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FISH AND BIVALVES AT BOLSA CHICA
MARSH RE-ESTABLISHMENT PROJECT

REPORT IV

by

Eric H. Knaggs
and
Rolf E. Mall

MARINE RESOURCES

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ABSTRACT

The objectives of the study are:

1. Determine changes in the number of species of fishes and bivalves before Phase I and during Phase I at Bolsa Chica Marsh.
2. Determine if California Department of Fish and Game's predicted benefits in Phase I were achieved by increases in fish species.
3. Determine influences of water management practices upon fish and bivalve composition.

This report is divided into two major topics: (1) the fishes and bivalves collected in July, August, and September 1980 and (2) a discussion of the project objectives after four quarters of sampling.

Fifteen species of fishes and eight species of bivalves were collected from inner Bolsa Bay and south Bolsa slough in July, August, and September 1980. Giant kelpfish, *Heterostichus rostratus*; gray smoothhound, *Mustelus californicus*; California halibut, *Paralichthys californicus*; yellowfin croaker, *Umbrina roncadore*; Washington clam, *Saxidomus nuttalli*; egg cockle, *Laevicardium substriatum*; and a small burrowing clam, *Cooperella subdiaphana*, have not been previously reported from inner Bolsa Bay.

The number of fish species in outer Bolsa Bay changed from 10 prior to Phase I to 18 during Phase I. The number of

^{1/} Marine Resources Region, Administrative Report No. 81-4, January 1981

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fish species in inner Bolsa Bay and south Bolsa slough changed from three prior to Phase I to 24 during Phase I. Eleven species of bivalves were found in outer Bolsa Bay both prior to Phase I and during Phase I. The number of bivalve species in inner Bolsa Bay changed from two prior to Phase I to nine during Phase I.

With the water management practices of Phase I in inner Bolsa Bay and south Bolsa slough; the number of resident fish species is 14, while the number of resident bivalves is five.

All three study objectives are discussed and recommendations are made on water management practices concerning fishes and bivalves in inner Bolsa Bay and south Bolsa slough.

INTRODUCTION

This study is designed to examine the fishes and bivalves that inhabit Bolsa Chica during Phase I of the marsh re-establishment project. Phase I is the time period from the original opening of the tide gates in mid-October 1978 until there are activities altering this Phase I salt marsh.

Project Objectives

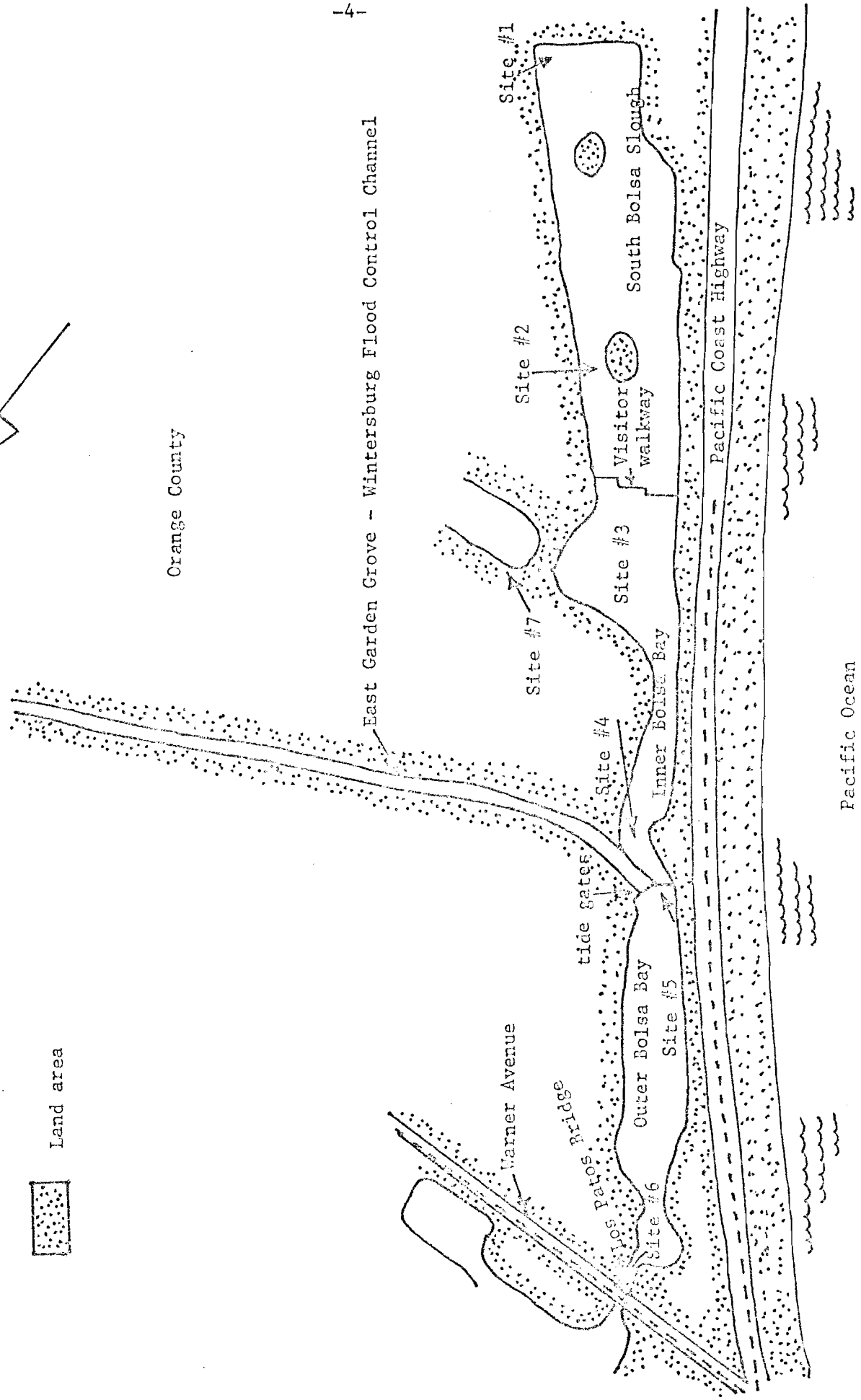
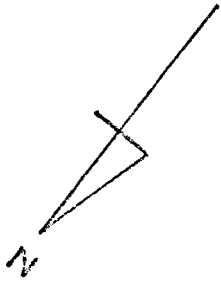
The objectives of this study are:

