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HISTORY AND STATUS OF INTRODUCED FISHES IN CALIFORNIA, 1871–1996

by

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FISHES INTRODUCED INTO THE SALTON SEA

The Salton Sea, in Riverside and Imperial counties, the largest body of inland water in California, is primarily the result of an accidental diversion of the Colorado River during the 1905–07 period. The diversion created a gigantic lake about 235 ft below sea level, and about 340 square miles in area, but only about 15 ft in average depth. It is essentially an inland sea with a high evaporative rate due to high summer temperatures, a salinity exceeding that of normal sea water, and two inlets carrying wastewater.

The Sea requires a special place in this report since the fish introduced into it have been marine, or at least euryhaline (as in the case of the coho salmon and striped bass). A complete list of the fishes introduced into this very saline environment is reproduced here (Table 2). Taken from Walker et al. (1961), it includes both fishes native to California and a group of exotics, totalling 38,730 fish

As will be seen in Table 2, there have been numerous attempts to introduce fishes into the Salton Sea which would survive, reproduce naturally, and supply food and sport. Some of the earliest attempts strove to introduce fishes which could furnish food (e.g. the anchoveta), but most of the attempts were to institute a fishery for sport fishes. As Lachner et al. (1970) have said, "The Salton Sea is an excellent example of an area where there was good chance to gain and nothing to lose or harm by trial and error introductions." Even scientists who seem generally opposed to fish introductions state that those into the Salton Sea were "... probably the most outstanding examples of well-planned releases where no adverse impacts were likely...." (Courtenay and Williams 1992 following Courtenay and Robins 1989).

Many articles have been written describing attempts to introduce fishes into the Salton Sea, the organisms which are present, and their ecology. The most detailed of these is the California Department of Fish and Game's Fish Bulletin 113, edited by Walker (1961). OC (1978) presented a good popular report on the subject. Some of the problems besetting the Sea were described by Calhoun (1968, 1969), and in recent years its increasing salinity has caused a decided decline in the sport fishery—once one of the largest in California.

With respect to the introductions of fishes from Mexico into the Salton Sea, however, the original published reference appears to be that of Douglas (1953). He briefly recapitulated the history of the Sea, pointed out that prior to 1948 the only fishes present in the Sea were striped mullet, western mosquitofish, desert pupfish, common carp, and possibly some machete (*Elops affinis*). Some longjaw mudsuckers which had been deliberately introduced were found in 1951. With respect to later introductions, Douglas (1953) stated, "Since 1948 four expeditions have been conducted to San Felipe, Mexico, on the western shores of the Gulf of California, by the California Department of Fish and Game to pro-

TABLE 2. Known fish introductions into the Salton Sea[1]

Date	Number	Species	Common name	Where acquired
20 Oct 1929	900	*Roccus saxatilis*	Striped bass	Tracy, California
24 Oct 1929	1500	*Roccus saxatilis*	Striped bass	Tracy, California
21 Oct 1930	1800	*Roccus saxatilis*	Striped bass	San Francisco Bay
13 Nov 1930	500	*Gillichthys mirabilis*	Longjaw mudsucker	San Diego Bay
1934	15000	*Oncorhynchus kisutch*	Silver salmon	Forest Home Hatchery
2 Oct 1948	43	*Anchoa mundeioloides*	Anchovy	Guaymas
23 Dec 1948	1000	*Centengraulis mysticetus*	Anchoveta	San Diego (tuna boat)
"	12	*Caranx caballus*	Green jack	San Diego (tuna boat)
10 May 1950	5000	*Centengraulis mysticetus*	Anchoveta	San Felipe
12 May 1950	29	*Albula vulpes*	Bonefish	San Felipe
"	2	*Centengraulis mysticetus*	Anchoveta	San Felipe
"	1	*Paralichthys aestuarius*	Halibut	San Felipe
"	40	*Colpichthys regis*	Silverside	San Felipe
"	1	*Eucinostomus argenteus*	Spotfin mojarra	San Felipe
"	2	*Trachinotus peitensis*	Paloma pompano	San Felipe
"	27	*Cynoscion xanthulus*	Orangemouth corvina	San Felipe
"	14	*Cynoscion parvipinnis*	Shortfin corvina	San Felipe
"	1	*Cynoscion macdonaldi*	Totuava	San Felipe
"	7	*Menticirrhus undulatus*	California corbina	San Felipe

