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OCCURRENCE, ABUNDANCE, AND SIZE OF FISH AT THE ROARING RIVER SLOUGH INTAKE, SUISUN MARSH, CALIFORNIA DURING THE 1980-81 AND THE 1981-82 DIVERSION SEASONS[1/]

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ABSTRACT

A sampling program at the intake for the Roaring River Slough distribution system in the Suisun Marsh was carried out from November, 1980 through May, 1981 and from September, 1981 through March, 1982. Over 14,000 fish of 34 species were collected, nearly all of which were less than 150 mm (6 in.) in length. The most numerous species was delta smelt followed by threespine stickleback, longfin smelt, and chinook salmon. A list of common and scientific names of fish collected is provided in the Appendix.

1/ Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, Technical Report No. 3. September, 1982.

INTRODUCTION

Suisun Marsh, located in the San Francisco Bay Estuary near the confluence of the Sacramento and San Joaquin rivers, provides habitat for many species of fish, several of which support significant sport and commercial fisheries (Baracco 1980). The marsh also provides habitat for many aquatic invertebrates upon which fish feed, and several native nongame fish whose range is being decreased elsewhere by various man-induced actions.

The California Department of Water Resources (DWR) and the U. S. Bureau of Reclamation (USBR) export large quantities of water from the Delta, upstream from Suisun Marsh. These diversions, together with other upstream withrawals and consumptive use within the Delta, have changed the amount and annual distribution of fresh water available for use in the marsh. As mitigation for adverse effects of these changes on waterfowl populations dependent on Suisun Marsh, DWR and USBR have proposed a series of channel modifications and flow distribution and diversion facilities to maintain adequate water quality in marsh channels (DWR 1980). The initial portions of the system, consisting of intake and channel modifications in the western marsh (Morrow Island Distribution System) and intake facilities and channel improvement on Hammond Island (Roaring River Slough Distribution System) have been completed.

The Roaring River Slough distribution system consists of eight 1.5 m (60 in.) intake culverts on Montezuma Slough with tidally activated gates just to the north of where Roaring River Slough meets Montezuma Slough (Figure 1). A 16 ha (40 acres) intake pond and levee improvements along the length of Roaring River Slough have also been provided.

A fish screen has been constructed in front of two of the intake culverts. The screen is a vertical stationary type with screen material made of wedge wire, a continuous slot material manufactured by Johnson Division UOP, St. Paul, Minnesota. The screen material has 2.4 mm (3/32 in.) openings.

This study was undertaken to determine the numbers, sizes, and species of fish present at the Roaring River Slough intake during its normal operating period (October to May) and to determine the effectiveness of the fish screens.

METHODS

Fyke nets were used to sample fish entering the diversion. A net 20 m (65.5 ft) in length with a mouth opening of 3 by 2.7 m (9.8 by 8.9 ft) and 3.2 mm (1/8 in.) mesh was cinched up around the downstream (pond) end of the culvert and strained all of the water being diverted by that culvert. Fish were collected in a live-box which measured 0.6 X 0.6 X 1 m (2 X 2 X 3 ft) attached to the cod end of the net.

