

JOB COMPLETION REPORT

As required by

FEDERAL AID IN FISHERIES RESTORATION ACT

TEXAS

Federal Aid Project No. F-5-R-12

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

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

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July 14, 1965

ABSTRACT

Seining expeditions to the Texas coast in April 1964, and February 1965, resulted in the stocking of 2,300 marine fish fingerling in saline inland waters. Included in this number are 1,178 red drum (Sciaenops ocellata) and 1,082 pinfish (Lagodon rhomboides). Red Bluff Reservoir received the majority of these fish since conditions for survival and propagation seemed more favorable than in the smaller, shallower Imperial Reservoir. Fish were also transplanted in the Pecos River, in small seepage pits adjacent to the Pecos River, and in a small lake near El Paso.

Fish were successfully flown inland in plastic bags containing water and oxygen by both departmental and commercial aircraft. Other fish were transported in hatchery-type tank trucks.

Several large red drum (20-25 pounds) from previous stockings were discovered dead and putrefied on the shores of Imperial Reservoir during March 1964. These brooder-size fish are believed to have been killed by cold weather during the winter, as the lake was extremely shallow during this time (maximum depth - 4½ feet). No other fish from stockings prior to this segment were captured, and there are no indications of reproduction.

Sixty-two red drum were recaptured from Red Bluff Reservoir and 22 were recovered from Imperial Reservoir. These were all fish moved during the year. In 6 months they grew from an average size of 9 grams to 1.79 pounds and 2.06 pounds in Red Bluff and Imperial Reservoirs respectively.

A spotted seatrout (Cynoscion nebulosus) 1 of 6 stocked, was recovered from Red Bluff Reservoir. It had grown from a fingerling to a 15-ounce fish in 6 months. Under similar circumstances, a pinfish grew to slightly more than 8 ounces.

Recommendations include further experiments with the use of plastic bags shipped by air, development of stripping techniques for producing fry, use of seepage pits for rearing fry to stocking size and the addition of gafftopsail catfish (Bagre marinus) and black drum (Pogonias cromis) to the list of introduced species.

JOB COMPLETION REPORT

State of Texas

Project No. F-5-R-12

Name: Fisheries Investigations and Surveys of the Waters of Region I-B

Job No. F-1 (6th year)

Title: Experimental Introduction of Marine Fish in Saline Waters of Western Texas

Period Covered March 1, 1964 - February 28, 1965

Objectives:

To determine the adaptability of certain marine species in inland waters.

Procedures:

1. References on marine species were examined to gather ecological information. Time was limited for library research at the marine laboratory in Rockport because field crews had to be directed in the quest for juvenile marine species.
2. Liaison was maintained with coastal personnel to determine when seining efforts would be most productive. Trips to Rockport were made in April 1964, and February 1965, to obtain marine species. A 100-foot bag seine, 6 feet deep, with $\frac{1}{2}$ -inch mesh was used to seine fingerlings. A 45-foot straight seine with $\frac{1}{8}$ -inch mesh and a $\frac{1}{16}$ -inch mesh push seine were used to obtain marine fry. Fish were transported in regional tank trucks; also, State and commercial airplanes were used to transport fish in plastic bags. These bags contained one-third water, two-thirds oxygen and a small quantity of acriflavine, a germicide.
3. Several small seepage pits, adjacent to the Pecos River near Imperial, Texas, were selected as marine fry rearing ponds because of their proximity to the major lakes to be stocked and because they contained saline water. An area of permanent water near the mouth and a section of deep water near Imperial, Texas, were the waters of the Pecos River selected to be stocked with fingerlings. Lake Imperial, Red Bluff Reservoir and a small lake near El Paso were also chosen as release sites for marine fingerlings.
4. In order to check mortality, growth rates and reproductive success of introduced species, gill nets and seines were used in Lake Imperial, Red Bluff Reservoir and the Pecos River. Nets used were standard 150-foot gill nets containing six, 25-foot sections of 1-inch to $3\frac{1}{2}$ -inch mesh and specific nets with 200 feet of 3-inch mesh. Seines used ranged from 40-foot, $\frac{1}{4}$ -inch mesh to 200-foot, 1-inch mesh.

The following common and/or scientific names are used in this report. These names are specified in "A List of Common and Scientific Names of Fishes from the United States and Canada", Second Edition, American Fisheries Society, Special Publication No. 2, 1960.

| | |
|----------------------|---------------------------------|
| Longnose gar | <u>Lepisosteus osseus</u> |
| Alligator gar | <u>Lepisosteus spatula</u> |
| Gizzard shad | <u>Dorosoma cepedianum</u> |
| Carp | <u>Cyprinus carpio</u> |
| Red shiner | <u>Notropis lutrensis</u> |
| River carpsucker | <u>Carpionodes carpio</u> |
| Blue sucker | <u>Cycleptus elongatus</u> |
| Smallmouth buffalo | <u>Ictiobus bubalus</u> |
| Gray redhorse | <u>Moxostoma congestum</u> |
| Blue catfish | <u>Ictalurus furcatus</u> |
| Channel catfish | <u>Ictalurus punctatus</u> |
| Flathead catfish | <u>Pylodictis olivaris</u> |
| Pupfish | <u>Cyprinodon</u> sp. |
| Rio Grande killifish | <u>Fundulus zebrinus</u> |
| Rainwater killifish | <u>Lucania parva</u> |
| Mosquitofish | <u>Gambusia affinis</u> |
| White bass | <u>Roccus chrysops</u> |
| Green sunfish | <u>Lepomis cyanellus</u> |
| Bluegill | <u>Lepomis macrochirus</u> |
| Largemouth bass | <u>Micropterus salmoides</u> |
| Freshwater drum | <u>Aplodinotus grunniens</u> |
| Spotted seatrout | <u>Cynoscion nebulosus</u> |
| Atlantic croaker | <u>Micropogon undulatus</u> |
| Black drum | <u>Pogonias cromis</u> |
| Red drum | <u>Sciaenops ocellata</u> |
| Pinfish | <u>Lagodon rhomboides</u> |
| Rio Grande perch | <u>Cichlasoma cyanoguttatum</u> |
| Tidewater silverside | <u>Menidia beryllina</u> |
| Southern flounder | <u>Paralichthys lethostigma</u> |

Findings:

Review of Literature

Gafftopsail catfish (Bagre marinus) range as far north as Cope Cod. ^{1/} Therefore, they could probably tolerate the mid-winter temperatures of the Pecos River's upland reservoirs in Texas. No gafftops were seined during the regular procurement trips for other species, and coastal personnel did not locate concentrations worthy of special expeditions to the coast. The fact that these fish inhabit the open waters of the Gulf, rather than the shallower, more easily seined Laguna Madre, makes them more difficult to obtain.

