

A Distribution Survey of Desert Pupfish
(Cyprinodon macularius) Around the Salton Sea, California 1/

Prepared for

California Department of Fish and Game
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by

Sabrina Lau and Claude Boehm
Scientific Aids

Under the Supervision of Kimberly Nicol
Region 5
Inland Fisheries

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ABSTRACT

During the months of April, May and June 1991, the California Department of Fish and Game conducted surveys to determine desert pupfish (Cyprinodon macularius) distribution around the Salton Sea. Baited minnow traps were set in agricultural drains leading to the sea, several shoreline pools along the northern and southern ends of the sea, and in Salt Creek, a natural tributary to the Salton Sea. In addition, San Felipe Creek was visually surveyed to determine pupfish and exotic fish presence. We found desert pupfish in a majority of the drains and shoreline pools of the Salton Sea, at the mouth of Salt Creek, and in lower San Felipe Creek.

INTRODUCTION

The desert pupfish, Cyprinodon macularius Baird and Girard (1853), is a member of the family Cyprinodontidae. Historically, it was widespread in portions of Arizona, southeastern California and northern Mexico. In California, it occurred in backwaters along the Colorado River and in springs, streams and seeps within the Salton Sink (Miller 1943). Its current distribution in California is limited to shoreline pools of the Salton Sea, two natural streams, eight artificial refugium ponds and several irrigation drains leading to the Salton Sea (Bolster 1990) (Figure 1). It is endangered due to habitat alteration and the introduction of exotic species. This species was listed as endangered by the California Fish and Game Commission in 1980, and by the U.S. Fish and Wildlife Service (USFWS) in 1986. In addition to the protection of remaining natural habitat, the draft USFWS recovery plan for the pupfish includes the creation of refugia for specific genetic stocks and periodic monitoring of pupfish populations. This report presents the results of a California Department of Fish and Game (CDFG) monitoring survey for desert pupfish in non-refugium habitats in the Salton Sea area and includes some management recommendations for these populations.

MATERIALS AND METHODS

During April, May and June 1991, we surveyed agricultural drains, selected shoreline pools of the Salton Sea, lower Salt Creek and lower San Felipe Creek (Figure 1). Wire mesh minnow traps were used to capture fish. Traps baited with cat food were placed in perforated sealed plastic bags, left in place overnight for approximately 20 hr, then pulled and their contents noted. Traps were set at the mouth and along the length or area of a drain or pool. Data recorded for each trap set included location, approximate depth, substrate type, water clarity, surrounding aquatic and terrestrial vegetation types and their relative abundance, and the time of trap placement and retrieval. In addition, a general habitat description was noted for each drain

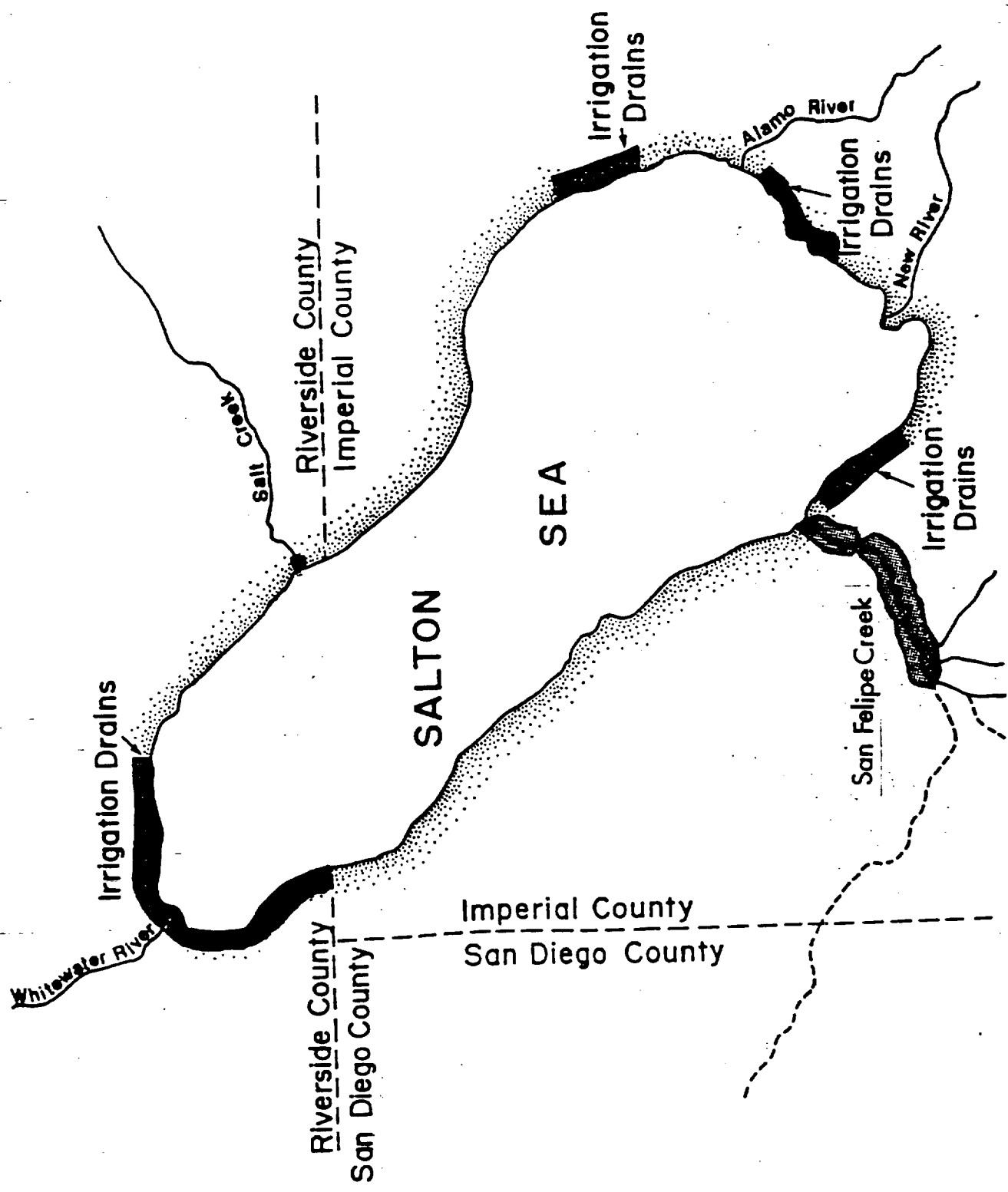
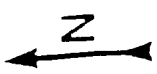
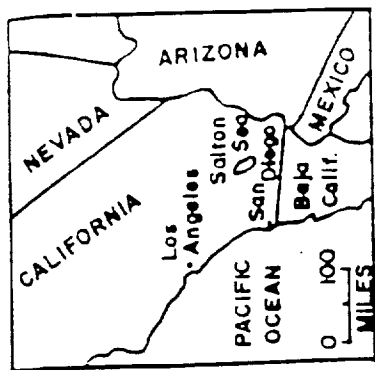


