

**Observations of Early Life Stages of  
Delta Smelt, *Hypomesus transpacificus*,  
in the  
Sacramento-San Joaquin Estuary in 1991,  
With a Review of  
Its Ecological Status in 1988 to 1990**

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Interagency Ecological Studies Program  
for the  
Sacramento-San Joaquin Estuary

A Cooperative Program of:

California Department of Water Resources  
State Water Resources Control Board  
U.S. Bureau of Reclamation  
U.S. Army Corps of Engineers

California Department of Fish and Game  
U.S. Fish and Wildlife Service  
U.S. Geological Survey  
U.S. Environmental Protection Agency



## SUMMARY

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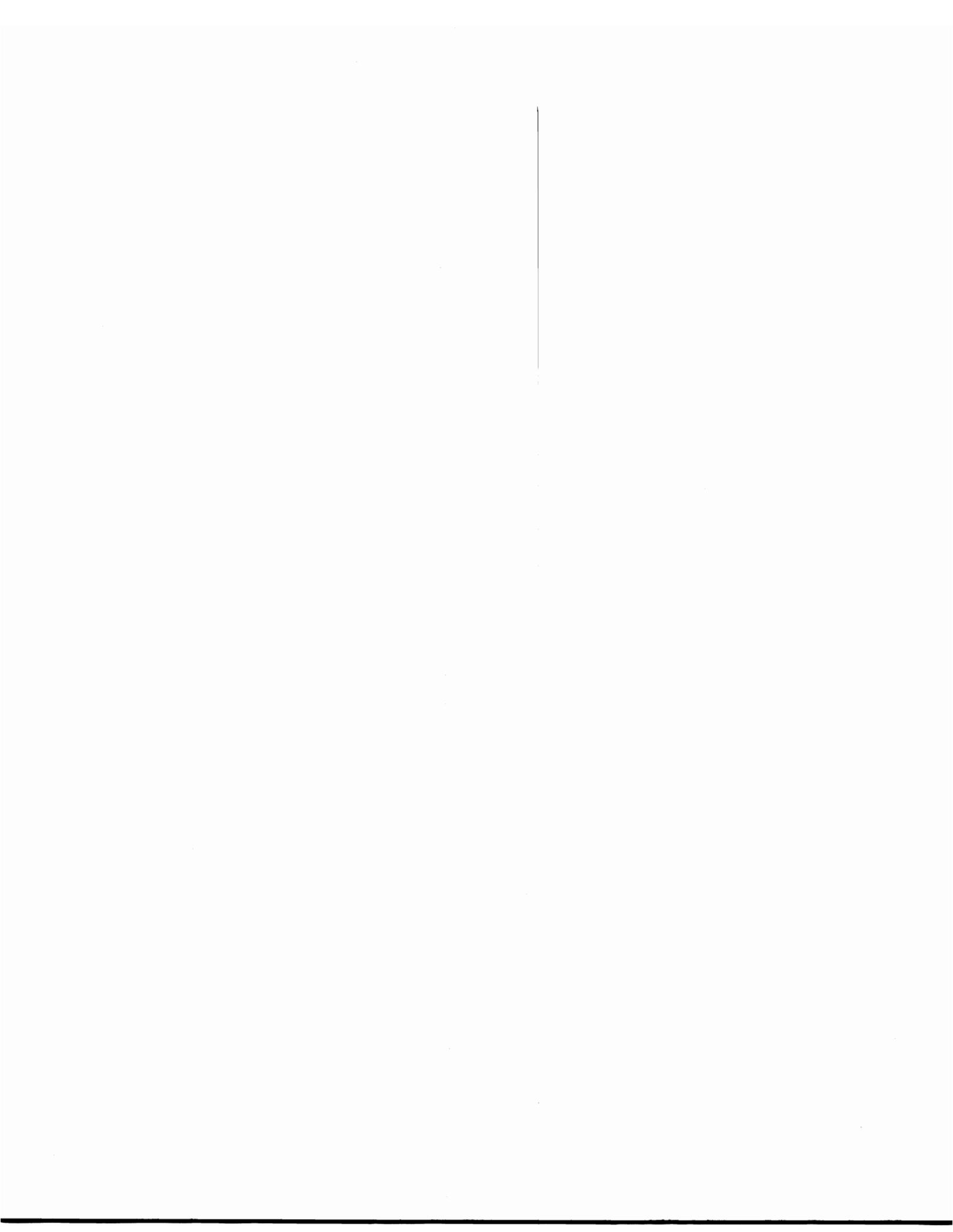
Spawning locations, spawning periods, nursery grounds, and movement of early life stages of delta smelt documented in this report are based mostly on samples collected from 1988 to 1991 in the Sacramento-San Joaquin estuary by the California Department of Fish and Game as part of the Interagency Ecological Studies Program.

From 1988 to 1990, major spawning grounds were near Bradford Island. Probably because of low flows, delta smelt spawned farther inland in 1991, with major spawning grounds in the eastern delta, toward the Mokelumne River and Venice Island, and in the mid-Sacramento River area near Isleton. Delta smelt also spawned in the Mokelumne River and Cache Slough.

During the four years of observations, spawning season has been February through June, with a peak in April and May. Spawning pulses were not observed.

The delta appears to have been the most important nursery area for delta smelt in 1988 to 1991. The "slough habitat" of the delta may have provided the necessary food and environment for rearing larvae.

The presence of various early life stages of delta smelt in samples collected from 1988 to 1991 shows that year classes 1987 to 1990 successfully completed their life cycles.



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## ACKNOWLEDGMENTS

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The authors thank Dale Sweetnam and Don Stevens for the opportunity to examine larval fish collected as part of the Interagency Ecological Studies Program. We also thank Vera Tharp for her invaluable editorial and formatting assistance and Howard Mann and his staff for the graphics.



## INTRODUCTION

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The delta smelt is a small, brackish-water fish found only in the Sacramento-San Joaquin estuary (Herald 1961; McAllister 1963). Historically, delta smelt has been found in Suisun Bay, Montezuma Slough, and into the delta sloughs (Radtke 1966; Moyle 1976). In about 1983 or 1984, its population in the Suisun Bay area declined rapidly, and recently it has been concentrated mostly in the lower Sacramento River portion of the delta (Sweetnam and Stevens 1991; Wang 1991).

This report has been prepared to help identify the spawning locations, spawning period, nursery grounds, distribution, and movement of early life stages of delta smelt. Observations are based mostly on information from samples collected by the Department of Fish and Game in 1991.

The DFG sampling program is part of an extensive interagency effort designed to provide information needed to assess the status of the delta smelt population and explain its decline. The study is funded by the California Department of Water Resources and U.S. Bureau of Reclamation.

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## MATERIALS AND METHODS

From February through July 1991, the Department of Fish and Game collected 1,631 samples from four areas, shown in Figure 1.

- **Delta Estuary** — Area 1 includes Honker Bay, the confluence of the Sacramento and San Joaquin rivers, and the delta between Antioch and Medford Island, along the sloughs and channels of the lower San Joaquin River. The 26 sampling stations in this area are: 66, 65, 5, 7, 9, 11, 13, 15, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 906, 909, 60, 61.
- **Sacramento River** — Area 2 includes Collinsville, Decker Island, Rio Vista, Isleton, Walnut Grove, Locke, Garcia Bend, West Sacramento, Verona, Knights Landing, and Grimes. The Sacramento River between Collinsville and Rio Vista is identified as the lower Sacramento River, the section between Rio Vista and West Sacramento as the mid-Sacramento River, and the section above West Sacramento as the upper Sacramento River. The 32 Sacramento River stations are: 17, 19, 21, 23, 25, 27, 29, 32, 72, 725, 70, 71, 73, 735, 74, 745, 75, 755, 76, 765, 77, 775, 78, 785, 79, 795, 80, 805, 81, 815, 82, 825.
- **Mokelumne River** — Area 3 includes Potato Slough, White Meat Slough, South Fork Mokelumne River, and North Fork Mokelumne River, all below Walnut Grove. In 1991, as part of the Interagency Ecological Studies Program, the Department of Fish and Game established the delta smelt habitat pilot study, which expanded the egg and larval sampling program by seven stations: 903, 919, 920, 921, 922, 923, 924.
- **Cache Slough** — In 1991, four sampling stations — 712, 713, 715, 717 — were estab-

lished in Cache Slough, Steamboat Slough, and the Sacramento River north of Isleton as part of the delta smelt habitat pilot study. This is designated Area 4.

The Department of Fish and Game sampling program from April to July, 1988 through 1991, is summarized below.

Year	Areas Sampled	Number of Samples Processed
1988	Sacramento River up to Station 32, Montezuma Slough	885
1989	Sacramento River up to Station 75	820
1990	Sacramento River up to Station 32, plus Stations 775 to 825	1,135
1991	Sacramento River up to Station 825, Mokelumne River, Cache Slough	1,631

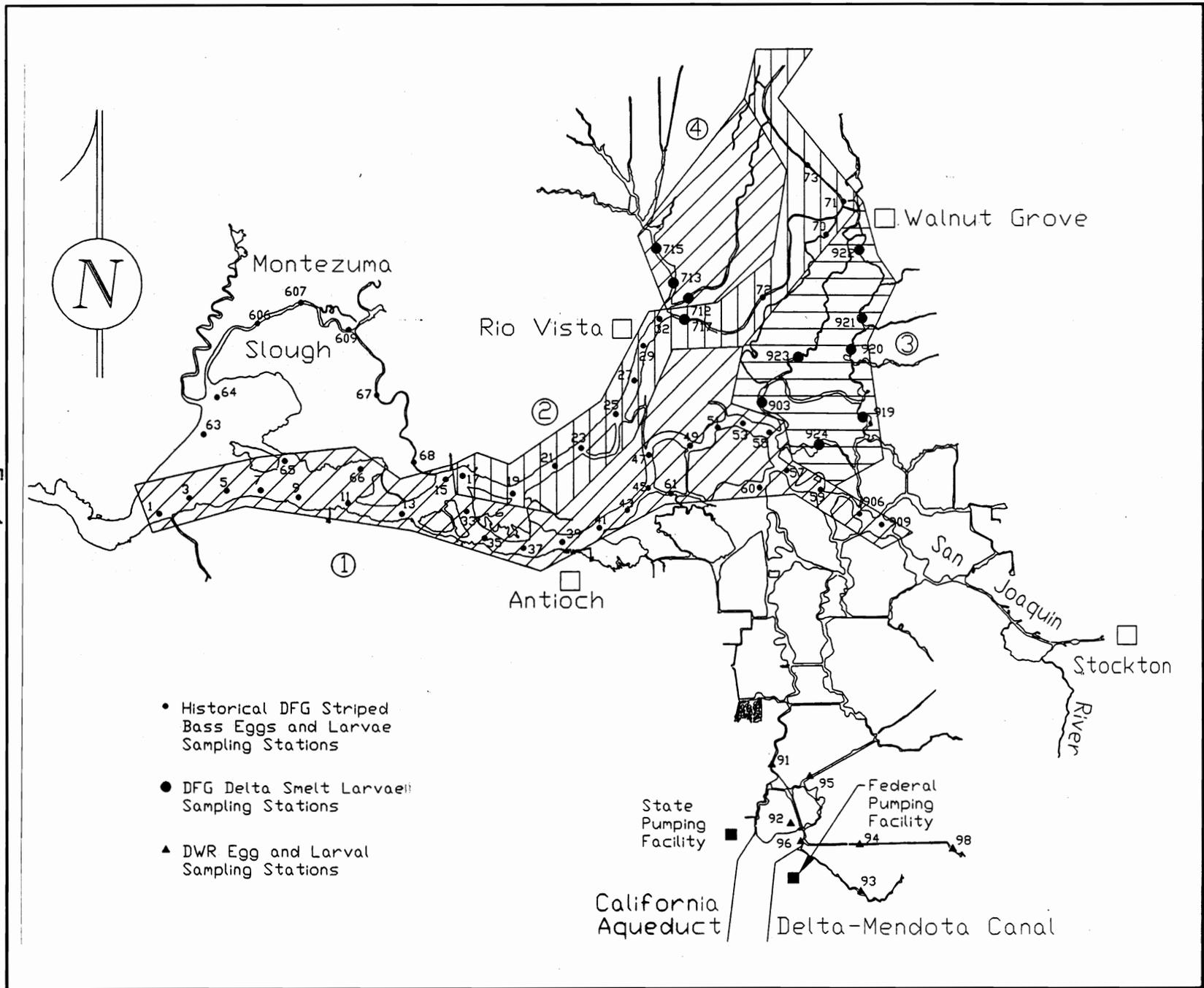
In the laboratory, all samples were sorted and identified by DFG personnel (Sweetnam and Stevens 1991). As part of the quality assurance and quality control procedure for this study, delta smelt and all other species were verified (Table 1). An extensive voucher of specimens and references was used (Wang 1986, 1991).

A Bausch and Lomb Stereozoom 7 microscope with mounted micrometer was used to measure all 1991 delta smelt to the nearest millimeter total length. Delta smelt size ranges (smallest and largest specimens collected in the same sample) were recorded for samples collected in 1988 through 1990.

Based on developmental stages, delta smelt early life stages were further classified (in millimeters total length) as:

4.0-4.9	Hatching Larvae (large yolk-sac, tail bent ventral)
5.0-5.9	Post-Hatching Larvae (absorbing yolk-sac, tail straight)
6.0-16.0 ~ 18.0	Larvae (gas bladder obscure, gut straight)
16.0~18.0 - 30.0	Prejuvenile and Juvenile

DEPARTMENT OF FISH AND GAME ICHTHYOPLANKTON SAMPLING STATIONS AND SAMPLING AREAS, 1991  
Figure 1



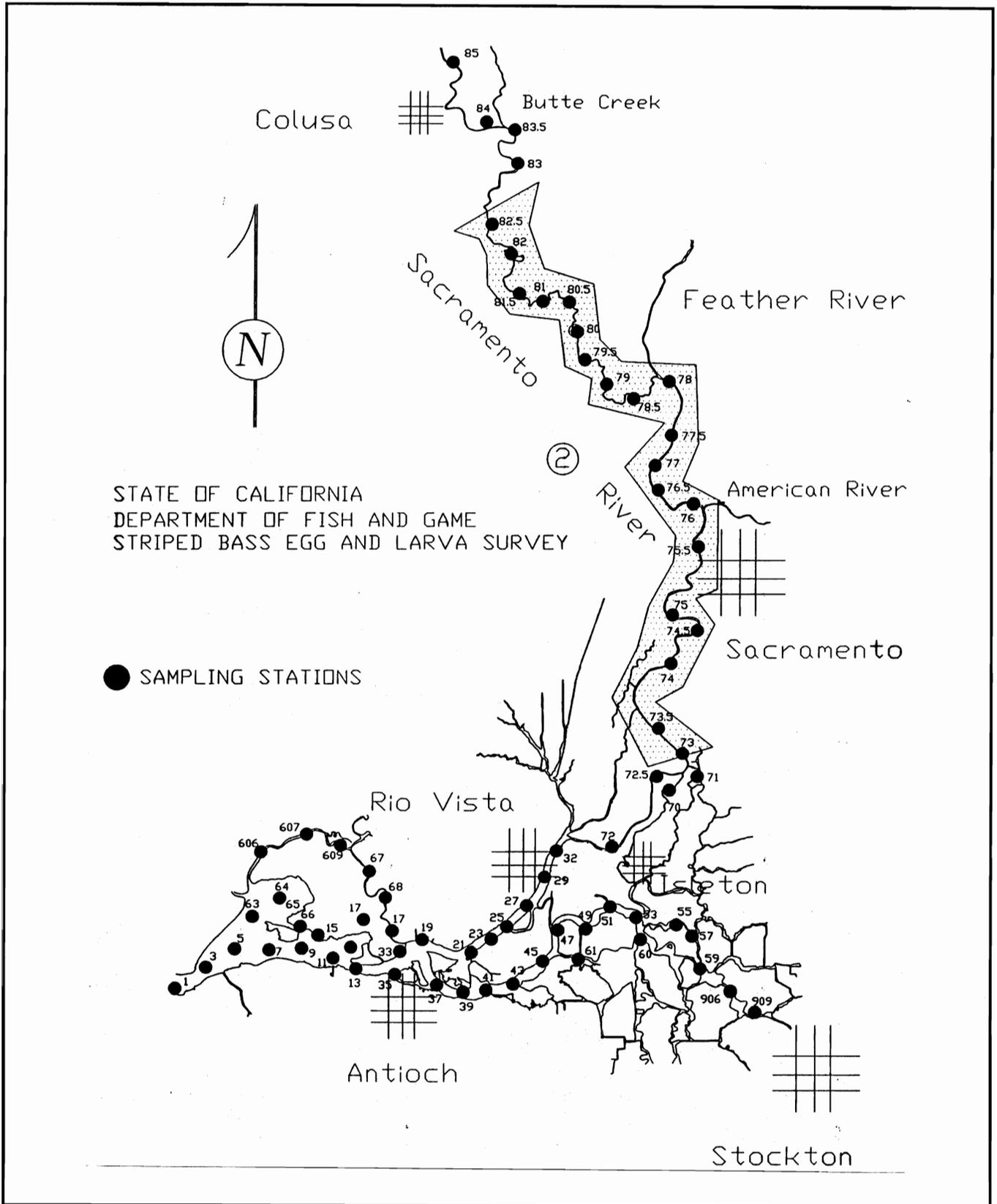


Figure 1 (continued)  
DEPARTMENT OF FISH AND GAME ICHTHYOPLANKTON SAMPLING STATIONS AND SAMPLING AREAS, 1991

Table 1  
CATCH OF EARLY LIFE STAGES OF FISHES IN THE SACRAMENTO-SAN JOAQUIN ESTUARY,  
1988 THROUGH 1991

Samples were collected by the California Department of Fish and Game except  
those marked with an asterisk, which were collected by Tenebra Environmental Service near PG&E's Pittsburg and Contra Costa powerplants.

