

JOB COMPLETION REPORT

As required by

FEDERAL AID IN FISHERIES RESTORATION ACT

TEXAS

Federal Aid Project No. F-5-R-11

FISHERIES INVESTIGATIONS AND SURVEYS OF THE WATERS OF REGION I-B

Job No. F-1 Experimental Introduction of Marine Fish into
Saline Waters of Western Texas

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ABSTRACT

At the end of the sixth year 1,920 marine fish of five species had been introduced into saline waters of the Pecos River watershed. Survival of two species was confirmed by recaptures during 1963. During the past year 171 red drum, 28 flounder, and 4 black drum were transported from the coast and released in Red Bluff Reservoir. Extensive reconnaissance netting recaptured 10 red drum from previous releases. These fish varied in size from 1 pound 7 ounces to 25 pounds 6 ounces. An analysis of data indicates: (1) most red drum have survived initial transplantation; (2) red drum and flounder experience a high degree of survival for at least 4 years and exhibit growth equal or greater than for the same species along the Texas coast; (3) degree of survival and rate of growth of red drum and flounder exceeds that for species of warm water fish that have been released from State fish hatcheries; (4) positive evidence of reproduction has not been obtained. Some data may be interpreted as being possible indices of attempted reproduction.

Recommendations include:

(1) Additional fish be stocked in sites where survival is proven; (2) if possible, releases should be made in new sites where conditions indicate their logical choice; (3) greater quantities of fish should be released to permit expansion of the study to include food habits and sexual development; (4) future work should have the benefit of more frequent council of a marine biologist with research experience; (5) consideration should be given to developing a more extensive program whose coordination and supervision would be the primary duty of a qualified individual.

JOB COMPLETION REPORT

State of Texas

Project No. F-5-R-11 Name: Fisheries Investigations and Surveys of the Waters of Region I-B

Job No. F-1 Title: Experimental Introduction of Marine Fish into Saline Waters of Western Texas

Period Covered March 1, 1963 - February 28, 1964

Objectives:

To determine adaptability of marine species in inland waters.

Techniques used:

1. To obtain fish, close contact was maintained with the coastal division of the Texas Parks and Wildlife Department. When suitable fish were captured and retained at the marine laboratory, project personnel left for the coast. April 8 and 9, 1963 were spent obtaining additional fish.

2. Captured fish were released in Red Bluff Reservoir on the morning of April 10, 1963. Released were 171 red drum, (Sciaenops ocellata), 28 flounders, (Paralichthys lethostigma), and 4 black drum, (Pogonias cromis).

3. Six field trips were made to Red Bluff and Imperial Reservoirs. In addition to recapturing marine fish, sampling of fish populations was designed to provide data contributive to objectives for Jobs B-28 and B-32. Gill netting included 139 standard or specific sets 26,200 feet long. Thirty-five seining collections were taken to determine reproductive activity or progeny survival.

Background Information:

This work is an attempt to provide a substantial sport fishery in western waters where saline properties limit game fish production in variety and quantity. Potentially, these waters are of tremendous recreational importance because of their nearness to heavily populated urban areas, located in semi-desert country that is cleaved by two primary tourist routes. Success in this effort should have wide application. To date 1,920 marine fish have been released. Except for a few year-old fish that were introduced into the Pecos River, fingerling size fish were used. All smaller fish were released in Red Bluff and Imperial Reservoirs. Atlantic croaker, (Micropogon undulatus), spot, (Leiostomus xanthurus), and seatrout, (Cynoscion nebulosus) have survived initial transplantation. Plans to release striped bass, (Roccus saxatalis), have not materialized. Details of previous findings are in completion reports for Job F-1, Project F-5-R-7, 8, 9 and 10.

Distribution of Species Introduced into Red Bluff Reservoir,
Imperial Reservoir and the Pecos River

Red Bluff Reservoir

Date	Species	Number	Average Size Inches	Condition on Arrival at Release Site
4-10-63	Red drum	171	2.7	Fair
	Flounder	28	3.3	Good
	Black drum	4	5.5	Good
4-10-61	Red drum	50	2.7	Poor
	Seatrout	30	3.8	Poor
	Flounder	25	3.3	Poor
4-12-61	Red drum	183	3.0	Good
	Seatrout	24	4.9	Fair
	Flounder	14	3.3	Good
	Croakers	470	3.5	Good
Totals	Red drum	404		
	Croakers	470		
	Seatrout	54		
	Flounder	67		
	Black drum	<u>4</u>		
		999		

Imperial Reservoir

Date	Species	Number	Average Size Inches	Condition on Arrival at Release Site
4-15-60	Red drum	246	3.0	Good
	Seatrout	50	4.9	Poor
	Flounder	75	3.8	Good
	Croakers	500	3.8	Fair
	Total	871		

Pecos River

Date	Species	Number	Average Size Inches	Condition on Arrival at Release Site
9-18-59	Red drum	50	12.00	Fair

Results:

Within the year water levels in the concerned reservoirs were drastically reduced. Salinities were higher than in many previous years and crowding of fish into lesser areas increased competition for the means of subsistence. Reported catches of marine fish were less frequent. Recaptures in nets dropped significantly.