Figure 1. Areas sampled during 1991 desert pupfish survey.

or pool. The time of trap retrieval and number of each fish species captured was recorded, as well as any changes in habitat or weather that may have occurred since trap placement. Marginal drain habitats where pupfish were not captured initially were retrapped.

Since this survey was qualitative in nature, emphasis was on locating probable pupfish habitat. The drains, shoreline pools and tributaries were surveyed subjectively based on the habitat description given in Black (1980). Traps were generally placed in clearer, slow-moving water of shallow depths between 2 in. and 2 ft. Drains and pools which were densely vegetated or stagnant were not sampled. Traps were set preferentially in or near algal growth or other aquatic vegetation. Substrate types ranged from barnacle and firm sand to fine silt and soft mud. The number of traps set per drain varied according to drain length and habitat quality. Drains with questionable habitat were trapped. Photographs were taken in areas where pupfish occurred.

Of the 66 drains documented by Imperial Irrigation District (IID) and Coachella Valley Water District (CVWD) maps as emptying into the sea, 27 out of 27 possible drains were trapped along the northern end of the Salton Sea in Riverside County, and 30 out of a possible 39 drains were surveyed in Imperial County along the southern portion of the sea. Five of the nine unsurveyed drains did not contain appropriate habitat. The remaining four drains shown on the maps had been eliminated and replaced by sump pumps.

The shoreline pool survey was limited to selected pools on the southern and eastern shores due to the large number of potential pools sea-wide and the logistics of surveying each. Eleven of the 14 pools surveyed were accessible only by airboat. Access to the remaining three pools was possible by foot. Several pools were not trapped due to inappropriate habitat. Beach seining and trapping in the Salton Sea proper was not considered since previous surveys found few pupfish and other work has shown the desert pupfish prefers still, shallow, shoreline pools (Black 1980).

Salt Creek was trapped only from the railroad tracks at Highway 111 west to the sea (Figure 2) due to dense salt cedar (Tamarix ramosissima) and giant reed (Arundo donax) growth upstream. A more accessible upper section of the creek is currently being trapped quarterly by Dr. Allen Schoenherr of Fullerton College, and was therefore not surveyed during this study.

Visual surveys, conducted in three segments, were used to monitor pupfish and exotic species in San Felipe Creek. The first segment extended from Tarantula Wash to Carrizo Wash. The second, from Carrizo Wash to Highway 86, was followed by a third survey from Highway 86 to the mouth at the Salton Sea (Figure 3).