Species	1988	1989	1990	1991
<b>Petromyzontidae - Lampreys</b>				
<i>Lampetra</i> spp . . . . .			+	+
<b>Acipenseridae - Sturgeons</b>				
<i>Acipenser</i> spp . . . . .	+			
<b>Clupeidae - Herrings</b>				
American shad, <i>Alosa sapidissima</i> (Ayres) . . . . .	+	+	+	+
Pacific herring, <i>Clupea harenguis pallasii</i> (Valenciennes) . . . . .	+	+	+	+
Threadfin shad, <i>Dorosoma petenense</i> (Gunther) . . . . .	+	+	+	+
<b>Engraulidae - Anchovies</b>				
Northern anchovy, <i>Engraulis mordax</i> (Girard) . . . . .	+	+	+	+
<b>Salmonidae - Trouts</b>				
Rainbow trout or Steelhead, <i>Salmo gairdneri</i> (Richardson) . . . . .				+
<b>Osmeridae - Smelts</b>				
Delta smelt, <i>Hypomesus transpacificus</i> (McAllister) . . . . .	+	+	+	+
Longfin smelt, <i>Spirinchus thaleichthys</i> (Ayres) . . . . .	+	+	+	+
<b>Cyprinidae - Minnows and Carps</b>				
Goldfish, <i>Carassius auratus</i> (Linnaeus) . . . . .	+	+	+	+
Common carp, <i>Cyprinus carpio</i> (Linnaeus) . . . . .	+	+	+	+
Hitch, <i>Lavinia exilicauda</i> (Baird and Girard) . . . . .			+	
Golden shiner, <i>Notemigonus crysoleucas</i> (Mitchell) . . . . .			+	
Fathead minnow, <i>Pimephales promelas</i> (Rafinesque) . . . . .			+	+
Splittail, <i>Pogarichthys macrolepidotus</i> (Ayres) . . . . .	+	+	+	+
<b>Catostomidae - Suckers</b>				
Sacramento sucker, <i>Catostomus occidentalis</i> (Ayres) . . . . .			+	+
<b>Ictaluridae - Catfishes</b>				
White catfish, <i>Ictalurus catus</i> (Linnaeus) . . . . .	+			+
Brown bullhead, <i>Ictalurus nebulosus</i> (Lesueur) . . . . .	+	+		
Channel catfish, <i>Ictalurus punctatus</i> (Rafinesque) . . . . .		+	+	
<b>Batrachoididae - Toadfishes</b>				
Plainfin midshipman, <i>Porichthys notatus</i> (Girard) . . . . .			+	
<b>Cyprinodontidae - Killifishes</b>				
*Rainwater killifish, <i>Lucania parva</i> (Baird) . . . . .	+	+	+	+
<b>Poeciliidae - Livebears</b>				
*Mosquitofish, <i>Gambusia affinis</i> (Baird and Girard) . . . . .	+	+	+	+
<b>Atherinidae - Silversides</b>				
Topsmelt, <i>Atherinops affinis</i> (Ayres) . . . . .		+	+	
Jacksmelt, <i>Atherinopsis californiensis</i> (Girard) . . . . .	+	+	+	+
Inland silverside, <i>Menidia beryllina</i> (Cope) . . . . .	+	+	+	+
<b>Gasterosteidae - Sticklebacks</b>				
Threespine stickleback, <i>Gasterosteus aculeatus</i> (Linnaeus) . . . . .	+	+		+
<b>Syngrathidae</b>				
Bay pipefish, <i>Syngrathus leptorhynchus</i> (Girard) . . . . .	+			

Table 1 (continued)  
**CATCH OF EARLY LIFE STAGES OF FISHES IN THE SACRAMENTO-SAN JOAQUIN ESTUARY,  
 1988 THROUGH 1991**

Samples were collected by the Department of Fish and Game except  
 those marked with an asterisk, which were collected by Tenere Environmental Service near PG&E's Pittsburg and Contra Costa powerplants.

Species	1988	1989	1990	1991
<b>Perichthyidae - Temperate Basses</b>				
Striped bass, <i>Morone saxatilis</i> (Walbaum) .....	+	+	+	+
<b>Centrarchidae - Sunfishes</b>				
Bluegill, <i>Lepomis macrochirus</i> (Rafinesque) .....		+		
<i>Lepomis</i> spp .....	+	+	+	+
<i>Micropterus</i> spp .....	+	+	+	+
<i>Pomoxis</i> spp .....				+
<b>Percidae - Perches</b>				
Bigscale logperch, <i>Percina marolepidus</i> (Stevenson) .....	+	+	+	+
<b>Embiotocidae - Surfperches</b>				
Tule perch, <i>Hysterocarpus traski</i> (Gibbons) .....		+		
<b>Gobiidae - Gobies</b>				
Yellowfin goby, <i>Acanthogobius flavimanus</i> (Temminck and Schlegel)....	+	+	+	+
Longjaw mudsucker, <i>Gillichthys mirabilis</i> (Cooper) .....	+	+	+	+
Cheekspot goby, <i>Ilypnus gilberti</i> (Eigemann and Eigemann) .....	+	+	+	+
Bay goby, <i>Lepidogobius lepidus</i> (Girard) .....	+	+	+	+
Chameleon goby, <i>Tridentiger trigorocephalus</i> (Gill) .....	+	+	+	+
<b>Cottidae - Sculpins</b>				
Prickly sculpin, <i>Cottus asper</i> (Richardson) .....	+	+	+	+
Pacific staghorn sculpin, <i>Leptocottus armatus</i> (Girard) .....				+
<b>Pleuronectidae - Righteye Flounders</b>				
Starry flounder, <i>Platichthys stellatus</i> (Pallas) .....	+	+	+	+



## RESULTS AND DISCUSSION

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A total of 606 delta smelt early life stages, including hatching, post-hatching, larvae, and prejuvenile and juvenile, were identified from 1,631 samples collected in the four areas in 1991. Catch data for 1988 through 1990 are presented in Table 1. Length distribution of delta smelt early life stages in all four spawning and/or nursery areas in 1991 are shown in Figures 2 through 7. Appendix A contains data on numbers and sizes of delta smelt collected from 1988 through 1991. Appendix B shows their spatial and temporal distribution.

### Overview of Results

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In 1991, spawning began in March and April in a dispersed pattern in the delta and moved gradually into the eastern region of the delta and the mid-Sacramento River in May. Peak spawning was near Isleton in May. Although the database is limited, recently-latched larvae were seen in the Mokelumne River and Cache Slough. Recently-hatched and early post-hatched larvae were observed in the lower and mid-Sacramento River during the entire spawning season.

In 1988 through 1990, spawning was concentrated near Bradford Island and in the lower Sacramento River. Spawning was not observed in the mid-Sacramento River until 1989. From 1988 through 1991, the spawning season extended from February through June, with a peak in April and May. Spawning pulses were not detected.

Data collected in 1988 through 1991 indicated Delta smelt used the estuary from Honker Bay and, possibly, Suisun Bay; the delta up to

Medford Island; and the Sacramento River up to Garcia Bend as major nursery habitat. Seasonal movement and spawning was limited in those areas.

Catch of early life stages of Pacific herring (*Clupea harengus pallasii*) in the delta from 1988 through 1991 (Figure 8) is a biological indication of the strength of saltwater intrusion, since Pacific herring is a coastal marine fish. As a result of increased saltwater intrusion during the drought, delta smelt spawning and nursery habitats moved farther inland.

### Delta Estuary

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For many years, the Department of Fish and Game has sampled this stretch of the waterway during April through June for striped bass (*Morone saxatilis*) eggs and larvae. In 1991, as part of the expanded delta smelt study, Fish and Game started sampling in February to sample the earlier-spawning delta smelt. In 1991, delta smelt larvae were first found in the San Joaquin River near Antioch on March 11 (Sweetnam and Stevens 1991). Larvae were captured near Bethel Island (Station 43) on February 26, and more larvae were taken from Pittsburg (Station 35) through Andrus Island (Station 53) on March 11. In early April, delta smelt larvae were found in samples from Honker Bay (Station 66) to Medford Island (Station 906). Those larvae captured in Honker Bay could have originated in Suisun Bay and Montezuma Slough.

In the delta stations, spawning appeared to be more active in March and April, but peaks were not seen at any station. Spawning moved

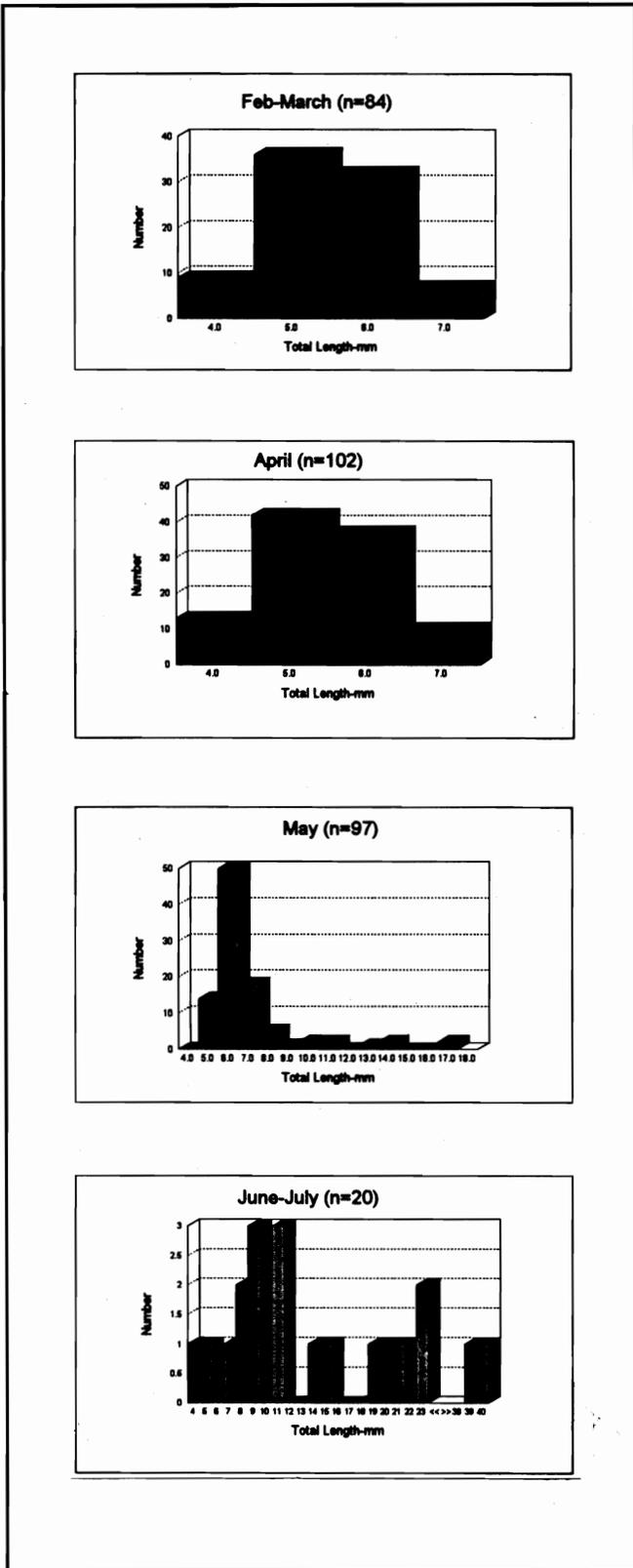


Figure 2  
 LENGTH DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES  
 COLLECTED IN AREA 1, DELTA ESTUARY, IN 1991  
 (in millimeters total length)

into the eastern region of the delta in May as a result of saltwater intrusion.

Historically, when the entrapment zone has been in the area of Carquinez Strait and Suisun Bay, Montezuma Slough (including Suisun Marsh) played an important role as part of the delta smelt spawning and nursery ground outside the delta (Moyle 1976; Moyle and Daniels 1981, Wang 1986, Moyle and Herbold 1989, Moyle *et al* 1991). The Montezuma Slough habitat may have provided important initial food (zooplankton was found in the gut of hatching and post-hatching larvae) and protective environmental conditions needed in the early life stages (Wang 1991).

**Sacramento River**

Samples were taken from Collinsville (Station 17) to Grimes (Station 825) in February through July 1991. Delta smelt early life stages were observed from Collinsville to the vicinity of Sacramento Metropolitan Airport (Station 755). Between 1988 and 1990, the lower and mid-Sacramento River were sampled only in 1989, and delta smelt larvae were observed.

In 1991, delta smelt larvae were first observed in the Sacramento River near West Sacramento on February 28. On the same date, longfin smelt (*Spirinchus thaleichthys*) were first captured above Locke (Sweetnam and Stevens 1991). Delta smelt larvae were collected from Isleton to West Sacramento on February 28, and longfin smelt larvae were not observed above Isleton, although they were found in Cache Slough in February and March. (Spatial and temporal distribution of longfin smelt in 1991 is shown in Appendix C).

Most spawning occurred between Rio Vista and Garcia Bend in April, May, and part of June. Samples were not taken in this area from March 19 to 28, so March spawning intensity is not known. Spawning pulses could not be

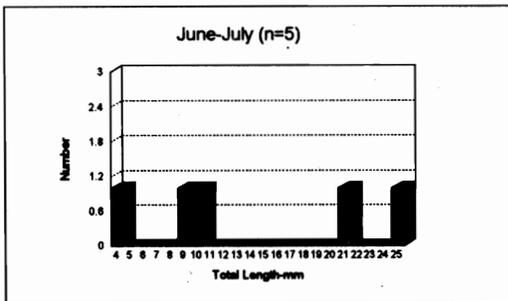
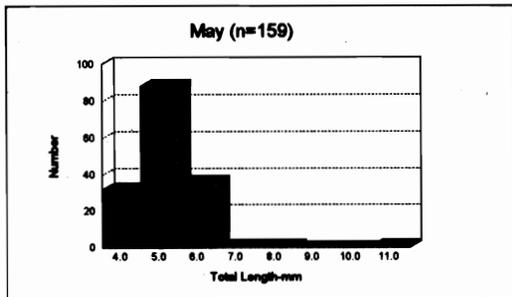
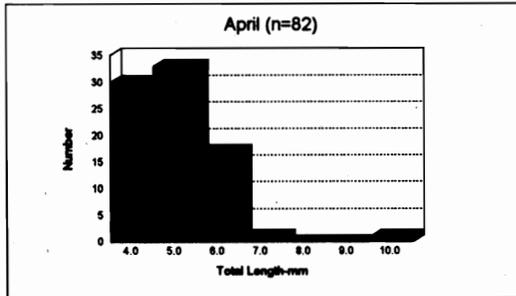
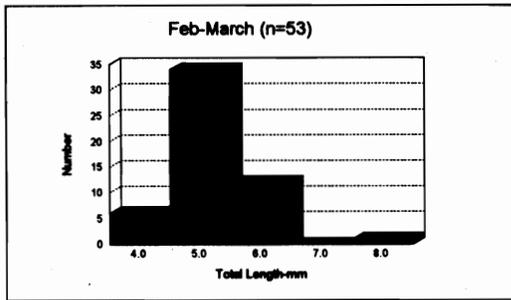


Figure 3  
LENGTH DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES  
COLLECTED IN AREA 2, SACRAMENTO RIVER, IN 1991  
(in millimeters total length)

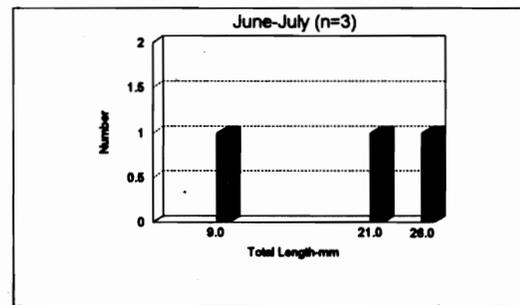
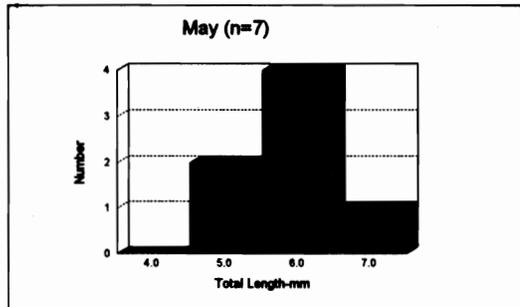
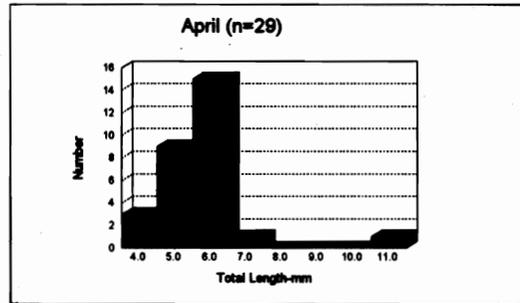
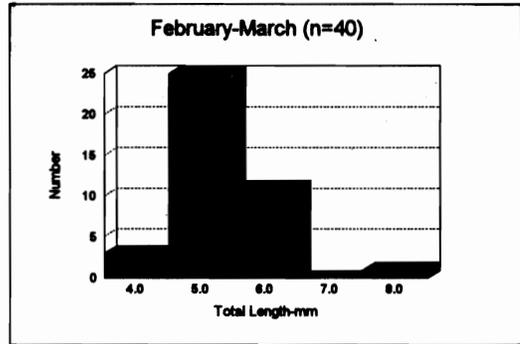


Figure 4  
LENGTH DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES  
COLLECTED IN THE  
LOWER SACRAMENTO RIVER PORTION OF AREA 2, 1991  
(in millimeters total length)

detected in this study, probably due to the low density of the cohort in the water column. The last batch of hatching-size larvae collected in the Sacramento River was from Station 755 on June 1, 1991. Water temperature at the station was 20°C (DFG unpublished data).

