

FOOD HABITS OF WHITE STURGEON, *ACIPENSER TRANSMONTANUS*, IN SAN PABLO AND SUISUN BAYS, CALIFORNIA¹

by

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The diet of white sturgeon is described based on an examination of the contents of 355 stomachs. Benthic invertebrates dominated the diet, with several species of clams being the most consistent important item. Barnacles, crabs and shrimp were important at times, but annelids were seldom eaten even though they are numerous in the area. Seasonally herring eggs were a major food, and several species of small fishes were sometimes eaten.

INTRODUCTION

In 1964, the sturgeon fishery in California's Sacramento-San Joaquin River estuary received a tremendous boost when it was discovered that using shrimp as bait would catch sturgeon. Yearly party boat catches jumped from 3 sturgeon in 1963 to 2,400 in 1967. The private boat fishery is probably keeping pace with the expansion.

The sturgeon in this water system have historically been overfished commercially (Pycha, 1956). Consequently, the California Department of Fish and Game initiated several studies to learn more of their life histories and angler exploitation to provide information necessary to manage the fishery. Among the studies was this survey of the sturgeon's food habits.

All of the fish sampled were caught by party boat anglers in either San Pablo Bay or the Carquinez Strait-Lower Suisun Bay area. Kelley (1966) describes these areas in some detail.

Schreiber (1960) and Radtke (1967) have described the diet of juvenile sturgeon collected in the Sacramento-San Joaquin Delta, but this is the first description of the diet of larger sturgeon from this river system.

METHODS

Sampling commenced in April of 1965 and ended in November of 1967. All of the samples were taken by a party boat skipper from fish caught by anglers on his boat. The entire alimentary tract was removed and frozen.

Laboratory analysis consisted of separating, counting and determining the volume by water displacement of the food organisms. Only material from the esophagus and stomach was examined as once the food got through the stomach, it was not identifiable.

The data were stratified by season and area. The areas were San Pablo Bay and the Carquinez Strait-Lower Suisun Bay region.

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RESULTS

San Pablo Bay

Clams were the most consistent important item in the 213 stomach samples collected in San Pablo Bay (Table 1). Several species as a group occurred in a third or more of the stomachs in all seasons, with their contribution to total food volume ranging seasonally from about 12 to 41%.

TABLE 1. Esophageal and Stomach Contents of White Sturgeon Caught by Anglers in San Pablo Bay.

Food item	Winter (49 fish)		Spring (90 fish)		Summer (35 fish)		Fall (39 fish)	
	Volume percent-age	Fre-quency percent-age	Volume percent-age	Fre-quency percent-age	Volume percent-age	Fre-quency percent-age	Volume percent-age	Fre-quency percent-age
Crustaceans								
Shrimp								
<i>Crago</i> sp.	3.1	30.6	3.1	38.9	6.8	40.0	6.9	28.2
<i>Palaeomon macrondactylus</i>	2.0	12.2	--	--	0.2	5.7	0.1	2.6
Unidentified	3.4	4.1	--	--	--	--	1.5	2.6
Isopods <i>Synidotea</i> sp.	3.1	6.1	0.3	11.1	4.6	34.3	*T	5.1
Amphipods (unidentified)	0.1	2.0	0.1	6.7	--	--	7.7	7.7
Barnacles <i>Balanus</i> sp.	3.4	4.1	0.9	4.4	44.1	25.7	--	--
Crabs								
<i>Rhithropanopeus harrisi</i>	28.6	51.0	0.8	8.9	0.4	11.4	12.1	30.8
<i>Cancer magister</i>	0.9	2.0	--	--	1.5	2.8	31.7	12.8
Hermit (unidentified)	--	--	--	--	--	--	0.4	2.6
Annelids								
Polychaete <i>Nereis</i> sp.	1.7	2.0	--	2.2	--	--	--	--
Nematode	--	--	T	--	--	--	--	--
Molluscs								
Clams <i>Gemma gemma</i> , <i>Macoma</i> sp., <i>Tapes semidecussata</i> unidentified re- mains	14.4	34.7	11.8	78.9	40.9	57.1	32.9	61.5
Mussel <i>Mytilus</i> sp.	0.4	4.1	2.6	3.3	0.2	8.6	--	--
Snail (unidentified)	0.1	2.0	0.3	6.7	1.1	11.4	0.1	2.6
Fish								
Striped bass <i>Morone saxatilis</i>	3.4	4.4	--	--	--	--	--	--
Starry flounder <i>Platichthys stellatus</i>	8.9	6.1	1.1	2.2	--	--	--	--
Goby	3.4	2.0	--	--	--	--	0.4	5.1
Herring <i>Clupea harengus pallasi</i>	--	--	T	1.1	--	--	--	--
Unidentified fish remains	2.5	4.1	0.1	2.2	--	--	6.0	2.6
Herring eggs <i>Clupea harengus pallasi</i>	20.5	18.4	78.9	46.7	--	--	--	--
Plant material	--	--	T	1.1	--	--	--	--
Empty	--	14.3	--	5.5	--	5.7	--	12.8
Total	99.9	--	100.0	--	99.8	--	99.8	--