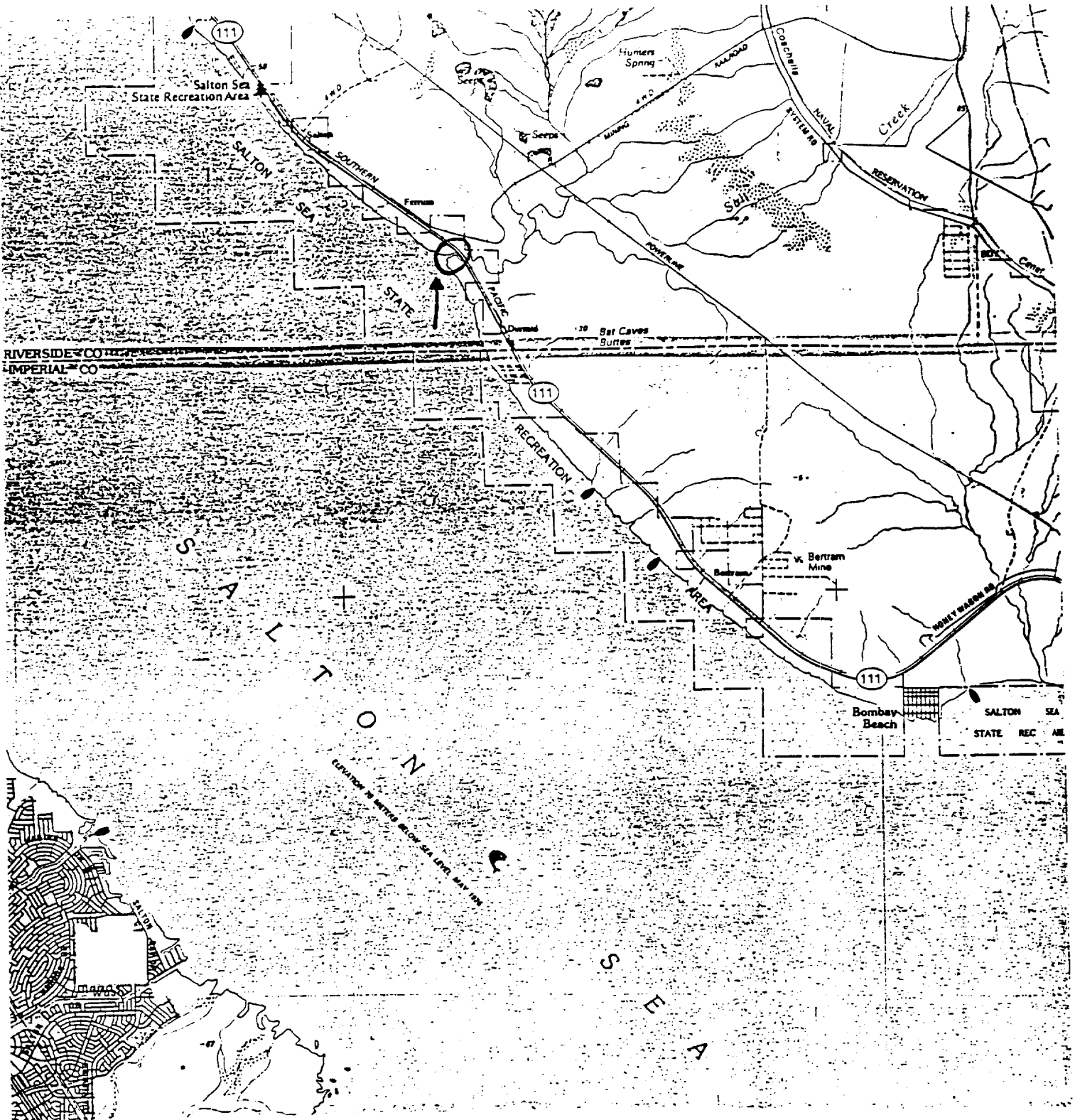


Figure 2. Salt Creek survey area, 1991 desert pupfish survey.

The Alamo and New rivers did not exhibit favorable pupfish habitat and were therefore not trapped.

To simplify potential identification questions in the field, sailfin and shortfin mollies, Poecilia latipinna and P. mexicana, respectively, were lumped as Poecilia sp. and are referred to as "molly". Similarly, the two species of African cichlids common to the sea, the Mozambique mouthbrooder (Tilapia mossambica), and Zills cichlid (T. zilli), were lumped under "tilapia".

RESULTS

In addition to desert pupfish, 12 species of fish and one species of crustacean were trapped. These include mollies (two species), tilapia (two species), longjaw mudsucker (Gillichthys mirabilis), mosquitofish (Gambusia affinis), red shiner (Notropis lutrensis), porthole livebearer (Poeciliopsis gracilis), variegated platyfish or swordtail (Xiphophorus variatus), orangemouth corvina (Cynoscion xanthulus), largemouth bass (Micropterus salmoides), green sunfish (Lepomis cyanellus), and crayfish (Procambarus clarkii). Other unidentified aquatic species captured included tadpoles, water beetles, water scavengers, pileworms, and snails (Table 1).