Spawning in the lower Sacramento River (Collinsville to Rio Vista) was mostly in March and April, when the salt water retreated into the estuary. In general, spawning activity in the lower Sacramento River in 1991 was similar to that of 1988 to 1990; the lower Sacramento River played a secondary role in spawning, although this area was heavily used by adults in 1990 and 1991 (Sweetnam and Stevens 1991).

Use of mid-Sacramento River (Isleton to Grimes) as a spawning ground was a recent discovery. Delta smelt larvae were first observed in the DFG samples in 1989. More hatching-size larvae were found near the Delta Cross Channel and Georgiana Slough in 1989 and 1990 (Arthur 1990; Arthur *et al* 1991). Spawning in the mid-Sacramento River near Isleton intensified in April and May 1991. Apparently spawners moved farther up into fresh water of the Sacramento River, as they did in the delta (this study).

Delta smelt early life stages collected in the Sacramento River in 1991 were dominated by the hatching and post-hatching sizes. There were very few larger-sized larvae collected in this area. Normally, delta smelt larvae probably descend into the vicinity of the entrapment zone by streamflow (Stevens *et al* 1990). Some larvae hatched in the mid-Sacramento may move through Threemile Slough, Georgiana Slough, or the Delta Cross Channel to the delta. The Sacramento River served as a spawning ground and nursery ground in 1988 through 1990, and mostly as a spawning ground in 1991.

Few smelt larvae were observed in the Sacramento River above Sacramento in 1991. One

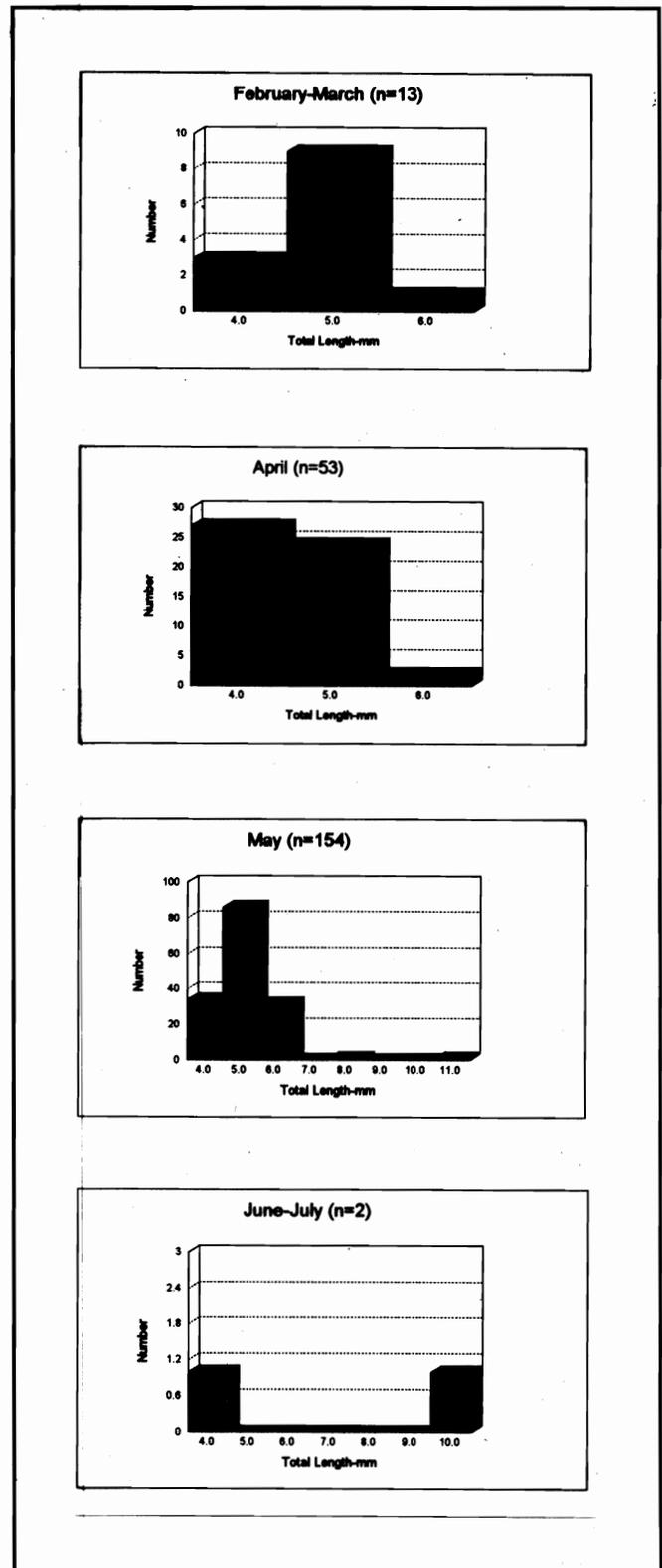


Figure 5  
LENGTH DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES  
COLLECTED IN THE  
MID-SACRAMENTO RIVER PORTION OF AREA 2, 1991  
(in millimeters total length)

larva (5.4 mm TL) was taken near Sacramento Metropolitan Airport on May 4.

Wang (1991) reported two larvae (5.5 and 6.0 mm TL) near Verona on April 20, 1990, and two larvae (8.5 and 10.0 mm TL) near Sacramento Metropolitan Airport on May 16, 1990. In addition, Dr. Charles H. Hanson (pers comm) captured three larvae (7.5, 9.0, and 9.8 mm TL) near Fair Oaks, on the American River, on April 17, 1991. Those larvae were slightly different from the delta smelt larvae, but because of the limited number and size observed, they were tentatively listed as delta smelt.

In 1989, Stevens *et al* (1990) reported collections of the Japanese wakasagi (*Hypomesus nipponensis*) from Folsom Lake, on the American River system. The early life history of wakasagi was almost unknown when the Department of Fish and Game introduced this species from Japan to California in 1959. Therefore, clarification is needed.

### Mokelumne River

In 1991, the Mokelumne River was sampled in February, March, May, and June, with a total of 46 early life stage delta smelt collected in the pilot study. Delta smelt larvae were first observed in the South Fork Mokelumne River on March 11 (Sweetnam and Stevens 1991). Delta smelt larvae were collected at both South Fork and North Fork Mokelumne River on March 5 (this study). Most specimens (27) were captured on May 23 and were in the hatching and post-hatching stages.

Apparently as a result of five years of drought in Northern California, delta smelt moved its spawning ground farther inland to fresh water of the Mokelumne River. The new spawning area receives fresh water from the upper drainage of the Mokelumne River and from the Sacramento River via the Delta Cross Channel. Some larvae may also have been transported from the Sacramento River via the Cross Channel.

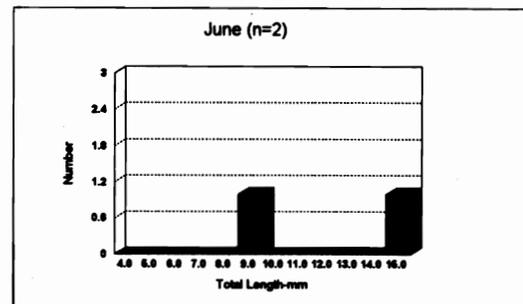
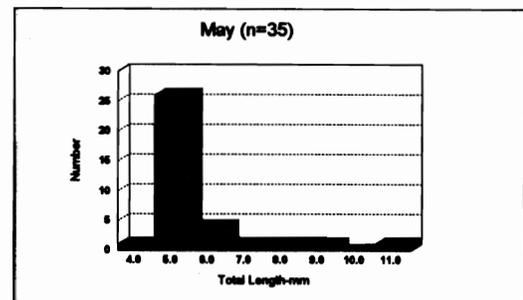
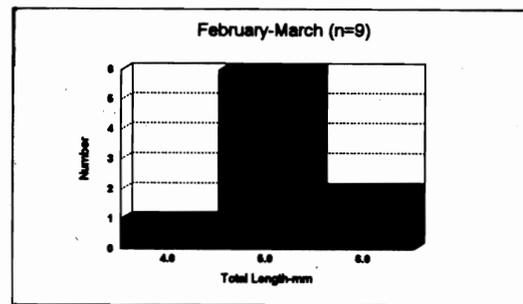


Figure 6  
LENGTH DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES  
COLLECTED IN AREA 3, MOKELUMNE RIVER, IN 1991  
(in millimeters total length)

## Cache Slough

The Department of Fish and Game conducted the Cache Slough pilot study in February and March 1991. From 14 samples collected, 85 early life stage delta smelt were identified. Delta smelt larvae were first observed there on March 11 (Sweetnam and Stevens 1991). Hatching and post-hatching size larvae were taken from Cache Slough (Stations 713 and 715) on February 27 (this study). Delta smelt and longfin smelt were observed at the same stations on many occasions, and this led to hypotheses that Cache Slough has a unique habitat as a "mini-estuary". The fresh water may come from the adjacent Steamboat Slough and the Sacramento River; the brackish water may come from the upper agricultural drains of Cache Slough.

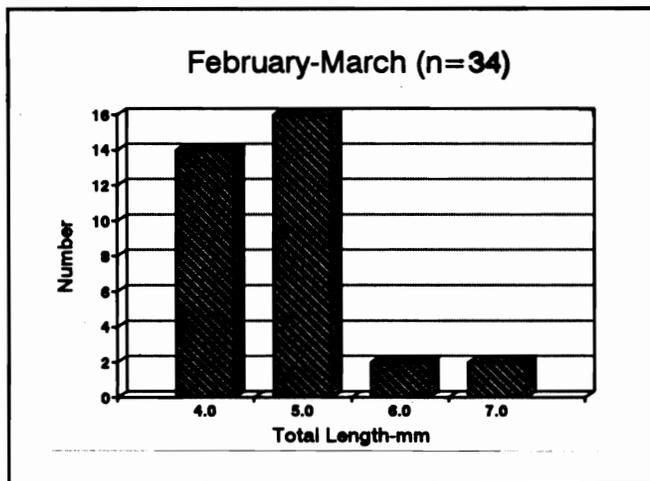


Figure 7

LENGTH DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES COLLECTED IN AREA 4, CACHE SLOUGH, IN 1991 (in millimeters total length)

## Seasonal Movement and Spawning

Delta smelt have a definite seasonal movement. The prespawning population concentrated in the lower delta and upper Suisun Bay in fall, then dispersed into delta channels and sloughs to spawn in winter (Erkkila *et al* 1950;

Ganssle 1966, Radtke 1966). Spawning also occurred in Montezuma Slough and the upper estuary in the predrought years (Moyle 1976; PG&E 1980a,b; Wang 1986). Juvenile delta smelt have a downstream movement pattern that starts in summer and fall (Moyle 1976; Wang 1991), although some juveniles may remain in the delta all their lives (this study).

In 1990 and 1991, delta smelt samples collected in the DFG midwater trawl (Sweetnam and Stevens 1991) demonstrated that prespawning adults congregated in the lower Sacramento River to Honker Bay as a fall (September-November) staging ground, then dispersed into downstream bays and upstream in winter (December-January) to look for a suitable spawning ground. They regrouped in a smaller biomass in areas that had good freshwater flow in the front and the entrapment zone not too far behind, such as Suisun Bay and Montezuma Slough (near Suisun Slough and Cordelia Slough), Sacramento River (near Isleton), Cache Slough and Steamboat Slough (above Rio Vista), lower San Joaquin River (near Andrus Island, and North and South Fork Mokelumne River (below Walnut Grove). Spawners seem to be opportunistic and will move from one location as a fraction spawner to ensure suitability of spawning and hatching (this study).

The delta smelt spawning period is longer in the Sacramento River than in the delta. The lower water temperature in the Sacramento River may be a favorable factor.

Limited numbers of delta smelt larvae have been collected in canals and sloughs near the Central Valley Project and State Water Project delta facilities since 1988 (Spaar 1990a,b, 1991). Delta smelt adults were observed at the Tracy Pumping Plant intake screens during winter in 1990 and 1991 (Wang 1991). For the most part, the window there for delta smelt larvae extends from March to June.

**1988 Stations**

Date	63	64	66	65	606	607	609	67	611	68	5	7	9	11	19	33	55
04/11																	
04/16																	
04/20																	
04/24																	
04/28																	
05/02																	
05/06																	
05/10																	
05/14																	
05/18																	
05/22																	
05/30																	

**1989 Stations**

	66	65	5	7													
04/12																	
04/20																	
04/28																	
05/22																	
06/03																	

**1990 Stations**

	66	65	5	7	9	11	17	19	33	35							
04/12																	
04/16																	
04/24																	
04/28																	
05/02																	
05/06																	
05/10																	
06/07																	
06/12																	

**1991 Stations**

	66	65	5	7	11	17	19	21	23	25	33	35	37	39	41	43	47	61
02/13																		
02/19																		
02/26																		
02/27																		
03/11																		
04/04																		
04/10																		
04/16																		
04/20																		
05/06																		
05/10																		
05/14																		
05/24																		
05/30																		

Figure 8

CATCH OF PACIFIC HERRING EARLY LIFE STAGES IN THE SACRAMENTO-SAN JOAQUIN ESTUARY, 1988-1991



## REFERENCES

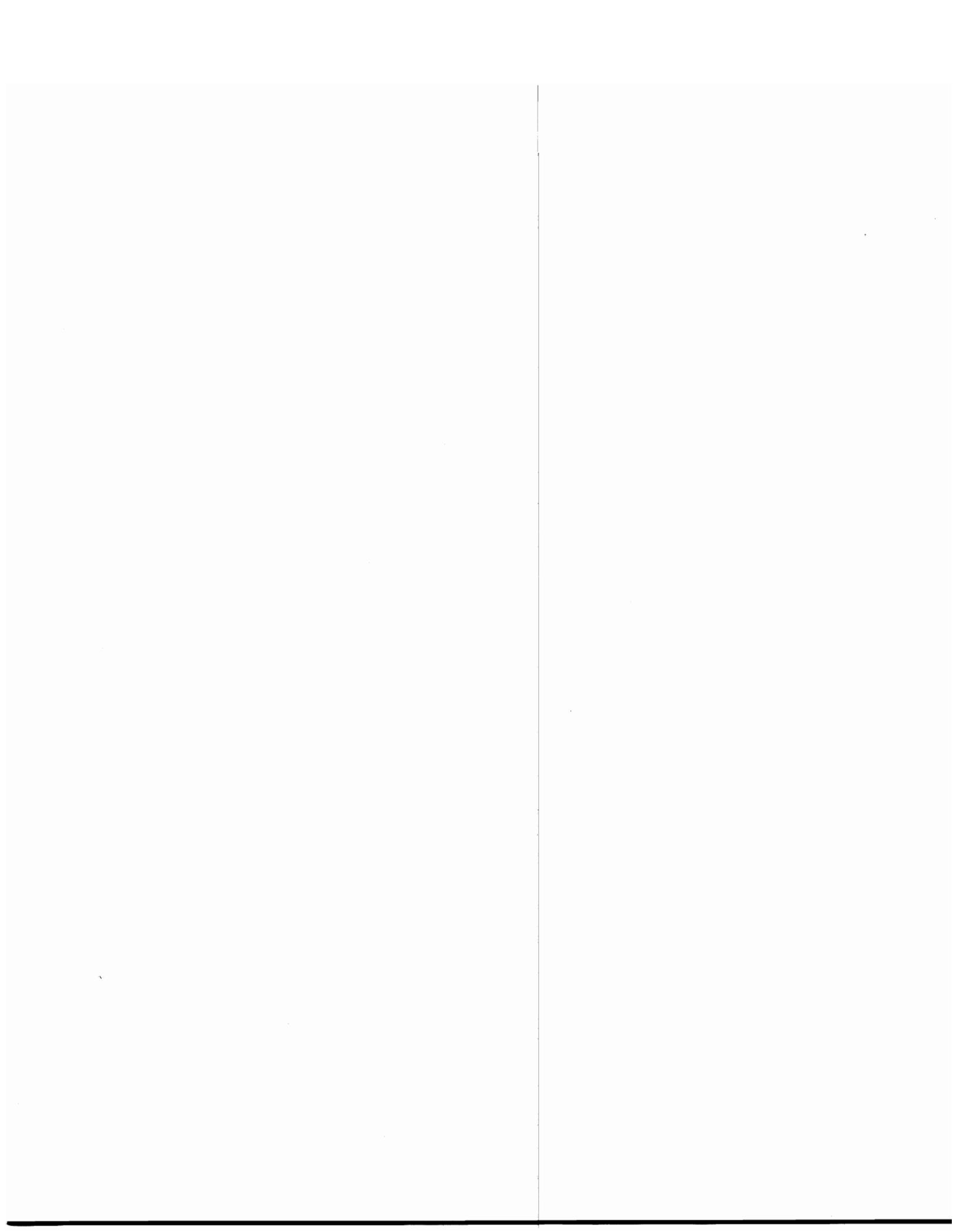
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Appendix A