In interpreting data that follows several assumptions are made. (1) Size averages of fish released are assumed sufficient for present needs. The rapid mortality of juvenile fish while awaiting transport, the impracticality of individual identification, the difficulty of obtaining fish, and the limited facilities available resulted in a decision to sacrifice positive measure to promote survival. A few flounders were 5 inches. A few red drum were 4 inches. Approximately 90 per cent of individuals were near the mean sizes indicated. Nearly all fish released were significantly smaller than averages indicated for similar age groups in previously completed marine life history studies. (2) It is assumed that all fish released were spawned between September and November. The "estimated age" of individuals is the number of days occurring between October 1 of the fall prior to release and the date of recapture. (i.e. Spawned Oct. 1, 1960 - recaptured Oct. 1, 1961 - estimated age 365 days). "Tenure" is the number of days between the individuals release and its recapture (i.e. released April 15, 1960 - recaptured April 15, 1961 - tenure 365 days). (3) Probably, spawning of any of the species is spread over a two to 4 week period, and the annual spawning period may deviate by two or three weeks. Assuming this to be true, individuals from several spawns (some occurring earlier than others) were probably included in transplants. This could partially account for the variation in subsequent growth. The actual age of individuals probably varied from the estimated age by as much as 30 days, but should not greatly exceed that quantity.

Recaptures of Marine Fish Introduced
Recaptures from Imperial Reservoir

Species	Date Released	Date Recaptured	Tenure (Days)	Est. Age (Days)	Length		Weight			
					MM	Inches	Grams	Lbs.	Oz.	K
Red drum	4-15-60	9-8-60	146	301	260	10.24	445	1	0	Dead
	4-15-60	9-8-60	146	301	279	11.00	445	1	0	
	4-15-60	6-15-61	427	582	440	17.32	1588	3	8	1.85
	4-15-60	6-15-61	427	582	430	16.92	1389	3	1	1.75
	4-15-60	6-15-61	427	582	425	16.73	1361	3	0	1.80
	4-15-60	6-15-61	427	582	445	17.52	1474	3	4	1.67
	4-15-60	10-19-61	552	707	583	22.95	3515	7	12	1.78
	4-15-60	10-19-61	552	707	539	21.22	2778	6	2	1.77
	4-15-60	10-19-61	552	707	543	21.38	2750	6	1	1.73
	4-15-60	10-19-61	552	707	562	22.12	2892	6	6	1.64
	4-15-60	10-19-61	552	707	556	21.89	2920	6	7	1.70
	4-15-60	10-19-61	552	707	578	22.76	3289	7	4	1.70
	4-15-60	10-19-61	552	707	570	22.44	3345	7	6	1.83
	4-15-60	10-19-61	552	707	540	21.26	2722	6	0	1.74
	4-15-60	10-19-61	552	707	582	22.91	3345	7	6	1.70
	4-15-60	10-19-61	552	707	572	22.52	3232	7	2	1.75
	4-15-60	10-19-61	552	707	556	21.89	2863	6	5	1.72

Imperial Reservoir Continued

Species	Date	Date	Tenure	Est. Age	Length		Weight			
	Released	Recaptured	(Days)	(Days)	MM	Inches	Grams	Lbs.	Oz.	K
Red drum	4-15-60	10-19-61	552	707	559	22.00	2977	6	9	1.75
	4-15-60	10-19-61	552	707	548	21.57	2778	6	2	1.69
	4-15-60	10-19-61	552	707	520	20.47	2438	5	6	1.74
	4-15-60	10-19-61	552	707	512	20.16	2381	5	4	1.77
	4-15-60	10-19-61	552	707	538	21.18	2835	6	4	1.83
	4-15-60	10-19-61	552	707	549	21.62	2892	6	6	1.75
	4-15-60	10-19-61	552	707	544	21.42	2835	6	4	1.76
	4-15-60	10-19-61	552	707	509	20.04	2466	5	7	1.88
	4-15-60	4-18-62	733	888	540	21.26	2722	6	0	1.74
	4-15-60	11-9-62	968	1123	695	27.36	5670	12	4	1.65
	4-15-60	11-8-63	1332	1487	709	27.91	11368	25	1	3.19
	Golden Croaker	4-15-60	10-19-61	552	707	235	9.25	307		10.5
Spot Croaker	4-15-60	10-19-61	552	707	192	7.56	180		6.35	2.54
Flounder	4-15-60	10-19-61	552	707	430	16.93	1899	4	3	2.38
Flounder	4-15-60	11-9-62	968	1123	505	19.88	3374	7	7	2.61
Flounder	4-15-60	2-27-63	1048	1203	504	19.84	2948	6	8	2.30