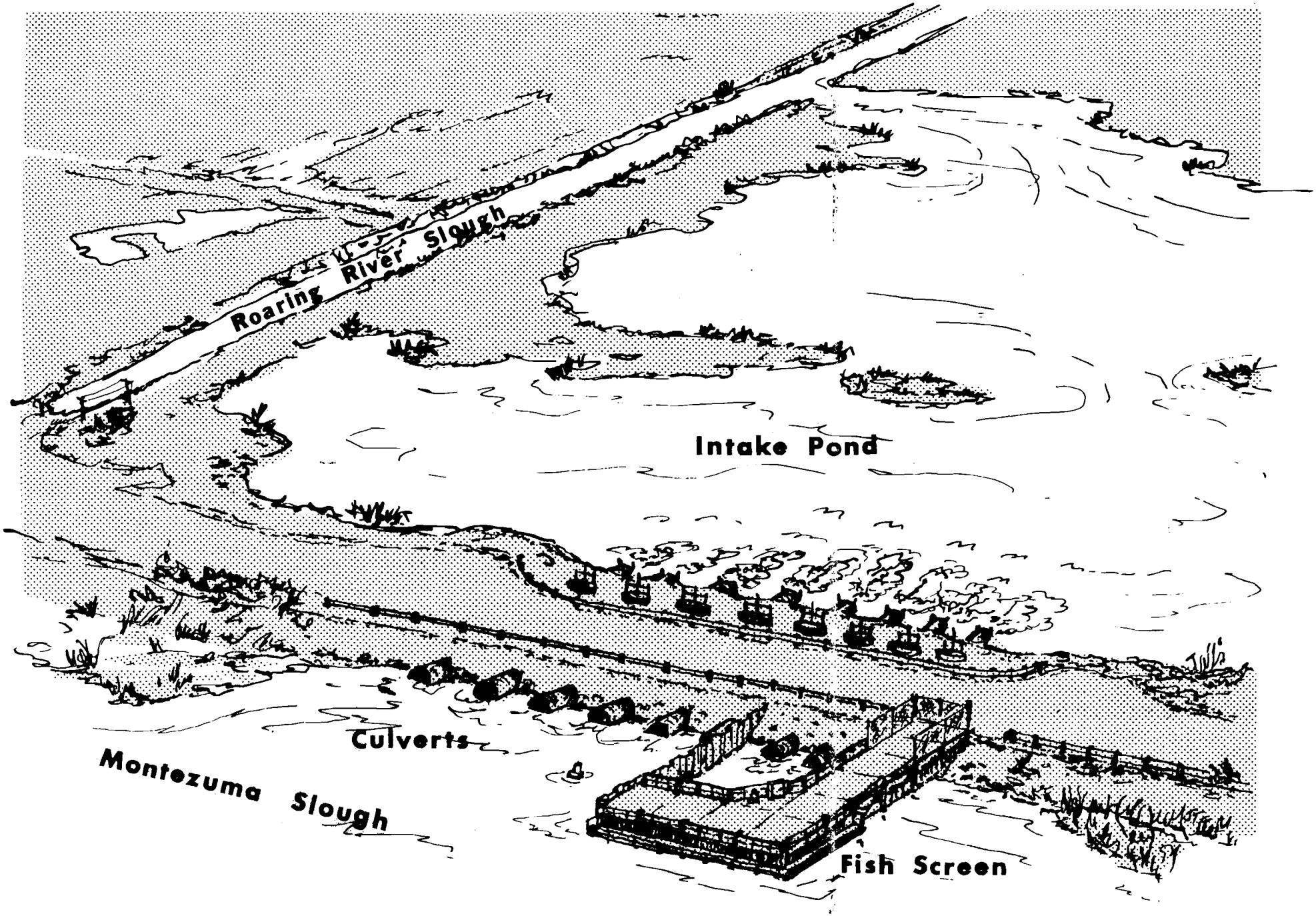

Figure 1. Artist's view of the Roaring River Slough intake and fish screen.

Sampling was conducted at approximately two week intervals from November, 1980 through mid-May, 1981. No sampling was done between mid-March and the end of April while the diversion was stopped for levee repair on Roaring River Slough. Sampling also was conducted on eight occasions from September, 1981 through March, 1982.

Sampling dates selected coincided with the highest tide during a 14-day tide cycle. A typical sampling scheme was to arrive at the diversion and set the net at low tide while the culverts were closed, allow the net to collect fish through the high-tide cycle, and collect the fish and remove the net after cessation of diversion at the following low tide. Each sampling period lasted several hours, the exact time and amount of water sampled was dependent on the height of the tide and the initial water level in the pond.

During the first year most samples were collected during daylight hours, however night samples were collected on several occasions during the latter months of the study. During the second year, day and night samples were collected at both high tides within a 24 h tide cycle.

The study program called for simultaneous sampling of a screened and an unscreened culvert throughout the study period. Completion of the fish screen was delayed several months and sampling behind screened culverts did not begin until early March, 1981. During the second year, simultaneous sampling of a screened and an unscreened culvert was accomplished during each visit.

