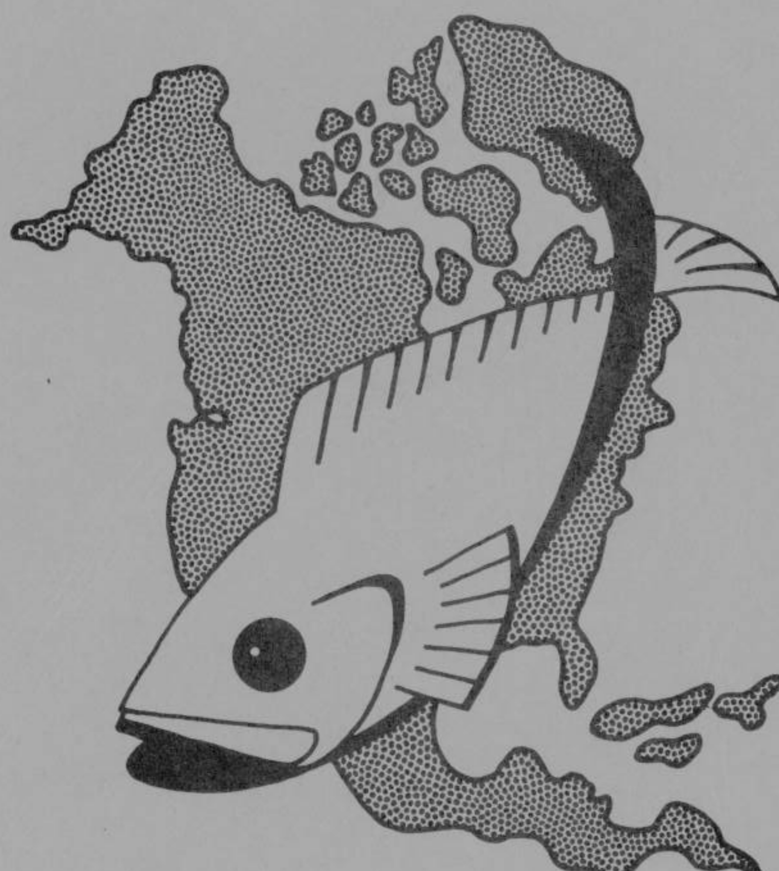
ANNUAL PROCEEDINGS of the TEXAS CHAPTER AMERICAN FISHERIES SOCIETY



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The dormitory facilities and meeting room were provided by the University of Texas Marine Science Institute at Port Aransas.

The shrimp at the Friday evening social were graciously provided by the Texas Shrimp Association.

AN ASSESSMENT OF STOCKING-INDUCED STRESS IN FINGERLING RED DRUM

by

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ABSTRACT

Stress induced by handling, hauling and net confinement was evaluated in red drum fingerlings (Sciaenops ocellatus) weighing 0.2-0.8 g. Changes in plasma glucose concentrations were used as a general indicator of stress, and changes in plasma chloride concentrations were used as an indicator of osmoregulatory dysfunction. Samples were taken at intervals during harvest and transport to stocking sites. In addition, fingerlings confined in a net for 9 hours were sampled at intervals in an attempt to determine the maximum possible changes in plasma glucose and chloride concentrations. Changes in the stress indicators generally followed the same trend for both net stress and stocking procedures. Plasma glucose levels exhibited an initial increase and a subsequent decrease to or below baseline levels (50 mg/100 ml) in both net confined and hauled fish. Plasma chloride levels exhibited a prolonged elevation from baseline (117 meq/liter) in response to both net confinement and hauling. Cumulative mortality was 53% after 9 hours of net confinement. The degree and consistency of the red drum's physiological responses to confinement and hauling stress were less than those observed in other fish species.

PHYSIOLOGICAL EVALUATION OF TRANSPORTATION STRESS IN CULTURED JUVENILE RED DRUM

by

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ABSTRACT

Red drum (Sciaenops ocellatus) has become an important species for its mariculture potential. Transportation is traumatic to juvenile red drum and elicits stress responses which can be measured by changes in plasma cortisol, glucose and osmolality. The objectives of the study were to: 1) determine the degree of stress induced in juvenile red drum by transportation procedures, 2) compare the stress responses elicited by transportation in ambient seawater versus a low salinity medium, and 3) determine the efficacy of using anesthetics during transport. Blood parameters measured were plasma cortisol, glucose and osmolality.