Recaptures from Red Bluff Reservoir

Species	Date	Date	Tenure	Est. Age	Length		Weight			
	Released	Recaptured	(Days)	(Days)	MM	Inches	Grams	Lbs.	Oz.	K
Red drum	4-12-61	11-7-61	209	372	308	12.13	1049	2	5	3.59
	4-12-61	11-7-61	209	372	305	12.00	879	1	15	3.09
	4-12-61	11-7-61	209	372	372	11.92	794	1	12	2.85
	4-12-61	5-9-62	392	555	432	17.00	1588	3	8	1.96
	4-12-61	12-5-62	602	765	574	22.60	3317	7	5	1.75
	4-10-63	11-5-63	209	370	391	15.39	1219	2	11	2.10
	4-10-63	11-5-63	209	370	349	13.74	737	1	10	1.70
	4-10-63	11-5-63	209	370	335	13.19	652	1	7	1.73
	4-10-63	11-5-63	209	370	349	13.74	879	1	15	2.07
	4-10-63	11-5-63	209	370	330	12.99	765	1	11	2.13
	4-10-63	11-5-63	209	370	364	14.29	964	2	2	2.00
	4-10-63	11-5-63	209	370	375	14.76	936	2	1	1.77
	4-10-63	11-5-63	209	370	324	12.76	709	1	9	2.08
	4-10-63	11-5-63	209	370	330	12.99	794	1	12	2.21

Rate of Growth of Marine Introductions

Data for red drum is regarded as sufficient to provide a reasonably accurate estimate of growth for two age groups. Other data are insufficient.

Red Drum at 370 Days (Age Group II)

Estimated Age (1 year 5 days)	Length		Weight			K
	MM	Inches	Grams	Lbs.	Oz.	
Days						
370	308	12.13	1049	2	5	3.59
370	303	11.92	794	1	12	2.85
370	305	12.00	879	1	15	3.09
370	391	15.39	1219	2	11	2.10
370	349	13.74	737	1	10	1.70
370	335	13.19	652	1	7	1.73
370	349	13.74	879	1	15	2.05
370	330	12.99	765	1	11	2.13
370	364	14.29	964	2	2	2.00
370	375	14.76	936	2	1	1.77
370	324	12.76	709	1	9	2.08
370	330	12.99	794	1	12	2.21
Mean	338.5	13.32	864.75	1	14.5	2.28

In the above data extreme deviation in length from the median is 44 mm. (1.73 inches). Sixty-six per cent of lengths deviated from the median by 25 mm. (1 inch) or less and 50 per cent deviated by less than 10 mm. (.39 inches). Extremes and deviations from weight and K factor means or medians was greater than for lengths, however this may be attributable to the ratio of males to females. This group of fish is slightly longer and exhibit significantly greater weight and condition than is indicated in life history studies from fish of the same age group occurring in coastal waters.

Red Drum at 550 to 582 Days (Age Group III)

Estimated Age (18-19 months)	Length		Weight			K
	MM	Inches	Grams	Lbs.	Oz.	
Days						
555	432	17.00	1588	3	8	1.96
582	440	17.32	1588	3	8	1.85
582	430	16.92	1389	3	1	1.75
582	425	16.73	1361	3	0	1.80
582	445	17.52	1474	3	4	1.67
Mean	434	17.10	1480	3	4.2	1.81

Although the above sample is too small to be statistically reliable; the mean length is the identical figure found in life history studies by the coastal division. The maximum length deviates from the median by only 10 mm (.39 inches) and weights and K factors are more uniform than for other age groups.