[1]*From Table 25 of Walker et al. (1961). Common family names are used when no specific common name is available. Common and scientific names have not been updated.*

TABLE 2. (

Date
12 May 1
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14 Dec 1
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28 Mar
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TABLE 2. Continued

Date	Number	Species	Common name	Where acquired
12 May 1950	1	*Menticirrhus nasus*	Corbina	San Felipe
"	15	*Micropogon megalops*	Croaker	San Felipe
"	67	*Bairdiella icistius*	Bairdiella	San Felipe
14 Dec 1950	25	*Mugil cureme*	White mullet	San Felipe
"	600	*Colpichthys regis*	Silverside	San Felipe
"	1	*Paralichthys woolmani*	Halibut	San Felipe
"	1	*Scomberomorus concolor*	Monterey spanish mackerel	San Felipe
"	1	*Menticirrhus undulatus*	California corbina	San Felipe
"	12	*Eucinostomus argenteus* *Eucinostomus gracilis*	Spotfin mojarra Mojarra	San Felipe
15 Dec 1950	15	*Mugil cephalus*	Striped mullet	San Felipe
"	80	*Mugil cureme*	White mullet	San Felipe
"	70	*Colpichthys regis*	Silverside	San Felipe
"	1	*Nematistius pectoralis*	Roosterfish	San Felipe
"	1	*Menticirrhus undulatus*	California corbina	San Felipe
"	75	*Eucinostomus argenteus* *E. gracilis*	Spotfin mojarra Mojarra	San Felipe
28 Mar 1951	30	*Cetengraulis mysticetus*	Anchoveta	San Felipe
"	300	*Leuresthes sardina*	Grunion	San Felipe
"	3	*Cynoscion xanthulus*	Orangemouth corvina	San Felipe

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non ie	Where acquired
bass	Tracy, California
bass	Tracy, California
bass	San Francisco Bay
iw iker	San Diego Bay
mon	Forest Home Hatchery
vy	Guaymas
eta	San Diego (tuna boat)
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mes are used when no names have not been

TABLE 2. Continued

Date	Number	Species	Common name	Where acquired
28 Mar 1951	2	*Cynoscion parvipinnis*	Shortfin corvina	San Felipe
31 Mar 1951	48	*Albula vulpes*	Bonefish	San Felipe
"	6	*Anchoa mundeoloides*	Anchovy	San Felipe
"	8	*Centengraulis mysticetus*	Anchoveta	San Felipe
"	5	*Mugil cureme*	White mullet	San Felipe
"	3	*Colpichthys regis*	Silverside	San Felipe
"	4	*Paralichthys aestuarius*	Halibut	San Felipe
"	140	*Hypsopsetta guttulata*	Diamond turbot	San Felipe
		Etropus crossotus	Flounder	
"	65	*Anisotremus davidsoni*	Sargo	San Felipe
"	12	*Paralabrax maculatofasciatus*	Spotted bass	San Felipe
"	7	*Girella simplicidens*	Opaleye	San Felipe
"	2	*Halichoeres (?)*	Wrasse	San Felipe
"	200	*Cynoscion xanthulus*	Orangemouth corvina	San Felipe
		C. othonopterus	Scalyfin corvina	
		C. parvipinnis	Shortfin corvina	
		C. macdonaldi	Totuava	
"	10	*Bairdiella icistius*	Bairdiella	San Felipe
"	2	*Menticirrhus nasus*	Corbina	San Felipe
"	1	*Eucinostomus argenteus*	Spotfin mojarra	San Felipe
"	63	*Gillichthys seta*	Mudsucker	San Felipe

TABLE 2. C

Date
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11 May 19
13 May 19
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15 May 19
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10 Mar 19
10–11 Ma 1955
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Apr–May 1956
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TABLE 2. Continued