In one experiment, red drum (21 cm mean standard length; 2 g mean weight) were acclimated to 32 o/oo seawater and hauled for 5.5 hours with and without 5 mg MS-222/liter. No mortalities occurred. In another experiment, red drum (13 cm and 40 g) were acclimated to low salinity seawater (4 o/oo), and were hauled for 2.5 hours with and without 25 mg MS-222/liter. Survival was 98%. In both experiments, plasma cortisol and glucose levels were significantly elevated during transport. However, plasma osmolality increased during seawater transport and decreased in the 4 o/oo transport. The use of MS-222 did not decrease the magnitude of the stress responses nor did it increase survival.

This study indicates that juvenile red drum can be transported in high and low salinity water with little or no mortality. However, these transport procedures rapidly induced classical stress responses, as indicated by changes in plasma cortisol, glucose and osmolality. No apparent benefits were observed by using MS-222 during transportation of juvenile red drum.

EFFECT OF LEAD ON THE ACID-SOLUBLE THIOL CONTENT OF ATLANTIC CROAKER TISSUES

by

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ABSTRACT

Heavy metals interact with sulfhydryl compounds including acid-soluble thiols (ASTs) in animal cells. Glutathione, metallothionein, and cysteine are the major ASTs present in the cell. Glutathione and metallothionein are thought to serve a protective function by sequestering metals. Previous studies have shown that heavy metals which induce the synthesis of metallothionein a high molecular weight AST, also cause glutathione levels to increase in fish tissues. However, it is not known whether glutathione levels increase in fish exposed to heavy metals (such as lead) which do not induce metallothionein synthesis. In this study the effect of daily oral ingestion of lead (1.85 mg $PbCl^{2}$/100 g fish) on the glutathione status of Atlantic croaker (Micropogonias undulatus) was investigated. Lead increased hepatic AST concentrations to 1.25 x control levels after 1 week and to 1.40 x controls after 6 weeks exposure. Glutathione accounted for almost all of this rise in ASTs. Intestinal AST content of lead-dosed fish showed an even greater increase, which was also shown to be mainly glutathione. These results suggest that increases in glutathione content can occur in tissues of fish exposed to metals in the absence of metallothionein synthesis.

REPRODUCTIVE BIOLOGY OF FEMALE SPOTTED SEATROUT IN A SOUTH TEXAS EMBAYMENT

by

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ABSTRACT

Spotted seatrout (*Cynoscion nebulosus*) reside year round in the shallow bays near Port Aransas, Texas. Thirty percent of female spotted seatrout reach maturity by age one, and all are sexually mature at the end of the second year. Spawning occurs at dusk over beds of submerged aquatic vegetation throughout a protracted spawning season from April through September. Asynchronous ovarian development and the presence of atretic bodies in the ovaries throughout the spawning season suggests an individual female is capable of several spawns during the year. A continuous distribution of oocytes throughout the size range, and the presence of maturing oocytes in the ovaries of spawning fish, indicate female spotted seatrout are capable of repeated spawns.

EFFECTS OF A LARGE BLUE CRAB POPULATION IN A FRESHWATER RESERVOIR

by

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ABSTRACT

Brazoria Reservoir, a 768 hectare impoundment built in 1954, serves as a freshwater supply for the Dow Chemical plant at Freeport, Texas. The reservoir level is maintained by pumping from the Brazos River at a point 40 km upstream from the Gulf of Mexico. Many estuarine species have established populations in the reservoir. The blue crab (Calinectes sapidus) population in the reservoir expanded rapidly in 1978 and has remained extremely high through 1983. Annual fish population sampling was conducted during 1981-1983 using experimental gill nets and electrofishing. Historical data were obtained from past fisheries management reports and from complete fish harvest records kept by reservoir personnel.

Spring and fall electrofishing revealed very low reproductive success for largemouth bass (Micropterus salmoides) and bluegill (Lepomis macrochirus) throughout the three years of the study. A Petersen population estimate of adult largemouth bass (> 300 mm) indicated a density of 4.8 adults/hectare in spring 1982. Catch per unit effort for largemouth bass declined steadily from 0.4 adult bass/fisherman-hour in 1979 to a record low of < 0.1 adult bass/fisherman-hour in 1983. Aquatic macrophytes were very abundant in Brazoria Reservoir before the blue crab population expansion. No aquatic vegetation remained in the reservoir by fall of 1981 at which time the blue crabs exhibited physical and behavioral symptoms of starvation. Blue crabs appear to have eliminated aquatic macrophytes from Brazoria Reservoir. This evidence suggests that the high population of crabs is interfering with the spawning success of largemouth bass, bluegill, as well as other nest-building centrarchids.

