2016 ARCTIC YUKON KUSKOKWIM SUSTAINABLE SALMON INITIATIVE PROJECT FINAL PRODUCT[1]

JUVENILE CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA)* EARLY ECOLOGY, PREY AND CONDITION ON THE YUKON DELTA, ALASKA

by:

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August 31, 2018

[1] Final products of AYK Sustainable Salmon Initiative-sponsored research are made available to the Initiatives Partners and the public in the interest of rapid dissemination of information that may be useful in salmon management, research, or administration. Sponsorship of the project by the AYK SSI does not necessarily imply that the findings or conclusions are endorsed by the AYK SSI.

ABSTRACT

Juvenile Chinook salmon on the Yukon River undertake one of the longest fish migrations in the world, travelling over 3000 kilometers from spawning grounds in Canada to the marine waters of the Bering Sea. Evidence suggests that much of the variability in Yukon River Chinook salmon production occurs prior to the end of the first summer at sea, either during freshwater rearing, downstream migration, or entry into the marine environment. Prey availability and prey quality are important factors in juvenile Chinook salmon growth and condition. This research investigated spatial and temporal patterns in prey consumption and availability on the Yukon River Delta. Results suggest that while there are limited spatial differences in availability, prey varies seasonally and juvenile Chinook exhibit prey selectivity. Comparisons of the results of this study with data from prior sampling years indicates that juvenile Chinook salmon in 2016 had lower stomach fullness and lower energy density than Chinook from prior years. Additional years of prey sampling is needed to identify factors that affect prey availability.

PRESS RELEASE

New report on juvenile Chinook prey dynamics on the Yukon Delta

Scientists from the National Oceanic and Atmospheric Administration and the University of Alaska Anchorage have teamed up with the Yukon Delta Fisheries Development Association to investigate the diets of outmigrating juvenile Chinook salmon in the lower Yukon River. This research examined the spatial and temporal availability of food resources and the quality of food items that juvenile Chinook salmon eat as they migrate out of the river and into the ocean.

In 2016, biologists sampled juvenile fish and drift invertebrates in the Yukon River from May through July. Juvenile Chinook salmon stomach contents were examined to identify recently consumed food items. The condition of both the Chinook salmon and their fish prey was evaluated by bomb calorimetry – the same process used to determine the calorie content of food! The amount of lipid, or fat, in the aquatic insects that drift down river was also investigated.

The researchers found that drift insect communities changed over time, but were not very different from one part of the delta to another. Juvenile Chinook salmon consumed a variety of stream fishes, including chum salmon, pink salmon, cisco, and whitefish; for a short time in the early summer, but these species rapidly outgrew their susceptibility to predation. Juvenile Chinook salmon showed preference for specific food items that were not always the most abundant or highest quality.

Juvenile Chinook in 2016 had much lower stomach fullness and energetic condition than juvenile Chinook from 2014 and 2015. With only one year of prey data, it is too early to determine if food

availability played a role. This research provides insight into food availability and diets of juvenile Chinook salmon during a critical life stage.

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PROJECT EVALUATION

The proposed research sought to address the question: How do outmigration timing, habitat use, and prey quality affect juvenile Yukon Chinook salmon diet, condition and size? The project objectives were to evaluate:

- the composition, spatial variation, and temporal variation in fish and invertebrate prey for juvenile Chinook salmon in tributary and delta front/prodelta habitats
- the quality (energy density) of dominant juvenile Chinook salmon prey
- whether there is a relationship between prey quality/composition and juvenile Chinook salmon size and condition during the summer
- juvenile Chinook salmon spatial distribution and habitat use in relation to fish and invertebrate prey communities in Yukon River tributary and delta front/prodelta habitats.

- spatial and temporal differences in juvenile Chinook salmon condition, size and energy content.

The following discussion of findings comes from the NOAA Technical Memorandum, Diets and prey items of juvenile Chinook salmon on the Yukon Delta, August 2018.