1. Determine changes in the number of species of fishes and bivalves before Phase I and during Phase I at Bolsa Chica Marsh.
2. Determine if California Department of Fish and Game's predicted benefits in Phase I were achieved by increases in fish species.
3. Determine influences of water management practices upon fish and bivalve species composition.

Area Description

Our general sample areas of Bolsa Chica Marsh are as follows:

1. Outer Bolsa Bay is the intertidal portion of Bolsa Chica Marsh within State Lands bounded by the Warner Avenue bridge (Los Patos bridge) on the northwest and the tide gates on the southeast (Figure 1).
2. Inner Bolsa Bay is the intertidal portion of Bolsa Chica Marsh bounded by the levee system on the northeast, tide gates on the northwest, visitor walkway on the southeast, and Pacific Coast Highway on the southwest (Figure 1).
3. South Bolsa Slough is the intertidal portion of Bolsa Chica Marsh bounded by the visitor walkway on the northwest, levee



Orange County

Land area

FIGURE 1. Phase I sites at Bolsa Chica Marsh.

system on the northeast and southeast, and Pacific Coast Highway on the southwest (Figure 1).

Sample Site Locations

Site number 1 is in south Bolsa slough in the northeast corner of the marsh (Figure 1). This site was chosen because it was a land area not subject to periodic flooding before Phase I, but during Phase I it is a water area influenced by tides. Therefore, all fishes captured at this site have invaded this site since the tide gates were opened.

Site number 2 is located in south Bolsa slough directly across from middle island. This site was chosen because it is a water area nearest an island which has heavy bird use. This site was a land area not subject to tidal flooding before Phase I.

Site numbers 3 and 4 are in inner Bolsa Bay. This was a water area before Phase I and continues to be a water area. Therefore, fish and bivalve collections at these sites during Phase I could be compared to pre-Phase fish collections in inner Bolsa Bay.

Site number 5 is in outer Bolsa Bay (Figure 1). This site was selected for comparing Phase I fish collections in outer Bolsa Bay with pre-Phase I fish collections from this area.

Site number 6 is in outer Bolsa Bay. This site was selected for comparing bivalves captured before and during Phase I.

Fish and Bivalve Names

Appendix I is provided to aid readers in relating the scientific names of fish used in this report with their accepted English common names, while appendix II contains the scientific and common names of bivalves. All scientific and common fish names used are from Miller and Lea, 1972.

We have divided this report into two major topics as follows: (1) the fishes and bivalves collected in July, August, and September 1980 and (2) a discussion of the project objectives after four quarters of sampling.

FISHES AND BIVALVES COLLECTED IN JULY, AUGUST, AND SEPTEMBER 1980

Materials and Methods

Materials and methods used to collect fishes during the August collection were the same as described by Knaggs and Mall (1980a, b). No minnow traps were used to collect fishes. Sample site #7 (Figure 1) was not sampled since the proposal to allow sea water from the area inside the Phase I dikes to flow outside and reflood a small portion of the former wetlands was halted, (Knaggs and Mall, 1980c). During our August sampling, two tide gates were open while the third remained closed.

Results

Fishes

Five bag-seine and one gill-net sample sites were chosen for collection of fishes on August 27, 1980. Fifteen species of fish were collected from inner Bolsa Bay and south Bolsa slough at sites 1, 2, 3, and 4 (Table 1). Four of these, the giant kelpfish, *Heterostichus rostratus*; gray smoothhound, *Mustelus californicus*; California halibut, *Paralichthys californicus*; and yellowfin creaker, *Umbrina roncadore* have not been reported previously from inner Bolsa Bay and south Bolsa slough.

Ten species of fishes were captured in outer Bolsa Bay at site 5. Two of these species, gray smoothhound and California halibut have not been reported here previously.

Bivalves

Eight species of bivalves were collected on August 27, 1980 at site

TABLE 1. Fishes Collected at Bolsa Chica Marsh August 27, 1980.