Irrigation Drains

We found desert pupfish in 72% of the drains surveyed around the Salton Sea (Table 1). Along the northern portion of the sea, 24 out of 27 (89%) drains surveyed contained pupfish (Figure 4). Four clear, shallow north-end drains were not trapped, but were confirmed to be pupfish habitat by dip-netting or visual identification. Visual observations were used in the McKinley 0.5 and Garfield Street drains. Pupfish were netted in the Avenue 82 drain and County Line Stormwater Channel. All 27 north-end drains except five were trapped from the mouth to their source or Highway 111, where habitat became unsuitable. The number of desert pupfish caught in each North-end drain varied from zero at the Johnson, Lincoln and Buchanan 0.5 drains to 155 at the Avenue 78 drain (Appendix I).

The southern Salton Sea drains yielded fewer pupfish than the northern ones. Of 30 southern drains surveyed, 17 (57%) captured pupfish (Figure 5). South-end drain trapping captured from zero to 44 pupfish per drain (Appendix II).

Shoreline Pools

Of 14 shoreline pools trapped, 9 (64%) contained pupfish (Figure 6). All pupfish captured in pools were the result of

Table 1. Summary of Species Commonly Caught in 1991 Salton Sea Area Desert Pupfish Survey.

	Species 1/							
	DSP	TIL	MOF	MOL	SKR	CRF	SHR	PTL
<u>NORTH END DRAIN</u>								
McKinley 0.5	X	X		X	X			
McKinley	X	X		X	X			
Cleveland 0.5	X	X		X	X			
Cleveland	X		X	X	X			
Arthur 0.5	X			X				
Arthur	X							
Garfield 0.5	X			X	X			
Garfield	X	X	X	X	X	X		
Hayes 0.5	X			X	X			
Hayes	X			X		X		
Grant 0.5	X	X	X	X	X			
Grant	X			X				
Johnson 0.5	X		X	X	X	X		
Johnson		X	X	X		X	X	X
Lincoln			X	X		X	X	X
Buchanan 0.5		X	X	X		X	X	
Ave. 76	X	X	X	X	X	X		X
Ave. 78	X		X	X		X		
King Sr.	X	X	X	X				
Ave. 79	X		X	X	X	X		
Ave. 80	X			X	X	X		
Ave. 81	X	X		X	X	X		
Ave. 82	X	X	X	X	X	X		X
Ave. 83	X	X		X	X			X
Ave. 84	X	X	X	X	X	X		X
Oasis-Grant	X	X		X	X	X	X	
County Line	X	X						
<u>SOUTH END DRAIN</u>								
Niland 4	X		X	X	X	X		
Niland 2	X			X	X			
Z				X	X	X		
U			X	X		X	X	
T						X		
R						X		
Q				X	X	X		
P					X	X		

1/ Abbreviations:

DSP = desert pupfish, TIL = tilapia, MOF = mosquitofish, MOL = molly, SKR = longjaw mudsucker, CRF = crayfish, SHR = red shiner, PTL = porthole livebearer.

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Table 1 (continued). Summary of Species Commonly Caught in 1991 Salton Sea Area Desert Pupfish Survey.

	Species 1/							
	DSP	TIL	MOF	MOL	SKR	CRF	SHR	PTL
<u>SOUTH END DRAIN (cont.)</u>								
Vail 4A	X				X		X	
Vail 5	X		X	X	X	X		
Vail 5A	X				X	X		
Vail 6	X	X		X	X			
WP-10/SS-11	X	X		X				
Vail Cut-Off				X	X	X		
Vail 7			X	X	X	X		
Trifolium 12 Lat.			X		X			
Trifolium 13					X	X		
Trifolium #1	X		X		X	X		
Trifolium Storm	X				X			
Trifolium 18	X			X				
Poe	X		X	X	X	X		
W. of Lone Tree	X				X			
Trifolium 19	X			X				
3W of Lone Tree	X			X	X	X		
Trifolium 22					X	X		
San Felipe Wash	X				X	X	X	
Trifolium 23	X				X	X		
Trifolium 23N	X	X	X		X			
<u>SHORELINE POOLS</u>								
Bison Ave. 82,83		X		X				
S. of Bombay	X		X	X				
N. of Niland 4	X		X	X		X		
S. of Niland 4			X			X	X	
N. of Niland 3	X					X		
By Niland 1	X		X	X		X		
New River Pool			X	X	X			
W. of New River	X				X			
S. of New River	X							
E. of Trifolium 22	X				X			

1/ Abbreviations: DSP = desert pupfish, TIL = tilapia, MOF = mosquitofish, MOL = molly, SKR = longjaw mudsucker, CRF = crayfish, SHR = red shiner, PTL = porthole livebearer.

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Table 1 (continued). Summary of Species Commonly Caught in 1991 Salton Sea Area Desert Pupfish Survey.

	Species 1/							
	DSP	TIL	MOF	MOL	SKR	CRF	SHR	PTL
SHORELINE POOLS (cont.)								
By Trifolium 23	X	X	X	X				
By Trifolium 23N	X	X						
CREEKS								
Salt Creek	X		X	X	X	X		
San Felipe Creek	X		X					

1/ Abbreviations: DSP = desert pupfish, TIL = tilapia, MOF = mosquitofish, MOL = molly, SKR = longjaw mudsucker, CRF = crayfish, SHR = red shiner, PTL = porthole livebearer.