Our research found evidence of temporal, but not spatial, variation in prey resources in the Yukon River. Other than amphipods, we did not capture the prey identified from juvenile Chinook diets on the delta front. Fish prey in diets was tentatively identified as sand lance. Although our sampling gear captures a large number of larval fish species and small invertebrates, no sand lance have been identified. It is possible that the diet items, being partially digested, were a different species of fish larvae. Future research should investigate alternative methods of prey sampling, as well as options such as gastric lavage which could potentially allow identification of diet items in the field.

Energy density of prey items was evaluated for fish prey, but the sample sizes for invertebrate drift were too small to use bomb calorimetry. As a result, we were able to obtain lipids for the invertebrates, but not energy density. Most of the invertebrate drift samples were preserved in ethanol in the field to prevent decomposition of small invertebrates. Comparison of this method to sample freezing showed little loss of quality from frozen samples (Dustin Merrigan, personal communication). Future sample collection will involve freezing all samples so that enumerated invertebrates can be used for laboratory processing. Future processing will also involve proximate composition to allow for comparison of lipid and protein between prey items.

We found juvenile Chinook salmon stomach fullness and energy density to be lower than in prior sampling years. Stomach fullness was not directly related to the ratio of invertebrate versus fish prey consumed; however, changes in abundance of drift taxa were noted. By freezing drift samples rather than preserving them in ethanol, as recommended above, it may be possible to compare changes in community composition and energetic quality of invertebrates to fish condition to determine whether prey quality varies. Additional years of prey data collection are needed to evaluate trends in the context of interannual variability in prey and Chinook abundance.

Neither juvenile Chinook abundance nor abundance of prey items varied substantially by tributary (habitat). It appears that prey is similarly abundant throughout the river. Spatial differences were not noted in the body size or energy density of juvenile Chinook in the river. Both body size and energetic condition varied temporally. In 2016, energy density of juvenile Chinook was below levels observed in prior sampling years with the largest divergence beginning near the end of June and early part of July. Stomach fullness was also lower in 2016, suggesting that prey availability might play a role in low body condition. However, prey information in lacking for prior study years. Additional years of prey data collection are needed to determine the extent to which prey is a factor in juvenile Chinook condition. Spatial difference in stomach fullness were observed in Chinook captured on the delta front.

DELIVERABLES

The following deliverables are associated with this project:

Reports:

NOAA Technical Memorandum, Diets and prey items of juvenile Chinook salmon on the Yukon Delta, August 2018. (*Once finalized, this Tech Memo will be published on the Alaska Fisheries Science Center's webpage*)

ADF&G Memorandum: Genetic Analyses of Yukon River Delta Chinook Salmon Smolt, 2016 Summary Report

Semiannual progress reports:

SAPR Miller Yukon Project # 1550, April 1, 2016 – June 30, 2016
SAPR Miller Yukon Project # 1550, July 1 – December 31, 2016
SAPR Miller Yukon Project # 1550, Jan 1 – June 30, 2017
SAPR Miller Yukon Project # 1550, July 1 – December 31, 2017
SAPR Miller Yukon Project # 1550, Jan 1 – June 30, 2018

Data

Access database of 2016 catch and in-situ temperature

Presentations:

Katharine Miller and Ashwin Sreenivasan, Variability in Juvenile Yukon River Chinook salmon Energy Content During Outmigration: Does Water Temperature Play A Role? 2017 Lowell Wakefield Fisheries Symposium: Impacts of a Changing Environment on the Dynamics of High-Latitude Fish and Fisheries. Anchorage, AK May 9-11, 2017

Katharine Miller and Katie Howard, Estuarine Fish Ecology of the Yukon River. Western Division American Fisheries Society Annual Meeting, Anchorage, AK May 21-25 2018.

Posters:

Rebecca Shaftel, Dan Bogan, Dustin Merrigan, and Katharine Miller, Juvenile Salmon Diets on the Yukon River Delta. Western Division American Fisheries Society Annual Meeting, Anchorage, AK May 21-25 2018.