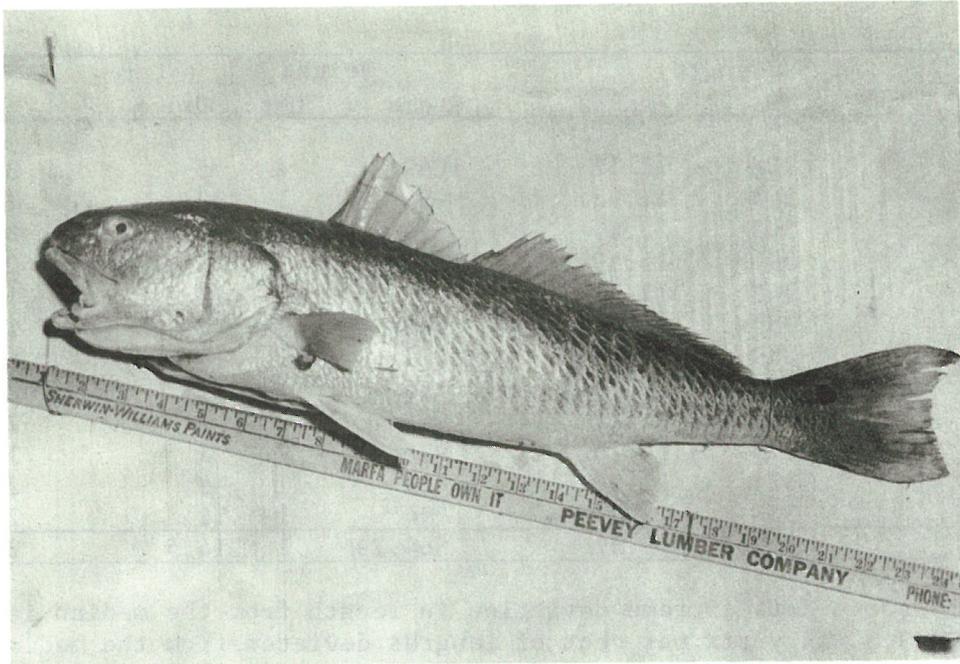


Figure 1. One of 50 red drum released in the Pecos River near Imperial in 1959. Fish had traveled approximately 200 miles prior to his recapture by sportsman Stanley Adams of Marfa. Fish weighed about 5 pounds and was 24 inches long. Stanley reported seeing other red drum in the area at that time, but none since.

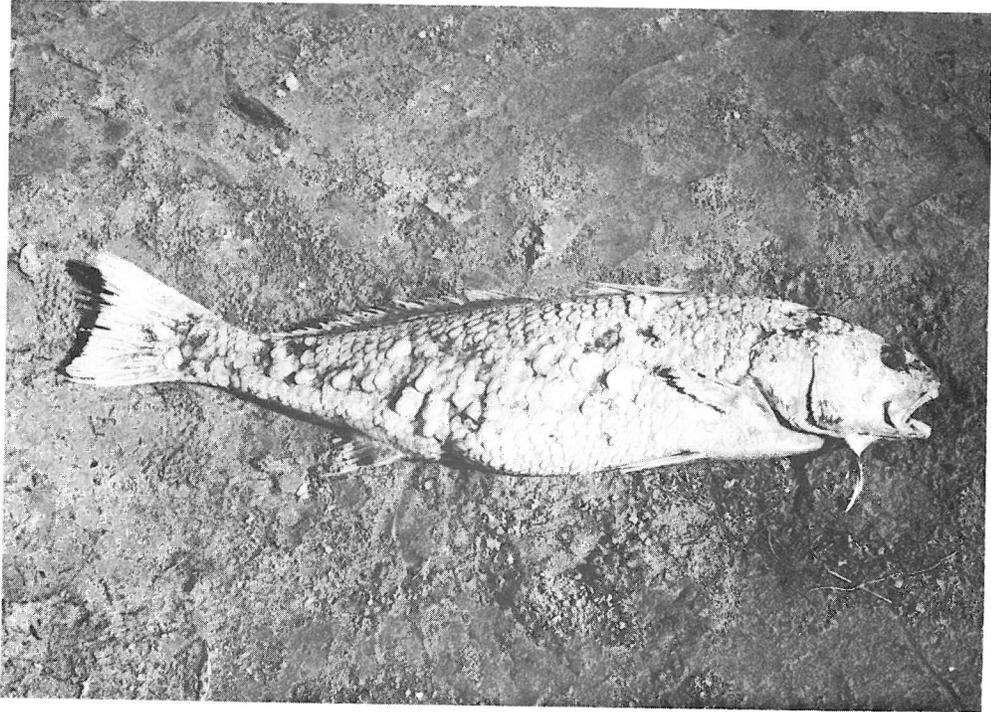


Figure 2 Three year old Red Drum found dead on beach of Imperial Reservoir. Fish was 25 inches long and would weigh between 17 and 20 pounds living.