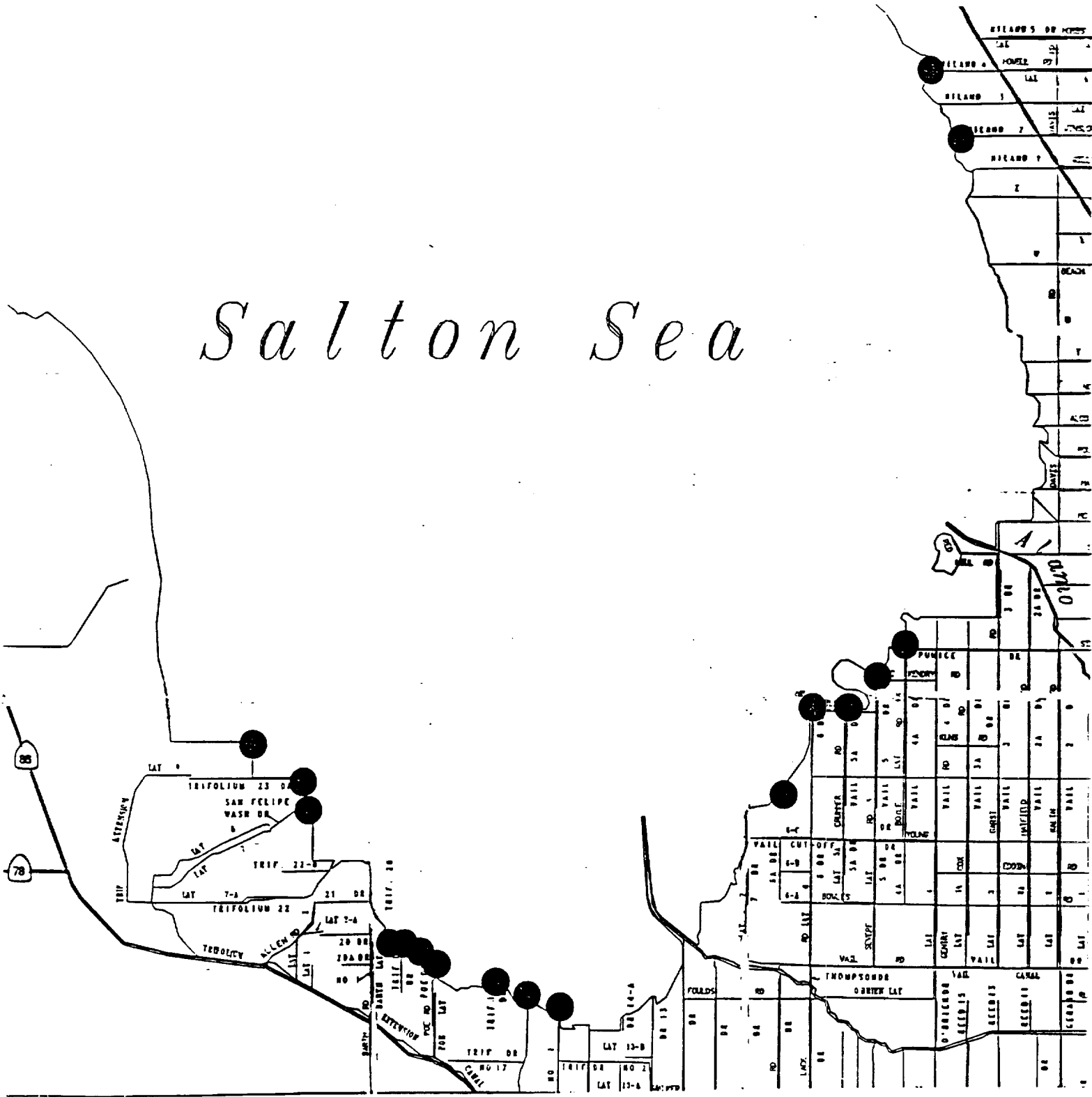


Figure 5. South end Salton Sea irrigation drains containing desert pupfish during 1991 survey.