INTENSIVE PRODUCTION OF GUADALUPE BASS

by

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ABSTRACT

A study was conducted to determine if the threatened Guadalupe bass (*Micropterus treculi*) could be adapted to hatchery production. Five hormone injected fish (one female, four males) stocked in a 0.04 hectare spawning pond produced approximately 1,200 harvestable fingerlings. The fish were size-graded into 3 classes and stocked into indoor rectangular tanks. Fingerlings (22-45 mm total length; 0.3-1.0 g) were trained to consume semimoist pellets (1.0-1.5 mm in diameter) in a simulated production environment at a rate greater than 48% of the stocked biomass/day throughout the 24-day training period. Training success for the three size classes was 96, 98, and 100%. Growth rates were similar to those of other *Micropterus* species. These results indicate that the Guadalupe bass is adaptable to fish hatchery conditions and, therefore, can be produced to supplement depleted native populations.

GENETIC IDENTIFICATION OF FISH SPECIES BY A NON-INVASIVE METHODOLOGY

by

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ABSTRACT

The development and application of very sensitive biochemical techniques for fish species identification would be a welcome addition to our present array of tools. Such methods could augment or even replace techniques dependent on invasive tissue sampling, which usually requires the sacrifice of the specimen in question.

Studies in our laboratory have recently employed the extremely sensitive technique of isoelectric focusing. It is possible to gather genetic information using extremely small tissue samples or even samples of mucus without sacrificing the fish.

THERMAL STRESS EFFECTS ON ADENYLATE ENERGY CHARGE IN BLUE TILAPIA

by

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ABSTRACT

The concentrations of ATP, ADP, AMP, and the Adenylate Energy Charge ratio were measured for blue tilapia (Tilapia aurea) acclimated at 12, 25, and 35°C ambient water temperatures for 2 to 3 weeks. Plasma corticosteroid and glucose level were also measured to serve as independent stress indicators.

Plasma corticosteroid levels, plasma glucose levels, and the Adenylate Energy Charge ratio were significantly different ($P \leq 0.05$) in fish acclimated at 12°C compared to 25 and 35°C groups.

PARASITISM IN BOTH NATIVE AND NON-NATIVE WALLEYE POPULATIONS WITH IMPLICATIONS FOR MANAGEMENT

by

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ABSTRACT

Parasites have been shown to reduce growth and increase mortality in a wide variety of fish species. Such effects could reduce the benefits available to anglers, and therefore are of concern to fisheries managers.

We examined walleye (Stizostedion vitreum) from near the center (Minnesota), on the periphery (Arkansas) and on the outside (Lake Meredith and Buffalo Springs, Texas) of the species' native range. Parasite prevalence and diversity were found to vary from 100% and high diversity in Minnesota to extremely low prevalence and low diversity in Texas. Walleye from Arkansas exhibited intermediate parasitism.

The low rates of parasitism in Texas may be explained by the biology and management of the two reservoirs sampled. Neither reservoir has a closely related fish species that could share its parasite fauna with walleye. Apparently an "empty niche" phenomenon existed where few parasites adaptable to walleye were present. Equally important in maintaining low parasitism of walleye in Texas is the practice of stocking walleye as fry, since very little parasitism has occured by this time in the fish's life cycle.

Since the treatment or eradication of parasites in existing fisheries is impractical, the best approach is to control the parasites of walleyes introduced into the reservoir from hatcheries. Preventive management measures include: 1) checking hatchery fish for parasites before they are introduced into the reservoirs, 2) controlling intermediate hosts of parasites in hatchery ponds, 3) stocking fry instead of fingerlings, and 4) not stocking a closely related fish species that could cause parasite spillover to walleye.

HYBRID STRIPED BASS FOR CONTROL OF STUNTED WHITE CRAPPIE

by

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and

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ABSTRACT

Small lakes and ponds throughout west Texas expand fishing opportunities in this arid region. Due to heavy fishing pressure on largemouth bass (Micropterus salmoides), many small lakes contain poor quality fish populations dominated by stunted sunfish (Centrarchidae) of several species. Through interference with bass nesting, these overabundant sunfish may hinder recovery of the bass population even when bass fishing is reduced.

