Trophic Relationships Of Juvenile Pacific Salmon and Associated Forage Fish In Coastal Waters Off Oregon and California

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INTRODUCTION

Recruitment and return of Pacific salmon to northeast Pacific rivers have been linked to their ocean survival, particularly during juvenile entry and residence within the marine environment. Whether this is a function of top-down (i.e. predation) or bottom-up (primary-secondary production and competition) control remains to be known. The objective of this study is to measure the spatial and temporal nature of the pelagic food web during the spring-summer transition period, and relate this to salmon growth and survival. The results presented here are from diet analyses of Pacific salmon and associated fish species from the GLOBEC 2000 sampling period.

METHODS

We collected fish for stomach content analysis and zooplankton from each station to describe and quantify the diets of different fish species and their prey field.

Sampling Frequency
Surveys were conducted over two time periods consisting of a mesoscale grid along the GLOBEC transects.
- Early summer (May 29-June 18, 2000)
- Late summer (July 28 – August 15, 2000).

Fish Collection
- Use of chartered fishing vessel (F/V Sea Eagle)
- Sampling gear - Nordic 264 rope trawl (Nor'Eastern Trawl Systems, Inc.)
  - Surface tows performed at each station
  - Tow duration – 30 minutes.
- Species of interest – Abundant species, and those associated with catches of juvenile salmon.
  - Forage fish species – Pacific herring, smelts (surf and whitebait), Pacific sardine, northern anchovy, and Pacific saury
  - Other potential predators and competitors of salmon – Jack mackerel, Pacific mackerel, sablefish, adult salmon, and sharks (blue and spiny dogfish).

Zooplankton Collection
- A neuston tow with a 1-m² mouth containing 333 µm mesh net was towed for 5 min ou each station.

Analysis of Diets and the Prey Field
- Identification of prey to lowest possible taxon, and quantification of number and dampı
- Measure diet overlap between different species - Percent overlap
- Prey contribution to diets - Percent Index of relative Importance (IRI = %F (%N + %ν. ,,

RESULTS

Percent Index of Relative Importance (TABLE 1)

- Euphausiids are a marketed contribution to the diets of all salmon species, Pacific saury, and Jack mackerel.
- Decapod larvae, invertebrate eggs (approx. 350 µm diameter) and calanoid copepods contributed more to the diets of surf smelt, whitebait smelt, and Pacific herring.
- Chinook were the most piscivorous of all fish examined for the two sampling periods.

Diet Overlap (by cruise date)

- June (TABLE 2A)
  - Steelhead and coho salmon had the highest percent overlap (83%) of their diet.
  - Chinook salmon diet overlapped steelhead and coho diet by about the same amount (36 and 39%, respectively).
  - Overlap among most other species was less than 30%.
- August (TABLE 2B)
  - Coho and Chinook salmon had the highest percent overlap (82%) of their diet.
  - Jack mackerel and surf smelt had the highest overlap with salmon and other fish species.

Selectivity (FIGURE 1)

Results from identification and enumeration of prey within salmon stomachs and neuston samples from selected stations (i.e., where stomachs were full and in fresh condition) reveals a general pattern of abundance in prey from the neuston coinciding with relative abundances of prey in the stomachs.

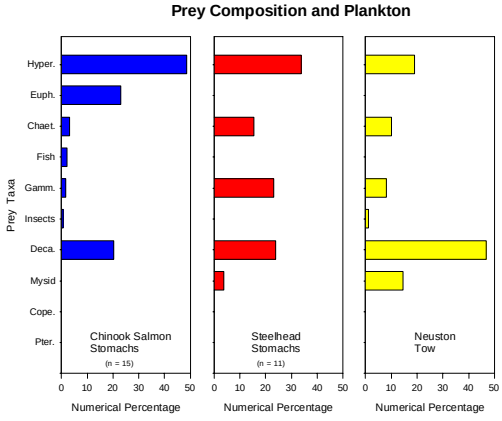

FIGURE 1. Coomparison of Chinook and steelhead diets to neuston tows.

TABLE 1. Percent Index of Relative Importance (IRI) of major prey groups to the diets of fish. Red lettering denotes prey groups that contributed >10% IRI to the diet of at least one fish species.

TABLE 2. Diet overlap of fish collected May-June (A) and July-August (B) 2000.

Diet Overlap for Major Nekton Species in June 2000 Based on Weight Composition

A	Chinook Salmon	Coho Salmon	Steelhead	Pacific Saury	Pacific Herring	Surf Smelt	Whitebait Smelt
Chinook Salmon	---						
Coho salmon	36.3	---					
Steelhead	39.5	83.3	---				
Pacific Saury	13.5	13.6	15.9	---			
Pacific Herring	36.4	32.7	22.5	22.6	---		
Surf Smelt	22.1	11.6	12.1	8.9	34.1	---	
Whitebait Smelt	11.7	15.7	14.9	13.5	21.8	23.6	---

Diet Overlap
< 30
30-60
>60

Diet Overlap for Major Nekton Species in August 2000 Based on Weight Composition

B	Chinook Salmon	Coho Salmon	Steelhead	Pacific Mackerel	Jack Mackerel	Surf Smelt	Whitebait Smelt
Chinook Salmon	---						
Coho salmon	82.6	---					
Steelhead	32.7	35.9	---				
Chub Mackerel	19.7	16.4	22.0	---			
Pacific Mackerel	31.7	27.6	45.1	36.4	---		
Surf Smelt	30.2	31.3	20.2	10.1	20.3	---	
Whitebait Smelt	14.8	8.5	5.6	4.0	7.1	4.0	---

Diet Overlap
< 30
30-60
>60

FUTURE DIRECTIONS

Diet Analysis

- Expansion of diet analysis to other fish species.
- Continued collection and analysis of fish and zooplankton.
- Measurement of prey size for estimation of size and taxonomic-specific feeding guilds.

Stable Isotope Analysis – $\delta^{13}C$ and $\delta^{15}N$ measurement of POM, zooplankton and fish.

- Confirm trophic levels and feeding guilds as observed by stomach content analysis
- Measure upwelling-induced offshore movement of POM and zooplankton using nearshore-offshore gradients in $\delta^{13}C$ enrichment.
- Laboratory examination of isotope turnover rates in zooplankton (Acartia clausi) and fish (Pacific herring) to confirm field observations.

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