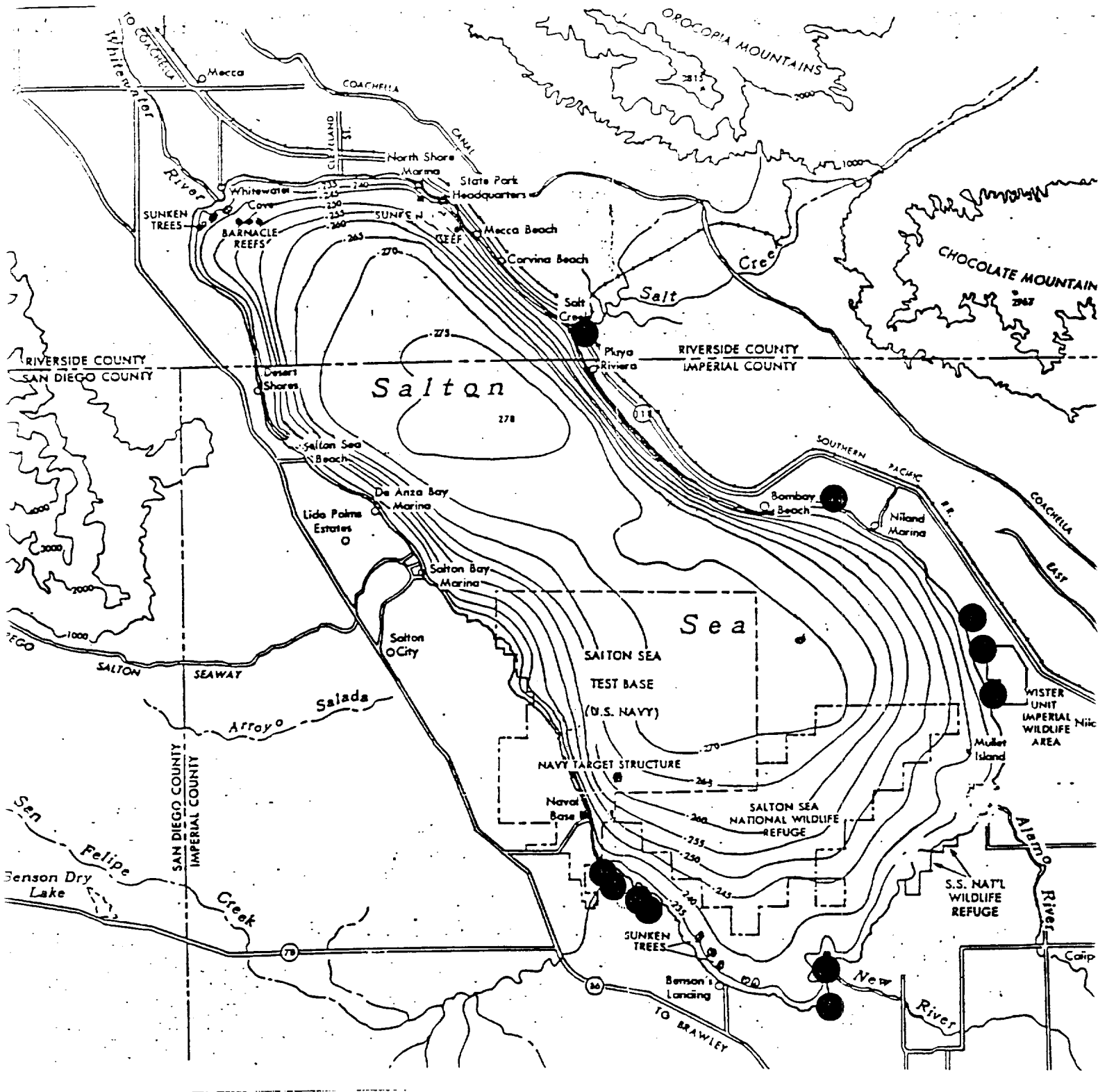


Figure 6. Shoreline pools containing desert pupfish during 1991 survey.

trapping, with the exception of the pool "between Trifolium 23 and Trifolium 23N", in which pupfish were netted. Shoreline pool trapping captured from zero to 30 pupfish per pool (Appendix III). More sampling is required to determine if this pupfish distribution is representative of Salton Sea shoreline pools as a whole.

Natural Tributaries

Pupfish were caught at the mouth of Salt Creek. Visual surveys of San Felipe Creek indicated that pupfish are presently inhabiting the entire creek (Appendix III). Many young pupfish and a few adults were seen. The only exotic species observed was the mosquitofish, which appeared to prefer larger, and deeper pools. During the course of this survey, San Felipe Creek flow was intermittent and restricted to shallow, disjunct pools in several areas between the Salton Sea and Highway 86.

DISCUSSION

We found desert pupfish in a majority of the drains, pools and natural tributaries of the Salton Sea. A variety of factors, however, may influence trap results. Trap placement, for example, appears to be important. Often, pupfish were caught in only one trap out of five or six set in what appeared to be fairly homogeneous habitat. Several drains in which the initial trapping did not yield pupfish often produced pupfish in subsequent trappings. The number of traps set per area may also affect pupfish catches. A large number of traps increases the chances of capture by saturating the area. Inconsistency in habitat evaluation and resulting trap placement could therefore lead to varied results. Differences in bait types, including brand, flavor, and amount may also have an effect on trapping efficiency. This survey generally utilized an inexpensive, fish-flavored variety.

Timing of the surveys relative to the growth and life cycles of desert pupfish is also a factor in trapping success since population densities fluctuate widely (Walker 1961). Matsui (1981) indicated that Salton Sea desert pupfish breed from late March through late September; surveys should coincide with this activity to maximize the possibility of catching fish while they are active and numbers are high.

Barlow (1958) observed changes in pupfish movements in response to daily fluctuations in water temperature or perhaps even light intensity. Trapping results in shoreline pools may have been affected by trap placement relative to temperature and light fluctuation.