All fish collected were identified by species, counted and when possible a sample of at least 25 fish per species was measured to the nearest millimeter fork length (FL) or nearest mm total length (TL), depending on the species.

RESULTS

Unscreened Culverts (1980-81)

For 12 sample dates, 7,615 fish of 27 species were collected (Table 1). Delta smelt were most numerous, followed by threespine stickleback, longfin smelt, chinook salmon, threadfin shad, and striped bass. Delta smelt averaged 66 mm (2.6 in.) FL, threespine stickleback averaged 35 mm (1.4 in.) TL, longfin smelt averaged 74 mm (2.9 in.) FL, chinook salmon averaged 37 mm (1.5 in.) FL, threadfin shad averaged 64 mm (2.5 in.) FL, and striped bass averaged 93 mm (3.7 in.) FL.

Screened Culverts (1980-81)

For two sample dates, 391 fish of 11 species were collected. Most numerous were threespine stickleback, followed by delta smelt, striped bass, and

TABLE 1. Occurrence and Size of Fish Collected, Roaring River Slough Intake (Unscreened Culvert), 1980-81.

Species	11/6/80	11/21/80	12/2/80	12/18/80	1/2/81	1/16/81	2/3/81	2/17/81	3/3/81	3/16/81	4/30/81	5/14/81	Total	FL (mm) Ave. size	FL (mm) Range
Threespine stickleback		6	9	4	2	51	245	152	35	455	81	42	1406	35*	15-60
Striped bass	1	11	15	30	2	1	8	5	2	1	9	9	117	93	56-253
Yellowfin goby	1	1				1		2	6		4	21	36	80*	23-174
Prickly sculpin			1		3			2		16	48	7	84	48*	12-120
Bigscale logperch		1		2				7	12				22	83*	63-92
Longfin smelt		42	426	366	214	13	4	1	12		16	5	1104	74	45-96
Delta smelt	8	429	1446	439	302	122	90	8	548	327	8	4	3731	66	30-100
White catfish									1	1		4	6	154	25-260
Chinook salmon							738	6	48	6	8	4	810	37	32-92
Threadfin shad	1	3	11	9	51	25	7		18	2			126	64	31-118
Inland silverside	2	23	6			2	2		2	1	2	2	42	64	40-89
Sacramento splittail		1	2				2	1	4		3	10	23	66	24-145
Rainwater killifish									1				1	33*	33
Brown bullhead								1	2				3	178*	95-240
Pacific lamprey									3				3	109*	103-120
Sacramento squawfish							26	4	5				35	66	42-98
Bluegill								1					1	32	32
Black crappie							5	1					6	77	42-104
Rainbow trout							1						1	225	225
Green sunfish							2						2	26	24-28
California roach							1						1	74	74
Golden shiner							1						1	65	65
Carp			1							1	1	2	5	167	23-451
Tule perch												43	43	34	31-37
Pacific staghorn sculpin											1	1	2	146*	41-78
Pacific herring											3		3	65	55-77
Warmouth											1		1	53	53

* mm TL

prickly sculpin (Table 2). Threespine stickleback averaged 33 mm (1.3 in.) TL, delta smelt averaged 71 mm (2.8 in.) FL, striped bass averaged 96 mm (3.8 in.) FL, and prickly sculpin averaged 66 mm (2.6 in.) TL.

Unscreened Culverts (1981-82)

For the 8 sample dates, 5,609 fish of 24 species were collected (Table 3). Most numerous were threespine stickleback, followed by delta smelt, striped bass, chinook salmon, and inland silverside. Threespine stickleback averaged 33 mm (1.3 in.) TL, delta smelt averaged 63 mm (2.5 in.) FL, striped bass averaged 79 mm (3.1 in.) FL, chinook salmon averaged 40 mm (1.6 in.) FL, and inland silverside averaged 57 mm (2.2 in.) FL.

Screened Culverts (1981-82)

For the 8 sample dates, 565 fish of 12 species were collected (Table 4). Most numerous were threespine stickleback, followed by yellowfin goby, striped bass, and prickly sculpin. Threespine stickleback averaged 31 mm (1.2 in.) TL, yellowfin goby averaged 164 mm (6.5 in.) TL, striped bass averaged 81 mm (3.2 in.) FL, and prickly sculpin averaged 82 mm (3.2 in.) TL.