The unusual rearing habits these fish exhibit might be conducive to reproduction and the survival of the young in inland lakes. "The eggs of this species are extremely large, averaging about 22 mm. in diameter. They are carried about in the mouth of the male until hatched as are the young fish until they are about 3 inches and able to shift for themselves. A male of 22 inches may carry as many as 55 eggs in this manner. The yolk sac is absorbed before liberation, which may occupy about 65 days. On the Carolina Coast breeding occurs in June or July." ^{2/}

^{1/} Charles M. Breder, Jr., Field Book of Marine Fishes of the Atlantic Coast From Labrador to Texas. (New York and London: G. P. Putnam's Sons, Revised 1948) p. 45.

^{2/} Ibid

Black drum (Pogonias cromis) is another marine species which may adapt to inland saline waters. They grow to 4 feet in length and weigh up to 146 pounds.^{3/} Only one was seined during the segment. Pearson reports that 2-year and older drum spawn in the Gulf of Mexico near the entrance to bays and lagoons from February to May. The larval forms then drift through the passes and congregate in shallow muddy bodies of water such as Oso and Nueces Bay. Here they remain until reaching a length of 4 inches at which time they move to deeper bays and, to a slight extent, into the Gulf of Mexico.^{4/}

No mention of pinfish (Lagodon rhomboides) was made in the job description for this project. However, during the year Marine Supervisor Ernest G. Simmons advised that this species would be easily obtainable, often reaches a weight of over 1 pound, and might reproduce in saline inland lakes. Reid, using trawls in the vicinity of Cedar Key, Florida, caught 5,132 specimens ranging from 20 to 90 mm. and 56 specimens larger than 100 mm. He found them present in shallow waters throughout the year. Most fish were taken where vegetation was present. He concluded that spawning occurs in the fall, since young fish (10 to 20 mm.) first appeared in late November. Other than plant material, crustaceans (Amphipods, copepods shrimp and crabs) were the most commonly devoured food items.^{5/}

Stocking Marine Species

The Laguna Madre near Rockport and Flour Bluff, Texas, was seined with a 100-foot, ½-inch mesh bag seine from April 6 through April 11, 1964. During this period 1,663 red drum (Sciaenops ocellata), 263 southern flounder (Paralichthys lethostigma), spot (Leiostomus xanthurus), Atlantic croaker (Micropogon undulatus), spotted seatrout (Cynoscion nebulosus) and uncounted numbers of pinfish were seined. The red drum retained for transporting were those averaging 9 grams in weight and 3 inches in length. Other transported species were of a similar size or smaller (Figure 1).

On April 7, 1964, several species of marine fingerlings were placed in 2 plastic bags containing 1 gallon of water, oxygen and 1 teaspoon of acriflavine and shipped by commercial jet airliner to El Paso, Texas, in order to test this method of transportation. Flight time was 4 hours 11 minutes. This was 56 minutes longer than normal. On arrival at El Paso the following observations were made (Table 1).

Table 1. Survival of Marine Species on Arrival at El Paso Airport.

| <u>Species</u> | <u>Number Living</u> | <u>Number Dead</u> |
|-------------------|----------------------|--------------------|
| Spotted seatrout | 0 | 1 |
| Atlantic croaker | 1 | 2 |
| Red drum | 10 | 2 |
| Southern flounder | 5 | 2 |
| Brown shrimp | 6 | 1 |
| Totals | 22 | 8 |

^{3/} Ibid p. 197

^{4/} John C. Pearson, "Natural History and Conservation of Redfish and Other Commercial Sciaenids on the Texas Coast." (unpublished report to Texas Game, Fish and Oyster Commission, 1927:) 17-25.

^{5/} George K. Reid Jr., "An Ecological Study of the Gulf of Mexico Fishes, in the Vicinity of Cedar Key, Florida," "Bulletin of Marine Science of the Gulf and Caribbean, Vol. 4, No. 1, 1954."



Figure 1. Selecting Desirable Marine Fish for Transplantation in Inland Waters.



Figure 2. Pinfish Being Released in Lake Imperial.

These fish were packaged 2 hours prior to departure so that the actual time in plastic bags to this point was approximately 6 hours 11 minutes. The air temperature at El Paso was 45° F. The water temperature when shipped was 63° F.; the water temperature on arrival was estimated to have been over 70° F. (The bags were not opened at this point.) This leads to the conclusion that the fish were inside a heated compartment on the airplane.

The two bags of fish were carried to Hideaway Lake near El Paso in the local game warden's automobile and released about 40 minutes after arrival in El Paso. Total time from packaging to release was approximately 6 hours 51 minutes. At the end of that time the observations recorded in Table 2 were made.

Table 2. Survival of Marine Species at Time of Release in Hideaway Lake Near El Paso.

| Species | Number Living | Number Dead |
|-------------------|---------------|-------------|
| Spotted seatrout | 0 | 1 |
| Atlantic croaker | 0 | 3 |
| Red drum | 8 | 4 |
| Southern flounder | 3 | 4 |
| Brown shrimp | 4 | 3 |
| Totals | 15 | 15 |

From the foregoing experiment it was concluded that transporting marine fingerlings in plastic bags might be very successful under slightly more favorable circumstances. On April 8, 1964, a larger shipment was made to Pecos, Texas, using a Parks and Wildlife Department aircraft. Twenty-five plastic bags, filled with water, oxygen and acriflavine, and containing approximately 20 fish each, were packed in separate cardboard containers. They were then flown, aboard the State's Cessna 185, to Pecos in 3 hours 30 minutes. At Pecos, one-half the fish were released in a hatchery agitator tank and the remainder were left in the plastic bags. The fish in bags arrived at Red Bluff Reservoir in 45 minutes while the fish in the water tank arrived in 1 hour. Since speed was considered a prime factor in safe arrival, separate tabulation on mortality between fish dead in bags and fish dead in the tank was not undertaken. The results of the combined stocking attempt are given in Table 3.

