■ Interagency Ecological Program for the Sacramento-San Joaquin Estuary ■

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IEP NEWSLETTER

VOLUME 12, NUMBER 1, WINTER 1999

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Density Dependent Growth and Diet Changes in Young-of-the-year Striped Bass (Morone saxatilis) in the Sacramento-San Joaquin Delta

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Introduction

Kimmerer (1997) presented analyses that suggest that the mortality and survival of young-of-the-year striped bass (Morone saxatilis) in the Sacramento-San Joaquin Delta is density dependent. If density-dependent mortality and survival are observable then density-dependent growth could also be observed in the same population.

To investigate this issue I examined the growth rates of young-of-the-year striped bass, between midsummer and fall, for density dependence. I also examined past and recent diets of young-of-the-year striped bass caught in the Department of Fish and Game (DFG) Fall Midwater Trawl Survey (FMTS) to determine if diet changes have occurred.

Methods

I calculated growth rates for young-of-the-year striped bass caught in the September, October, November, and December FMTS from 1969 to 1997 except for: November, 1969, September and December, 1976, (no FMTS conducted), 1974 and 1979 (no FMTS done for the entire year), 1983 (no young-of-the-year 38 mm index calculated), and 1995 (young-of-the-year 38 mm index was estimated but not measured). I used the following equation to calculate the growth rate for each month:

Growth rate (mm/day) = [Average fork length (in a given month) - 38 mm]/(Midday of survey - Date of 38 mm townet index)

I regressed the growth rate on the 38 mm young-of-the-year index calculated from the DFG Midsummer Townet Survey. Density-dependent growth would be suggested if the slope parameter was negative and if the P value was less than or equal to 0.05. All four months were analyzed to determine if there was a particular time that growth rate became density dependent.

I analyzed diet data on young-of-the-year striped bass caught in the September, October, and November FMTS for the two periods 1968-1972 and 1996-1997. I summed these data by month for each time period and calculated the total number of bass sampled, the percentage of striped bass with food in the stomach, and the average number of major prey items per striped bass with food in the stomach.

Results

The only statistically significant linear relationship was found between the November growth rate and the 38 mm young-of-the-year index (Figure 1):

Growth rate (mm/day) = 0.526 - 0.001*(38 mm index) (standard error) (0.019) (0.0005) with r^2 (adjusted) = 0.22 and $P \leq 0.0106$ (with 23 degrees of freedom).

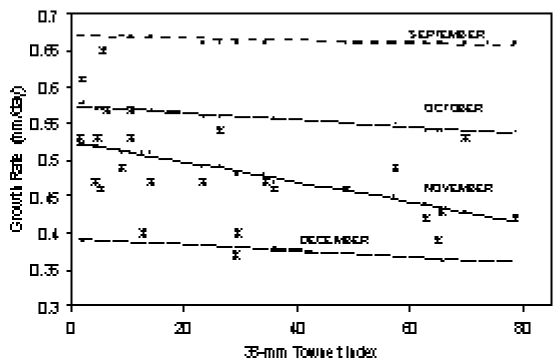

Figure 1 Linear relationship of growth rate and 38 mm Townet Survey Index of young-of-the-year striped bass (Morone saxatilis) caught in the September, October, November, and December midwater trawl. Calculated growth rates for the November FMTS are displayed as *.

Table 1 Percent of young-of-the-year striped bass (Morone saxatilis) with food in the stomach and average number of major food items for striped bass caught in the midwater trawl for the months September, October, and November in the years 1968-1972 and 1996-1997 [a]

			Food Items					
			Mysids			*Amphipods*		
Years and Months	*Number of Stomachs*	*Percent with Food*	*Neomysis*	*Acanthomysis*	*Other*	*Corophium*	*Gammarus*	*Other*
1968-1972								
Sep	1,627	80	3.54	0.00	0.00	2.67	0.00	2.75
Oct	1,737	74	5.63	0.00	0.00	1.11	0.00	0.00
Nov	1,430	55	3.12	0.00	0.00	0.60	0.00	3.80
1996-1997								
Sep	291	63	0.02	0.68	0.10	0.56	11.37	0.00
Oct	155	73	0.00	0.73	0.90	0.37	24.47	0.00
Nov	79	63	0.00	1.89	0.41	0.87	2.30	0.00

[a] No data available for November, 1969. All food items are for bass that had food in the stomach.

A statistically significant quadratic relationship was found between the December growth rate and the 38 mm young-of-the-year index [R^2 (adjusted) = 0.19, F = 3.795 with 2 and 22 degrees of freedom]. However, this relationship is not biologically realistic and was not considered further.

The diet analysis revealed that there has been a shift in young-of-the-year striped bass diet and that young-of-the-year striped bass (in the size range caught by the FMTS) are able to utilize non-native prey species (Table 1). During the earlier period (1968-1972) striped bass diet was primarily composed of the mysids, Neomysis spp., and amphipods, Corophium spp. and others. During the more recent period (1996-1997) the diet had shifted to other sources; mainly the introduced mysids Acanthomysis spp., and greatly towards the introduced amphipods Gammarus spp. with some contribution from Corophium spp. In the most recent period Gammarus decreased by an order of magnitude from October to November (see Table 1).

Food consumption, as indicated by the percentage of bass with food in the stomach, did not vary greatly between time periods. It was higher during the earlier period for September and October but lower in November (see Table 1).

Discussion

Meaningful density dependent growth of young-of-the-year striped bass is not evident from this study. The growth rate analysis for November is suggestive; however, the slope and r^2 values were small. Hence, these results do not concur with Kimmerer (1997) findings of density-dependent mortality.

Density dependence suggests a carrying capacity is being exceeded. Competition for food is the most likely cause of density dependence; however, significant correlation between food resources and carrying capacity are not evident. Although Neomysis (a staple food for striped bass in the earlier period) has declined (Orsi and Mecum 1996) other food items have taken its place and the percentage of striped bass with food in the stomach is not much different between the two time periods (see Table 1). The effect these new food sources have had on carrying capacity and growth have yet to be determined.

This research was done for the IEP/COMPMECH Striped Bass Workshop held on 10 and 11 August 1998, in Stockton, California.

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Feyrer F, and R Baxter. Fecundity and egg size of splittail. California Fish and Game 84:119-126.

Gartz R, R Fujimura, L Miller, and P Smith. Measurement of larval striped bass, Morone saxatilis, net avoidance using evasion radius estimation to improve estimates of abundance and mortality. Accepted by the Journal of Plankton Research.

Orsi JJ, and S Ohtsuka. Introduction of the Asian copepods Acartiella sinensis, Tortanus dextrilobatus (Copepoda:Calanoida), and Limnoithona tetraspina (Copepoda:Cyclopoida) to the San Francisco Estuary, California, USA. Accepted by Plankton Biology and Ecology.

Other Publications

Orsi J (Editor), R Baxter, S DeLeon, K Fleming, and K Hieb. Report on 1980-1995 fish, shrimp, and crab sampling in the San Francisco Estuary. IEP Technical Report 63 (Due for publication in 1999).

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