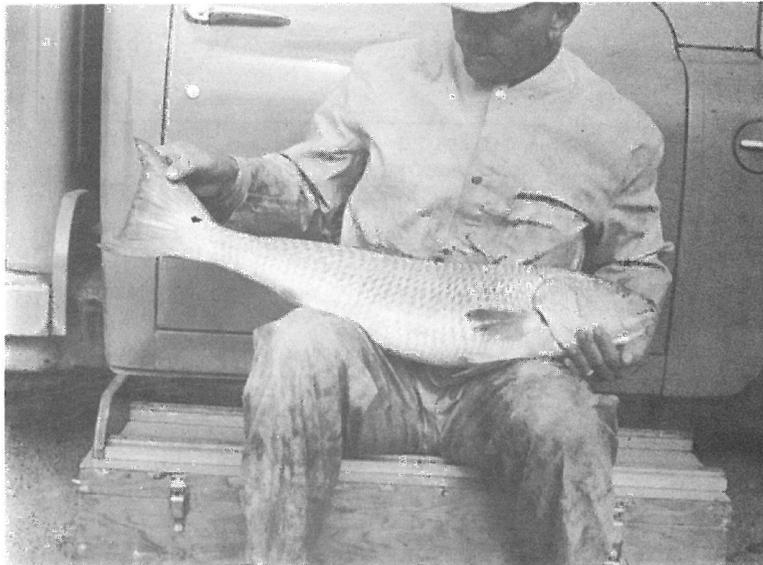


Figure 3 Four year old Red Drum recaptured from Imperial Reservoir. Fish weighed over 25 pounds, and had survived the hottest summer recorded for the area.

Red Drum at 707 Days (Age Group IV)

Estimated Age (1 year, 11 mos., 7 days)	Length		Weight			K
	MM	Inches	Grams	Lbs.	Oz.	
Days						
707	583	22.95	3515	7	12	1.78
707	539	21.22	2778	6	2	1.77
707	543	21.38	2750	6	1	1.73
707	562	22.13	2892	6	6	1.64
707	556	21.89	2920	6	7	1.70
707	578	22.76	3289	7	4	1.70
707	570	22.44	3345	7	6	1.83
707	540	21.26	2722	6	0	1.74
707	582	22.91	3345	7	6	1.70
707	572	22.52	3232	7	2	1.75
707	556	21.89	2863	6	5	1.72
707	559	22.00	2977	6	9	1.75
707	548	21.57	2778	6	2	1.69
707	520	20.47	2438	5	6	1.74
707	512	20.16	2381	5	4	1.77
707	538	21.18	2835	6	4	1.83
707	549	21.62	2892	6	6	1.75
707	544	21.42	2835	6	4	1.76
707	509	20.04	2466	5	7	1.88
Mean	550.52	21.67	2908	6	6.57	1.75

In this sample length extremes deviate from the median by 37 mm (1.45 inches), and 78 per cent of the individuals lengths deviate by less than 25 mm (1 inch). Fifty-three per cent deviate by less than 13 mm (1/2 inch). The mean length for this group (21.67 inches) is 1.17 inches greater than life history studies indicated for fish occurring in coastal waters.

Red Drum 765 to 888 Days (Age Group V)

Estimated Age (26 months)	Length		Weight			K
	MM	Inches	Grams	Lbs.	Oz.	
765	574	22.60	3317	7	5	1.75
888	540	21.26	2722	6	0	1.74

Red Drum 1123 to 1203 Days (Age Group VI)

Estimated Age (3 years 6 months)	Length		Weight			K
	MM	Inches	Grams	Lbs.	Oz.	
1123	695	27.36	5670	12	8	1.65
1203 (Dead on Beach)	709	25.00	Est. 17-20 lbs.			

Red Drum at 1487 Days (Age Group VII)

Estimated Age (4 years 27 days)	Length		Weight			
	MM	Inches	Grams	Lbs	Oz.	K
1487	709	27.91	11368	25	1	3.19

With the exception of age groups II and IV, data are insufficient for reliable statistical analysis. However, growth indicated for other ages is substantially in agreement with that for fish of the same age as determined through studies of marine biologists. Assuming data to be reasonably close to true growth rate, the following hypothetical history of growth of red drum in inland waters is plausible.

Young, spawned the fall preceding their release, probably grew from about 10 mm in October to 50 or 60 mm the following April. The fish reached an average size of about 13 inches in October at the end of their first year and weighed about 864 grams. This would be a growth of slightly over one inch per month and an increase in weight of 862 grams. However, the rate of growth from June to October was about 2 inches per month and weight was increased proportionally. During the second year rapid growth continued, but linear growth was reduced to less than one inch per month. The weight of the fish was tripled. Again the most rapid growth was experienced between June and October. During the third year linear growth was drastically reduced; however, the fish doubled in weight. The rate of linear growth was further reduced during the fourth year; however, the weight was again doubled. In all instances it appeared growth was markedly decreased during the winter.