Water drawdown followed by chemical reclamation and restocking is the typical management approach to restore balance within a pond fish population. Drawdown of impoundments in arid west Texas is not a feasible management alternative, so costs of chemical reclamation can be prohibitively high. The stocking of a "superpredator", such as white bass x striped bass hybrids (Morone chrysops x Morone saxatilis), may be an economical means of controlling overabundant sunfish and restoring balance within the lake. Hybrid striped bass stocked as fingerlings (30 mm long) have been ineffective for stunted sunfish control in previous studies, but the lack of success may have been due to heavy crappie predation on the stocked fingerlings. We investigated the effectiveness of hybrid striped bass, stocked as advanced fingerlings (120-180 mm long), for controlling a population of stunted white crappie (Pomoxis annularis).

Shoreline vegetaion of a 35-acre private lake near Matador, Texas, was treated with rotenone during the summer of 1982 to reduce the overabundant crappie population. Chemical treatment was followed by the stocking of 20 fingerling hybrid striped bass per acre in October 1982, and an additional 20 fish per acre in October 1983. Throughout 1983 and 1984 the lake was periodically surveyed to monitor survival and growth of the hybrid bass, recovery of the largemouth bass population, and reduction of white crappie abundance. Results indicate that hybrid bass will overwinter in small west Texas lakes and appear to be effectively reducing white crappie abundance. Average size of white crappie captured in standardized electrofishing

samples increased 128% between spring 1982 and spring 1984. Bluegill (*Lepomis macrochirus*) concurrently increased in average size (100%) over the same time period. Successful largemouth bass reproduction became evident. Hybrid striped bass can effectively control white crappie populations if the predator is stocked at a size large enough to immediately utilize the available forage.

THE FOOD HABITS OF REDBREAST SUNFISH IN THE SAN MARCOS RIVER, TEXAS

by

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ABSTRACT

A food habit study was conducted on three size classes (1-76 mm, 77-152 mm, >152 mm total length) of redbreast sunfish (*Lepomis auritus*) to determine changes in diet in relation to changes in season and size of individuals. Fish were collected from April, 1982 to August, 1983 from three areas of the San Marcos River, one of which received effluent from a sewage treatment plant. Empty stomachs comprised 2.4% of the stomachs examined (N = 592). Stomach analysis of all size groups indicated that the redbreast sunfish is an opportunistic feeder with aquatic insects being the dominant prey in terms of number, weight, and frequency of occurrence. The smallest size class of fish fed heavily on small ostracods. Terrestrial invertebrates were more important to the largest size class then to the other size classes. The Schoener index indicated significant overlap in food habits only between the medium and large size classes. Seasonal data revealed an expected decrease in terrestrial organisms and an increase in aquatic organisms in the diet during winter months.

INITIAL SURVIVAL OF RED DRUM FINGERLINGS STOCKED IN TEXAS BAYS DURING 1983

by

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ABSTRACT

Red drum (Sciaenops ocellatus) were stocked in the San Antonio Bay system during May 1983 and in the Corpus Christi Bay system during September and November 1983. Random samples of fish from each load of stocked fish were placed in cages to determine initial 24-h survival after release. There were no significant differences ($P > 0.01$) in fingerling survival between bay systems. There were, however, significant differences ($P \leq 0.01$) in survival among stocking dates, suggesting differences in the condition of fingerlings among stocking. Mean survival ranged from $62.0 \pm 14.8\%$ on 28 May to $98.7 \pm 2.3\%$ on 12 September. Overall survival of red drum fingerlings held in cages was $89.4 \pm 2.7\%$, indicating that harvesting, transporting and stocking procedures currently used are adequate for survival of stocked fish. This program, therefore, has a potential for rebuilding overharvested populations of red drum.

Aquaculture of marine and estuarine finfish species in the United States is relatively new. The rearing and stocking of marine fishes has generally been limited to various anadromous salmonid species and began through mitigation of lost habitat (Bardach et al. 1972). The Japanese have developed stocking programs for various marine organisms including finfishes (Moffet 1981). Stocking of post-larval shrimp (Penaeus japonicus) was begun in 1962 in the Seto Inland Sea. A strong correlation between stocking rates and harvest has demonstrated the potential of enhancing populations of valuable marine species (Cowan 1981) such as red sea bream (Pagrus major).

Stocking of red drum (Sciaenops ocellatus) in Texas bays to enhance depleted stocks began in 1975 with the development of techniques to spawn and rear red drum in captivity (Arnold et al. 1977). During the 7 years from 1975-1982, Texas bays (Figure 1) were stocked with 8.5 million red drum eggs, 45.1 million fry and 2.8 million fingerlings (Matlock 1984).