Due to the irregular supply of waste irrigation water, the level of the drains and the sea is subject to frequent variation. This fluctuation could affect trapping efficiency. Drains with an open exchange with the sea were often subtly altered on subsequent visits by changes in water level, direction of flow, or discontinued sea access. Strong winds also caused water levels to fluctuate, possibly discouraging fish from entering traps by diffusing or disrupting bait scent trails.

Periodic vegetation removal by IID and CVWD may impact pupfish distribution and abundance. Maintenance occurs more frequently within CVWD's service area on the north end of the sea than within IID's service area to the south. A higher percentage of north end drains contained pupfish (89%) than on the south end (57%). Drain maintenance may prevent the habitat from becoming too overgrown and stagnant. During this survey, three drains which contained desert pupfish and underwent partial vegetation removal still contained pupfish after the maintenance activities.

RECOMMENDATIONS

Future surveys should be expanded to cover all potential shoreline pool habitats and any other potential pupfish habitat not sampled during this survey. These surveys should be repeated at least every two years.

Since the desert pupfish appears to be well established in agricultural drains, the effects of continued drain maintenance should be studied. Although pupfish appeared to survive drain maintenance, it should be noted that a portion of the drain was left undisturbed during the maintenance procedure. Formal agreements to regulate the frequency and extent of drain maintenance should be developed among the USFWS, the CDFG and the irrigation districts. Other human impacts to pupfish in drains including water diversion, bait fishing, agriculture and water quality, should also be investigated.

Pupfish interaction with introduced species occurring in the Salton Sea merits further attention. Schoenherr (1981) noted that five Cyprinodon species have been reduced in number by interaction with mosquitofish. Matsui (1981) documented that Zill's cichlids and sailfin mollies interfered behaviorally with desert pupfish reproduction.

Many aspects of desert pupfish life history are known and were summarized by Schoenherr (1988). Results from this survey suggest, however, that studies investigating pupfish tolerance of human impacts and interactions with exotic species could prove helpful in the future management of this endangered species.

ACKNOWLEDGEMENTS

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APPENDIX I. Trapping Results in North End Drains During 1991 Salton Sea Desert Pupfish Survey.

Drain	Species 1/				Other	Total no. fish	No. traps set	No. traps containing pupfish	Retrap	Comments
	DSP	TIL	MOF	MOL						
McKinley 0.5	obs, 2/ obs			obs		0	2	0		x
McKinley	17	9		15 obs, 2		43	5	1		
Cleveland 0.5	net Y 3/ net Y 10 obs A 4/ 14			40 2, 17		83	12	3		x
Cleveland	18	3		27	1	49	4	2		
Arthur 0.5	18			105		123	3	3		
Arthur	4					4	4	1		
Garfield 0.5	2			4	3	9	3	1		
Garfield,	obs	obs A	obs	18 obs	4, 5	38	12	0		x
	1, 7	1	2	2						
Hayes 0.5	9			24	8	41	5	4		
Hayes	2			1	5	8	5	1		
Grant 0.5	7	2		8	5	28	6	2		
Grant	92			1		93	7	4		
Johnson 0.5	37			24, 22	2, 1	125	12	3		x
Johnson	obs	2, 7	27, 5	49	12, 26	138	12	0		x
	16, 3			3, 26						
Lincoln				11, 6	3	48	6	0		
Buchanan 0.5	18			51	12	148	6	0		
Ave. 76	1	obs	1, 3	76, 34	1, 9	164	20	1		x
		1, 2			18, 1, 11					
Ave. 78	155			66	1	246	12	5		
				24	tadpole					

1/ Abbreviations: DSP = desert pupfish, TIL = tilapia, MQF = mosquitofish, MOL = molly, SKR = longjaw mudsucker, SHR = red shiner, CRF = crayfish, GSF = green sunfish, PTL = porthole livebearer, SWT = swordtail

2/ Presence determined visually.

3/ Netted young.

4/ Observed adults.

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APPENDIX I (continued). Trapping Results in North End Drains During 1991 Salton Sea Desert Pupfish Survey

Drain	Species 1/										Total fish	No. traps set	No. traps containing pupfish	Retrap	Comments
	DSP	TIL	MOF	MOL	SKR	SHR	CRF	Other tadpoles	2 fish lost (escaped)	2 fish lost					
King Sr.	64,3	17,40	15,6	3,30							178	8	4		
Ave. 79	22		2	16	2		34				76	11	4		
Ave. 80	80			49	29		9				167	4	4		
Ave. 81	net Y	net Y		42	1		1				48	3	1		After dredging
	3	1													Very recently dredged
Ave. 82	net Y	net Y	4	5	3		9				96	10	0		
	obs A	obs A													
	75														
Ave. 83	5	191		12	15						227	6	2		
Ave. 84	10,28	10,13	50,3	56,	2,28		35,1,				356	13	7		x
			10	10,90			10								After
Oasis-Grant County Line	7	3,56		3	2,1		229				323	8	1		
	net Y	net Y													
TOTALS	594	479	213	816	135	329	283				2,859	199	54		

1/ Abbreviations: DSP = desert pupfish, TIL = tilapia, MOF = mosquitofish, MOL = molly, SKR = longjaw mudsucker, SHR = red shiner, CRF = crayfish, GSF = green sunfish, PTL = porthole livebearer, SWT = swordtail
 2/ Presence determined visually.
 3/ Netted young.
 4/ Observed adults.