Table 3. Survival of Marine Species Flown from Rockport to Pecos and Transported on to Red Bluff Reservoir by Pickup Truck on April 8, 1964.

| Species | Number Living | Number Dead |
|-------------------|---------------|-------------|
| Spotted seatrout | 6 | 0 |
| Red drum | 378 | 38 |
| Pinfish | 23 | 2 |
| Southern flounder | 15 | 1 |
| Brown shrimp | 48 | 2 |
| Totals | 470 | 43 |

Total time, from packaging to release ranged between 6 and 7 hours. All these fish had been seined in the 2 days preceding shipment and held in live boxes and aquaria. Their physical condition was possibly somewhat impaired.

On April 12, 1964, the additional fish seined were transported to the Pecos River, one of the seepage pits adjacent to the Pecos River near Imperial, Texas, Lake Imperial and Red Bluff Reservoir. The tank trucks in which the seining crews had driven to the coast were used for these deliveries. A tabulation of fish that arrived alive at these various destinations is given in Table 4.

Table 4. Marine Species Successfully Transported to Inland Waters by Tank Trucks on April 12, 1964.

| Species | Lower Pecos River | Upper Pecos River | Pecos River Seepage Pit | Imperial Reservoir | Red Bluff Reservoir |
|-------------------|-------------------|-------------------|-------------------------|--------------------|---------------------|
| Black drum | 0 | 0 | 0 | 0 | 1 |
| Red drum | 50 | 78 | 0 | 100 | 368 |
| Pinfish | 0 | 0 | 15 | 0 | 220 |
| Southern flounder | 0 | 0 | 0 | 1 | 8 |
| Brown shrimp | 0 | 8 | 0 | 3 | 45 |
| Totals | 50 | 86 | 15 | 104 | 642 |

Table 5 is a compilation of all fish stocked by both air shipment and land transport during the April seining expedition. Only those fish which swam away from the release sites in good condition are included.

Table 5. Total Marine Fingerlings Successfully Transported to Inland Waters During April 1964.

| Species | Location | | | | | Totals |
|-------------------|-------------|-------------|---------------|--------------------|---------------------|--------|
| | Pecos River | Seepage Pit | Hideaway Lake | Imperial Reservoir | Red Bluff Reservoir | |
| Spotted seatrout | 0 | 0 | 0 | 0 | 6 | 6 |
| Black drum | 0 | 0 | 0 | 0 | 1 | 1 |
| Red drum | 128 | 0 | 8 | 100 | 746 | 982 |
| Pinfish | 0 | 15 | 0 | 0 | 243 | 258 |
| Southern flounder | 0 | 0 | 3 | 1 | 23 | 27 |
| Brown shrimp | 8 | 0 | 4 | 3 | 93 | 108 |
| Totals | 136 | 15 | 15 | 104 | 1,112 | 1,382 |

The small brown shrimp (*Pinaeus aztecus*) stocked were dipped up incidentally from the holding boxes and aquaria, and were left in the containers merely as a possible source of forage. However, the establishment of this species in the Pecos River Watershed would probably be beneficial both to man and fish.

The last seining expedition to the coast was from February 22 to February 26, 1965. A severe norther impeded efforts for acquiring marine fingerlings by blowing the water off the nursery areas and driving the fish to deeper, warmer waters. Small numbers of red drum, pinfish and flounder were obtained.

The boat basins near the Rockport Marine Laboratory contained large numbers of fry of various species. Probably 90 per cent of these were spot and pinfish. They were easily obtained by using a small-meshed push net and survival was high in the aquaria and holding boxes. However, the continual churning of the agitator paddles against their hail screen enclosures in the fish hauling tanks was apparently too severe for these small fishes. Most of them died in transit.

Some of the larger (1- to 3-inch) pinfish were observed dying when only 50 miles from Rockport. Many scales had been knocked or scraped off these deceased fish. The agitators were turned off and the remainder of the load was safely transported to Imperial Reservoir. Survival without agitation was possible because of the cold water temperature (54° F.) (Table 6) (Figure 2).

Table 6. Marine Fish Fingerlings Successfully Transported to Inland Waters by Tank Trucks on February 25, 26, 1965.

| Species | Location | | | |
|-------------------|-------------------|-------------------|--------------------|---------------------|
| | Small Seepage Pit | Large Seepage Pit | Imperial Reservoir | Red Bluff Reservoir |
| Red drum | 2 | 8 | 0 | 186 |
| Pinfish | 51 | 0 | 408 | 365 |
| Southern flounder | 0 | 0 | 0 | 6 |
| Totals | 53 | 8 | 408 | 557 |

The seepage pits near Imperial, Texas, were selected to receive assorted marine fry, which would have been later seined, sorted and stocked in the larger reservoirs as fingerlings. Since most of the fry died in transit, one small pit (about ¼ acre) was stocked with fingerling pinfish and a larger one (approximately 3 acres) with fingerling red drum in an effort to expedite the acquisition of brood fish for future attempts at artificial propagation. (Table 7) (Figures 3 and 4).

Table 7. A Tabulation of all Marine Fish Successfully Transplanted to the Inland Waters of Fisheries Region I-B from March 1, 1964, to February 28, 1965.

| Species | Location | | | | | Totals |
|-------------------|-------------|--------------|---------------|--------------------|---------------------|--------|
| | Pecos River | Seepage Pits | Hideaway Lake | Imperial Reservoir | Red Bluff Reservoir | |
| Spotted seatrout | 0 | 0 | 0 | 0 | 6 | 6 |
| Black drum | 0 | 0 | 0 | 0 | 1 | 1 |
| Red drum | 128 | 10 | 8 | 100 | 932 | 1,178 |
| Pinfish | 0 | 66 | 0 | 408 | 608 | 1,082 |
| Southern flounder | 0 | 0 | 3 | 1 | 29 | 33 |
| Totals | 128 | 76 | 11 | 509 | 1,576 | 2,300 |



Figure 3. Small Seepage Pit Where Pinfish Were Stocked.