* T = Trace.

Other items made a less consistent but seasonally more important contribution than clams. A crab, *Rhithropanopeus harrisi*, made up nearly a third of the diet in the winter, and another crab, *Cancer magister*, contributed a similar percentage in the fall. Barnacles constituted about 44% of the food in the summer. Eggs of the herring, *Clupea harengus*, made up about a fifth of the diet in the winter and four-fifths in the spring.

Several species of fish composed about 18% of the diet in the winter and about a third as much in the fall.

Shrimp consistently occurred frequently (28-40% of all stomachs) but never contributed more than 7% of the total volume.

Suisun Bay and Carquinez Strait

Clams were also the most consistent important item in the 142 stomachs collected in this area (Table 2). Here, however, they were a significantly larger proportion of the total food volume than in San Pablo Bay.

Other items making major contributions to total food volume seasonally were barnacles in the spring and summer, crabs (*Rhithropanopeus harrisi*) in the winter and spring, and several fish species in the spring.

Shrimp again consistently occurred frequently. They contributed a somewhat greater percentage to total food volume than in San Pablo Bay. Also, oriental shrimp (*Palaeomon macrondactylus*) made a more important contribution than in San Pablo Bay.

TABLE 2. Esophageal and Stomach Contents of White Sturgeon Caught by Anglers in Suisun Bay and Carquinez Strait.

Food item	Winter (15 fish)		Spring (59 fish)		Summer (27 fish)		Fall (41 fish)	
	Volume percent-age	Fre-quency percent-age	Volume percent-age	Fre-quency percent-age	Volume percent-age	Fre-quency percent-age	Volume percent-age	Fre-quency percent-age
Crustaceans								
Shrimp								
<i>Crago</i> sp.	4.9	26.7	6.9	47.5	7.6	31.5	3.2	17.1
<i>Palaeomon macrondactylus</i>	7.5	13.3	0.3	5.1	1.1	0.3	1.7	9.8
<i>Neomysis</i> sp.	--	--	*T	1.7	--	--	--	--
Unidentified	2.6	6.7	--	--	--	--	--	--
Isopods <i>Synidotea</i> sp.	1.5	20.0	1.6	22.0	9.5	47.2	0.5	14.6
Amphipods (unidentified)	--	--	T	1.7	T	1.6	--	--
Barnacles <i>Balanus</i> sp.	T	6.7	10.9	13.5	29.1	21.2	5.4	12.2
Crabs <i>Rhithropanopeus harrisi</i>	27.4	40.0	10.3	16.9	0.4	4.7	3.1	4.9
Annelids								
Polychaete <i>Nereis</i> sp.	--	--	T	3.4	--	--	--	--
Molluscs								
Clams <i>Gemma gemma</i> , <i>Macoma</i> sp., <i>Tapes semidecussata</i> unidentified re- mains	44.2	53.3	21.1	50.8	40.7	46.5	77.0	75.0
Mussel <i>Mytilus</i> sp.	0.6	13.3	--	--	--	--	--	--
Fish								
Striped bass <i>Morone saxatilis</i>	--	--	17.5	1.7	--	--	2.3	2.0
Starry flounder <i>Platichthys stellatus</i>	--	--	11.4	1.7	--	--	6.8	2.0
Anchovy <i>Engraulis mordax</i>	--	--	4.0	1.7	0.2	0.8	--	--
Midshipman <i>Porichthys notatus</i>	--	--	--	--	8.2	0.8	--	--
Staghorn sculpin <i>Leptocottus armatus</i>	--	--	0.1	1.7	--	--	--	--
Unidentified fish remains	3.8	20.0	12.9	5.1	3.2	4.7	--	--
Herring eggs <i>Clupea harengus pallasi</i>	7.5	6.7	2.9	1.7	--	--	--	--
Plant material	--	--	--	--	T	0.8	--	--
Empty	--	6.7	--	15.2	--	7.1	--	1.7
Total	100.0	--	99.9	--	100.0	--	100.0	--