Site No.	Number of sets	Bag seine	Gill net	Scientific name	Common name	Prephase I pond numbered areas corresponding to our site numbers	No. captured*	Total length in mm TL	
								min.*	max.*
1	1			<i>Atherinops affinis</i>	topsmelt	none	>500	79	155
				<i>Fundulus parvipinnis</i>	Calif. killifish		6	50	98
				<i>Tilapia mossambica</i>	tilapia		1	45	
				<i>Syngnathus leptorhynchus</i>	bay pipefish		6	108	180
				<i>Quietula y-cauda</i>	shadow goby		11	30	62
2	1			<i>Atherinops affinis</i>	topsmelt	none	>500	70	153
				<i>Fundulus parvipinnis</i>	Calif. killifish		>500	46	95
				<i>Anchoa compressa</i>	deepbody anchovy		1	122	
				<i>Quietula y-cauda</i>	shadow goby		2	44	46
				<i>Syngnathus leptorhynchus</i>	bay pipefish		2	66	103
				<i>Atherinops affinis</i>	topsmelt	4	>500	70	150
3	1			<i>Fundulus parvipinnis</i>	Calif. killifish		56	36	103
				<i>Urophycis halleri</i>	round stingray		28		
				<i>Urophycis regia</i>	yellowfin croaker		1	153	
				<i>Quietula y-cauda</i>	shadow goby		1	55	
				<i>Tilapia mossambica</i>	tilapia		12	90	110
				<i>Syngnathus leptorhynchus</i>	bay pipefish		10	72	126
				<i>Hyporhamphus guttulata</i>	diamond turbot		3	69	132
				<i>Atherinops affinis</i>	topsmelt	4	>500 (>500)	71 (69)	140 (140)
				<i>Fundulus parvipinnis</i>	Calif. killifish		3 (5)	53 (50)	56 (103)
				<i>Gillichthys mirabilis</i>	longjaw mudsucker		1 (8)	139 (110)	(147)
				<i>Acanthopagrus flavimanus</i>	yellowfin goby		1	177	
4	2			<i>Quietula y-cauda</i>	shadow goby		5 (11)	54 (52)	56 (56)
				<i>Syngnathus leptorhynchus</i>	bay pipefish		2 (25)	168 (77)	208 (214)
				<i>Anchoa compressa</i>	deepbody anchovy		(1)	(126)	
				<i>Leptocottus armatus</i>	staghorn sculpin		(1)	(96)	
				<i>Urophycis halleri</i>	round stingray	4	15 (2)		
				<i>Acanthopagrus flavimanus</i>	yellowfin goby		3 (6)	175 (168)	182 (155)
				<i>Paralichthys californicus</i>	Calif. halibut		8 (3)	167 (180)	302 (220)
				<i>Urophycis regia</i>	yellowfin croaker		17 (48)	168	203
				<i>Atherinops affinis</i>	topsmelt		5 (17)	145 (95)	200 (188)
				<i>Syngnathus leptorhynchus</i>	bay pipefish		2 (2)	103 (116)	206 (130)
				<i>Quietula y-cauda</i>	shadow goby		2	52	52
				<i>Mustelus californicus</i>	gray smoothhound		7 (11)	363 (390)	868 (765)
				<i>Hyporhamphus guttulata</i>	diamond turbot		9 (5)	103 (90)	222 (191)
<i>Anchoa compressa</i>	deepbody anchovy		(1)	(157)					
<i>Heterostichus rostratus</i>	giant kelpfish		(1)	(112)					
5	2			<i>Atherinops affinis</i>	topsmelt	1	>500 (>500)	44	173
				<i>Fundulus parvipinnis</i>	Calif. killifish		4 (2)	39 (38)	66 (58)
				<i>Gillichthys mirabilis</i>	longjaw mudsucker		3 (9)	92 (90)	114 (146)
				<i>Acanthopagrus flavimanus</i>	yellowfin goby		3 (11)	119 (122)	130 (170)
				<i>Anchoa compressa</i>	deepbody anchovy		5	123	131
				<i>Syngnathus leptorhynchus</i>	bay pipefish		11 (25)	88 (59)	222 (223)
				<i>Quietula y-cauda</i>	shadow goby		(2)	(47)	(50)
				<i>Mustelus californicus</i>	gray smoothhound		(1)	(426)	
				<i>Paralichthys californicus</i>	Calif. halibut		(1)	(105)	
				<i>Tilapia mossambica</i>	tilapia		(25)	(103)	

* Number in parenthesis is second set

4 (Table 2). Three of these species, Washington clam, *Saxidomus nuttalli*; egg cockle, *Laevicardium substriatum*; and small burrowing clam, *Cooperella subdiaphana* have not been reported from inner Bolsa Bay. Six species of bivalves were collected on July 16, 1980, and September 10, 1980 at site 6. All species of bivalves collected at site 6 have been reported from outer Bolsa Bay prior to or during Phase 1.

Discussion

Fishes

Large numbers of topsmelt were taken in all bag seine sets. An exotic fish, *Tilapia mossambica*, was observed and captured throughout Bolsa Chica Marsh. Another exotic species, the yellowfin goby, *Acanthogobius flavimanus*, was also collected in significant numbers. The yellowfin gobies captured ranged in size from 119 to 302 mm total length. Bay pipefish, *Syngnathus leptorhynchus*, occurred at all stations sampled. Male bay pipefish were brooding larvae.

Bivalves

A clam bed located at site 4 contained a number of different species of bivalves. Recruitment of the 1980 year class of common littleneck clams, *Protothaca staminea*, and Washington clams was successful. The common littleneck was sampled in larger numbers than the smooth chione, *Chione fluctrifraga*, (Table 2). This is the first time another bivalve species was more numerous at site 4 than the smooth chione. A large population of the common littleneck continues to occur at site 6.

Correction to Fish Collected at Bolsa Chica Marsh May 15, 1980

Certain gobies in the May 15, 1980 collection were mis-identified. The goby identified as *Clevelandia ios* was in actuality two species,

TABLE 2. Bivalves Collected at Bolsa Chica Marsh.