Growth of Other Marine Species

The numbers of fish recaptured do not permit meaningful statistical analysis. Data infer that flounders grow as rapidly as on the coast, and croakers grow at about the same rate as in their marine habitat.

Reproduction of Marine Species

Evidence of reproduction is lacking. When the amount of sampling with seines and gill nets is considered reproduction is deemed unlikely. Lack of reproduction may be attributable to: (1) reduction of populations beyond adequate breeding potential; (2) lack of stability of breeding requirements and (3) lack of breeding requirements. Some observations and occurrences may be interpreted as indicating reproduction is possible. Bait seekers seining for minnows in the reservoir in the late spring of 1963 reported capturing small fish that they had not previously encountered, and could not identify. The description of these fish suggests that they might have been juvenile red drum. It is known that a great many of the fish have been recaptured by sportsmen. Several individuals who captured and retained the fish stated that ovaries of females were developed to a point where individual eggs were identifiable. Usually, sampling efforts conducted between April and September were ineffectual. Of 51 fish recaptured 47 (92.15 per cent) were recaptured in the fall and winter. (October to March). Forty-five recaptures (88.23 per cent) were made between October and December. Most recaptures were from relatively shallow marginal waters. The location and time of these catches suggests (a) the fish may have been congregating as a result of spawning stimuli and (b) they may have migrated to areas similar to coastal beaches as a result of spawning impulse. Post-mortem examination of three red drum has indicated gonadal development is apparently normal.



Figure 4 Flounder that grew from about 35 grams (1.2 ounces) when he was released to 7 pounds 7 ounces less than three years later when he was recaptured.

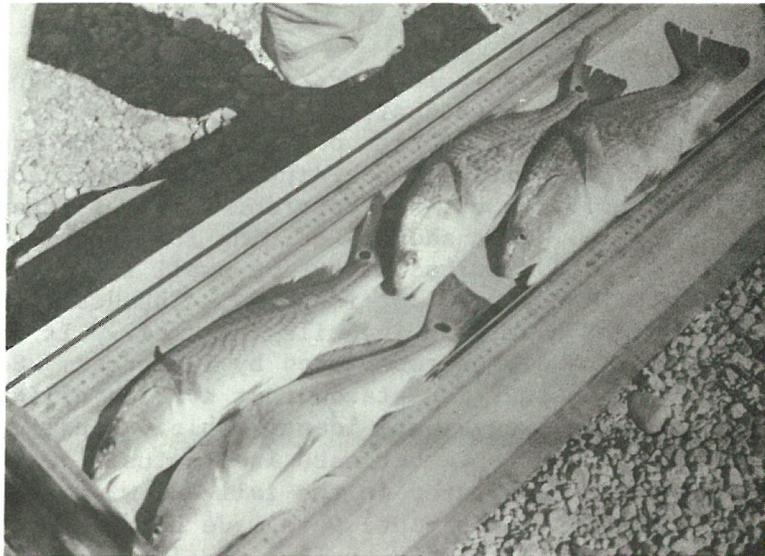


Figure 5 Year old red drum recaptured during the past year from Red Bluff Reservoir. Average weight was 1 pound 7 ounces.