**EARLY LIFE STAGES OF DELTA SMELT  
COLLECTED IN THE  
SACRAMENTO-SAN JOAQUIN ESTUARY**



# DELTA SMELT EARLY LIFE STAGES COLLECTED

# AREA 1

Station Number No. Caught	Sizes (mm Total Length)	Station Number No. Caught	Sizes (mm Total Length)	Station Number No. Caught	Sizes (mm Total Length)	Station Number No. Caught	Sizes (mm Total Length)
— 1 9 9 1 —							
<b>02/13/91</b>		<b>03/27/91</b>		<b>04/08/91</b>		<b>04/18/91</b>	
None		41 5	5.8 6.2 6.2 6.2 6.7	66 1	6.3	41 1	—
<b>02/26/91</b>		43 1	7.1	65 2	5.8 7.0	57 1	5.6
43 2	4.2 4.5	45 1	5.3	5 5	6.5 6.6 7.4 7.4 7.5	60 1	6.7
<b>02/27/91</b>		47 1	5.7	9 1	6.9	<b>04/20/91</b>	
None		51 1	5.7	39 1	6.0	53 1	6.2
<b>03/11/91</b>		53 3	4.8 5.4 5.6	43 2	5.4 6.0	57 1	6.0
35 1	5.0	55 1	6.5	47 1	5.7	60 2	6.8 6.9
37 1	4.5	57 1	6.7	49 1	5.5	<b>04/22/91</b>	
39 2	5.0 6.0	906 1	6.0	53 1	5.8	51 1	6.0
43 8	5.1 5.6 5.7 6.0 6.0 6.4 7.0 7.0	61 2	5.0 5.4	59 3	5.0 5.2 5.2	53 3	5.5 5.5 6.0
45 8	5.3 5.3 5.4 5.5 5.7 6.0 6.2 6.4	<b>04/04/91</b>		61 1	5.0	55 1	4.5
47 13	4.8 4.9 5.1 5.2 5.5 5.5 5.6 5.7 5.7 6.0 6.2 6.8 7.2	65 2	5.7 6.6	<b>04/10/91</b>		57 1	6.6
49 2	5.1 5.2	13 3	5.6 7.6 7.7	13 2	6.0 6.2	<b>04/24/91</b>	
51 4	5.2 5.5 6.5 7.0	35 2	4.2 4.7	33 1	5.4	51 2	5.2 5.6
53 4	5.1 5.8 6.3 6.3	39 1	4.5	39 2	5.5 6.3	55 1	4.4
<b>03/13/91</b>		43 4	4.2 4.5 4.5 5.2	41 1	5.0	<b>04/26/91</b>	
55 1	5.8	51 1	4.4	<b>04/12/91</b>		59 1	6.2
906 1	6.0	53 1	6.0	65 1	7.8	<b>04/28/91</b>	
60 2	6.0 7.0	55 2	5.3 6.0	43 3	6.0 6.2 6.4	51 1	6.0
<b>03/26/91</b>		59 1	5.1	45 2	5.5 6.0	55 1	5.3
33 8	5.5 5.7 5.8 6.0 6.2 6.2 6.5 6.7	<b>04/06/91</b>		47 1	6.3	57 6	5.0 5.2 5.5 5.6 5.6 6.4
35 3	5.0 6.7 7.4	33 1	5.1	59 1	5.0	59 1	5.4
37 5	5.7 6.4 6.5 6.5 6.6	35 1	4.3	906 1	6.4	906 1	6.0
43 2	4.3 4.5	39 2	5.7 6.1	60 1	5.0	61 1	7.8
		41 7	4.0 4.7 5.0 5.1 5.2 6.0 6.0	<b>04/14/91</b>		<b>04/30/91</b>	
		45 1	6.8	43 1	6.0	37 1	6.0
		49 2	5.7 6.8	49 2	4.7 6.2	55 1	6.0
		53 2	5.5 5.7	<b>04/16/91</b>			
		59 1	5.2	43 1	5.3		
				60 2	7.1 7.2		

**DELTA SMELT EARLY LIFE STAGES COLLECTED****AREA 1**

Station Number No. Caught	Sizes (mm Total Length)	Station Number No. Caught	Sizes (mm Total Length)	Station Number No. Caught	Sizes (mm Total Length)	Station Number No. Caught	Sizes (mm Total Length)
— 1 9 9 1 —							
<b>05/02/91</b>		<b>05/14/91</b>		<b>05/26/91</b>		<b>06/23/91</b>	
33	1 6.8	41	1 7.0	None		43	1 23.2
39	1 7.5	43	1 8.4	<b>05/30/91</b>		<b>06/25/91</b>	
55	1 5.8	57	1 7.0	43	1 6.9	None	
59	11 5.1 5.7 6.0 6.0 6.2 6.2 6.3 6.4 6.5 6.7 7.4	59	1 8.5	55	1 17.5	<b>06/27/91</b>	
60	2 6.0 6.1	906	2 6.8 11.3	57	1 13.0	51	1 9.5
61	1 6.7	<b>05/16/91</b>		60	1 10.0	<b>06/28/91</b>	
<b>05/06/91</b>		55	2 6.3 6.5	<b>06/03/91</b>		None	
57	4 5.5 5.5 6.0 8.5	57	1 7.1	51	1 19.0	<b>07/01/91</b>	
59	6 5.6 6.3 6.8 6.9 7.0 7.0	60	1 9.7	55	1 8.4	None	
<b>05/08/91</b>		61	2 7.5 10.2	<b>06/07/91</b>		<b>07/02/91</b>	
39	1 7.7	<b>05/18/91</b>		43	2 5.5 7.1	None	
41	1 6.7	51	4 5.8 6.5 6.8 7.1	49	1 21.2	<b>07/05/91</b>	
45	1 6.8	<b>05/20/91</b>		<b>06/11/91</b>		65	1 31.0
47	4 5.7 5.7 6.0 6.8	47	1 7.2	47	3 9.3 11.0 20.0	51	1 11.5
49	3 5.5 5.7 6.0	51	2 6.5 7.0	61	1 9.1	57	1 11.8
51	2 5.5 6.2	<b>05/22/91</b>		<b>06/15/91</b>		<b>07/09/91</b>	
55	5 6.5 7.0 7.2 7.4 8.1	51	10 5.8 6.0 6.2 6.2 6.3 6.4 6.5 6.8 6.8 7.0	43	1 8.7	13	1 43.5
59	1 5.8	906	1 14.5	51	1 23.8	<b>07/13/91</b>	
906	1 7.0	61	2 6.0 6.1	59	1 4.0	None	
<b>05/10/91</b>		<b>05/24/91</b>		<b>06/19/91</b>			
None		37	1 6.7	51	2 14.8 15.0		
<b>05/12/91</b>		39	1 6.9				
47	1 6.4	43	2 6.3 8.2				
59	2 6.7 6.8	57	3 6.8 8.7 14.2				
61	1 6.7	59	2 11.2 17.7				
		60	1 7.3				

# DELTA SMELT EARLY LIFE STAGES COLLECTED

# AREA 1

Station Number No. Caught	Sizes (mm Total Length)						
------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------

— 1 9 9 0 —

### 04/12/90

37	2	5.8	6.5
41	8	4.6	7.5
43	2	6.0	7.2
47	4	5.8	8.0
49	7	5.8	7.8
51	1	5.5	
55	3	4.5	5.3
57	1	5.0	
906	2	5.3	7.0
60	1	7.0	

### 04/14/90

39	2	5.8	6.2
41	2	6.0	7.2
43	2	6.0	6.7
45	3	5.5	6.5
47	5	5.0	7.4
49	6	5.7	7.4
51	8	4.8	6.0
53	2	6.2	6.5
55	1	5.6	
57	1	4.8	
59	3	5.6	6.0
60	2	7.4	8.8
61	2	5.8	6.8

### 04/16/90

45	2	5.0	5.4
47	1	4.8	
49	4	6.0	7.8
51	2	5.8	6.0
57	3	4.8	6.5

### 04/20/90

37	1	6.4	
39	1	5.2	
43	5	5.3	8.4
45	1	6.8	
47	4	4.7	8.0
49	11	5.4	7.8
53	2	7.2	8.0
57	1	5.0	
59	1	6.7	
906	1	6.7	
60	3	6.0	6.3
61	4	6.3	10.1

### 04/22/90

37	1	5.1	
41	2	5.2	9.0
45	1	6.5	
47	4	6.7	7.2
53	1	5.0	
57	2	4.2	5.6
59	4	5.0	8.2
61	3	6.0	7.0

### 04/24/90

41	2	8.3	10.5
45	12	5.3	8.0
49	2	—	
53	3	4.1	7.5
57	2	5.0	6.6
60	3	5.5	9.0
61	4	8.2	10.8

### 04/26/90

45	1	11.2	
49	6	5.8	8.0
51	4	5.1	5.3
53	2	5.8	8.0
55	3	6.0	9.8
59	2	4.7	5.2
60	4	6.0	7.8
61	1	5.5	

### 04/28/90

41	1	6.5	
45	4	6.0	6.8

### 04/30/90

None

### 05/02/90

41	1	7.2	
43	2	5.7	7.4
49	8	5.0	6.0
57	3	5.0	6.8
906	4	5.5	9.8
60	4	5.3	6.5

### 05/04/90

35	1	7.1	
37	1	6.4	
39	1	6.7	

### 05/06/90

43	1	6.1	
45	22	5.8	10.0
49	6	5.8	11.0
53	1	6.5	
57	4	5.5	8.5
906	2	6.0	6.8
60	5	5.9	9.7
61	3	6.7	9.5

### 05/08/90

45	2	6.2	6.6
57	2	7.7	25.0
60	2	6.2	8.2
61	3	6.2	9.0

### 05/10/90

45	1	20.5	
53	1	11.0	
57	1	14.0	
60	1	10.0	
61	1	15.0	

### 05/12/90

43	1	9.2	
45	1	7.3	
60	2	9.8	10.4
61	1	8.0	

### 05/14/90

906	7	5.8	8.7
60	1	10.8	

### 05/16/90

51	1	6.5	
57	1	20.7	
60	4	8.3	23.0

### 05/18/90

49	20	7.0	11.7
57	1	10.8	
906	1	15.0	
60	1	16.0	
61	1	9.7	

Area 1 -- 1990

**DELTA SMELT EARLY LIFE STAGES COLLECTED****AREA 1**

Station Number No. Caught	Sizes (mm Total Length)						
------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------

— 1 9 9 0 —

**05/20/90**

37	1	14.2
47	2	7.5 8.0
51	1	11.0
55	1	12.0
61	1	9.0

**05/22/90**

41	2	9.5 9.7
53	1	13.3

**05/24/90**

47	2	14.7 19.8
59	1	10.8
906	2	8.4 10.7

**05/26/90**

49	1	6.5
51	1	24.3
53	2	24.0 25.5
55	2	14.2 18.5
906	1	14.0
61	1	13.5

**05/30/90**

43	1	23.0
51	1	23.5
55	1	20.0
60	2	18.4 26.8
61	1	13.8

**06/01/90**

None

**06/03/90**

43	1	11.5
57	1	9.2
60	1	22.5

**06/07/90**

49	1	14.3
----	---	------

**06/09/90**

None

**06/11/90**

None

**06/12/90**

45	1	22.5
----	---	------

**06/13/90**

None

**06/15/90**

None

**06/17/90**

None

**06/19/90**

41	1	29.0
----	---	------

**06/21/90**

None

**06/23/90**

45	1	29.8
----	---	------

**06/27/90**

47	1	28.0
----	---	------

**07/01/90**

None

**07/05/90**

None

**07/09/90**

None

**07/13/90**

11	2	53.5 54.0
----	---	-----------

# DELTA SMELT EARLY LIFE STAGES COLLECTED

# AREA 1

Station Number No. Caught	Sizes (mm Total Length)						
— 1 9 8 9 —							
<b>04/12/89</b>		<b>04/24/89</b>		57 2 4.4 4.7		<b>05/26/89</b>	
33 2	5.0 6.1	39 1	7.3	59 5	5.6 - 6.3	43 1	9.4
35 2	5.5 5.6	43 2	5.7 7.4	906 1	5.4	45 1	6.0
37 3	7.0 - 8.5	51 2	5.5 5.6	60 4	5.6 - 6.6	<b>05/30/89</b>	
39 7	6.0 - 7.2	53 2	5.3 5.5	61 13	5.3 - 6.5	35 1	15.0
43 3	6.2 - 7.0	55 3	5.3 - 5.5	<b>05/06/89</b>		37 1	5.5
45 1	5.5	57 1	5.3	13 1	6.5	<b>06/03/89</b>	
47 3	5.0 - 6.0	60 4	5.3 - 7.2	15 1	5.7	39 1	6.5
49 6	5.3 - 9.0	61 1	6.3	41 1	13.0	49 1	6.7
51 3	5.4 - 5.8	<b>04/28/89</b>		55 1	5.8	<b>06/07/89</b>	
55 3	5.2 - 6.0	33 1	10.3	57 1	5.9	None	
57 1	6.7	37 11	5.2 - 8.5	59 1	7.2	<b>06/11/89</b>	
60 4	4.3 - 5.0	39 1	5.0	<b>05/10/89</b>		35 1	22.5
61 4	5.5 - 7.0	41 16	5.8 - 11.6	37 1	5.5	<b>06/15/89</b>	
<b>04/16/89</b>		43 4	5.0 - 9.2	39 1	13.5	None	
5 2	5.7 6.2	45 1	5.5	43 1	7.0	<b>06/19/89</b>	
35 2	7.0 10.8	47 29	5.5 - 9.2	47 1	6.4	None	
39 2	6.0 6.1	49 100	4.9 - 8.0	49 3	5.3 - 5.8	<b>06/23/89</b>	
41 2	5.7 6.7	51 3	4.7 - 6.5	55 2	4.3 5.0	43 1	23.5
43 1	5.7	55 6	4.5 - 7.0	906 1	10.8	45 1	32.0
45 4	6.0 - 6.5	57 4	5.0 - 6.4	<b>05/14/89</b>		49 1	17.5
49 2	5.2 5.5	59 2	5.2 5.4	43 3	6.0 - 6.5	53 1	40.0
51 2	6.8 6.9	906 3	5.0 - 6.0	47 21	4.8 - 6.6	<b>06/27/89</b>	
55 2	6.2 6.7	60 3	5.5 - 6.1	55 2	6.5 7.0	None	
57 2	5.0 5.5	<b>05/02/89</b>		<b>05/18/89</b>		<b>07/01/89</b>	
<b>04/20/89</b>		33 1	5.9	39 1	5.5	45 1	42.0
37 1	5.0	35 1	7.5	41 3	5.7 - 8.0	61 1	15.0
43 3	6.8 - 8.4	37 4	5.5 - 5.8	49 1	11.1	<b>07/05/89</b>	
45 7	5.5 - 6.5	39 2	5.4 10.1	47 1	7.4	None	
51 2	6.8 7.3	41 9	5.0 - 6.2	49 2	6.4		
53 2	5.4 6.0	45 6	5.2 - 6.4	55 1	7.9		
55 3	5.3 - 6.4	47 5	5.5 - 8.7	<b>05/22/89</b>			
57 2	5.5 6.4	49 7	5.5 - 6.2	None			
906 6	5.2 - 6.5	51 7	4.8 - 6.0				
61 1	6.1	53 3	5.0 - 6.7				
		55 4	5.3 - 5.8				