Date	Site No.	Scientific name*	Common name	Prephase I pond numbered areas corresponding to our site numbers	Number taken
7/15/80	6	<i>Protothaca staminea</i>	common littleneck	1	196
		<i>Tresus nuttalli</i>	gaper clam		32
		<i>Petricola californiensis</i>	nestling clam		8
8/27/80	4	<i>Chione fluctifraga</i>	smooth chione	4	41
		<i>Protothaca staminea</i>	common littleneck		69
		<i>Saxidomus nuttalli</i>	Washington clam		9
		<i>Masonia nesuta</i>	benthose clam		5
		<i>C. californiensis</i>	banded chione		3
		<i>Cooperella subdiaphana</i>	-		2
<i>Laevicardium substriatum</i>	egg cockle		1		
9/10/80	6	<i>Protothaca staminea</i>	common littleneck	1	166
		<i>Saxidomus nuttalli</i>	Washington clam		1
		<i>Tagelus californicus</i>	Calif. jackknife clam		1

* *Axytilus edulis* numerous at stations 4 and 6 but not collected

C. ios and *Quietula y-cauda* (Table 3). All other fishes were correctly identified.

DISCUSSION OF PROJECT OBJECTIVES AFTER FOUR QUARTERS OF SAMPLING

Objectives

Determine Changes in the Number of Species of Fishes and Bivalves Before Phase I and During Phase I at Bolsa Chica Marsh

Fishes. Ten species of fishes were collected in outer Bolsa Bay prior to Phase I (Table 4). Seven species of fishes were sampled in the fall of 1979, and the total number of species increased to 10 with the February 1980 sample. The number of fish species collected in May 1980 increased the total fish species found in this area to 15, while a total of 18 fish species were found when our sampling ended in August 1980 (Table 4).

Three species of fishes were collected in inner Bolsa Bay prior to Phase I (Table 5). Eight species of fishes were collected in the fall of 1979, and the total number of species captured continued to increase to 23 during August 1980 (Table 5).

No fish species were found at our sample sites in south Bolsa slough prior to Phase I since these sample sites were land areas not subject to periodic flooding. Eight species of fishes were collected in November 1979, while a total of 13 species were found after four quarters of sampling (Table 6).

We expected the number of fish species found in outer Bolsa Bay during Phase I to be approximately the same as found prior to Phase I since this area was not modified physically. The only change that occurred in this area was a greater volume of water flowing through outer Bolsa Bay to flood and drain inner Bolsa Bay and south Bolsa slough. Nevertheless, there was an increase from 10 fish species found prior to

TABLE 3. Amendment to Fishes Collected at Bolsa Chica Marsh May 15, 1980.

Site No.	Number of sets		Scientific name	Common name	Prephase I pond numbered areas corresponding to our site numbers	No. captured*	Total length in mm TL	
	Bag seine	Gill net					min.*	max.*
1	1		<i>Anchoa compressa</i>	deepbody anchovy	none	1	86	
			<i>Fundulus parvipinnis</i>	Calif. killifish		2	86	90
			<i>Clevelandia ios</i>	arrow goby		2	30	32
			<i>Acanthogobius flavimanus</i>	yellowfin goby		1	54	
			<i>Atherinops affinis</i>	topsmelt		99	21	180
			<i>Quietula y-cauda</i>	shadow goby		32	26	54
2	1		<i>Atherinops affinis</i>	topsmelt	none	>500	38	179
			<i>Fundulus parvipinnis</i>	Calif. killifish		2	81	87
			<i>Clevelandia ios</i>	arrow goby		25	35	38
			<i>Anchoa compressa</i>	deepbody anchovy		5	119	132
			<i>Quietula y-cauda</i>	shadow goby		21	37	55
3	1		<i>Atherinops affinis</i>	topsmelt	4	28	31	136
			<i>Fundulus parvipinnis</i>	Calif. killifish		2	79	85
			<i>Acanthogobius flavimanus</i>	yellowfin goby		4	67	80
			<i>Gillichthys mirabilis</i>	longjaw mudsucker		1	82	
			<i>Clevelandia ios</i>	arrow goby		5	36	42
4	2		<i>Atherinops affinis</i>	topsmelt	4	158(164)	28(20)	208(193)
			<i>Hypocypsetta guttulata</i>	diamond turbot		2(1)	19	28(207)
			<i>Clevelandia ios</i>	arrow goby		2(65)	23(21)	(45)
				jacksmelt		(12)	(73)	(88)
			<i>Cymatogaster aggregata</i>	shiner surfperch		(3)	(115)	(119)
			<i>Acanthogobius flavimanus</i>	yellowfin goby		(1)	(58)	
			<i>Urolophus halleri</i>	round stingray		2		
			<i>Quietula y-cauda</i>	shadow goby		2(60)	51(27)	58(57)
4	2		<i>Porichthys myriaster</i>	specklefin midshipman	4	1	288	
			<i>Hypocypsetta guttulata</i>	diamond turbot		2(2)	110(158)	264(160)
			<i>Cymatogaster aggregata</i>	shiner surfperch		1(3)	115(109)	(115)
			<i>Atherinops affinis</i>	topsmelt		4(79)	172(122)	217(218)
			<i>Clevelandia ios</i>	arrow goby		1	56	
			<i>Leptocottus armatus</i>	staghorn sculpin		2(2)	145(131)	170(152)
			<i>Urolophus halleri</i>	round stingray		4		
			<i>Mugil cephalus</i>	striped mullet		(1)	(334)	
5	1		<i>Atherinops affinis</i>	topsmelt	1	532	30	192
			<i>Cymatogaster aggregata</i>	shiner surfperch		16	41	70
			<i>Leptocottus armatus</i>	staghorn sculpin		19	61	100
			<i>Tilapia mossambica</i>	tilapia		1	16	
			<i>Fundulus parvipinnis</i>	Calif. killifish		1	90	
			<i>Gillichthys mirabilis</i>	longjaw mudsucker		5	42	132
			<i>Clevelandia ios</i>	arrow goby		>50	29	44
			<i>Acanthogobius flavimanus</i>	yellowfin goby		1	49	
			<i>Syngnathus leptorhynchus</i>	bay pipefish		8	105	216
			<i>Quietula y-cauda</i>	shadow goby		>50	35	52
7	1	<i>Clevelandia ios</i>	arrow goby	6	1			