Figure 4. Large Seepage Pit Where Red Drum Were Stocked.

Survival, Growth and Reproduction of Introduced Species

Lake Imperial - This lake is 12 miles northwest of Imperial, Texas. It is a 1,000-acre irrigation reservoir fed by a canal from the Pecos River. On March 17-19, 1964, 14 netting and 6 seining collections were obtained. No marine species were captured. (Tables 8 and 9).

Table 8. Results of 14 Netting Collections Obtained from Imperial Reservoir on March 17-19, 1964.

| Species | Number | Per Cent by No. | Total Wt. Pounds | Avg. Wt. Pounds | Per Cent by Wt. | Average "K" |
|--------------|--------|--------------------|---------------------|--------------------|--------------------|----------------|
| Longnose gar | 2 | .58 | 2.62 | 1.31 | 1.77 | .39 |
| Gizzard shad | 281 | 82.65 | 71.90 | .25 | 48.58 | 1.96 |
| White bass | 57 | 16.77 | 73.48 | 1.29 | 49.65 | 2.84 |
| Totals | 340 | 100.00 | 148.00 | | 100.00 | |

Table 9. Results of Six Seining Collections Obtained from Imperial Reservoir On March 17-20, 1964.

(Five Collections with a 200-Foot Straight Seine, 10 Feet Deep With 1-Inch Mesh) (One Collection with a 40-Foot Straight Seine, 6 Feet Deep with $\frac{1}{2}$ -Inch Mesh)

| Species | Number | Size Range in Inches |
|----------------------|---------|----------------------|
| Longnose gar | 1 | 20 |
| Gizzard shad | 1,000 + | 5-14 |
| Carp | 2 | 8 |
| Pupfish | 17 | 1-2 |
| Rio Grande killifish | 28 | 1-2 |
| Tidewater silverside | 81 | 1-4 |
| Total | 1,129 + | |

On March 20, 1964, eight putrefied red drum were discovered on the shore. These were estimated to have weighed between 20 and 25 pounds when alive. Only two were intact enough for examination; one a sexually advanced male, 700 mm. in standard length, the other a mature female with no apparent egg development, 715 mm. in standard length. The local game warden reported observing 12 or 13 dead red drum the winter of 1963 (Figure 5).

It is theorized that these fish were the victims of cold weather. Lake Imperial had a maximum depth of only $4\frac{1}{2}$ feet during both of these winters and several extremely cold northers occurred. Unfortunately these were the specimens which would have been old enough (4 years) to have spawned during this segment had they lived.

Irrigation district personnel were contacted and encouraged to maintain a higher water level, but since the level is contingent on the amount of water available for release from Red Bluff Reservoir, no assurances could be given.



Figure 5. Putrefied Red Drum Found at Imperial Reservoir during March 1964.

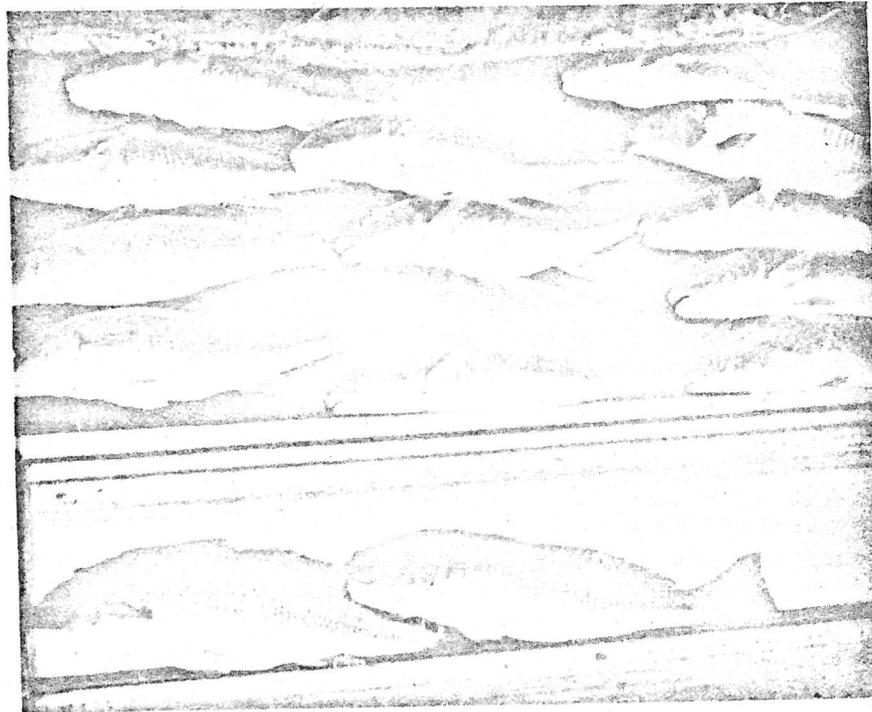


Figure 6. Red Drum Captured in Imperial Reservoir During October 1964. These Fish were Fingerlings Six Months Earlier.

On June 19, 1964, 4 netting and 6 seining collections were obtained. One of the 100 red drum fingerlings released on April 12, 1964, was recaptured in a net. It had grown from approximately .9 grams on April 21, to 72 grams on June 19, and had a standard length of 58 mm. This was an immature female with 12 small pupfish (Cyprinodon sp.) in its stomach. These forage fish were plentiful in the seining collections, also (Tables 10 and 11).