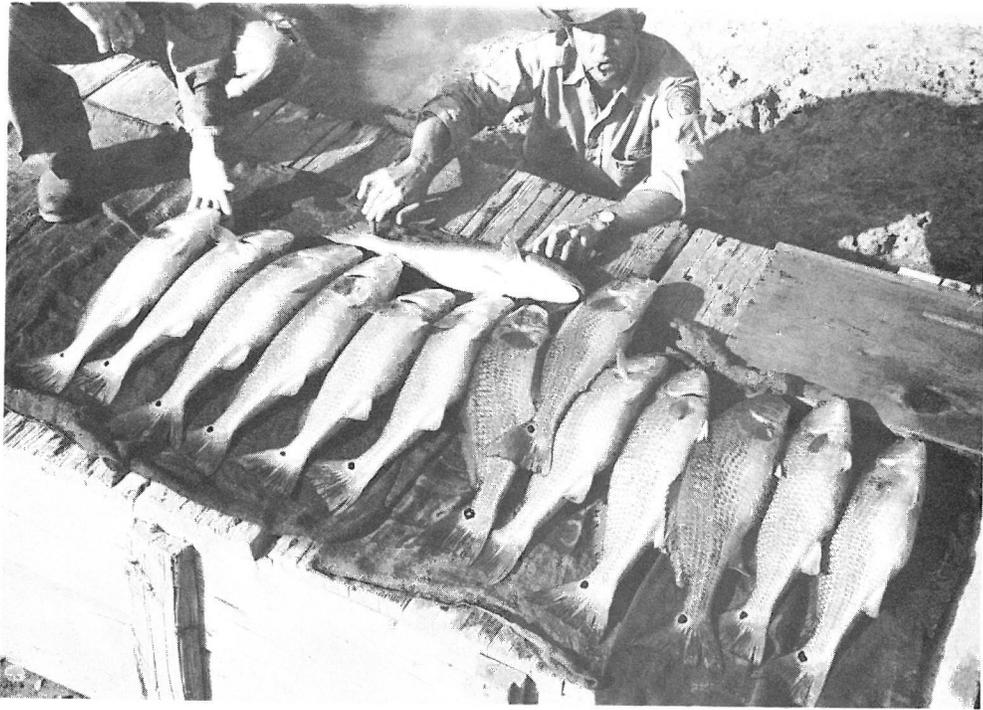


Figure 6 Two year old Red Drum recaptured from Imperial Reservoir that averaged about 6 and one half pounds.

Substantiality of Stocking Marine Species

The importance of developing an inland marine fishery is one that excites the imagination. However, the obvious, immediate and dire necessity of acquiring some means of increasing game fish production in saline western waters is a poignant reality. This fact is partially illustrated by data that follows.

Warm Water Game Fish Stocked and Recaptured From
Red Bluff Reservoir as Determined by Reconnaissance
Netting Between 1961 and 1963

Warm Water Game Fish Stocked	Number Released (1961 - 1963)	Number Recaptured (15,800 feet gill nets)	Per Cent Recaptured
Largemouth bass (fry and fingerling)	358,500	4	.001
Channel catfish (fingerling)	22,750	15	.066
White crappie (fingerling)	12,000	1	.008
Sunfish (fingerling)	9,000	12	.133
Totals	402,250	32	.079

Marine Fish Stocked and Recaptured from Red Bluff
Reservoir as Determined by Gill Netting Between 1961 and 1963

Marine Fish Stocked	Number Released (1961 - 1963)	Number Recaptured (15,800 feet gill nets)	Per Cent Recaptured
Red drum (fingerling)	404	14	3.47
Flounder (fingerling)	67	0	0
Seatrout (fingerling)	54	0	0
Croakers (fingerling)	470	0	0
Black drum (juveniles)	4	0	0
Totals	999	14	1.40

Warm Water Game Fish Stocked and Recaptured From Imperial Reservoir
as Determined by Reconnaissance Netting Between 1961 and 1963

Warm Water Game Fish Stocked	Number Released (1961 - 1963)	Number Recaptured (15,500 feet gill nets)	Per Cent Recaptured
Largemouth bass (fry and fingerling)	119,400	7	.006
Channel catfish (fingerling)	19,100	2	.011
White crappie (fingerling)	17,200	0	0
Sunfish (fingerling)	2,200	6	.273
Totals	157,900	15	.014

Marine Fish Stocked and Recaptured from Imperial Reservoir
as Determined by Gill Netting Between 1961 and 1963

Marine Fish Stocked	Number Released (1961 - 1963)	Number Recaptured (15,800 feet gill nets)	Per Cent Recaptured
Red drum (fingerling)	246	31	12.60
Seatrout (fingerling)	50	0	0
Flounder (fingerling)	75	3	4.00
Croakers (fingerling)	500	3	.60
Totals	871	37	4.25

This information is presented to illustrate stocking results that are pertinent to this job. The analysis should not be considered as the usual results of stocking in ordinary warm water situations. This datum does not provide a true reflection of game fish production. It does not take into account natural production of white bass, the most important game species in these waters. It indicates: (1) red drum are more adaptable for game fish production than freshwater species normally produced in state fish hatcheries; (2) marine introductions may be the least expensive method of producing sport fishing and (3) there may be less competition between some marine species and white bass than apparently exists between freshwater species.

Discussion and Conclusions:

Throughout the United States productivity of bay and inshore waters is being reduced through changing of natural conditions and a resulting destruction of fishery habitat. Flow from streams into estuaries and lagoons is diminishing as a result of an expansion of impoundments on watersheds. Dredging and pollution spoil fishing areas, and seashore developments may tend to reduce the quantity of fish produced. Inland the exploitation of subsurface waters for irrigation of farm lands reduces flow from springs, and pollution of both surface and subsurface waters from oil field brine, industrial pollution, and natural sources increases salinity in streams and reservoirs. The work in marine introductions is designed to provide game fishing under these changing conditions. Although the effort has not produced techniques that are immediately applicable, the perspective of the future importance of such techniques justifies an expansion of this research.