DISCUSSION

Several observations are of interest from fish collections behind unscreened culverts over the duration of the study. It is apparent that substantial numbers of fish were diverted into the distribution system. Most fish were juveniles or of species that do not attain large sizes as adults. Some species, such as delta and longfin smelt, threespine stickleback, and striped bass were present throughout the study period. Others, such as chinook salmon, tule perch, American shad and Sacramento squawfish were collected only during certain times. Catches were generally higher for samples collected at night.

As soon as sampling began behind a screened culvert in March, 1981, it was apparent that the screen was not operating properly. Many fish were captured that could not physically fit through the 2.4 mm (3/32 in.) screen material. Sampling behind the screened culverts was suspended after underwater inspection of the screen structure revealed a large hole (approximately 1 by 3 m [3.2 by 9.7 ft] at the base of the screen at the northwest corner. Inspection also revealed a poor seal between the U-channel that supported the screen panels and the edge of the screen panels.

The hole at the base of the fish screen was repaired by rockfill during August, 1981. Sampling in the fall of 1981 indicated there were still "leaks" in the screen structure.

TABLE 2. Occurrence and Size of Fish Collected, Roaring River Slough Intake (Screened Culvert), 1980-81.

Species	3/3/81	3/16/81	Total	FL (mm) Ave. size	Range
Threespine stickleback	247	50	297	33*	14-53
Striped bass	24		24	96	72-116
Yellowfin goby	1	1	2	161*	160-161
Prickly sculpin	14	4	18	66*	22-87
Bigscale logperch	6	1	7	86*	82-92
Starry flounder	1		1	115*	115
Longfin smelt	4		4	80	72-88
Delta smelt	9	23	32	71	60-81
White catfish	1		1	58	58
Chinook salmon	4		4	39	33-47
Pacific lamprey		1	1	127*	127

* mm TL

Table 3. Occurrence and Size of Fish Collected, Roaring River Slough Intake (Unscreened Culvert), 1981-82.

Species	9/29/81	10/26/81	11/23/81	12/21/81	1/26/82	2/8/82	2/22/82	3/8/82	Total	FL (mm) Ave. size	Range
Threespine stickleback	9	24	92	17	549	1435	2	52	2180	33*	19-64
Striped bass	29	26	207	10	9	3	1		465	79	49-180
Yellowfin goby	36	27	18	3	8	3	5	1	101	135*	35-177
Prickly sculpin	2	1		2	12	5	1	4	27	83*	57-135
Bigscale logperch					2	1			3	84*	77-94
Longfin smelt	25	1	3						29	73	49-112
Delta smelt	719	109	1203	4	11	63		1	2110	63	41-107
Chinook salmon			81	6	68	102	6	16	279	40	31-76
Threadfin shad	37	4	39		24	19		1	104	66	42-95
Inland silverside	33	14	34		23	22			176	57	32-104
Redear sunfish					7				7	60	50-84
Rainwater killifish			2		8				10	28*	21-33
Hardhead							1		1	375	375
Pacific lamprey	3		9						12	xx	
Sacramento squawfish				1	5	2		1	9	69	49-116
Bluegill			27	4	21	1		3	56	37	25-55
Black crappie					10				10	83	51-155
Northern anchovy	2	4							6	67	50-83
American shad	7	1	1						9	92	88-102
Largemouth bass					1				1	79	79
Carp			4						4	52	45-64
Tule perch					4				4	99	94-103
Mosquitofish						1			1	27	27
Warmouth			1		3			1	5	47	43-55

* mm TL

xx Not Measured

TABLE 4. Occurrence and Size of Fish Collected, Roaring River Slough Intake (Screened Culvert), 1981-82.