Table 10. Results of Four Netting Collections Obtained from Imperial Reservoir on June 19, 1964.

| Species | Number | Per Cent by No. | Total Wt. Pounds | Avg. Wt. Pounds | Per Cent by Wt. | Average "K" |
|--------------|--------|--------------------|---------------------|--------------------|--------------------|----------------|
| Gizzard shad | 102 | 89.47 | 23.00 | .23 | 69.29 | 1.52 |
| White bass | 11 | 9.65 | 10.03 | .91 | 30.22 | 2.15 |
| Red drum | 1 | .88 | .16 | .16 | .49 | 1.85 |
| Totals | 114 | 100.00 | 33.19 | | 100.00 | |

Table 11. Results of Six Seining Collections Obtained from Imperial Reservoir on June 19, 1964

(One Collection with a 200-Foot Straight Seine, 10 Feet Deep with 1-Inch Mesh)
 (Two Collections with a 100-Foot Straight Seine, 6 Feet Deep with ½-Inch Mesh)
 (One Collection with a 30-Foot Straight Seine, 6 Feet Deep with ½-Inch Mesh)
 (Two Collections with a 10-Foot Common Sense Seine, 4 Feet Deep with 1/8-Inch Mesh)

| Species | Number | Size Range in Inches |
|----------------------|--------|----------------------|
| Gizzard shad | 208 | 5-9 |
| Pupfish | 388 | 1-2 |
| Rainwater killifish | 3 | 1-2 |
| Tidewater silverside | 518 | 1-4 |
| Total | 1,117 | |

Sago pondweed (Potamogeton pectinatus) was heavily infesting the lake during this trip and small quantities were found in the stomachs of white bass (Roccus chrysops). Had the vegetation become more profuse, fishing would have been almost impossible. However, 3 weeks prior to the survey the water level had been raised 3 feet. The resulting increase in turbidity (16-22 inches - Secchi) and depth probably temporarily impeded the pondweed's rapid rate of congestion.

On October 22 and 23, 1964, 12 netting samples were obtained. Of the 99 red drum that could have possibly been left from the April 12 stocking, 21 were recaptured. Sixteen of these were returned to the lake after being weighed and measured. The other five were dead or in bad condition from net marks. These were all immature females. One had unidentifiable fish remains in its stomach; the others were empty (Tables 12 and 13) (Figure 6).

The absence of river carpsuckers (Carpiodes carpio) and carp (Cyprinus carpio) in the Lake Imperial netting and seining samples immediately gives rise to speculation that the large (20-25 pound) red drum devoured them. In past reconnaissance surveys at this lake, these species have been prevalent. When the limited number of red drum introduced and the large size of many of the carp

Table 12. Weight, Length and Condition of 21 Red Drum Released on April 12, 1964, and Recaptured on October 22, 23, 1964, from Imperial Reservoir.

| Red Drum Number | Weight | | | Length | "K" Factor |
|-----------------|--------|--------|------------|-------------|------------|
| | Grams | Pounds | and Ounces | Millimeters | |
| 1. | 1,247 | 2 | - 12 | 392 | 2.07 |
| 2. | 907 | 2 | - 0 | 362 | 1.91 |
| 3. | 879 | 1 | - 15 | 371 | 1.72 |
| 4. | 964 | 2 | - 2 | 376 | 1.81 |
| 5. | 1,077 | 2 | - 6 | 390 | 1.81 |
| 6. | 1,077 | 2 | - 6 | 375 | 2.04 |
| 7. | 936 | 2 | - 1 | 372 | 1.81 |
| 8. | 1,021 | 2 | - 4 | 376 | 1.92 |
| 9. | 794 | 1 | - 12 | 354 | 1.78 |
| 10. | 737 | 1 | - 10 | 350 | 1.71 |
| 11. | 907 | 2 | - 0 | 362 | 1.91 |
| 12. | 851 | 1 | - 14 | 352 | 1.95 |
| 13. | 964 | 2 | - 2 | 354 | 2.17 |
| 14. | 851 | 1 | - 14 | 352 | 1.95 |
| 15. | 936 | 2 | - 1 | 352 | 2.14 |
| 16. | 964 | 2 | - 2 | 370 | 1.90 |
| 17. | 964 | 2 | - 2 | 366 | 1.96 |
| 18. | 1,049 | 2 | - 5 | 376 | 1.97 |
| 19. | 737 | 1 | - 10 | 333 | 1.99 |
| 20. | 936 | 2 | - 1 | 351 | 2.16 |
| 21. | 851 | 1 | - 14 | 336 | 2.24 |

Table 13. Results of 12 Netting Collections Obtained from Imperial Reservoir on October 22, 23, 1964.

| Species | Number | Per Cent | Total Wt. | Avg. Wt. | Per Cent | Average |
|--------------|--------|----------|-----------|----------|----------|---------|
| | | by No. | Pounds | Pounds | by Wt. | "K" |
| Longnose gar | 6 | 2.02 | 11.62 | 1.93 | 6.85 | .43 |
| Gizzard shad | 230 | 77.70 | 59.55 | .26 | 35.11 | 2.08 |
| White bass | 39 | 13.80 | 55.12 | 1.41 | 32.50 | 2.86 |
| Red drum | 21 | 7.10 | 43.31 | 2.06 | 25.54 | 1.94 |
| Totals | 296 | 100.00 | 169.60 | | 100.00 | |

and suckers is considered, it seems more probable that their reduction is attributable to other causes. Two plausible explanations have been deduced. A buildup of salinity past the threshold of these species tolerance could have occurred. Concrete structures have been built in the lake's feeder canal. These small dams would allow fish to pass over them when water was entering the lake, but would not allow them to return to the lake when the flow subsided. Inquiries revealed that many fish had been stranded in the canal above these structures every time water was released into Lake Imperial.

Chloride measurements were attempted during October but were beyond the range (2,500 ppm) of available analysis kits. On February 27, 1965, when additional marine species were stocked, the salinity was 6,000 ppm.

Red Bluff Reservoir - This lake is located near Orla, Texas, on the Texas-New Mexico border. It covers 11,700 surface acres when full, but was about 25 feet below spillway level during most of the segment. On June 17, 1964, 6 netting and 8 seining collections were obtained. No marine fish were captured (Tables 14 and 15).