* Number in parenthesis is second set

TABLE 4. Species of Fishes Captured in Outer Bolsa Bay Prior to Phase I and During Phase I.

<u>Species of Fishes Prior to Phase I</u>	<u>Species of Fishes During Phase I</u>
1. Arrow goby	1. Arrow goby
2. California corbina	2. Bay pipefish
3. California killifish	3. California halibut
4. Deepbody anchovy	4. California killifish
5. Round stingray	5. Cheekspot goby
6. Shiner surfperch	6. Deepbody anchovy
7. Staghorn sculpin	7. Diamond turbot
8. Striped mullet	8. Grey smoothhound
9. Tidewater goby	9. Longjaw mudsucker
10. Topsmelt	10. Shadow goby
	11. Shiner surfperch
	12. Staghorn sculpin
	13. Striped bass
	14. Striped mullet
	15. Tilapia
	16. Topsmelt
	17. White croaker
	18. Yellowfin goby

TABLE 5. Species of Fishes Captured in Inner Bolsa Bay Prior to Phase I and During Phase I.

<u>Species of Fishes Prior to Phase I</u>	<u>Species of Fishes During Phase I</u>
1. Bay pipefish	1. Arrow goby
2. California killifish	2. Bay pipefish
3. Topsmelt	3. California halibut
	4. California killifish
	5. Deepbody anchovy
	6. Diamond turbot
	7. Giant kelpfish
	8. Goldfish
	9. Grey smoothhound
	10. Jacksmelt
	11. Longjaw mudsucker
	12. Northern anchovy
	13. Queenfish
	14. Round stingray
	15. Shadow goby
	16. Shiner surfperch
	17. Specklefin midshipman
	18. Staghorn sculpin
	19. Striped mullet
	20. Tilapia
	21. Topsmelt
	22. Yellowfin croaker
	23. Yellowfin goby

TABLE 6. Species of Fishes Captured in South Bolsa Bay Prior to Phase I and During Phase I.

Species of Fishes Prior to Phase I

No species of fish since this area was a land area not subject to periodic flooding.

Species of Fishes During Phase I

1. Arrow goby
2. Bay pipefish
3. California killifish
4. Deepbody anchovy
5. Diamond turbot
6. Northern anchovy
7. Pacific bonito
8. Shadow goby
9. Staghorn sculpin
10. Striped mullet
11. Tilapia
12. Topsmelt
13. Yellowfin goby

Phase I to 18 species found during Phase I (Table 7).

We did expect an increase in the number of fish species in inner Bolsa Bay, but we expected the number of fish species to level off or increase very slowly after several quarters of sampling. With this leveling off of the total number of fish species captured, we could assume that we had captured the fish species inhabiting inner Bolsa Bay. This leveling off of the total number of fish species captured did not occur, and the total number of new fish species captured continued to increase during our sampling (Table 7). Thus we can hypothesize that either (a) our equipment was not adequately sampling all species of fishes, or (b) fish species continued to be recruited to this area during our sampling. We have rejected the first hypothesis since the project sampling gear has been used successfully to capture large numbers of fish species in similar coastal areas of southern California.

The number of fish species found in south Bolsa slough continued to climb during the sampling, but at a slower rate and with fewer species than inner Bolsa Bay (Table 7).

Total number of fish species found during Phase I increased over the number of fish species found prior to Phase I in outer Bolsa Bay, inner Bolsa Bay, and south Bolsa slough. Thus, we feel the opening of tide gates to allow tidal action in inner Bolsa Bay and south Bolsa slough has been successful in increasing the number of fish species found in the Bolsa Chica Marsh.

Bivalves. The number of bivalve species found in outer Bolsa Bay was 11 prior to Phase I. During Phase I, we found only three species at the beginning of our study (Table 8); however, by the end of our study a total of 11 species were found in outer Bolsa Bay. We feel that most of the bivalves in outer Bolsa Bay have been discovered since (a) the number

TABLE 7. Number of Fish Species Collected by Area and Time in the Bolsa Chica Ecological Reserve.

<u>Date of collection</u>	Number of Species by Area ^{1/}		
	<u>Outer Bolsa Bay</u>	<u>Inner Bolsa Bay</u>	<u>South Bolsa Slough</u>
Prior to Phase I	10	3	0
Phase I			
Sept.-Nov. 1979	7	8	8
Feb. 1980	10	12	8
Apr.-May 1980	15	18	12
Aug. 1980	18	23	13

^{1/} The number of species is cumulative for Phase I

TABLE 8. Number of Bivalve Species Collected by Area and Time in the Bolsa Chica Ecological Reserve.