Date	Number	Species	Common name	Where acquired
14 Dec 1951	72	*Colpichthys regis*	Silverside	San Felipe
11 May 1953	6000	*Engraulis mordax*	Northern anchovy	Los Angeles Harbor
13 May 1953	44	*Cynoscion parvipinnis*	Shortfin corvina	San Felipe
"	35	*Micropogon megalops*	Croaker	San Felipe
"	4	*Menticirrhus undulatus*	California corbina	San Felipe
"	1	*Trachinotus paitensis*	Paloma pompano	San Felipe
"	26	*Opisthonema libertate*	Pacific thread herring	San Felipe
15 May 1953	50	*Cynoscion parvipinnis*	Shortfin corvina	San Felipe
"	38	*Cynoscion xanthulus*	Orangemouth corvina	San Felipe
"	4	*Menticirrhus undulatus*	California corbina	San Felipe
10 Mar 1955	3000	*Cantengraulis mysticetus*	Anchoveta	Gulf of California
10–11 May 1955	114	*Cynoscion parvipinnis*	Shortfin corvina	San Felipe
"	4	*Cynoscion xanthulus*	Orangemouth corvina	San Felipe
Apr–May 1956	8	*Cynoscion macdonaldi*	Totuava	San Felipe
"	1	*Cynoscion othonopterus*	Scalyfin corvina	San Felipe
"	1545	*Cynoscion parvipinnis*	Shortfin corvina	San Felipe
"	59	*Cynoscion xanthulus*	Orangemouth corvina	San Felipe

cure marine game and forage fishes for experimental plants in the Salton Sea. Approximately 10,000 such fish, of many kinds, have now been planted in this body of water."[174] Another article (prepared by Douglas) also discussed the establishment of a sport fishery in the Sea (California 1954). Few details of the plants themselves were given in either article; pertinent ones appear below. Most of the 1953 article was devoted to an account of the recoveries that were made in 1952: bairdiella and orangemouth corvina.

In 1956, the sargo (*Anisotremus davidsoni*) was taken from the Salton Sea, and the shortfin corvina (*Cynoscion parvipinnis*) established a breeding population there for a time. These species will not be discussed here, because, although they were introduced into the Salton Sea from San Felipe, Mexico, they were already resident in California coastal waters.[175] Williams and Jennings (1991) made the same mistake of other authors in listing the sargo as an "exotic."

Details concerning the fishes from Mexico not native to California waters introduced into the Salton Sea follow.

Mexican fishes which were successful

Bairdiella, *Bairdiella icistia* (Jordan & Gilbert)

The bairdiella, a member of the drum family (Sciaenidae) native to the Gulf of California, Mexico, was formerly known as the Gulf croaker.

Fifty-seven bairdiella from San Felipe, Baja California, Mexico, were planted in the Salton Sea by the Department of Fish and Game on 12 May 1950. This plant was followed by another on 31 March 1951 by the Department of 10 fish from the same place (Walker et al. 1961, p. 78). OC (1958c) stated that the bairdiella were first planted in the Salton Sea on 5 October 1950, and Shapovalov et al. (1981)—apparently following this lead—also said that it was first introduced into the Sea in October 1950. These statements are discounted in view of statements by Douglas (1953) and Walker et al. (1961).

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[174] *The authors' own calculation, based on Table 2, is that 27,797 fish were planted during the 1929–52 period, but Douglas (1953) was probably alluding only to the marine fish stocked between 1948 and 1953. Table 2 indicates that 7042 fish were stocked in the Sea during this period. OC (1957c) said that since 1948 the Department of Fish and Game had introduced more than 35,000 saltwater fish of 35 species into the Sea. OC (1958c) said that by the end of 1951, the Department of Fish and Game had transported a total of some 34,000 saltwater fish from the Gulf of California into the Sea. Calhoun (1968) said that some 7000 fish were planted during 1950 and 1951. As has been emphasized before, the number of fish introduced varies with the author, and—in itself—is of not much importance. The best figures we have are those in Table 2.*

[175] *Although the introduction of San Felipe stock into the Salton Sea was a logical move, we cannot resist pointing out that the successful introduction of sargo was not based on "logic" or "science" but on good luck or "gut feeling." See Young (1977).*

Douglas (1953) reported the first bairdiella found in the Salton Sea, a 1.75-inch specimen found on 11 July 1952, which he believed to be the spawn of individuals from either the May 1950 or March 1951 planting. Other specimens of bairdiella up to 6.5 inches were found later that year, indicating that a reproducing population had been established.