## DELTA SMELT EARLY LIFE STAGES COLLECTED

AREA 1

Station Number No.	Caught	Sizes (mm Total Length)	Station Number No.	Caught	Sizes (mm Total Length)	Station Number No.	Caught	Sizes (mm Total Length)	Station Number No.	Caught	Sizes (mm Total Length)
-----------------------	--------	----------------------------	-----------------------	--------	----------------------------	-----------------------	--------	----------------------------	-----------------------	--------	----------------------------

— 1 9 8 8 —

## 04/12/88

35	2	5.6 5.8
43	4	5.9 - 9.5
45	2	5.3 6.0
47	15	5.2 - 11.3
49	10	6.0 - 9.2
51	4	5.8 - 6.7
53	9	5.2 - 8.0
55	1	5.4
59	17	5.2 - 9.8
906	6	5.2 - 8.5

## 04/16/88

35	6	6.5 - 10.4
37	5	6.2 - 7.1
39	5	6.0 - 7.2
41	3	5.8 - 7.0
43	1	5.5
45	3	5.0 - 6.0
47	3	5.5 - 10.5
49	4	5.7 - 10.0
51	3	5.3 - 10.2
53	1	7.0
55	1	5.6
57	1	6.8
59	6	5.7 - 6.7
909	1	5.6
60	3	6.0 - 10.2

## 04/20/88

37	2	6.0 8.8
39	6	5.2 - 7.3
41	1	5.6
43	2	6.1 10.7
47	3	5.8 - 6.3
49	5	5.0 - 7.1

51	2	6.4 6.5
53	3	6.0 - 9.7
55	6	6.3 - 7.6
59	4	5.8 - 8.7
906	4	5.2 - 12.4
909	1	6.2
60	1	6.5
61	1	7.5

## 04/24/88

66	2	5.5 6.0
33	2	5.8 6.0
35	6	5.4 - 6.4
37	16	5.7 - 10.0
39	4	5.7 - 7.4
41	1	6.2

## 04/28/88

68	5	5.2 - 6.6
37	4	6.0 - 7.4
39	2	6.2 6.7
43	1	6.3
51	1	10.4
55	2	5.2 5.5
57	2	5.7 5.9
59	2	5.9 6.2
61	1	12.2

## 05/02/88

68	2	6.9 7.1
33	2	6.8 7.0
35	3	6.8 - 7.3
43	3	5.7 - 8.4
45	3	6.0 - 6.7

## 05/06/88

39	1	6.1
47	1	7.4
61	1	6.7

## 05/10/88

37	1	8.0
39	4	5.3 - 8.7
41	1	7.8
47	3	6.4 - 7.2
906	2	6.5 7.8
60	3	7.0 - 8.7

## 05/14/88

68	2	5.7 5.8
37	1	8.2
39	1	8.5
41	2	7.0 8.3
43	2	6.5 8.2
49	1	6.0
53	1	6.3
60	3	6.4 - 11.3

## 05/18/88

39	1	8.3
41	6	7.4 - 10.2
43	1	5.7
57	1	5.2
61	6	5.7 - 6.9

## 05/22/88

35	3	5.2 - 6.6
39	1	5.8
43	1	6.5
60	1	6.5
61	2	5.5 6.0

## 05/26/88

11	1	7.8
35	2	7.2 10.0
37	3	9.5 - 11.4
41	2	8.5 10.0
43	6	6.0 - 14.7
45	2	5.3 6.2

## 05/30/88

15	1	6.6
----	---	-----

## 06/03/88

39	2	8.0 20.0
45	1	25.0
51	1	14.4

## 06/07/88

None

## 06/11/88

59	2	16.0 16.2
----	---	-----------

## 06/15/88

45	1	28.6
59	1	6.0
909	1	22.0

## 06/19/88

41	1	26.2
47	2	16.7 19.8
57	1	21.0

## 06/23/88

41	1	25.5
43	1	27.7
47	1	18.5
49	1	23.0
55	1	27.2

**DELTA SMELT EARLY LIFE STAGES COLLECTED**

**AREA 1**

Station Number No. Caught	Sizes (mm Total Length)						
------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------

— 1 9 8 8 —

**06/27/88**

41	1	25.5
43	1	27.3
47	1	18.1
49	1	22.5
51	1	28.0

**07/01/88**

None

**07/05/88**

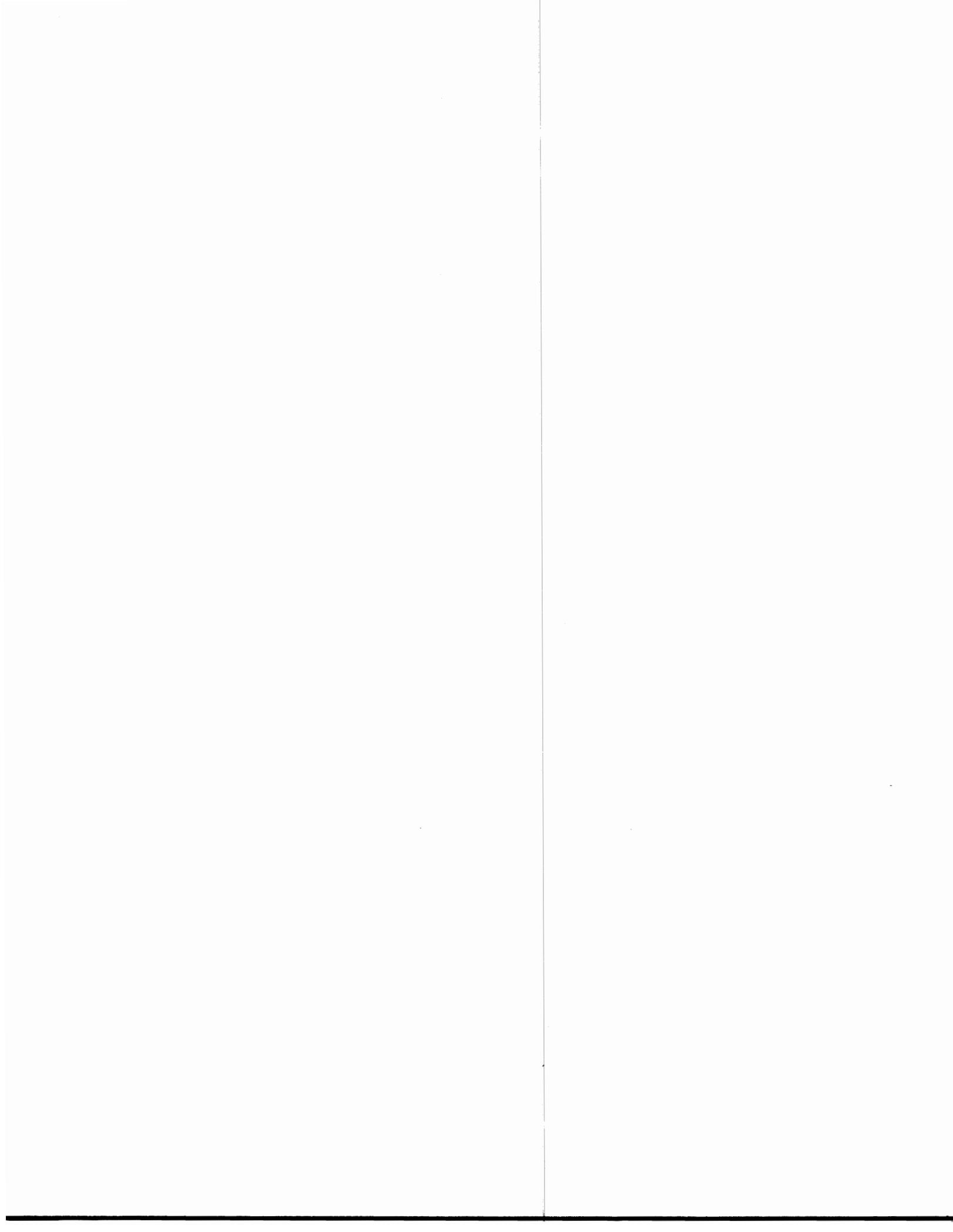
None

**07/09/88**

None

**07/13/88**

None



**DELTA SMELT EARLY LIFE STAGES COLLECTED**

**AREA 2**

Station Number No. Caught	Sizes (mm Total Length)						
------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------

— 1 9 9 1 —

<b>02/13/91</b> None		<b>03/28/91</b> 19 2 5.0 5.2 29 1 5.2 32 3 5.0 5.2 5.5		<b>04/28/91</b> 19 1 11.0 23 3 4.7 4.7 6.2 25 2 5.2 6.7 27 1 6.0 32 11 4.5 5.0 5.1 5.5 5.5 5.7 5.7 6.0 6.0 6.0 6.4 72 3 4.0 4.8 5.2 725 7 4.3 4.5 4.6 4.6 4.7 4.9 5.0 70 1 4.8 71 2 5.3 5.7 73 2 5.0 5.1 735 2 4.5 5.2 74 1 4.2 745 3 4.3 4.5 5.0		<b>05/04/91</b> 72 4 5.0 5.1 5.5 6.0 70 2 5.4 5.9 71 1 5.7 735 2 4.9 5.0 74 1 4.4 745 1 4.3 75 1 5.3 755 1 4.8 775 1 5.4
<b>02/19/91</b> None		<b>04/04/91</b> 21 1 6.0 25 1 6.2 32 1 7.0		<b>04/30/91</b> 72 4 5.1 5.5 5.7 6.0 725 4 4.3 4.6 5.1 5.5 70 6 4.9 5.0 5.2 5.4 5.5 5.6 735 1 4.5 74 1 3.6 745 1 4.2 75 2 4.1 4.8		<b>05/06/91</b> 32 4 5.3 6.0 6.0 7.3 72 5 4.8 5.4 5.6 5.8 6.0 725 5 4.7 5.1 5.3 5.5 5.5 71 1 4.8 74 1 5.3 745 1 4.0
<b>02/20/91</b> None		<b>04/06/91</b> None		<b>05/02/91</b> 72 8 4.9 5.0 5.0 6.0 6.0 6.2 6.3 6.5 725 4 5.0 6.0 6.0 6.4 70 3 5.0 5.5 6.0 71 3 4.5 5.0 5.2 735 2 5.0 6.0 74 1 5.7 745 2 4.7 5.0		<b>05/08/91</b> 72 3 5.0 5.3 6.0 725 2 5.2 5.3 71 1 5.3 73 3 5.0 5.1 5.5 735 3 5.2 5.6 8.8 74 2 4.9 5.2 745 1 4.5
<b>02/26/91</b> None		<b>04/10/91</b> 17 1 6.8 25 2 5.8 6.5 29 1 6.0		<b>05/10/91</b> 71 1 5.0 73 5 4.8 5.0 5.2 5.2 5.3 735 1 5.0		<b>05/12/91</b> 725 2 5.3 5.5 70 1 4.8 74 1 4.7
<b>02/27/91</b> 70 1 5.1		<b>04/12/91</b> None				
<b>02/28/91</b> 73 1 4.4 75 1 5.0 755 3 5.0 5.3 5.5 76 2 5.7 5.8		<b>04/16/91</b> 25 2 5.5 6.2				
<b>03/05/91</b> 71 5 4.4 4.7 5.2 5.3 6.0		<b>04/20/91</b> 29 1 6.7 32 1 6.0				
<b>03/18/91</b> 17 6 4.7 5.0 5.7 5.7 5.8 6.5 19 7 4.9 5.0 5.4 6.8 6.8 6.9 8.6 21 11 5.3 5.4 5.4 5.5 5.5 5.9 6.0 6.0 6.3 6.3 6.5 23 2 5.9 6.0 25 1 5.5 27 2 4.0 5.8 32 3 5.1 5.4 5.5		<b>04/24/91</b> None				
<b>03/27/91</b> 25 1 5.2 27 1 6.0		<b>04/26/91</b> 72 3 5.1 5.3 6.0 725 2 4.7 5.0 71 3 4.5 4.7 4.7 735 3 4.7 5.1 5.2 74 1 5.0 745 1 4.0				

## DELTA SMELT EARLY LIFE STAGES COLLECTED

AREA 2

Station Number No. Caught	Sizes (mm Total Length)						
------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------

— 1 9 9 1 —

## 05/14/91

32	2	5.7	6.5
72	36	5.2	5.3 5.4 5.4 5.4 5.5
		5.5	5.7 5.7 5.7 5.7
		5.7	5.7 5.8 5.8 5.9
		5.9	6.0 6.0 6.0 6.0
		6.1	6.2 6.2 6.2 6.5
		6.5	6.7 6.6 6.8 6.8 6.9

725 3 5.0 5.7 6.0

70 2 5.0 5.1

73 1 4.8

74 1 5.0

745 2 4.0 11.1

755 3 4.2 4.5 4.6

## 05/16/91

745 1 5.1

## 05/18/91

725 1 5.5

70 1 6.6

735 1 5.0

75 2 4.2 4.9

## 05/20/91

72 1 5.7

725 2 5.3 5.7

71 1 5.5

75 1 4.5

755 3 4.4 4.5 4.5

## 05/22/91

72 1 5.8

735 1 5.2

74 1 4.7

745 2 4.6 4.8

75 1 4.7

## 05/24/91

70 1 5.6

73 2 5.1 5.2

735 2 5.1 5.2

74 2 5.2 5.5

## 05/26/91

29 1 6.5

## 05/28/91

735 1 5.4

75 2 4.4 4.6

## 05/30/91

None

## 06/01/91

755 1 4.0

## 06/03/91

None

## 06/05/91

735 1 10.9

## 06/06/91

None

## 06/07/91

32 1 9.0

## 06/09/91

None

## 06/11/91

None

## 06/13/91

None

## 06/15/91

32 1 25.5

## 06/17/91

None

## 06/19/91

None

## 06/28/91

None

## 07/01/91

None

## 07/05/91

25 1 21.9

## 07/09/91

None

## 07/13/91

None

# DELTA SMELT EARLY LIFE STAGES COLLECTED

# AREA 2

Station Number No. Caught	Sizes (mm Total Length)						
------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------

— 1 9 9 0 —

<b>04/12/90</b>
25 1 5.0
27 7 5.0 - 9.8
32 9 4.0 - 9.0
<b>04/14/90</b>
None
<b>04/16/90</b>
27 1 5.2
<b>04/20/90</b>
23 3 5.2 - 5.4
27 4 5.0 - 7.7
78 2 5.7 6.0
<b>04/22/90</b>
None
<b>04/24/90</b>
23 1 8.4
27 2 5.7 11.7
32 3 4.8 - 5.0
<b>04/26/90</b>
None
<b>04/28/90</b>
27 2 4.0 4.8
32 2 4.8 5.0
<b>04/30/90</b>
None

<b>05/02/90</b>
32 3 4.8 - 5.0
<b>05/04/90</b>
None
<b>05/06/90</b>
27 1 4.5
<b>05/08/90</b>
None
<b>05/10/90</b>
32 1 6.0
<b>05/12/90</b>
None
<b>05/14/90</b>
None
<b>05/16/90</b>
775 2 8.5 10.5
<b>05/18/90</b>
None
<b>05/20/90</b>
None
<b>05/22/90</b>
23 2 9.7 10.2
27 1 11.0

<b>05/24/90</b>
None
<b>05/26/90</b>
None
<b>05/30/90</b>
None
<b>06/01/90</b>
None
<b>06/03/90</b>
None
<b>06/07/90</b>
None
<b>06/09/90</b>
None
<b>06/11/90</b>
None
<b>06/12/90</b>
None
<b>06/13/90</b>
None
<b>06/15/90</b>
27 1 17.0
32 1 25.0

<b>06/17/90</b>
None
<b>06/19/90</b>
25 1 23.1
<b>06/21/90</b>
None
<b>06/23/90</b>
None
<b>06/27/90</b>
21 1 41.5
23 4 31.0 - 37.0
<b>07/01/90</b>
19 1 43.8
21 8 28.5 - 42.2
23 1 22.0
<b>07/05/90</b>
19 1 38.0
21 1 16.5
23 1 36.2
<b>07/09/90</b>
None
<b>07/13/90</b>
23 1 5.0

## DELTA SMELT EARLY LIFE STAGES COLLECTED

AREA 2

Station Number No. Caught	Sizes (mm Total Length)						
------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------

— 1 9 8 9 —

## 04/12/89

19	2	5.5	6.0
21	3	5.8	6.5
25	2	6.0	6.5
29	2	4.8	5.0
32	1	4.8	

## 04/16/89

29	2	5.0	5.2
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## 04/20/89

25	3	5.0	5.4
27	1	5.5	
29	5	4.6	6.8
725	2	4.4	4.7
70	1	4.7	
71	3	4.2	4.5
73	1	4.0	
745	1	3.9	