Table 14. Results of Six Netting Collections Obtained from Red Bluff Reservoir on June 17, 1964.

| Species | Number | Per Cent by No. | Total Wt. Pounds | Avg. Wt. Pounds | Per Cent by Wt. | Average "K" |
|--------------------|--------|--------------------|---------------------|--------------------|--------------------|----------------|
| Longnose gar | 9 | 3.19 | 18.23 | 2.02 | 8.21 | .44 |
| Gizzard shad | 98 | 34.75 | 13.68 | .14 | 6.16 | 1.34 |
| Carp | 27 | 9.57 | 13.26 | .49 | 5.97 | 2.28 |
| River carpsucker | 72 | 25.53 | 56.72 | .79 | 25.55 | 1.86 |
| Smallmouth buffalo | 65 | 23.05 | 108.54 | 1.67 | 48.88 | 2.71 |
| Channel catfish | 4 | 1.42 | 5.24 | 1.31 | 2.36 | 1.58 |
| White bass | 5 | 1.78 | 6.08 | 1.22 | 2.74 | 2.34 |
| Green sunfish | 1 | .35 | .09 | .09 | .04 | 2.81 |
| Bluegill | 1 | .36 | .19 | .19 | .09 | 3.63 |
| Totals | 282 | 100.00 | 222.03 | | 100.00 | |

Table 15. Results of Eight Seining Collections Obtained from Red Bluff Reservoir on June 17, 1964.

(Two Collections with a 200-Foot Straight Seine, 10 Feet Deep with 1-Inch Mesh)
 (Three Collections with a 100-Foot Straight Seine, 6 Feet Deep with ½-Inch Mesh)
 (One Collection with a 30-Foot Straight Seine, 6 Feet Deep with ½-Inch Mesh)
 (Two Collections with a 10-Foot Common Sense Seine, 4 Feet Deep with 1/8-Inch Mesh)

| Species | Number | Size Range in Inches |
|----------------------|--------|----------------------|
| Gizzard shad | 1,153 | 2-11 |
| Carp | 38 | 7-12 |
| Red shiner | 65 | 2-4 |
| River carpsucker | 15 | 6-12 |
| Smallmouth buffalo | 1 | 14 |
| Pupfish | 1 | 2 |
| Mosquitofish | 8 | 1-2 |
| Bluegill | 1 | 6 |
| Tidewater silverside | 224 | 1-3 |
| Total | 1,506 | |

On October 27, 28 and 29, 1964, 19 netting collections were obtained. Sixty-two red drum, 1 spotted seatrout and 1 pinfish were captured. The red drum were netted at localities all over the lake and as far as 5 miles up the river. The trout and pinfish were both netted near the dam. In 6 months they had grown to desirable angling size (Tables 16 and 17) (Figures 7, 8 and 9).

Six red drum were cut open to determine sexual development and stomach contents. All were immature females. Only one stomach was completely empty.

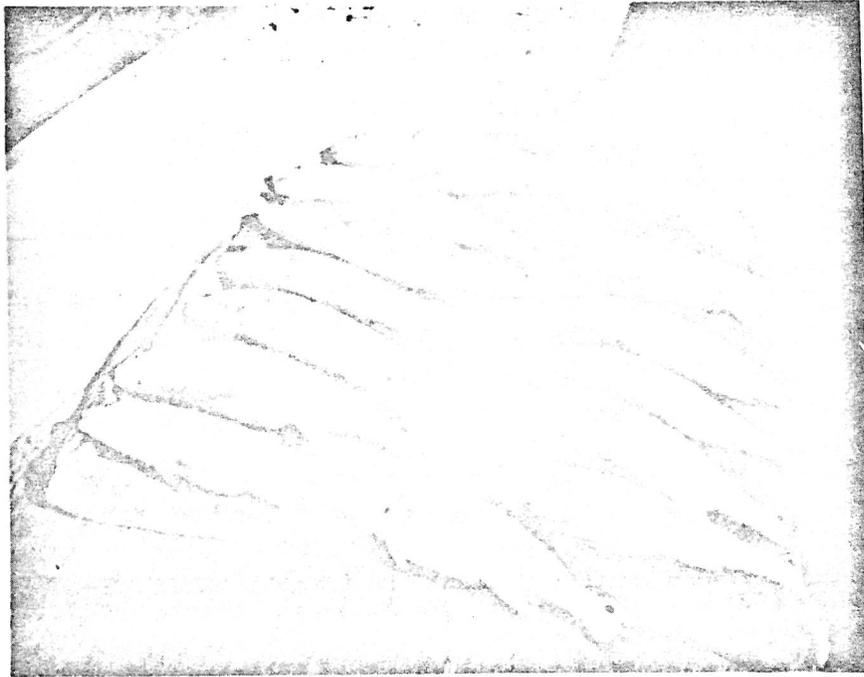


Figure 7. Red Drum Captured from Red Bluff Reservoir During October 1964. These Fish were Released as Fingerlings During April 1964.



Figure 8. A 15-Ounce Spotted Seatrout Recovered from Red Bluff Reservoir in October 1964. This was one of six Fingerlings Released in April 1964.



Figure 9. The First Pinfish Recovered from Inland Waters. This 8-Ounce Specimen weighed less Than One-Half Ounce When Stocked 6 Months Earlier.



Figure 10. Netting the Pecos River Near Imperial, Texas, where Marine Fish had been Previously Released.

Table 16. Weight, Length and Condition of 62 Red Drum, 1 Spotted Seatrout and 1 Pinfish Released as Fingerlings on April 8 and 12, 1964, and Recaptured on October 27 - 29, 1964, from Red Bluff Reservoir.