Species	9/29/81	10/26/81	11/23/81	12/21/81	1/26/82	2/8/82	2/22/82	3/8/82	Number	FL (mm) Ave. size	Range
Threespine stickleback	2	1	1		204	132	12	7	359	31*	16-54
Striped bass	5	1	8	3	11	1	1		30	81	56-106
Yellowfin goby	15	31	30	2	21	2	1		102	164*	87-182
Prickly sculpin		1	3		10	11	3	1	29	82*	64-119
Bigscale logperch	1	1				3			5	79*	77-102
Delta smelt					6	1	1		8	60	25-74
Chinook salmon					8		4		12	37	34-42
Inland silverside	5				7				12	48	29-74
Rainwater killifish	1				2				3	28*	27-30
Bluegill					3				3	29	24-33
Tule perch					1				1	99	99
Redear sunfish						1			1	70	70

* mm TL

Several possibilities exist to explain our collections behind the screened culverts during the second year:

1. Cleaning procedures were accomplished by removing the screen panels from the support structure. The accumulation and type of aquatic growth present required several hours for cleaning, during which at least one screen panel was out of the water. Fish may have entered the area behind screens at this time. Cleaning was done on two occasions (10/29/81 and 12/8/81) but neither event immediately preceded our sampling dates.

2. Fish may still have been able to "leak" under the screen footing or around screen panel edges. Underwater inspection of the rockfill revealed no large holes, but benthic species such as yellowfin goby which were collected might have been able to migrate through interstices between the rock. Small salmon and threespine stickleback might be able to migrate around the screen panel edges.

3. Fish may be moving from the pond into the culverts and into the screen bay at the beginning and end of the high tide cycle when the velocity through the culverts is low. Also, the flap gates on the pond end of the culverts may not close tightly and water (and fish) may pass back towards Montezuma Slough. This situation was observed on several occasions on an unscreened culvert.

CONCLUSIONS

The results of the sampling confirmed the presence of juvenile chinook salmon in the marsh, providing additional evidence to support the requirement for screens.

The number and variety of species collected from the screened culverts indicate that the source of leakage is probably a combination of all three of the possibilities discussed above. These collections were significantly lower than at the unscreened culverts. Based on the results of these studies we recommend the fish screen be completed prior to the 1982-83 diversion season and further evaluations scheduled.

ACKNOWLEDGMENTS

We wish to thank the personnel at Grizzly Island Wildlife Area for the use of their facilities and equipment and the many permanent and seasonal

employees of the Department who helped with the sampling program. Figure one was drawn by James Gibboney.

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APPENDIX

List of Common and Scientific Names of Fish Collected at the Roaring River Slough Intake, 1980-82.

Threespine stickleback	*Gasterosteus aculeatus*
Striped bass	*Morone saxatilis*
Yellowfin goby	*Acanthogobius flavimanus*
Prickly sculpin	*Cottus asper*
Bigscale logperch	*Percina macrolepida*
Longfin smelt	*Spirinchus thaleichthys*
Delta smelt	*Hypomesus transpacificus*
White catfish	*Ictalurus catus*
Chinook salmon	*Oncorhynchus tshawytscha*
Threadfin shad	*Dorosoma petenense*
Inland silverside	*Menidia beryllina*
Sacramento splittail	*Pogonichthys macrolepidotus*
Rainwater killifish	*Lucania parva*
Brown bullhead	*Ictalurus nebulosus*
Pacific lamprey	*Lampetra tridentata*
Sacramento squawfish	*Ptychocheilus grandis*
Bluegill	*Lepomis macrochirus*
Black crappie	*Pomoxis nigromaculatus*
Rainbow trout	*Salmo gairdneri*
Green sunfish	*Lepomis cyanellus*
California roach	*Hesperoleucus symmetricus*
Golden shiner	*Notemigonus crysoleucas*
Carp	*Cyprinus carpio*
Tule perch	*Hysterocarpus traski*
Pacific staghorn sculpin	*Leptocottus armatus*
Pacific herring	*Clupea harengus*
Warmouth	*Lepomis gulosus*
Starry flounder	*Platichthys stellatus*
Redear sunfish	*Lepomis microlophus*
Hardhead	*Mylopharodon conocephalus*

Northern anchovy	Engraulis mordax
Largemouth bass	Micropterus salmoides
Mosquitofish	Gambusia affinis
American shad	Alosa sapidissima