## 04/24/89

21	1	6.2	
25	4	5.3	5.7
27	2	5.2	5.5
29	2	4.8	5.7
32	3	4.8	6.0
725	1	4.8	
71	1	5.0	
73	1	4.6	
735	1	4.2	
74	3	4.0	4.5

## 04/28/89

27	2	5.0	6.5
29	1	5.0	
72	2	5.3	5.5
70	1	5.0	
71	1	5.2	
73	1	4.5	
735	3	4.8	11.5
74	2	5.0	5.1
745	1	4.5	

## 05/02/89

21	1	5.8	
25	2	5.0	6.0
27	1	5.2	
29	2	5.0	5.2
32	3	5.2	5.4
725	1	5.2	
70	2	4.2	5.5
73	4	4.9	5.8

## 05/06/89

23	1	5.5	
29	1	5.0	
32	2	4.8	5.0
725	1	4.1	
70	2	4.4	4.6
73	1	4.5	

## 05/10/89

21	3	8.0	9.5
32	1	5.5	
72	1	4.8	
73	1	5.3	
735	1	5.0	
74	1	4.4	

## 05/14/89

29	1	5.5	
32	1	5.5	

## 05/18/89

None

## 05/22/89

29	1	5.3	
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## 05/26/89

None

## 05/30/89

75	1	6.5	
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## 06/03/89

25	1	6.3	
----	---	-----	--

## 06/07/89

None

## 06/11/89

None

## 06/15/89

None

## 06/19/89

None

## 06/23/89

None

## 06/27/89

None

## 07/01/89

19	1	46.0	
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## 07/05/89

25	1	5.0	
----	---	-----	--

# DELTA SMELT EARLY LIFE STAGES COLLECTED

AREA 2

Station Number No. Caught	Sizes (mm Total Length)						
— 1 9 8 8 —							
<b>04/12/88</b>		<b>04/24/88</b>		<b>05/18/88</b>		<b>06/15/88</b>	
25	2 5.8 7.3	25	2 5.2 8.5	17	1 6.5	25	1 22.0
27	1 7.3	29	2 4.3 10.8	<b>05/22/88</b>		27	1 5.7
29	1 7.0	<b>04/28/88</b>		None		<b>06/19/88</b>	
32	4 5.4 - 8.8	23	3 5.3 - 6.3	<b>05/26/88</b>		None	
<b>04/16/88</b>		25	5 5.2 - 6.3	17	2 6.0 6.4	<b>06/23/88</b>	
17	2 5.8 6.2	<b>05/02/88</b>		32	1 5.7	23	1 45.0
21	8 5.2 - 7.4	29	3 5.5 - 6.0	<b>05/30/88</b>		<b>06/27/88</b>	
23	3 5.2 - 7.7	<b>05/06/88</b>		None		None	
25	7 4.6 - 9.1	27	2 5.5 6.0	<b>06/03/88</b>		<b>07/01/88</b>	
27	11 4.8 - 10.1	<b>05/10/88</b>		None		None	
32	3 5.0 - 6.0	None		<b>06/07/88</b>		<b>07/05/88</b>	
<b>04/20/88</b>		<b>05/14/88</b>		None		21	1 32.0
19	6 5.2 - 6.3	17	3 6.0 - 6.5	<b>06/11/88</b>		<b>07/09/88</b>	
21	6 5.4 - 13.2	23	2 9.3 10.2	None		None	
23	4 5.5 - 9.0	32	1 7.8			<b>07/13/88</b>	
25	1 5.3					None	
29	2 6.0 6.5						



**DELTA SMELT EARLY LIFE STAGES COLLECTED**

**AREA 3**

Station Number No. Caught	Sizes (mm Total Length)						
------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------	------------------------------	----------------------------

— 1 9 9 1 —

**02/21/91**

None

**03/05/91**

919	1	6.5
921	1	5.5
922	2	5.2 5.5
923	4	4.9 5.1 5.5 6.2

**03/13/91**

924	1	5.3
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**05/09/91**

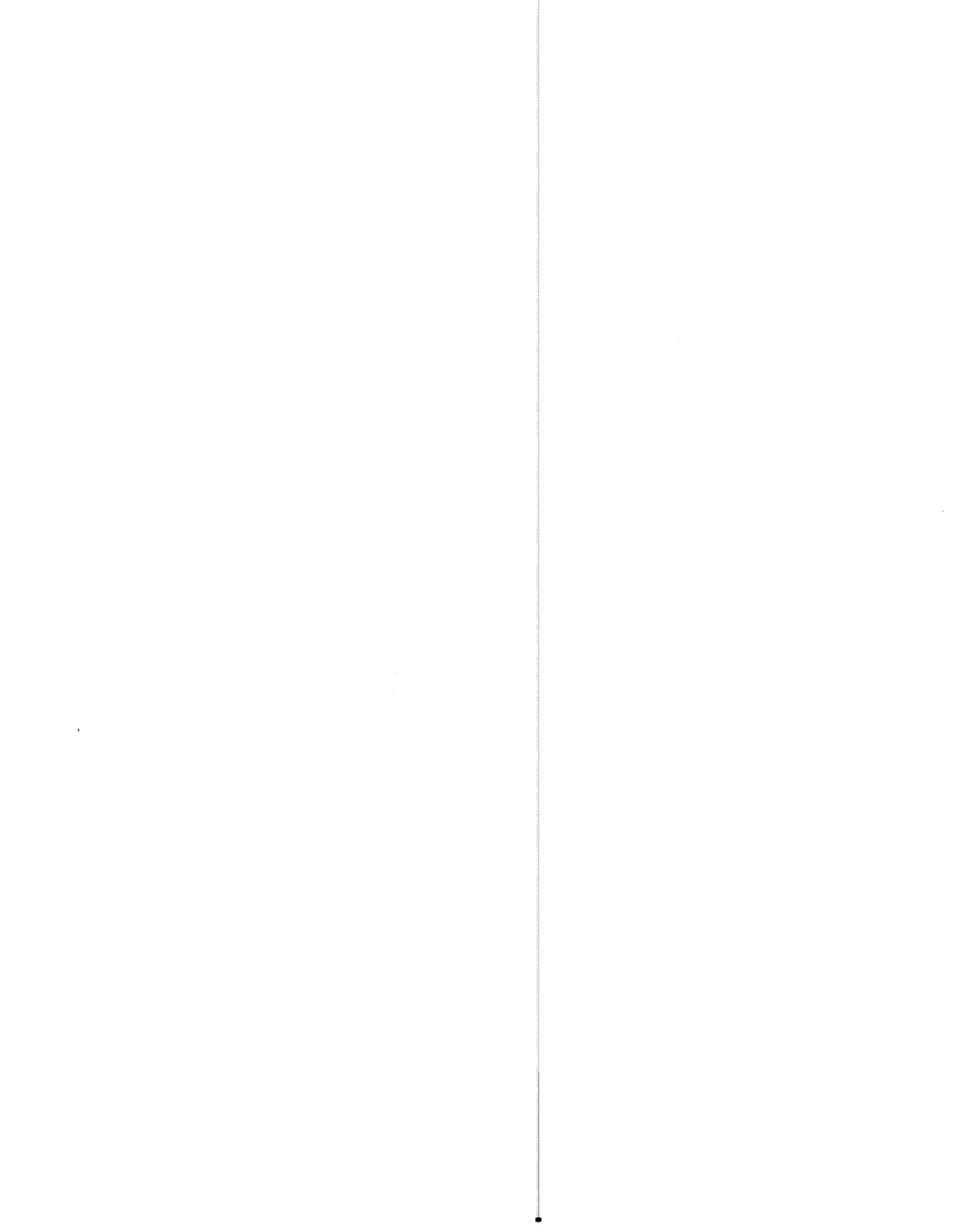
903	1	5.3
919	2	5.7 6.0
920	1	6.2
922	4	5.2 5.2 5.2 5.3

**05/23/91**

903	4	5.5 5.7 5.8 6.0
919	6	4.5 5.3 5.3 5.4 5.5 5.8
920	4	5.2 6.2 7.0 8.6
921	3	5.3 6.5 9.1
922	9	5.0 5.0 5.1 5.1 5.2 5.2 5.2 5.5 12.2
923	1	5.9

**06/12/91**

922	2	9.2 15.8
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**DELTA SMELT EARLY LIFE STAGES COLLECTED**

**AREA 4**

Station Number No.	Caught	Sizes (mm Total Length)	Station Number No.	Caught	Sizes (mm Total Length)	Station Number No.	Caught	Sizes (mm Total Length)	Station Number No.	Caught	Sizes (mm Total Length)
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— 1 9 9 1 —

**02/19/91**

None

**02/27/91**

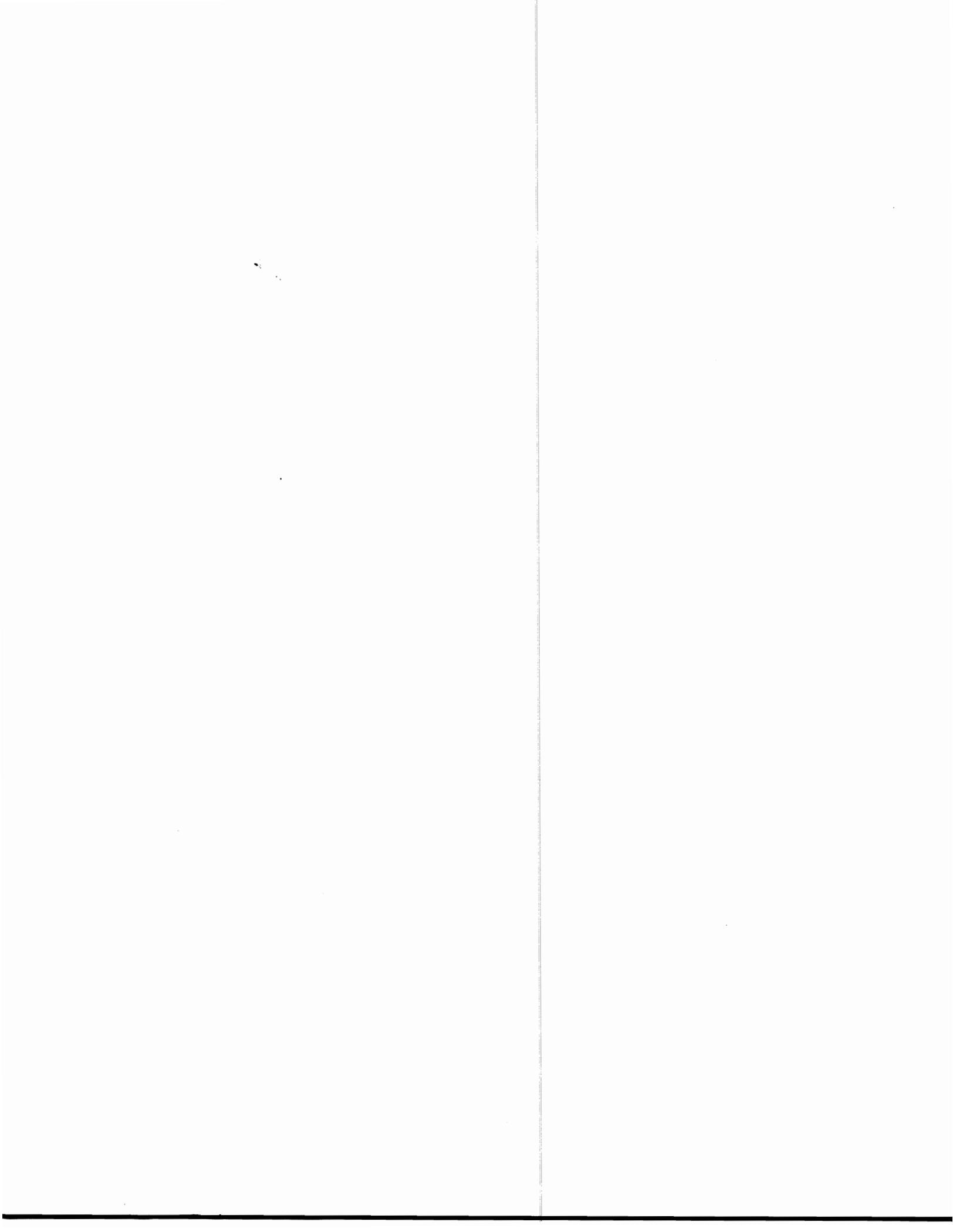
713	17	4.2 4.5 4.5 4.7 4.7 4.8 4.8 4.9 5.0 5.0 5.0 5.2 5.2 5.3 5.6 5.7 5.8
715	51	Not Measured

**03/18/91**

712	1	4.4
713	5	4.5 5.2 5.3 5.7 7.0
715	8	4.5 4.5 4.7 5.0 5.5 5.6 6.2 7.0

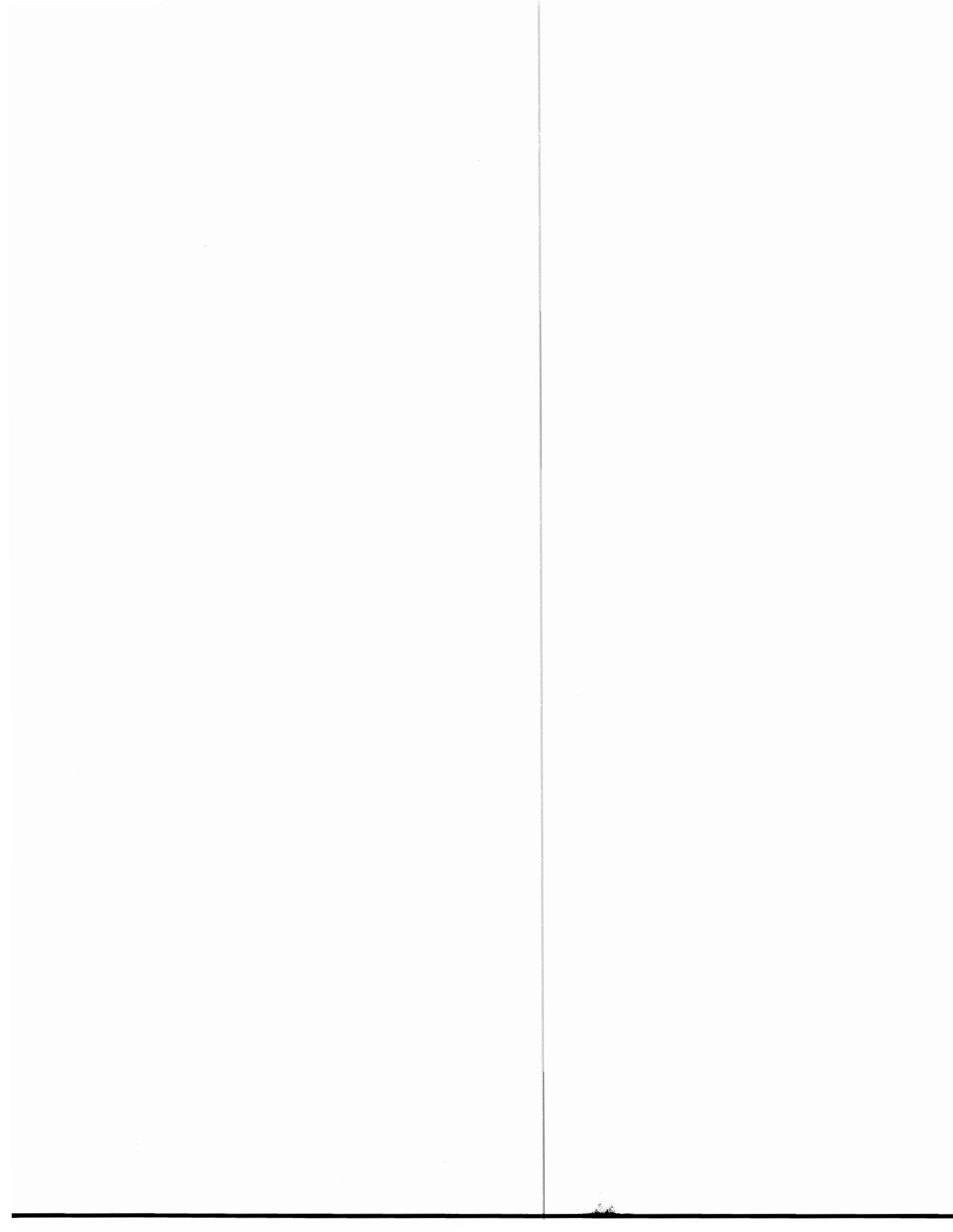
**03/27/91**

715	3	4.2 5.2 6.2
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Appendix B

**SPATIAL AND TEMPORAL DISTRIBUTION  
OF  
DELTA SMELT EARLY LIFE STAGES  
COLLECTED IN THE  
SACRAMENTO-SAN JOAQUIN ESTUARY**