The Gulf Coast Conservation Association (GCCA)-John H. Wilson Marine Fish Hatchery (GCCA-JWMFH), a cooperative venture of the GCCA, Central Power and Light Company and the Texas Parks and Wildlife Department (TPWD), started operations in 1982. The facility was designed to produce approximately 10 million red drum fingerlings annually. A three-year program of intensive stocking in Espiritu Santo Bay (San Antonio Bay system) and Nueces Bay (Corpus Christi Bay system) was established to assess the contribution of hatchery-reared red drum for rebuilding overharvested populations and provide increased red drum harvest by fishermen within four years of first stocking. These bay systems were selected because adequate fishery-independent sampling relative to surface area was available, they are diversely different in habitats (Hegen and Matlock 1980) and they have diverse fishing pressures (McEachron and Green 1983). Furthermore, because native fish have similar and limited migration patterns and bays are well separated such that any "overflow" from one bay would not impact populations in the other (Osburn et al. 1982).

The handling of fish through harvest, transport and stocking can result in stress, thereby reducing the fitness of the fish for surviving after stocking (Ayles et al. 1976, Myers and Peterka 1976, Strange and Shreck 1978, Barton et al. 1980, Carmichael et al. 1983). Stress measured by plasma cortisol levels, was found to be highest during harvest, slightly elevated during transport and high during stocking in experiments with fingerling rainbow trout (<u>Salmo gairdneri</u>) (Barton et al. 1980). The objective of this study was to determine the initial 24-h post-stocking survival of red drum fingerlings.

METHODS

Red drum were spawned and reared at the GCCA-JWMFH during 1983 according to procedures described by Roberts et al. (1978). Fingerlings were stocked in Espiritu Santo Bay (San Antonio Bay system) during May 1983 and in Nueces Bay (Corpus Christi Bay system) during September and November 1983 (Figures 2 and 3).

All fish were transported from the hatchery to stocking sites in 1950-l hauling tanks secured on gooseneck trailers. A similar tank was secured to a barge for final transport to stocking sites. Oxygen was supplied to each hauling tank chamber from compressed gas cylinders.

Survival cages (0.6 m long, 0.3 m in diameter) were covered with 25 mm fiberglass screening (18 meshes/25 mm), weighted at the bottom to maintain an upright position in the water column and staked in water deep enough to insure water coverage throughout the tidal cycles. Cages were located in the immediate vicinity of fingerling release.

One hatchery pond was harvested for each day of stocking. Draining of the ponds began approximately 72 hours before scheduled releases. Fish were removed from the pond by dip net. During the May 1983 stocking period, the fish were held for 12 hours in concrete holding troughs treated with 10 ppm furacin to reduce bacterial activity. Fish were then loaded into and transported via hauling trailer to the release sites. During the September and November 1983 stocking periods fingerlings were transferred directly from the pond to the hauling trailers to reduce handling.

All fish were again treated with 10 ppm furacin in the hauling trailer tanks. Oxygen was bubbled through each tank at a rate of 4-6 l/minute to maintain a dissolved oxygen level of 4-10 ppm. Fish stocked in Expiritu Santo Bay were transfered to the barge hauling tank by gravity flow through PVC pipe and towed to the release site.

Fingerlings were acclimated to ambient release-site temperatures and salinities by exchanging hauling water with release-site water at a rate of approximately 2600 l/hour until water temperature and salinity in the hauling tank were within 2°C and 5 o/oo, respectively, of that at the release site.

Initial hauling mortality was estimated by visual inspection at the stocking site prior to release of red drum fingerlings. A random sample of live fish was removed by dip net from each of the tank chambers. From this sample, 25 fish were placed in each of three or four survival cages. The number of fish surviving after 24 hours was visually determined. Cages were checked after approximately 24 hours to enumerate surviving fish.

Water temperature (nearest 0.5°C) and salinity (nearest 0.1 o/oo) were measured in the hauling trailers before acclimation began, periodically during acclimation, prior to releasing the fish, at the release site when the fish were placed in cages, and again when they were examined after 24 hours.

Percent survival for each cage was calculated as the ratio of the number of fish alive at the end of 24 hours divided by the number of fish initially placed in the respective cages.