The population of bairdiella became very large in the Salton Sea where its main role was to provide forage primarily for the orangemouth corvina. Since bairdiella can achieve a length of 15 inches, however, many were caught by anglers.

Orangemouth corvina, *Cynoscion xanthulus*, Jordan & Gilbert

The orangemouth corvina normally ranges within the Gulf of California, Mexico, where it is a well-known game fish.

It was first stocked in the Salton Sea on 12 May 1950 when 27 specimens from San Felipe, Mexico, were stocked by the Department of Fish and Game (Douglas 1953; Walker et al. 1961). The initial plant was followed by others, up to and including May 1956. The exact number of fish stocked is unknown, but apparently the total number did not exceed 272 (see Table 2). OC (1978) said that 250 were planted; this is probably close enough.

Douglas (1953) reported the first orangemouth corvina caught in the Salton Sea, when a 22-inch fish was caught in a gill net by a mullet fisherman on 17 January 1952, saying that it represented one of the original introductions made either in May 1950 or March 1951. Whitney (1961) said that the orangemouth corvina apparently spawned in the Sea for the first time in 1952, and it has continued to do so.

The orangemouth corvina became the chief game fish in the Sea and revolutionized its fishing. At first, it was difficult to catch on hook and line, but following its capture in this way in 1956, an evolution in angling methods began (OC 1956a, 1957c, 1958c). Although it is predominantly a fish of saline waters, it has also penetrated the fresh or near fresh waters of the Whitewater River which enters the Sea from the northwest (Swift et al. 1993). Prentice (1985) has shown that the orangemouth corvina will survive conversion to completely fresh water.

Circa 1974, it was considered for transplant from the Salton Sea to California coastal waters by an advisory committee to the Department of Fish and Game composed of marine scientists (from California universities, the National Marine Fisheries Service, and the California Academy of Sciences), but the idea was dropped because it was considered that the Salton Sea fishery was having troubles, and that it was injudicious to draw fish from such a troubled source (Young 1974).

Mexican fishes which were unsuccessful

Although none of the fishes listed below is known to have survived in the Salton Sea, and although they were introduced using the "shotgun" method (i.e. a nonselective approach), a few notes are appended on the unlikely chance that any of them should ever be taken here. Unless otherwise indicated, all of the data concerning stocking is derived from Table 2.

"Anchovy," *Anchoa mundeoloides*

Forty-three anchovy from Guaymas, Mexico, were stocked in the Salton Sea on 2 October 1948, and six more from San Felipe were planted on 31 March 1951. The primary uses for such fish were as bait or food.

"Mojarra," *Eucinostomus gracilis*

A total of 12 *Eucinostomus gracilis* and *E. argenteus* (which is also from California) from San Felipe were planted in the Sea on 14 December 1950. It is used both for bait and food.

White mullet, *Mugil carema*

White mullet from San Felipe, Mexico, were stocked in the Sea as follows: 25 on 14 December 1950, 60 on 15 December 1950, and 5 on 31 March 1951.

On the other hand, Hendricks (1957) said that 105 "mullet" from the Gulf of California were transplanted to the Salton Sea in 1950. He included 15 *Mugil cephalus*, which is resident in California and was already in the Sea. Aside from the fact that these were "shotgun" introductions, there seems to have been little point in introducing another mullet into an area where *M. cephalus* was already present.

"Silverside," *Colpichthys regis*

All of the silversides (family Atherinidae) planted in the Salton Sea were from San Felipe, Mexico: 40 on 12 May 1950, 600 on 14 December 1950, 70 on 15 December 1950, three on 31 March 1951, and 72 on 14 December 1951. It is assumed that they were introduced as forage fish.

"Flounder," *Etropus crossotus*

A total of 140 diamond turbot, *Hypsopsetta guttulata*, (which is native to California) and "flounder," *Etropus crossotus*, from San Felipe, Mexico, was planted in the Salton Sea on 31 March 1951.

