase the absolute abundance of the smaller size class fish and may provide similar results to this study when looking at relative comparisons. Little is known of these natural variations in populations and less is known of the temporal scale from which observations should be made. In the case of this study, larger changes in the mean length of rainbow trout sampled from the Negukthlik River were observed between 1989 and 1990 rather than between 1990 and 2003.

Additionally, the biological significance of these changes in length structure cannot be determined through this study. The length structure of the rainbow trout population in 1989 was utilized as a reference condition for comparison purposes and to detect trends, but there is a lack of evidence to support this as the average or modal state of the fish population. Because populations are naturally stochastic and a snap shot picture lacks any information of natural variability, these data only represent a portion of the full story. Therefore, caution must be taken when drawing conclusions from infrequent comparisons. Further research is needed to understand the natural variability of length composition and to determine the best temporal scale for monitoring studies that utilize length composition as a response variable of rainbow trout populations.

Although data among years were standardized to limit variability, sampling bias may have affected the outcomes of length analysis. Hook and line sampling has been the accepted method for evaluating most rainbow trout populations in southwest Alaska, but variability can exist between anglers through their selections of gear and experience. Although lure types and sizes similar to those used in 1989 and 1990 were utilized, different anglers were used between the studies. These types of inconsistencies can compound variability in the data and affect the ability of the methods to detect trends.

Conclusion

The rainbow trout population of the lower Negukthlik and Ungalikthluk Rivers appears to have experienced a relative decrease of larger size class fish from 1989 to 2003. Although the focus of this discussion has been placed on the potential influence of the current rainbow trout fishery, the cause of these changes is likely multiple factors. Fishery use regulations are based on the vulnerability of the fish populations regardless of the specific causes of population changes. To determine how conservative these regulations need to be to preserve the natural diversity of the rainbow trout of the Negukthlik and Ungalikthluk Rivers, continued monitoring is warranted. Specific efforts should be made to determine the vulnerability of the rainbow trout population of the Negukthlik and Ungalikthluk Rivers.

Future studies should focus on verifying the number of genetically isolated populations within the system, identifying their spawning habitats, and estimating the abundance of these populations. Although the lower Negukthlik River has been identified as a spawning location (Lisac 1996) and is believed to be the only spawning location of rainbow trout inhabiting the Negukthlik and Ungalikthluk Rivers, little is known of the life history characteristics of fish in the upper reaches of the Negukthlik River. Spawning size fish are known to occur in the upper reaches of the Negukthlik River, but there is insufficient telemetry data from Lisac (1996) to describe their seasonal movements or lack thereof into the lower river spawning area. By better describing these characteristics of rainbow trout in these systems, management actions can be focused to more effectively and efficiently protect the historical state of these fish while providing optimal opportunities for subsistence and sport uses.

Additionally, monitoring efforts should continue in the future to provide a more complete picture of population trends. Only through multiple year studies can the natural variability of population abundance and length composition be separated from abnormal fluctuation and trends. This separation is necessary for accurate evaluation of management actions in the future.

Acknowledgements

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