<u>Date of collection</u>	Number of Species by Area ^{1/}	
	<u>Outer Bolsa Bay</u>	<u>Inner Bolsa Bay</u>
Prior to Phase I	11	2
Phase I		
November 1978	3	no sample
January 1979	3	no sample
March 1979	3	no sample
May 1979	3	no sample
July 1979	5	no sample
November 1979	5	no sample
December 1979	9	1
January 1980	10	3
March 1980	10	4
May 1980	10	6
July 1980	11	no sample
August 1980	no sample	9
September 1980	11	no sample

^{1/} Number of species is cumulative for Phase I

of species has equalized at 11, and (b) 11 species is the same number found prior to Phase I.

Only two species of bivalves were found in inner Bolsa Bay prior to Phase I. The number of bivalve species found during Phase I has increased to nine (Table 9). It appears that recruitment in inner Bolsa Bay is still continuing (Table 8). Sampling for bivalves was not conducted in South Bolsa slough.

Opening the tide gates does not appear to have affected the number of bivalve species found in outer Bolsa Bay. Nevertheless this action did increase significantly the number of bivalve species found in inner Bolsa Bay during Phase I (Table 8).

Determine if California Department of Fish and Game's Predicted Benefits in Phase I Were Achieved by Increases in Fish Species

It is stated on page 26 in a Department of Fish and Game report entitled "Bolsa Chica Marsh Re-establishment Project, Volume I," "that a predicted benefit would be an increase in the number of species of fish from four collected during pre-Phase I to nine species during Phase I." It should be noted that we assume this statement refers only to inner Bolsa Bay and south Bolsa slough. Since the mosquito fish, *Gambusia affinis*, was found outside the Phase I marsh, there were only three species of fishes within inner Bolsa Bay and south Bolsa slough prior to Phase I. The number of nine species predicted in Phase I was exceeded by 15 species to a total of 24 species in inner Bolsa Bay and south Bolsa slough (Table 10). Thus, the predicted benefits of increases in fish species was exceeded by 2.7 times.

Determine Influences of Water Management Practices Upon Fish and Bivalve Composition

Since we believe the major impacts of water management practices

TABLE 9. Species of Bivalves Captured in Inner Bolsa Bay Prior to Phase I and During Phase I.

Species of Bivalves Prior to Phase I

1. Bay mussel
2. Smooth chione

Species of Bivalves During Phase I

1. Banded chione
2. Bay mussel
3. Bentnose clam
4. California jackknife clam
5. Common littleneck clam
6. Cooperella clam
7. Egg cockle
8. Smooth chione
9. Washington clam

TABLE 10. Species of Fishes Captured in Inner Bolsa Bay and South Bolsa Slough Prior to Phase I and During Phase I.

Species of Fishes Prior to Phase I

1. Bay pipefish
2. California killifish
3. Topsmelt

Species of Fishes During Phase I

1. Arrow goby
2. Bay pipefish
3. California halibut
4. California killifish
5. Deepbody anchovy
6. Diamond turbot
7. Giant kelpfish
8. Goldfish
9. Grey smoothhound
10. Jacksmelt
11. Longjaw mudsucker
12. Northern anchovy
13. Pacific bonito
14. Queenfish
15. Round stingray
16. Shadow goby
17. Shiner surfperch
18. Specklefin midshipman
19. Staghorn sculpin
20. Striped mullet
21. Tilapia
22. Topsmelt
23. Yellowfin croaker
24. Yellowfin goby

have been on inner Bolsa Bay and south Bolsa slough, we will confine our remarks to inner Bolsa Bay and south Bolsa slough areas.

The passage of water between inner and outer Bolsa Bay is possible through three 48 in. (122 cm) culverts with flat tide gates on the outer Bolsa Bay side of each culvert. Many different combinations of opening and closing the three culverts have been tried during Phase I. However, only two combinations have been used for lengthy periods of time: (1) one culvert open for the period mid-October 1978 to March 1980, and (2) two culverts open from March 1980 to the end of our sampling in August 1980.

We were not able to determine statistically if one culvert or two culverts open was more beneficial to increased fish and bivalve species' immigration. We continued to find increases in the number of fish species in inner Bolsa Bay with either one or two culverts open. However, with only four data points, it would appear that more species entered with two culverts open (Table 7).

The number of fish species (eight) remained the same in south Bolsa slough with one culvert open, but increased to 12 with two culverts open.

The difference in numbers of bivalves with two culverts open was that recruitment increased within a species such as the common littleneck clam, and Washington clam, and juveniles of these species were able to survive in inner Bolsa Bay. This may be related to water quality improving considerably when two culverts were open (Feldmeth and Associates, 1980).

We defined resident fishes as fishes that were captured in two out of four of our sampling quarters (Table 11). Therefore, there are 12 fish species determined to be resident fishes in inner Bolsa Bay and seven fish species in south Bolsa slough (Table 12). The number of resident fish species in the combined inner Bolsa Bay and south Bolsa slough is 14 species.

TABLE 11. Fishes Captured at Bolsa Chica Marsh During Phase I of the Re-establishment Project. Fishes Collected in Outer Bolsa Bay = O, Fishes Collected in Inner Bolsa Bay = I, and Fishes Collected in South Bolsa Slough = S.