* T = Trace.

DISCUSSION

As expected, benthic invertebrates dominated the diet of sturgeon. The kinds of organisms eaten are qualitatively similar to the invertebrate fauna found in this region (Ganssle, 1966; Painter, 1966). The principal exception is annelids, which are numerous in the area but seldom eaten.

The marked seasonal variation in the consumption of barnacles and crabs presumably reflects variations in availability, but the factors affecting availability are not clear. For example, Gausse (unpublished data) caught numerous *Cancer magister* in both the summer and fall of 1964 in San Pablo Bay, yet they contributed little to the sturgeon's diet in summer. The irregular seasonal occurrence of significant amounts of fish in the diet is also difficult to interpret.

The differences in diet between the two areas primarily reflect the geographical distribution of prey related to salinity. The primary examples are the more marine species (e.g., *Cancer magister* and herring) occurring principally in San Pablo Bay.

Since shrimp are used as bait, their contribution to diet is presumably biased. Both *Crago* and *Palaemon* are used as bait, so the differences in the relative contribution in the two areas suggest that much of the shrimp eaten is not bait.

This study points up the importance of shallow areas within the estuaries for the production of food for the sturgeon. Nearly all the food items found are numerous in the mudflat communities, and sturgeon are observed in great numbers in the mudflat areas. It is unlikely the present sturgeon population could sustain itself if these areas were taken out of production by landfills.

LITERATURE CITED

- Gausse, David. 1966. Fishes and decapods of San Pablo and Suisun Bays, p. 64-94. In: D. W. Kelley (editor), Ecological Studies of the Sacramento-San Joaquin Estuary. Calif. Fish and Game, Fish Bull. (133) : 1-133.
- Kelley, D. W. 1966. Description of the Sacramento-San Joaquin estuary, p. 8-17. In: D. W. Kelley, Ecological Studies of the Sacramento-San Joaquin estuary. Calif. Fish and Game, Fish Bull. (133) : 1-133.
- Painter, Richard E. 1966. Zoobenthos of San Pablo and Suisun Bays, p. 40-56. In: D. W. Kelley (editor), Ecological Studies of the Sacramento-San Joaquin estuary. Calif. Fish and Game, Fish Bull. (133) : 1-133.
- Pycha, Richard L. 1956. Progress report on white sturgeon studies. Calif. Fish and Game 42(1) : 23-25.
- Radtke, Larry D. 1967. Distribution of smelt, juvenile sturgeon and starry flounder in the Sacramento-San Joaquin Delta with observations on the food of sturgeon, p. 115-129. In: Turner, Jerry L. and D. W. Kelley (editors), Ecological Studies of the Sacramento-San Joaquin Delta, Part II, Fishes of the Delta. Calif. Fish and Game, Fish Bull. (136) : 1-168.
- Schreiber, Max R. 1960. Observations on the systematics and food habits of juvenile white sturgeon (*Acipenser transmontanus*) and green sturgeon (*Acipenser medirostris*). Calif. Dep. of Fish and Game, Inland Fisheries Admin. Rept. No. 60-15, 5 p.