APPENDIX II. Trapping Results in South End Drains During 1991 Salton Sea Desert Pupfish Survey.

Drain	Species 1/		SKR	SHR	CRF	Other	Total fish	No. traps set	No. traps containing pupfish	Retrap	Comments
	DSP	TIL									
Niland 4	19	1	13	10	7		50	4	4		Mouth only
Niland 3											No connection 2/
Niland 2	2	2	2	4			8	1	1		Mouth only
Niland 1								3	0		
"Z"		2	2	101	3		106	6	0	x	No connection
"W"											
"U"	1	9	1	8,14			33	6	0	x	No connection
"T"					10		10	1	0		No connection
"S"											No connection
"R"		3	1,1		3		3	2	0		No connection
"Q"					4,6		15	4	0	x	No connection
"P"					3		12	4	0	x	No connection
"O"											Dry
Vail 3											Non-existent
Vail 3A											Sump pump
Vail 4 A	1			1	9		11	5	1	x	No connection
Vail 5	44	26	1,3	1,23	13		111	12	5	x	No connection
Vail 5A	26			3	1		30	4	3		No connection
Vail 6	1	382	36	14			433	5	1		No connection
WP-10 SS-11	1	1	52				54	4	1		
Vail Cut-Off			1	3	4		8	4	0		Presently dredging,
Vail 7		1	1,1	16	3	corvina 1,	23	6	0	x	Presently dredging

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 2/ No connection to Salton Sea.

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APPENDIX II (continued). Trapping Results in South End Drains During 1991 Salton Sea Desert Pupfish Survey.

Drain	Species 1/							Total fish	No. traps set	No. traps containing pupfish	Retrap	Comments
	DSP	TIL	MOF	MOL	SKR	SHR	CRF					
Trifolium 12 lat			1		1			2	5	0		
Trifolium 13					5		3	8	2	0		
Trifolium 14A			4		4		4	21	2	1		No connection
Trifolium #1	9				4			10	2	1		Recently dredged
Trifolium Storm	1				9			14	3	1		No connection
Trifolium 18	2			12				98	7	4	X	Recently dredged
Poe	10,3		1	40,2	30,3		1					
Lone Tree Wash									2	0		
W. of Lone Tree	8				2			10	4	1		
Trifolium 19	8			8				16	4	2		
3W of Lone Tree	6			4	4		5	19	5	1		
Trifolium 20												
Trifolium 21												
Trifolium 22					16		2,4	22	4	0		Sump pump
San Felipe Wash	5				28		2	37	5	1	X	Sump pump
Trifolium 23	13				1		3	17	4	3		
Trifolium 23N	2	3	1		2			8	8	1	X	
TOTALS	161	386	36	190	300	15	100	1,189	128	32		

1/ Abbreviations: DSP = desert pupfish, TIL = tilapia, MQF = mosquitofish, MOL = molly, SKR = longjaw mudsucker, SHR = red shiner, CRF = crayfish, GSF = green sunfish, PTL = porthole livebearer, SWT = swordtail

2/ No connection to Salton Sea.

APPENDIX III. Trapping Results in Shoreline Pools and Tributary Creeks During 1991 Salton Sea Desert Pupfish Survey.

	Species 1/										Total fish	No. traps set	No. traps containing pupfish	Retrap	Comments	
	DSP	TIL	MOF	MOL	SKR	SHR	CRF	Other								
Pools																
Bison Ave. 82,83		229		48								11	0			
S. of Bombay	23		2	2								2	2			
N. of Niland 4	30		9	1			3					2	2			
S. of Niland 4			3			7	1			largemouth bass-2		3	0			
N. of Niland 3	9							1				2	2			
By Niland 1	4		2	1				obs		pileworms		5	3			
New River Pool			1	12	38							2	0			
W. of New River	7				2							2	2			
S. of New River	1											2	1			
SE of 3 hunt.blinds												2	0			
N. of Trifolium 13												4	0			
E. of Trifolium 22	6								5			2	0			
By Trifolium 23	4	2	1	1								2	2			
By Trifolium 23N												3	1			
net Y obs A																
TOTALS	85	231	18	65	45	7	5		2		498	42	15			
Creeks																
Salt Creek	1		3	2	25		74				105	13	1			
San Felipe Creek	obs Y,		obs													

1/ Abbreviations: DSP = desert pupfish, TIL = tilapia, MOF = mosquitofish, MOL = molly, SKR = longjaw mudsucker, SHR = red shiner, CRF = crayfish, GSF = green sunfish, PTL = porthole livebearer, SWT = swordtail