# SPATIAL AND TEMPORAL DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES

# AREA 1

No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number																							Area 1 Total					
	66	65	5	7	9	11	13	15	33	35	37	39	41	43	45	47	49	51	53	55	57	59	906		909	60	61		
02/13/91																													-
02/26/91																													2
02/27/91																													-
03/11/91																													43
03/13/91																													4
03/26/91																													18
03/27/91																													17
04/04/91																													17
04/06/91																													17
04/08/91																													19
04/10/91																													6
04/12/91																													10
04/14/91																													3
04/16/91																													3
04/18/91																													3
04/20/91																													4
04/22/91																													6
04/24/91																													3
04/26/91																													1
04/28/91																													11
04/30/91																													2
05/02/91																													17
05/06/91																													10
05/08/91																													19
05/10/91																													-
05/12/91																													4
05/14/91																													6
05/16/91																													6
05/18/91																													4
05/20/91																													3
05/22/91																													13
05/24/91																													10
05/26/91																													-
05/30/91																													4

Area 1 -- 1991

**SPATIAL AND TEMPORAL DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES** **AREA 1**

No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number																							Area 1				
	66	65	5	7	9	11	13	15	33	35	37	39	41	43	45	47	49	51	53	55	57	59	906	909	60	61	Total	
	— 1 9 9 1 —																											
06/03/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	2
06/07/91	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	3
06/11/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	1	4	
06/15/91	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	-	3	
06/19/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	
06/23/91	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	
06/25/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/27/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	
06/28/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
07/01/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
07/02/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
07/05/91	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	3	
07/09/91	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
07/13/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<b>Total</b>	<b>1</b>	<b>6</b>	<b>5</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>6</b>	<b>-</b>	<b>11</b>	<b>7</b>	<b>8</b>	<b>11</b>	<b>16</b>	<b>32</b>	<b>13</b>	<b>25</b>	<b>11</b>	<b>34</b>	<b>15</b>	<b>18</b>	<b>21</b>	<b>32</b>	<b>8</b>	<b>-</b>	<b>13</b>	<b>11</b>	<b>305</b>	

# SPATIAL AND TEMPORAL DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES

## AREA 1

No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number																						Area 1 Total				
	66	65	5	7	9	11	13	15	33	35	37	39	41	43	45	47	49	51	53	55	57	59		906	909	60	61
	— 1 9 9 0 —																										
04/12/90	-	-	-	-	-	-	-	-	-	2	-	8	4	-	4	7	1	-	3	1	-	2	-	-	1	-	33
04/14/90	-	-	-	-	-	-	-	-	-	-	2	2	2	3	5	6	8	2	1	1	3	-	-	-	2	2	39
04/16/90	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	4	2	-	-	3	-	-	-	-	-	-	12
04/20/90	-	-	-	-	-	-	-	-	-	1	1	-	5	1	4	11	-	2	-	1	1	1	1	-	3	4	35
04/22/90	-	-	-	-	-	-	-	-	-	1	-	2	-	1	4	-	-	1	-	2	4	-	-	-	-	3	18
04/24/90	-	-	-	-	-	-	-	-	-	-	-	2	-	12	-	2	-	3	-	2	2	-	-	-	3	4	28
04/26/90	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	6	4	2	3	-	2	-	-	4	1	23
04/28/90	-	-	-	-	-	-	-	-	-	-	-	1	-	4	-	-	-	-	-	-	-	-	-	-	-	-	5
04/30/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/02/90	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	8	-	-	-	3	-	4	-	4	-	-	22
05/04/90	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
05/06/90	-	-	-	-	-	-	-	-	-	-	-	-	1	22	-	6	-	1	-	4	-	2	-	5	3	44	
05/08/90	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	-	2	-	-	2	3	9	
05/10/90	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	-	1	-	-	-	1	1	5	
05/12/90	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	2	1	5	
05/14/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	1	-	8	
05/16/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	4	-	6	
05/18/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	1	-	1	-	1	1	1	24	
05/20/90	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	-	1	-	1	-	-	-	-	-	1	6	
05/22/90	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-	-	-	-	-	-	-	3	
05/24/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	1	2	-	-	5	
05/26/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	2	-	-	1	-	-	1	8	
05/30/90	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	1	-	-	-	-	2	1	6	
06/01/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/03/90	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	1	-	3	
06/07/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	
06/09/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/11/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/12/90	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	
06/13/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/15/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/17/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/19/90	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
06/21/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/23/90	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	
06/27/90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	

Area 1 -- 1990

**SPATIAL AND TEMPORAL DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES**

**AREA 1**

No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number																							Area 1				
	66	65	5	7	9	11	13	15	33	35	37	39	41	43	45	47	49	51	53	55	57	59	906	909	60	61	Total	
	<b>— 1 9 9 0 —</b>																											
07/01/90						-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/05/90						-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/09/90						-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/13/90						2				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Total						2				1	6	4	19	17	52	23	72	19	15	11	23	11	20			36	26	357

# SPATIAL AND TEMPORAL DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES

## AREA 1

No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number																						Area 1 Total					
	66	65	5	7	9	11	13	15	33	35	37	39	41	43	45	47	49	51	53	55	57	59		906	909	60	61	
	— 1 9 8 9 —																											
04/12/89			-						2	2	3	7	-	3	1	3	6	3	-	3	1					4	4	42
04/16/89		2							-	2	-	2	2	1	4	-	2	2	-	2	2					-	-	21
04/20/89											1			3	7			2	2	3	2		6			-	1	27
04/24/89												1		2				2	2	3	1					4	1	16
04/28/89									1		11	1	16	4	1	29	100	3		6	4	2	3			3	-	184
05/02/89								1	1	4	2	9	-	6	5	7	7	3	4	2	5	1			4	13	74	
05/06/89						1	1						1							1	1	1						6
05/10/89											1	1		1		3				2			1					10
05/14/89														3		21				2								26
05/18/89												1	3	1		1	1			1								8
05/22/89																												-
05/26/89														1	1													2
05/30/89									1	1																		2
06/03/89												1					1											2
06/07/89																												-
06/11/89										1																		1
06/15/89																												-
06/19/89																												-
06/23/89														1	1		1		1									4
06/27/89																												-
07/01/89															1												1	2
07/05/89																												-
<b>Total</b>			2			1	1	4	7	21	16	31	20	22	60	121	19	8	27	13	8	11			15	20	427	

Area 1 -- 1988

**SPATIAL AND TEMPORAL DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES**

**AREA 1**

No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number																							Area 1				
	66	65	5	7	9	11	13	15	33	35	37	39	41	43	45	47	49	51	53	55	57	59	906	909	60	61	Total	
	— 1 9 8 8 —																											
04/12/88	-	-				-				2	-	-		4	2	15	10	4	9	1	-	17	6	-	-	-	-	70
04/16/88	-	-								6	5	5	3	1	3	3	4	3	1	1	1	6	-	1	3	-	46	
04/20/88	-	-									2	6	1	2	-	3	5	2	3	6	-	4	4	1	1	1	41	
04/24/88	2	-							2	6	16	4	1														31	
04/28/88	-	5									4	2	-	1	-	-	-	1	-	2	2	2	-	-	-	1	20	
05/02/88	-	2						2	3	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	13	
05/06/88	-	-										1	-	-	1	-	-	-	-	-	-	-	-	-	-	1	3	
05/10/88	-	-									1	4	1	-	3	-	-	-	-	-	-	-	2	-	3	-	14	
05/14/88	-	2									1	1	2	2	-	1	-	1	-	-	-	-	-	-	3	-	13	
05/18/88	-	-										1	6	1	-	-	-	-	-	-	1	-	-	-	-	6	15	
05/22/88	-	-								3	-	1	-	1	-	-	-	-	-	-	-	-	-	-	1	2	8	
05/26/88	-	-			1					2	3	-	2	6	2	-	-	-	-	-	-	-	-	-	-	-	16	
05/30/88	-	-					1																				1	
06/03/88	-	-										2	-	-	1	-	-	1	-	-	-	-	-	-	-	-	4	
06/07/88	-	-																									-	
06/11/88	-	-																				2					2	
06/15/88	-	-													1							1		1			3	
06/19/88	-	-											1			2						1					4	
06/23/88	-	-											1	1	-	1	1	-	-	1	-	-	-	-	-	-	5	
06/27/88	-	-											1	1	-	1	1	1	-	-	-	-	-	-	-	-	5	
07/01/88																											-	
07/05/88	-	-																									-	
07/09/88	-	-																									-	
07/13/88	-	-																									-	
<b>Total</b>	<b>2</b>	<b>9</b>				<b>1</b>		<b>1</b>	<b>4</b>	<b>22</b>	<b>32</b>	<b>27</b>	<b>19</b>	<b>23</b>	<b>12</b>	<b>29</b>	<b>22</b>	<b>12</b>	<b>14</b>	<b>11</b>	<b>5</b>	<b>32</b>	<b>12</b>	<b>3</b>	<b>11</b>	<b>11</b>	<b>314</b>	

# SPATIAL AND TEMPORAL DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES

# AREA 2

No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number																				Area 2 Total				
	17	19	21	23	25	27	29	32	72	725	70	71	73	735	74	745	75	755	76	765		77	775	78-825	
	— 1 9 9 1 —																								
02/19/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
02/20/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
02/26/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
02/27/91	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
02/28/91	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	3	2	-	-	-	-	-	7
03/05/91	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	5
03/18/91	6	7	11	2	1	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32
03/19/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3/27/91	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
03/28/91	-	2	-	-	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
04/04/91	-	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
04/06/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/10/91	1	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
04/12/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/16/91	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
04/20/91	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
04/24/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/26/91	-	-	-	-	-	-	-	-	3	2	-	3	-	3	1	1	-	-	-	-	-	-	-	-	13
04/28/91	-	1	-	3	2	1	-	11	3	7	1	2	2	2	1	3	-	-	-	-	-	-	-	-	39
04/30/91	-	-	-	-	-	-	-	-	4	4	6	-	-	1	1	1	2	-	-	-	-	-	-	-	19
05/02/91	-	-	-	-	-	-	-	-	8	4	3	3	-	2	1	2	-	-	-	-	-	-	-	-	24
05/04/91	-	-	-	-	-	-	-	-	4	-	2	1	-	2	1	1	1	1	-	-	-	1	-	-	14
05/06/91	-	-	-	-	-	-	-	4	5	5	-	1	-	-	1	1	-	-	-	-	-	-	-	-	17
05/08/91	-	-	-	-	-	-	-	-	3	2	-	1	3	3	2	1	-	-	-	-	-	-	-	-	15
05/10/91	-	-	-	-	-	-	-	-	-	-	-	1	5	1	-	-	-	-	-	-	-	-	-	-	7
05/12/91	-	-	-	-	-	-	-	-	-	2	1	-	-	-	1	-	-	-	-	-	-	-	-	-	4
05/14/91	-	-	-	-	-	-	-	2	36	3	2	-	1	-	1	2	-	3	-	-	-	-	-	-	50
05/16/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
05/18/91	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	-	2	-	-	-	-	-	-	-	5
05/20/91	-	-	-	-	-	-	-	-	1	2	-	1	-	-	-	-	1	3	-	-	-	-	-	-	8
05/22/91	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1	2	1	-	-	-	-	-	-	-	6
05/24/91	-	-	-	-	-	-	-	-	-	-	1	-	2	2	2	-	-	-	-	-	-	-	-	-	7
05/26/91	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
05/28/91	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	3
05/30/91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

17



# SPATIAL AND TEMPORAL DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES

## AREA 2

No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number																			Area 2 Total					
	17	19	21	23	25	27	29	32	72	725	70	71	73	735	74	745	75	755	76		765	77	775	78-825	
	— 1 9 9 0 —																								
04/12/90	-	-	-	1	7			9																	17
04/14/90	-	-	-	-	-			-																	-
04/16/90	-	-	-	-	1			-																	1
04/20/90	-	-	3	-	4			-															2		9
04/22/90	-	-	-	-	-			-																	-
04/24/90	-	-	1	-	2			3																	6
04/26/90	-	-	-	-	-			-																	-
04/28/90	-	-	-	-	2			2																	4
04/30/90	-	-	-	-	-			-																	-
05/02/90	-	-	-	-	-			3																	3
05/04/90	-	-	-	-	-			-																	-
05/06/90	-	-	-	-	1			-																	1
05/08/90	-	-	-	-	-			-																	-
05/10/90	-	-	-	-	-			1																	1
05/12/90	-	-	-	-	-			-																	-
05/14/90	-	-	-	-	-			-																	-
05/16/90	-	-	-	-	-			-														2			2
05/18/90	-	-	-	-	-			-																	-
05/20/90	-	-	-	-	-			-																	-
05/22/90	-	-	2	-	1			-																	3
05/24/90	-	-	-	-	-			-																	-
05/26/90	-	-	-	-	-			-																	-
05/30/90	-	-	-	-	-			-																	-
06/01/90	-	-	-	-	-			-																	-
06/03/90	-	-	-	-	-			-																	-
06/07/90	-	-	-	-	-			-																	-
06/09/90	-	-	-	-	-			-																	-
06/11/90	-	-	-	-	-			-																	-
06/12/90	-	-	-	-	-			-																	-
06/13/90	-	-	-	-	-			-																	-
06/15/90	-	-	-	-	1			1																	2
06/17/90	-	-	-	-	-			-																	-
06/19/90	-	-	-	1	-			-																	1
06/21/90	-	-	-	-	-			-																	-
06/23/90	-	-	-	-	-			-																	-
06/27/90	-	1	4	-	-			-																	5

Area 2 -- 1990

**SPATIAL AND TEMPORAL DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES**

**AREA 2**

No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number																		Area 2 Total							
	17	19	21	23	25	27	29	32	72	725	70	71	73	735	74	745	75	755		76	765	77	775	78-825		
	— 1 9 9 0 —																									
07/01/90		1	8	1	-	-																				10
07/05/90		1	1	1	-	-																				3
07/09/90		-	-	-	-	-																				-
07/13/90		-	-	1	-	-																				1
Total		2	10	13	2	19		19																2	2	69

# SPATIAL AND TEMPORAL DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES

# AREA 2

No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number																				Area 2 Total				
	17	19	21	23	25	27	29	32	72	725	70	71	73	735	74	745	75	755	76	765		77	775	78-825	
	— 1 9 8 9 —																								
04/12/89		2	3	-	2	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
04/16/89		-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
04/20/89		-	-	-	3	1	5	-	-	2	1	3	1	-	-	1	-	-	-	-	-	-	-	-	17
04/24/89		-	1	-	4	2	2	3	-	1	-	1	1	1	3	-	-	-	-	-	-	-	-	-	19
04/28/89		-	-	-	-	2	1	-	2	-	1	1	1	3	2	1	-	-	-	-	-	-	-	-	14
05/02/89		-	1	-	2	1	2	3	-	1	2	-	4	-	-	-	-	-	-	-	-	-	-	-	16
05/06/89		-	-	1	-	-	1	2	-	1	2	-	1	-	-	-	-	-	-	-	-	-	-	-	8
05/10/89		-	3	-	-	-	-	1	1	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	8
05/14/89		-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
05/18/89		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/22/89		-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
05/26/89		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/30/89		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
06/03/89		-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
06/07/89		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/11/89		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/15/89		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/19/89		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/23/89		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/27/89		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/01/89		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
07/05/89		-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<b>Total</b>		<b>3</b>	<b>8</b>	<b>1</b>	<b>13</b>	<b>6</b>	<b>17</b>	<b>11</b>	<b>3</b>	<b>5</b>	<b>6</b>	<b>5</b>	<b>9</b>	<b>5</b>	<b>6</b>	<b>2</b>	<b>1</b>								<b>101</b>