Fish Name	Months and Year Fish Collected			
	9-11/79	2/80	4-5/80	8/80
Arrow goby	S	S	O-I-S	
Bay pipefish	I-S		O	O-I-S
California halibut				O-I
California killifish	O-I-S	I	O-I-S	O-I-S
Cheekspot goby		O		
Deepbody anchovy			S	O-I-S
Diamond turbot	O-I-S	I	I	I
Giant kelpfish				I
Goldfish		I		
Grey smoothhound				O-I
Jacksmelt			I	
Longjaw mudsucker	O		O-I	O-I
Northern anchovy	S-I			
Pacific bonito			S	
Queenfish		I		
Round stingray			I	I
Shadow goby			O-I-S	O-I-S
Shiner surfperch		I	O-I	
Specklefin midshipman			I	
Staghorn sculpin	O-S	O-I	O-I	I
Striped bass		O		
Striped mullet	I-S	O-I	O-I	
Tilapia	I		O	O-I-S
Topsmelt	O-I-S	O-I-S	O-I-S	O-I-S
White croaker	O			
Yellowfin croaker				I
Yellowfin goby	O-I		O-I-S	O-S

TABLE 12. Fish Species Considered to be Resident in Inner Bolsa Bay and South Bolsa Slough During Phase I of the Bolsa Chica Marsh Re-establishment Project.

Inner Bolsa Bay

Bay pipefish
California killifish
Diamond turbot
Longjaw mudsucker
Round stingray
Shadow goby
Shiner surfperch
Staghorn sculpin
Striped mullet
Tilapia
Topsmelt
Yellowfin goby

South Bolsa Slough

Arrow goby
Bay goby
California killifish
Deepbody anchovy
Shadow goby
Topsmelt
Yellowfin goby

Fishes that use inner Bolsa Bay and south Bolsa slough as spawning and nursery grounds are topsmelt, shadow goby, arrow goby, bay pipefish, and tilapia. Fishes that use these areas as nursery grounds are California killifish, longjaw mudsucker, diamond turbot, staghorn sculpin, striped mullet, California halibut, and yellowfin goby. Fishes that use inner Bolsa Bay and south Bolsa slough as nursery areas only, may spawn here also, but we have no spawning data on these fishes.

We defined resident bivalves as those species that were captured in two out of the four delineated time periods (Table 13). We did not sample south Bolsa slough for bivalves. The resident bivalve species in inner Bolsa Bay are bay mussel, banded chione, bentnose clam, common littleneck clam, and smooth chione.

To predict if any other fishes or bivalves might occur in inner Bolsa Bay or south Bolsa slough, we reviewed our field data for outer Bolsa Bay and animals captured in Huntington Harbour (Hardy, 1970). Based on these data, we predict that the slough anchovy, white croaker, cheekspot goby, California mactra, gaper clam, Washington clam, California jackknife clam, rosy razor clam, nestling clam, and mud piddock, will probably become resident animals. The black croaker, shovelnose guitarfish, striped bass, and California corbina, may invade inner Bolsa Bay and south Bolsa slough, but they are found in such low numbers in surrounding waters that these animals will probably not become established as resident fishes.

A population estimate of fishes in Bolsa Chica Marsh could not be made with our study methods. However, a qualitative estimate of the abundance of fish species was made for the Marsh. For fishes captured with a bag seine, the most abundant fish was topsmelt in outer Bolsa Bay, inner Bolsa Bay, and south Bolsa slough (Table 14). The second most

TABLE 13. Bivalves Captured at Bolsa Chica Marsh During Phase I of the Re-establishment Project. Bivalves Collected in Outer Bolsa Bay = 0, and Bivalves in Inner Bolsa Bay = I.

<u>Bivalve Name</u>	<u>Month and Year Bivalve Collected</u>			
	<u>11/78-12/79</u>	<u>1/80</u>	<u>3-5/80</u>	<u>7-9/80</u>
Banded chione			I	I
Bay mussel	0-I	0-I	0-I	0-I
Bentnose clam	0		I	I
California jackknife clam	0	0-I	0	0
Common littleneck clam	0	0	0-I	0-I
Cooperella clam				I
Egg cockle				I
Gaper clam	0		0	0
Native oyster	0			
Nestling clam				0
Ribbed horse mussel	0			
Rosy razor clam		0		
Smooth chione	0	I	I	I
Washington clam	0	0		0-I

TABLE 14. Average Number of Fishes Captured for Resident Fish Species by Bag^{1/2/} Seine for Outer Bolsa Bay, Inner Bolsa Bay and South Bolsa Slough.^{3/}

<u>Fish Name</u>	<u>Average Number of Species Captured</u>		
	<u>Outer Bolsa Bay^{3/}</u>	<u>Inner Bolsa Bay^{3/}</u>	<u>South Bolsa Slough^{3/}</u>
Arrow goby			3
Bay pipefish	9	3	1
California killifish	1	14	53
Deepbody anchovy			1
Diamond turbot		1	
Longjaw mudsucker	3	1	
Round stingray		3	
Shadow goby	10	7	7
Shiner surfperch		<1	
Staghorn sculpin	4	<1	
Striped mullet	<1	2	
Tilapia	5	1	
Topsmelt	301	235	282
Yellowfin goby	3	<1	<1

^{1/}

Numbers were calculated by taking total numbers of each species captured and dividing this number by total number of bag seine sets. When the number of a species captured was over 500 for a set, then 500 was used for total number captured for that set

^{2/}

Assumes all fishes equally vulnerable to bag seine

^{3/}

If number is blank, fish not considered a resident for this area

abundant fish was killifish in inner Bolsa Bay and south Bolsa slough (Table 14).