PROJECT DATA SUMMARY

Data from this project is provided within one year of collection to InPort. InPort is the centralized repository of documentation (*metadata*) for NMFS data and the tools to access the data, as required by the Data and Information Policy Directive and the Data Documentation Procedural Directive. As NMFS's official *metadata* catalog, InPort is the single most important component in NMFS Enterprise Data Management (EDM) architecture which enables our customers to find, access and understand our vast array of data and information.

Data are stored in a Microsoft Access database comprised of four tables: Site, Sample, Set, and Catch. Field descriptors for these tables are as follows:

Site Table

SiteID	A number that identifies a unique Site in space. Links Data_Sites to other tables.
Locale	General sampling area for purposes of Fish Atlas
Station	Name of the sampling station
Lat	Mean center of all recorded start longitude coordinates (decimal degrees west) at station
Lon	Mean center of all recorded start latitude coordinates (decimal degrees north) at station

Samples table

Site_ID	A number that identifies a unique Site in space. Links Data_Sites to other tables.
Sample_ID	"A number that identifies a unique sampling effort (e.g., set, tow, haul) in space and time. Sample IDs are combinations of numeric date and station names"
Date	Date that sampling took place: month/day/year as xx/xx/xxxx.
Trib	"Yukon River distributary in which the sampling occurred. SM=South Mouth, MM= Middle Mouth, NM= North Mouth"
Station	Station name or abbreviation
Investigators	Scientists and crew
Stat_Time	Time (24 hour) sampling at a station starts.
Temp	Water temperature in degrees C
Lat_Start	Latitude (decimal degrees north) at start of tow
Lon_Start	Longitude (decimal degrees west) at start of tow
Lat_end	Longitude (decimal degrees west) at start of tow
Lon_end	Longitude (decimal degrees west) at end of tow
Comments	Comment(s) about station sampling
Gear	"Sampling gear used. Examples: 2BOAT = two-boat tow net, SCOOP = smolt scoop, PUSH = push trawl, SEINE - beach seine"

Set Table

Set_ID	"A number that identifies a unique trawl or gear set in space and time. Set IDs are combinations of numeric date, station name and set number"
Sample_ID	"A number that identifies a unique sampling effort (e.g., set, tow, haul) in space and time. Sample IDs are combinations of numeric date and station name."
Set	Sequential set number
Depth_start	River depth at the start of the sampling set
Depth_stop	River depth at the end of the sampling set
Flow_Start	Mechanical flow meter number at the start of the set
Flow_Stop	Mechanical flow meter number at the end of the set
Flow_Diff	Calculated difference between the starting and ending flow meter numbers = number of rotations
Flow_net	Area swept calculated as the number of rotations of the flow meter X 0.0269 meters/rotation X 6.8 m net width
Comments	Comment(s) about station sampling

Catch Table

Set_ID	A number that identifies a unique trawl or gear set in space and time
Seq	Sequence of data entry
Set	Sequential set number
Species	Common species name of species caught
Tally	Number of fish caught per species
Age	Recorded age of fish caught
Length	"Length (mm) of an individual fish. Depending on species, either fork length or total length."
Weight	Weight (g) of an individual fish.
SIN	Specific Identification Number (SIN) assigned to individual fish collected for energetics or diet analysis.
GSI	"Genetic Sample Identification (GSI) number assigned to individual fish sampled for genetic material. Top portion of caudal fin taken for coho and chinook salmon, and entire fish collected for chum salmon."
E/D/V/M	"Indicates if fish collected for Energetics, Diet, Voucher, or Metabolomic analysis. In the field, energetics fish frozen, and diet fish preserved in 10% buffered formalin."
P	Indicates whether digital photo taken.
Comments_post	Comments by laboratory and database reviewers
Comments_field	Comments from biologist in the field

APPENDICES

NOAA Technical Memorandum, Diets and prey items of juvenile Chinook salmon on the Yukon Delta, August 2018.

RNA/DNA Growth Index Laboratory Study Report

ADF&G Memorandum: Genetic Analyses of Yukon River Delta Chinook Salmon Smolt, 2016 Summary Report