Conclusions:

- (1) With the possible exception of seatrout marine species have survived transplantation into inland waters.
- (2) Marine fish recaptured have exhibited growth and condition that equals or greatly exceeds that indicated for the same species in coastal waters.
- (3) Of five species introduced red drum and flounder offer the greatest potential in game fish production. These species have survived for several years under adverse conditions, have exhibited excellent growth and advanced sexual development, and are obviously more suitable for game fish production in these waters than species normally produced in state fish hatcheries.
- (4) Small numbers of croakers have survived transplantation, and seatrout may have maintained existence for a limited period. However, there are no indications of a high rate of survival or of a prolonged existence. Data do not provide a substantial basis for concluding that these species are positively unadaptable to inland waters. (a) Individuals for both species were near death at the time of their release and, (b) the few individuals that may have survived would not have been sufficiently numerous to provide adequate breeding potential or to make recaptures statistically probable.
- (5) At present, state law and the means of law enforcement are inadequate to provide sufficient protection to fish released.
- (6) Although past efforts reflect credit on cooperating personnel, the numbers of fish secured for introduction have been insufficient to permit carrying out studies as thoroughly as desired. (a) In order to attempt to assure breeding potential with a very limited number of fish, fish captured were not subjected to examinations that involve opening the body cavity. As a result little has been learned of sexual development and feeding habits. (b) With two possible exceptions, the number of fish recaptured are insufficient to warrant conclusions on rate of growth within known age groups. (c) The reduction of individuals with age progression has probably reduced the number of surviving individuals below the number required to assure breeding potential.

(7) Reproduction, the attempt to reproduce, and spawning success or failure are unknown. However, conditions and circumstances could account for this. (a) Only fish in the four year class would be expected to spawn, and only a few of these fish were in Imperial Reservoir. By the late spring of 1963 the reservoir had been drastically reduced to less than 50 per cent of normal capacity. Approximately 80 per cent of the lake was less than 3 feet deep. The reservoir was maintained at this level during the hottest part of the year. A great many of the 246 fish released in 1960 have been caught and retained by anglers. At least six of the larger red drum (15 to 25 pounders) have been destroyed by being struck by outboard motors or other objects. The larger fish are more difficult to capture. This is not only because of increased speed and mobility but due to their remarkable strength. One red drum was observed to literally tear himself free of a nylon gill net, and other unexplained tears in nets may have resulted in this manner. Although the capture of a 25-pound red drum is proof of survival, it is doubtful if enough fish remained to assure spawning even if spawning was attempted. (b) Natural spawning may not be necessary to success of the program. An adult female is capable of containing 250,000 eggs. Incubation of this number of eggs could meet regional stocking needs.

(8) Findings indicate an inland marine fishery is possible, and justify an expansion of the effort to include: (a) making additional and more specific studies of ecological requirements and life histories of the concerned species and of other species whose inheritant attributes tend to designate them as logical choices for future introductions; (b) studies whose results may furnish practical means of achieving artificial means of propagation of marine species; (c) studies that may evolve a practical method of trapping and moving fish from coastal waters where natural spawning exceeds biological needs, and (d) an expansion of release sites to determine climatic and basic tolerance limits of marine species in inland waters.

Recommendations:

(1) Statewide consideration and attention should be focused on drawing up an overall program for research in exotic introductions. The subdivision of such a study that marine introductions would comprise should, in general, follow the conclusions above. If a statewide program is adopted it should be coordinated by an individual who can devote much of his time to such a program. This coordinator should be authorized to delegate specific tasks according to skills, interest and facilities available to various subordinates.

(2) If the present study is to progress, it is imperative that a greater number of fish be secured for release and subsequent study. (a) Consideration should be given to setting up a system of trapping young red drum as they migrate, in post larval stage, from the gulf into bay areas. (b) When adult drum are observed milling in spawning concentrations, fish should be captured and induced spawning attempted. (c) A system of baiting areas to concentrate young drum might prove effective.

(3) If other species are available, such as seatrout and croakers, an attempt should be made to fly these fish to release sites in order to assure better condition of the fish when released.

(4) Future efforts should include inspection of the work by a marine biologist, or marine fisheries supervisor.

(5) The introduction of gaff-topsail catfish (Bagre marinus) is recommended because channel catfish production for waters of the upper Pecos Watershed has been extremely meager and stocking from hatcheries has been ineffective.

(6) Black Drum (Pogonias cromis) are recommended for release at various sites because of this species high tolerance to salinity and other evidence of adaptability.

(7) If possible, shallow ponds should be secured where introduced species may be more closely studied. (on the coast such pits could be created along the seashore by excavation with a bulldozer)

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