Gill nets were used only in inner Bolsa Bay. The most abundant fish captured was topsmelt (Table 15).

Recommendations on Water Management Practices as Concerns Fishes and Bivalves in Inner Bolsa Bay and South Bolsa Slough

Since the number of fish and bivalve species continues to increase, we recommend that two culverts be left open for tidal flooding and flushing. This water exchange rate with two culverts open appears to be beneficial to all species of fishes which use Bolsa Bay and south Bolsa slough for spawning and nursery grounds. Recruitment of bivalve species increased in inner Bolsa Bay with two culverts open, and juveniles of these clam species were able to survive in this area. Although we do not have any concrete biological data that two culverts open maximizes fish populations or biomass preyed upon by birds; it has been observed that piscivorous birds are highly successful in capturing various species of fishes, and the numbers of these birds using inner Bolsa Bay and south Bolsa slough has increased significantly (Harold Novick, Wildlife Manager-Biologist, Calif. Dept. Fish and Game, pers. commun.).

Project Recommendations

The number of species of fishes and bivalves continued to increase in inner Bolsa Bay and south Bolsa slough during Phase I when our sampling ended in August 1980. We recommend that sampling of fishes and bivalves continue in Bolsa Chica Marsh until the numbers of new species found levels off. We recommend also that sampling should be conducted on any new areas opened to tidal action within the Bolsa Chica Marsh.

TABLE 15. Average Number of Fish Captured for Resident Fish Species by Gill Net for Inner Bolsa Bay^{1/}.

<u>Fish Name</u>	<u>Average Number of Species Captured in Inner Bolsa Bay</u>
Bay pipefish ^{2/}	1
California killifish ^{2/}	0
Diamond turbot	5
Longjaw mudsucker ^{2/}	0
Round stingray	4
Shadow goby ^{2/}	0
Shiner surfperch	1
Staghorn sculpin	1
Striped mullet	2
Tilapia ^{3/}	0
Topsmelt	27
Yellowfin goby	2

^{1/} Numbers were calculated by taking total numbers of each species captured and dividing this number by total number of gill net sets

^{2/} Species not fully vulnerable to gill net

^{3/} Species vulnerable to gill net, but not captured

Appendix 1. Common Fish Names with Equivalent Latin Scientific Name.

<u>Common Name</u>	<u>Scientific Name</u>
Arrow goby	<i>Clevelandia ios</i>
Bay pipefish	<i>Cheilotrema saturnum</i>
Black croaker	<i>Syngnathus leptorhynchus</i>
California corbina	<i>Menticirrhus undulatus</i>
California halibut	<i>Paralichthys californicus</i>
California killifish	<i>Fundulus parvipinnis</i>
Cheekspot goby	<i>Ilpnus gilberti</i>
Deepbody anchovy	<i>Anchoa compressa</i>
Diamond turbot	<i>Hypsopsetta guttulata</i>
Giant kelpfish	<i>Heterostichus rostratus</i>
Goldfish	<i>Carassius auratus</i>
Grey smoothhound	<i>Mustelus californicus</i>
Jacksmelt	<i>Atherinopsis californiensis</i>
Longjaw mudsucker	<i>Gillichthys mirabilis</i>
Northern anchovy	<i>Engraulis mordax</i>
Pacific bonito	<i>Sarda chiliensis</i>
Queenfish	<i>Seriphus politus</i>
Round stingray	<i>Urolophus halleri</i>
Shadow goby	<i>Quietula y-cauda</i>
Shiner surfperch	<i>Cymatogaster aggregata</i>
Shovelnose guitarfish	<i>Rhinobatos productus</i>
Slough anchovy	<i>Anchoa delicatissima</i>
Specklefin midshipman	<i>Porichthys myriaster</i>
Staghorn sculpin	<i>Leptocottus armatus</i>
Striped bass	<i>Roccus saxatilis</i>
Striped mullet	<i>Mugil cephalus</i>
Tilapia	<i>Tilapia mossambica</i>
Topsmelt	<i>Atherinops affinis</i>
White croaker	<i>Umbrina roncador</i>
Yellowfin croaker	<i>Acanthogobius flavimarius</i>
Yellowfin goby	<i>Genyonemus lineatus</i>

Appendix 2. Common Bivalve Names with Equivalent Latin Scientific Name.

<u>Common Name</u>	<u>Scientific Name</u>
Banded chione	<i>Chione californiensis</i>
Bay mussel	<i>Mytilus edulis</i>
Bentnose clam	<i>Macoma nasuta</i>
California jackknife clam	<i>Tagelus californianus</i>
California mactra	<i>Mactra californica</i>
Common littleneck clam	<i>Protothaca staminea</i>
Cooperella clam	<i>Cooperella subdiaphana</i>
Egg cockle	<i>Laevicardium substriatum</i>
Gaper clam	<i>Tresus nuttalli</i>
Mud piddock	<i>Barnea subtruncata</i>
Native oyster	<i>Ostrea lurida</i>
Nestling clam	<i>Petricola californiensis</i>
Ribbed horse mussel	<i>Geukensia demissa</i>
Rosy razor clam	<i>Solen rosaceus</i>
Smooth chione	<i>Chione fluctifraga</i>
Washington clam	<i>Saxidomus nuttalli</i>

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