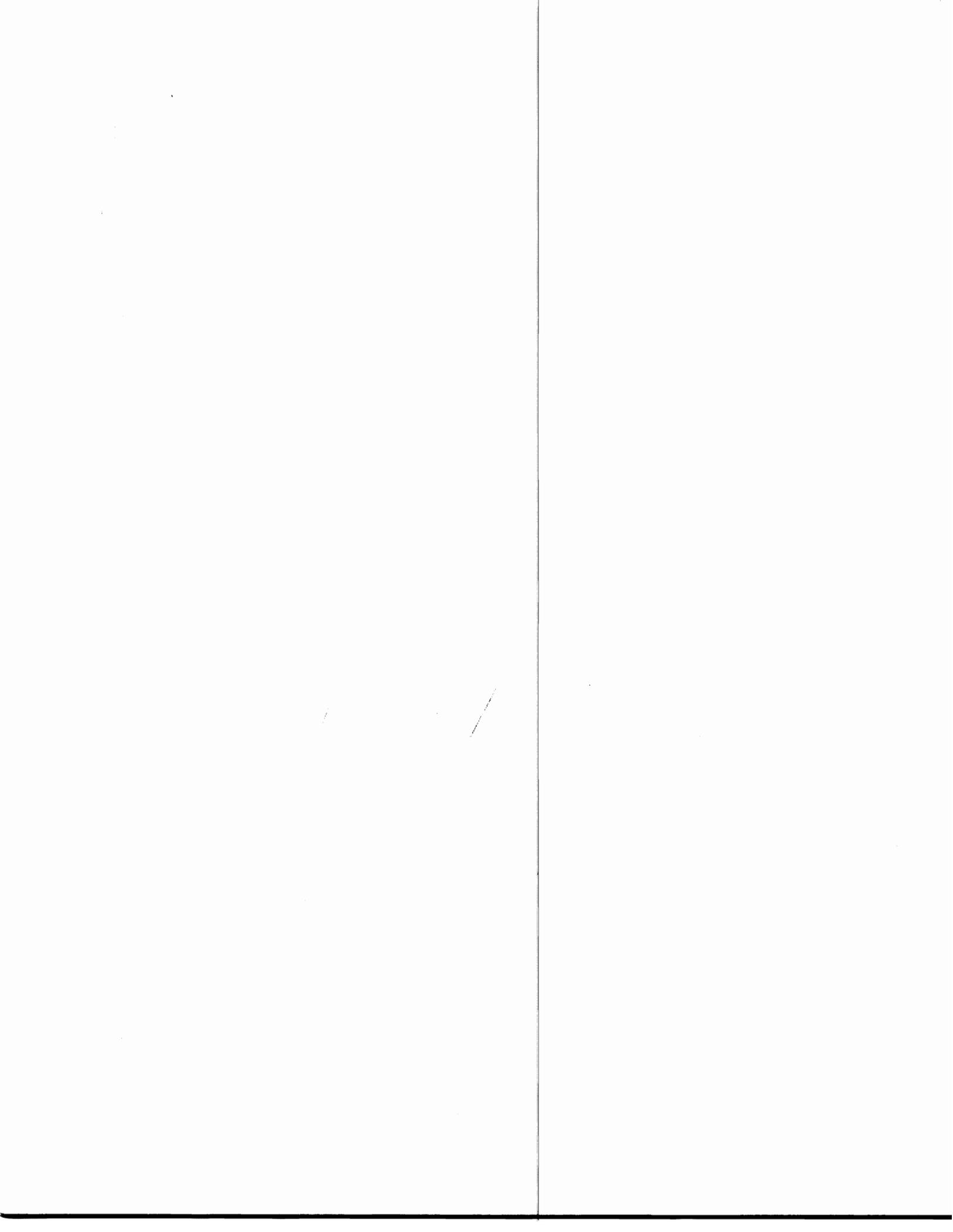
## SPATIAL AND TEMPORAL DISTRIBUTION OF DELTA SMELT EARLY LIFE STAGES

**AREA 3**

**AREA 4**

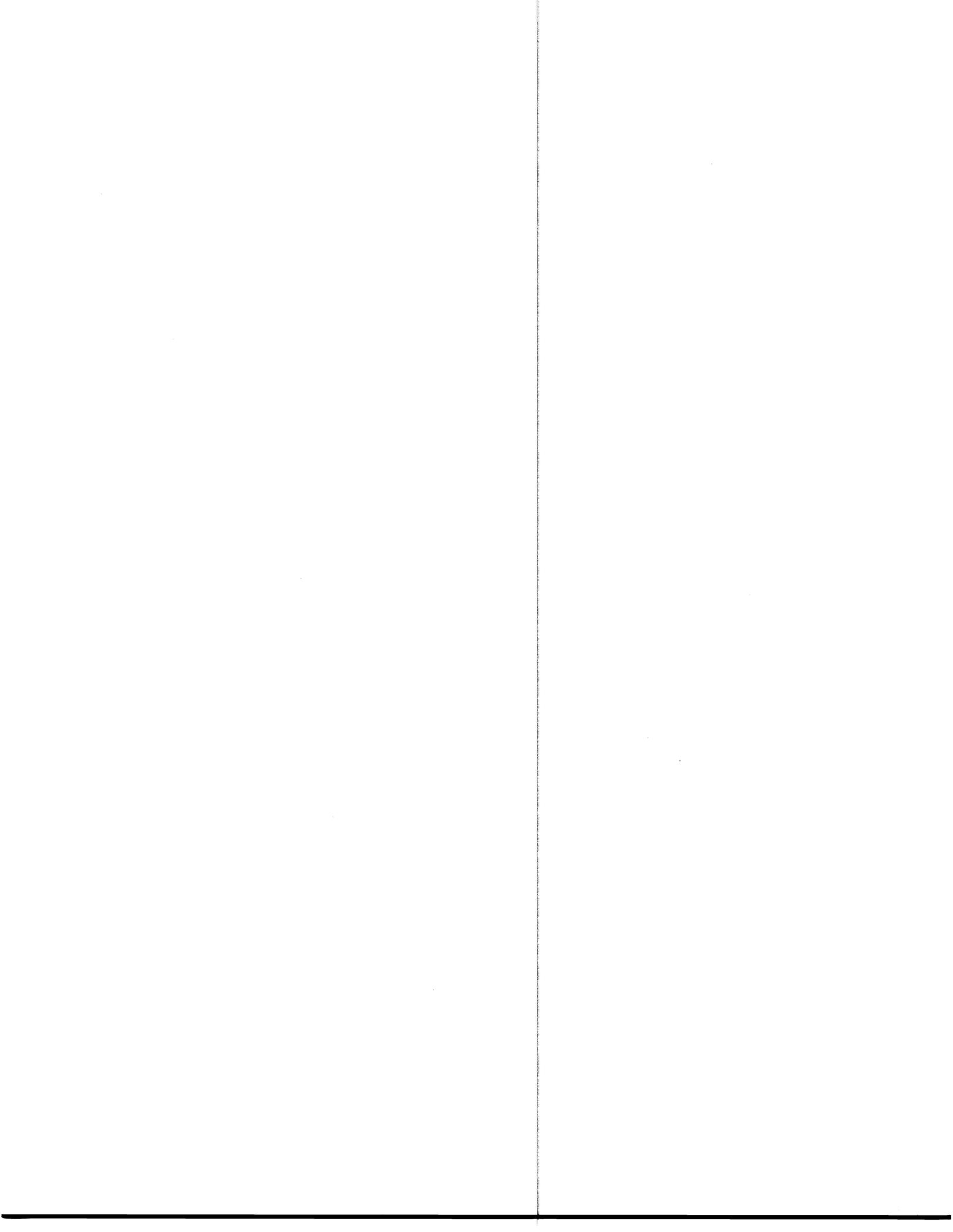
No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number							Area 3 Total	Date	Station Number				Area 4 Total
	903	919	920	921	922	923	924			712	713	715	717	
								— 1 9 9 1 —						
02/21/91	-	-	-	-	-	-	-	-	02/19/91	-	-	-	-	-
03/05/91	-	1	-	1	2	4	8	8	02/27/91	-	17	51	-	68
03/13/91	-	-	-	-	-	-	1	1	03/18/91	1	5	8	-	14
05/09/91	1	2	1	-	4	-	-	8	03/27/91	-	-	3	-	3
05/23/91	4	6	4	3	9	1	-	27	Total	1	22	62	-	85
Total	5	9	5	4	15	5	1	44						

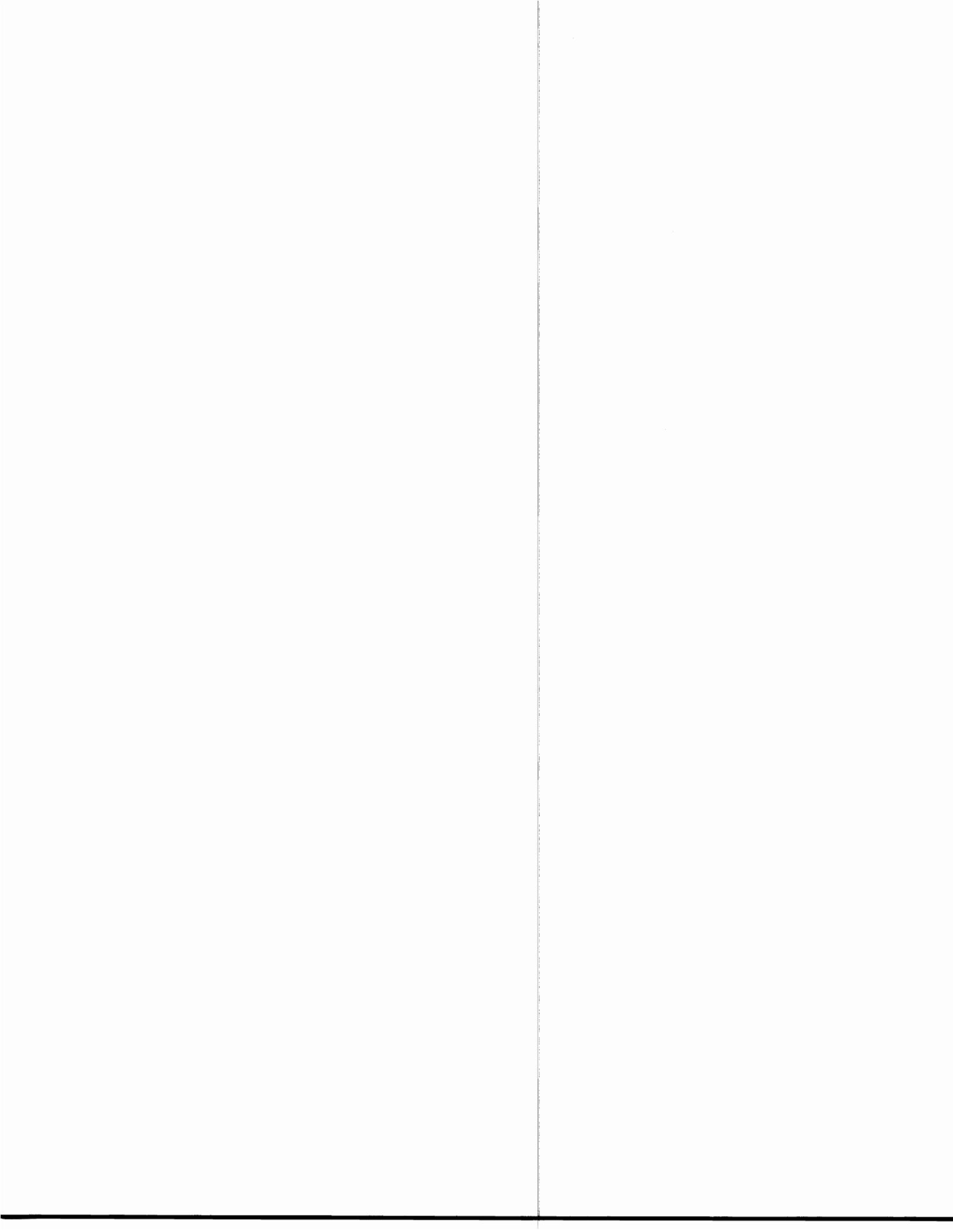


Appendix C

**SPATIAL AND TEMPORAL DISTRIBUTION  
OF  
LONGFIN SMELT EARLY LIFE STAGES  
COLLECTED IN THE  
SACRAMENTO-SAN JOAQUIN ESTUARY**





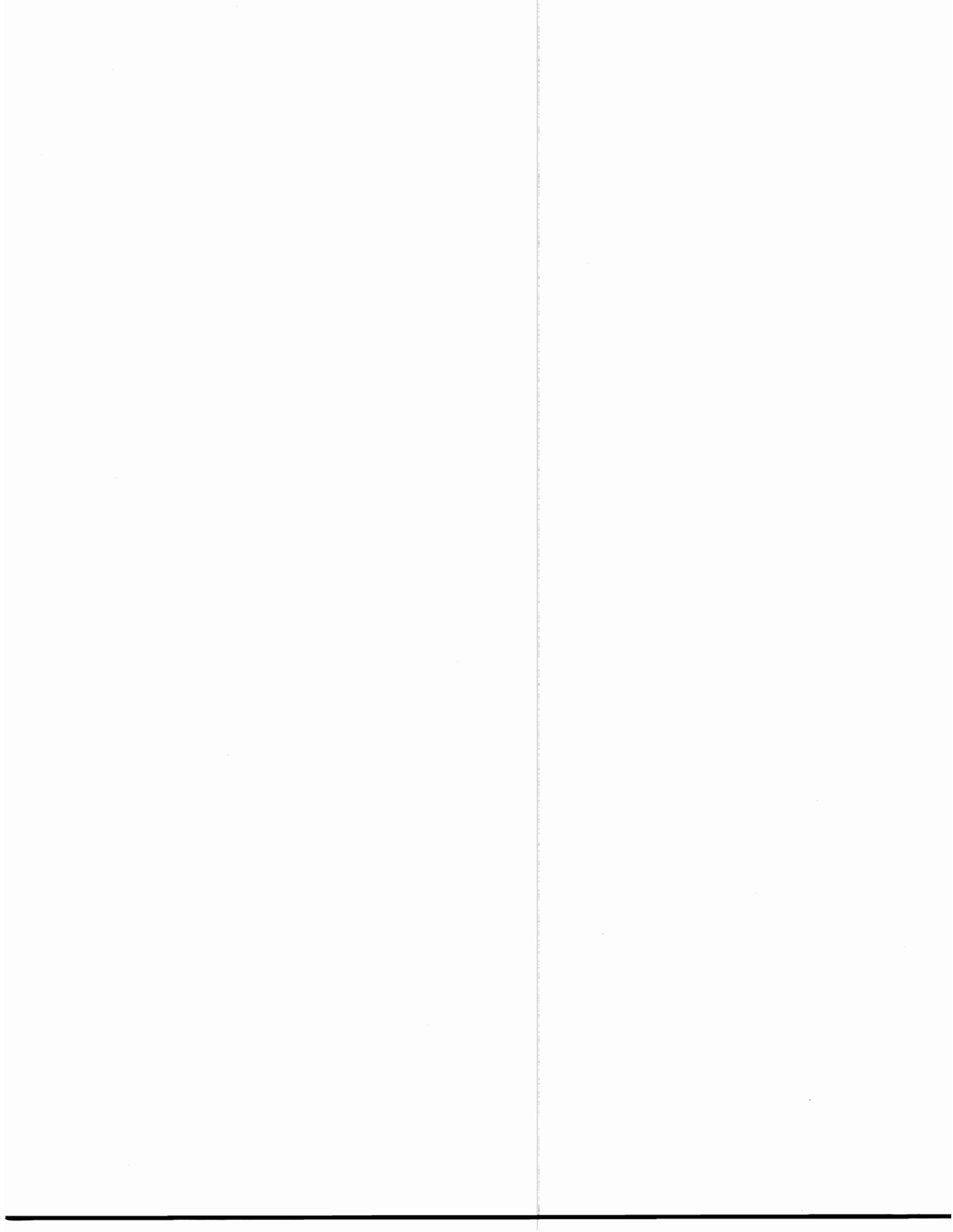


# SPATIAL AND TEMPORAL DISTRIBUTION OF LONGFIN SMELT

# AREA 2

No value indicates no sample was taken; "-" indicates samples did not contain delta smelt.

Date	Station Number																		Area 2 Total						
	17	19	21	23	25	27	29	32	72	725	70	71	73	735	74	745	75	755		76	765	77	775	78-825	
— 1 9 9 1 —																									
02/19/91	53	70	71	-	151	160	55	36																	596
02/28/91	12	63	193	34	59	140	51	25																	577
03/18/91	6	3	9	-	-	-	-	-																	18
03/28/91	-	1	-	-	-	-	1	1																	3
04/04/91	2		-		-	-	-	-																	2
04/06/91				-																					-
04/10/91	-	-	-	-	-	-	-	-																	-
04/12/91	-	-	-	-	-	-	-	1																	1
04/16/91	1	-	-	-	-	-	-	-																	1
04/20/91	-	-	1	-	1	-	-	-																	2
04/24/91	-	1	-	-	-	-	-	-																	1
04/28/91	-	-	2	-	-	-	-	-																	2
05/02/91	1	-	-	-	1	-	-	-																	2
05/06/91	-	-	1	-	-	-	-	-																	1
05/10/91	-	-	-	-	1	1	-	-																	2
05/14/91	-	-	-	-	2	-	-	-																	2
05/18/91	-	-	-	-	2	-	-	-																	2
05/22/91	-	-	1	2	2	-	2	-																	7
05/26/91	-	1	-	-	-	-	-	-																	1
05/30/91	-	1	-	-	-	-	-	-																	1
06/03/91	-	-	-	-	1	1	-	-																	2
06/07/91	-	-	-	-	-	-	-	-																	-
06/11/91	-	-	-	-	-	-	-	-																	-
No longfin smelt were caught in samples from 06/13/91 to 07/13/91.																									
Total	75	140	278	36	220	302	109	53																	1213



**SPATIAL AND TEMPORAL DISTRIBUTION OF LONGFIN SMELT**

**AREA 4**

No value indicates no sample was taken; "-" indicates samples did not contain longfin smelt.

Date	Station Number				Area 4 Total
	712	713	715	717	
					— 1 9 9 1 —
02/28/91	52	3	5	-	60
03/18/91		-	2	-	2
03/27/91			-		-
03/28/91		-			-
Total	52	3	7	-	62