"Halibut," *Paralichthys aestuarias*

One "halibut" from San Felipe was stocked in the Salton Sea on 12 May 1950 by fishery workers who were obviously unacquainted with sex. Four more from

the same place were stocked in the Sea on 31 March 1951 either by a different group or after attending a lecture on the birds and the bees.

"Halibut," *Paralichthys woolmani*

One "halibut" from San Felipe, Mexico, was stocked in the Sea on 14 December 1950.

"Grunion," *Leuresthes sardina*

On 28 March 1951, 300 grunion from San Felipe, Mexico, were stocked in the Salton Sea.

"Opaleye," *Girella simplicidens*

Seven opaleye from San Felipe were stocked in the Salton Sea on 31 March 1951.

Totuava, *Totoaba macdonaldi*

Then known as *Cynoscion macdonaldi*, one totuava from San Felipe, Mexico, was planted in the Salton Sea on 12 May 1950. On 31 March 1951, an unknown quantity of this species was planted here, and during the April–May period of 1956, eight more from San Felipe were added. The only member of its genus, the totuava is both a good food and sport fish, and its air-bladder is used as a condiment by Asians.

Scalyfin corvina, *Cynoscion othonopterus*

An unknown number (less than 200) of scalyfin corvina from San Felipe, Mexico, was planted in the Salton Sea on 31 March 1951, and one more from San Felipe was planted here during the April–May period of 1956.

"Corvina," *Menticirrhus nasus*

One corvina from San Felipe, Mexico, was planted in the Salton Sea on 12 May 1950, and two more, also from San Felipe, were planted on 31 March 1951 to keep him or her company.

"Mudsucker," *Gillichthys seta*

The Salton Sea already had a supply of mudsuckers, probably from San Diego Bay, planted there on 13 November 1930 by the California Division of Fish and Game. The resident species, the longjaw mudsucker (*Gillichthys mirabilis*) is a major bait fish, a relatively unimportant predator, and at certain seasons is important in the diet of the orangemouth corvina in the Salton Sea. Sixty-three *G. seta* from San Felipe, Mexico, were introduced into the Sea on 31 March 1951.

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In summary, of the entire group of fishes deliberately introduced into the Salton Sea and known to have survived until today (three species), two species were alien to California.

DISCUSSION

"Almost all human activities, from farming, lumbering and mining to creating and releasing pollutants [and nonresident fishes] make life difficult for the other organisms with which we share the planet."

—A.H. Ehrlich and P.R. Ehrlich 1987

"We choose exotics on the basis of what they can do for us and not primarily on what they can do for the non-human system."

—H.A. Regier 1968

"We of the minority see a law of diminishing returns in progress; our opponents do not."

—A. Leopold 1949

Charles Elton of Oxford may have set the modern scene for viewing introductions in 1958 in his classic "The Ecology of Invasions by Animals and Plants." (His title might have included the words "Human-assisted.") Aside from his "worst case scenarios," he painted a very gloomy picture of the future: "If we look far enough ahead, the eventual state of the biological world will become not more complex but simpler—and poorer. Instead of six continental realms of life with all their minor components of mountain tops, islands and fresh waters, separated by barriers to dispersal, there will only be one world, with the remaining wild species dispersed up to the limits set by their genetic characteristics, not to the narrower limits set by mechanical barriers as well." Since that time, the scientific community has accepted many of his remarks or opposed them with vigor.

Elton's remarks can be supplemented by those of Ross (1994): "... often free of the natural predators they found at home, these [introduced] species sometimes run amok, disrupting food chains and displacing native species." In other words, the "success" of many introduced forms seems to lie largely in the absence of natural checks to their expansion. Similarly, native species are not accustomed to the introduced ones and are sometimes displaced by them. Conversely, if the introduced species is suited to its new home, it usually experiences a rapid population increase, but once local resources are depleted its numbers fall. Eventually, it comes into balance with an altered ecosystem (Flannery 1995).

Many papers have been written concerning fish introductions, and there have been many meetings on the subject. Fish introductions have been discussed on a local and on a worldwide basis. Organizations have been formed to discuss, foster, or to combat introductions. The American Fisheries Society has a special committee and an Introduced Fish Section (both authors have been members).