| Fish Number | Weight | | | Length Millimeters | "K" Factor |
|-------------|--------|--------|------------|-----------------------|------------|
| | Grams | Pounds | and Ounces | | |
| Red Drum | | | | | |
| 1. | 907 | 2 | - 0 | 371 | 1.77 |
| 2. | 907 | 2 | - 0 | 361 | 1.92 |
| 3. | 794 | 1 | - 12 | 348 | 1.88 |
| 4. | 737 | 1 | - 10 | 349 | 1.73 |
| 5. | 737 | 1 | - 10 | 325 | 2.14 |
| 6. | 879 | 1 | - 15 | 361 | 1.86 |
| 7. | 794 | 1 | - 12 | 356 | 1.75 |
| 8. | 907 | 2 | - 0 | 365 | 1.86 |
| 9. | 737 | 1 | - 10 | 339 | 1.89 |
| 10. | 822 | 1 | - 13 | 331 | 2.27 |
| 11. | 652 | 1 | - 7 | 319 | 2.01 |
| 12. | 652 | 1 | - 7 | 312 | 2.15 |
| 13. | 737 | 1 | - 10 | 325 | 2.15 |
| 14. | 765 | 1 | - 11 | 329 | 2.15 |
| 15. | 794 | 1 | - 12 | 335 | 2.11 |
| 16. | 907 | 2 | - 0 | 359 | 1.96 |
| 17. | 737 | 1 | - 10 | 341 | 1.86 |
| 18. | 765 | 1 | - 11 | 344 | 1.88 |
| 19. | 936 | 2 | - 1 | 347 | 2.24 |
| 20. | 936 | 2 | - 1 | 361 | 1.99 |
| 21. | 851 | 1 | - 14 | 347 | 2.04 |
| 22. | 851 | 1 | - 14 | 351 | 1.97 |
| 23. | 794 | 1 | - 12 | 326 | 2.29 |
| 24. | 794 | 1 | - 12 | 326 | 2.29 |
| 25. | 737 | 1 | - 10 | 318 | 2.30 |
| 26. | 851 | 1 | - 14 | 334 | 2.28 |
| 27. | 794 | 1 | - 12 | 335 | 2.11 |
| 28. | 680 | 1 | - 8 | 324 | 2.00 |
| 29. | 931 | 2 | - 1 | 340 | 2.37 |
| 30. | 794 | 1 | - 12 | 322 | 2.38 |
| 31. | 794 | 1 | - 12 | 333 | 2.15 |
| 32. | 680 | 1 | - 8 | 308 | 2.33 |
| 33. | 822 | 1 | - 13 | 331 | 2.27 |
| 34. | 1,049 | 2 | - 5 | 351 | 2.43 |
| 35. | 680 | 1 | - 8 | 321 | 2.06 |
| 36. | 680 | 1 | - 8 | 320 | 2.08 |
| 37. | 680 | 1 | - 8 | 312 | 2.24 |
| 38. | 879 | 1 | - 15 | 335 | 2.34 |
| 39. | 851 | 1 | - 14 | 335 | 2.26 |
| 40. | 907 | 2 | - 0 | 321 | 2.74 |
| 41. | 822 | 1 | - 13 | 339 | 2.11 |
| 42. | 1,021 | 2 | - 4 | 362 | 2.15 |
| 43. | 680 | 1 | - 8 | 319 | 2.10 |
| 44. | 765 | 1 | - 11 | 329 | 2.15 |
| 45. | 851 | 1 | - 14 | 337 | 2.22 |
| 46. | 709 | 1 | - 9 | 332 | 1.94 |

| Fish Number | Weight | | | Length Millimeters | "K" Factor |
|------------------|--------|-------------------|------|-----------------------|------------|
| | Grams | Pounds and Ounces | | | |
| 47. | 652 | 1 | - 7 | 307 | 2.25 |
| 48. | 709 | 1 | - 9 | 326 | 2.05 |
| 49. | 822 | 1 | - 13 | 322 | 2.46 |
| 50. | 964 | 2 | - 2 | 365 | 1.98 |
| 51. | 992 | 2 | - 3 | 360 | 2.13 |
| 52. | 851 | 1 | - 14 | 345 | 2.07 |
| 53. | 794 | 1 | - 12 | 330 | 2.21 |
| 54. | 879 | 1 | - 15 | 341 | 2.22 |
| 55. | 936 | 2 | - 1 | 360 | 2.01 |
| 56. | 1,106 | 2 | - 7 | 385 | 1.94 |
| 57. | 652 | 1 | - 7 | 320 | 1.99 |
| 58. | 510 | 1 | - 2 | 310 | 1.71 |
| 59. | 794 | 1 | - 12 | 340 | 2.02 |
| 60. | 652 | 1 | - 7 | 309 | 2.21 |
| 61. | 1,106 | 2 | - 7 | 384 | 1.95 |
| 62. | 822 | 1 | - 13 | 354 | 1.85 |
| Spotted seatrout | | | | | |
| 1. | 425 | 0 | - 15 | 280 | 1.94 |
| Pinfish | | | | | |
| 1. | 230 | 0 | - 8 | 186 | 3.57 |

Table 17. Results of 19 Netting Collections Obtained from Red Bluff Reservoir on October 27 - 29, 1964.

| Species | Number | Per Cent by No. | Total Wt. Pounds | Avg. Wt. Pounds | Per Cent by Wt. | Average "K" |
|--------------------|--------|--------------------|---------------------|--------------------|--------------------|----------------|
| Longnose gar | 18 | 5.42 | 54.82 | 3.05 | 13.85 | .53 |
| Gizzard shad | 94 | 28.31 | 28.79 | .31 | 7.28 | 1.93 |
| Carp | 4 | 1.20 | 2.62 | .66 | .66 | 2.70 |
| River carpsucker | 58 | 17.47 | 49.46 | .85 | 12.50 | 2.20 |
| Smallmouth buffalo | 33 | 9.94 | 113.53 | 3.44 | 28.69 | 2.71 |
| Channel catfish | 2 | .61 | 2.87 | 1.44 | .73 | 1.44 |
| White bass | 35 | 10.54 | 27.76 | .79 | 7.01 | 3.21 |
| Green sunfish | 24 | 7.23 | 3.50 | .15 | .89 | 3.97 |
| Red drum | 62 | 18.67 | 110.87 | 1.79 | 28.02 | 2.10 |
| Spotted seatrout | 1 | .30 | .93 | .93 | .24 | 1.94 |
| Pinfish | 1 | .31 | .51 | .51 | .13 | 3.57 |
| Totals | 332 | 100.00 | 395.66 | | 100.00 | |

Two contained unidentifiable fish remains, 2 contained shad up to 4 inches long and 1 contained both shad and pupfish. The rest of the red drum and the seatrout and pinfish were returned to the lake in good condition.

Pecos River - Nets were set in the Pecos River near Imperial, Texas, on the Hoover Ranch in Crockett County and near its confluence with the Rio Grande. Marine fish had been previously released at the Imperial netting site and near the confluence of the Pecos and Rio Grande Rivers. No introduced fish were recaptured. Results of these investigations are shown in Tables 18, 19 and 20 and Figure 10).

Table 18. Results of Six Netting Collections Obtained from the Pecos River Near Imperial, Texas, on March 18-20, 1964.

| Species | Number | Per Cent by No. | Total Wt. Pounds | Avg. Wt. Pounds | Per Cent by Wt. | Average "K" |
|--------------|--------|--------------------|---------------------|--------------------|--------------------|----------------|
| Gizzard shad | 11 | 100.00 | 9.46 | .86 | 100.00 | 2.25 |
| Total | 11 | 100.00 | 9.46 | | 100.00 | |

Table 19. Results of 11 Netting Collections Obtained from the Pecos River at its Confluence with the Rio Grande on November 11 - 13, 1964.

| Species | Number | Per Cent by No. | Total Wt. Pounds | Avg. Wt. Pounds | Per Cent by Wt. | Average "K" |
|--------------------|--------|--------------------|---------------------|--------------------|--------------------|----------------|
| Longnose gar | 83 | 40.09 | 111.42 | 1.34 | 19.66 | .38 |
| Alligator gar | 2 | .97 | 46.18 | 23.09 | 8.15 | .82 |
| Gizzard shad | 26 | 12.56 | 25.46 | .98 | 4.49 | 2.32 |
| River carpsucker | 10 | 4.83 | 15.48 | 1.55 | 2.74 | 2.78 |
| Blue sucker | 4 | 1.93 | 17.00 | 4.25 | 3.00 | 1.50 |
| Smallmouth buffalo | 26 | 12.56 | 221.68 | 8.53 | 39.12 | 3.17 |
| Gray redhorse | 3 | 1.45 | 5.12 | 1.71 | .90 | 2.21 |
| Blue catfish | 8 | 3.87 | 51.62 | 6.45 | 9.11 | 1.83 |
| Channel catfish | 3 | 1.45 | 4.31 | 1.44 | .77 | 1.86 |
| Flathead catfish | 4 | 1.93 | 27.06 | 6.76 | 4.77 | 1.92 |
| Bluegill | 10 | 4.83 | 1.39 | .14 | .25 | 3.05 |
| Largemouth bass | 4 | 1.93 | 2.10 | .53 | .37 | 2.33 |
| Freshwater drum | 23 | 11.11 | 37.48 | 1.63 | 6.61 | 2.58 |
| Rio Grande perch | 1 | .49 | .30 | .30 | .06 | 4.75 |
| Totals | 207 | 100.00 | 566.60 | | 100.00 | |

Table 20. Results of Two Netting Collections Obtained from the Pecos River in Crockett County on November 10, 1964.

| Species | Number | Per Cent by No. | Total Wt. Pounds | Avg. Wt. Pounds | Per Cent by Wt. | Average "K" |
|------------------|--------|--------------------|---------------------|--------------------|--------------------|----------------|
| Gizzard shad | 22 | 68.75 | 26.30 | 1.20 | 64.17 | 2.21 |
| Carp | 1 | 3.12 | 3.62 | 3.62 | 8.84 | 2.41 |
| River carpsucker | 5 | 15.63 | 4.26 | .85 | 10.39 | 2.25 |
| Blue sucker | 1 | 3.12 | 5.25 | 5.25 | 12.81 | 1.55 |
| Gray redhorse | 1 | 3.13 | 1.12 | 1.12 | 2.74 | 1.98 |
| Channel catfish | 1 | 3.12 | .35 | .35 | .85 | 1.52 |
| Bluegill | 1 | 3.13 | .08 | .08 | .20 | 3.40 |
| Totals | 32 | 100.00 | 40.98 | | 100.00 | |

The presence of nothing but shad in the sample from the Pecos River near Imperial lends credence to the hypothesis that chlorides, or some other aspect of the water quality, became, at some time, intolerable for carp and suckers. A chloride reading from a seepage pit adjacent to the Pecos River near Imperial was 15,000 ppm on April 12, 1964. A reading from the Pecos at its confluence with the Rio Grande was only 1,800 ppm on the same date. On February 27 and 28, 1965, seepage pit chlorides ranged from 5,900 ppm to 7,700 ppm.

Conclusions and Recommendations:

The recreational value of one 25-pound red drum or 9-pound flounder (see completion report for F-5-R-11) on the end of a fisherman's line is inestimable. Even the knowledge that desirable game fish of this size are in a lake, which has heretofore been practically devoid of game fish, adds greatly to the total recreational usage. Since survival, under normal conditions, and rapid growth rates have been proven for certain marine species in Lake Imperial and Red Bluff Reservoir, it is recommended that efforts to establish a marine fishery at these lakes be continued. However, since water levels at Lake Imperial are erratic, Red Bluff Reservoir should be given first priority.

Presently there may be an adequate brood stock of red drum and pinfish in Red Bluff Reservoir. If these fish do not reproduce, consideration should be given to developing techniques for stripping the mature fish and producing fry under laboratory conditions or to perfecting the wholesale acquisition and transportation of marine fry from the coast. In either case, the seepage pits near Imperial, Texas, could be used as rearing ponds.

The use of plastic bags and air shipment seems to be the most successful method of transporting marine fry and fingerling seatrout. Further experiments, especially with seatrout, should be made.

When total costs of labor, per diem and operating expenses are considered, air transport is probably more economical than tank truck shipment. The use of plastic bags transported by truck would probably be even cheaper. However, data gathered during the year indicate that marine fish could not survive containment in the bags long enough for this to be accomplished.

Three criteria brought to mind by the recent attempts to fly marine species in plastic bags are: 1) do not hold the fry in plastic bags over 5 hours; 2) keep the water temperature under 70°F.; and 3) be prepared to replenish the oxygen and/or part of the water should the fish become moribund.

If coastal personnel can locate substantial congregations of gafftopsail catfish and black drum, it is recommended that these species be transported to Red Bluff Reservoir. These would probably have to be seined from the Gulf beaches and the shallow muddy bays.

Past efforts at recapturing introduced marine species from Lake Imperial and Red Bluff Reservoirs have always been most successful during October and November. Since time available to achieve project requirements is usually inadequate, it might be wise to restrict sampling surveys to the autumn months.

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