Significant differences ($P \leq 0.05$) in mean percent survival among bays stocked and dates stocked within each bay were determined using a nested analysis of variance (Sokal and Rohlf 1969). Bay systems and dates stocked within bay systems were considered random effects. Percentages were arcsin transformed prior to analysis to reduce variance heterogeneity.

RESULTS

Mean survival of red drum fingerlings held in cages in 1983 was 89.4 ± 2.7%. Mean survival of fingerlings held in cages was not significantly different ($P > 0.01$) between bay systems (Table 1). Significant differences $P \leq 0.05$) were found among stocking dates. Mean survival ranged from 62.0 ± 14.8% on 28 May to 98.7 ± 2.3% on 12 September (Table 2).

The overall mean estimated hauling mortality during all stocking dates over bay systems was 1% and ranged from 0% to 18% in the San Antonio Bay system and from <.1% to 1% in the Corpus Christi Bay system (Table 2).

There was generally little difference in water temperatures between hauling trailers and release sites. The greatest difference (1.5°C) occurred during the 7 September stocking when trailer water temperature was 29.0°C and the site water temperature was 27.5°C (Table 3). Temperatures also varied slightly between initial and final survival check periods. The greatest difference (5.5°C) occurred during the 9-10 November survival check.

Salinity values were higher (27-40 o/oo) in the hauling trailer than at the release site (20-32 o/oo) (Table 3). Salinities changed slightly between the initial and final survival check periods. The greatest difference (6.0 o/oo) occurred during the 13-14 November survival check.

Acclimation time varied among stockings from 0.0-2.2 hours.

DISCUSSION

Success of any stocking program depends upon the health and survivability of organisms released. Handling and transport can reduce that survivability by inducing stress in the fingerlings (Barton et al. 1980, Carmichael et al. 1983, Wheaton 1977). The findings of this study demonstrate that approximately 90% of stocked red drum fingerlings survive the first 24 hours after release regardless of bay system or season stocked. Survival after 24 hours is not expected to decrease. Barton et al. (1980) found that the high plasma cortisol levels detected in fingerling rainbow trout after stocking persisted through 24 hours and was reduced to near-normal levels at 48 hours. However, significant differences in survival among stocking dates suggests that the condition of the fingerlings or induced stresses varied among trailer loads. These differences could be attributed to: 1) the initial condition of fish in the ponds; 2) different levels of stress induced by different handling techniques including the number of times fish were handled; 3) stress induced by acclimating procedures; and 4) variations in holding conditions in the bays. It was assumed that the survival cages affected all fish equally. The impact of these fish on the ultimate harvest by sport fishermen is yet to be determined.

Since hauling mortality was estimated from a visual appraisal of the number of dead fish in the hauling tanks, no analyses were conducted to determine a mathematical relationship between hauling mortality and survival of caged fish. However, gross examination of the data indicates no obvious relationship. When the estimated hauling mortality was highest (18%), mean survival in cages was above average (92.0 ± 7.3%) and when survival in cages was lowest (62.0 ± 14.8%), estimated hauling mortality was about 1%. The high estimated hauling mortality of 26 May was associated with the failure of an oxygen valve shutting off oxygen to the trailer.

During periods of low survival, caged fish were subjected to intense wave action (27 May) and intermittent high turbidities caused by passing boats (8 and 13 September). During most stocking periods, fingerlings underwent various lengths of acclimation time to stabilize salinities.

It is recommended that during future stocking efforts handling stress can be minimized by: 1) reducing the number of handling steps; 2) placing survival cages in areas near release sites but protected from strong wave action and boat traffic; and 3) increasing acclimation time to minimize effects of osmotic and thermal shock.

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Table 1. Nested analysis of variance of arcsine transformed mean percent survival among bay systems and dates stocked within bay systems of red drum (*Sciaenops ocellatus*) held in cages for 24 h during May-November 1983.

Source of variation	Degrees of freedom	Mean square	F
Total	47	0.04428	
Bays	1	0.02195	0.1986
Dates	14	0.11055	6.9180**
Error	32	0.01598	

**Significant at $P \leq 0.01$

Table 2. Summary of percent survival of red drum (Sciaenops ocellatus) fingerlings held in cages, by bay system, date and stocking site during 1983. (Blanks indicate no data).

Bay system	Stocking site number	Stocking date	Mean estimated hauling mortality (%)	Mean total time in cages (h)	Percent survival				Daily Mean percent survival ± 1 S.E.
					Cage 1	Cage 2	Cage 3	Cage 4	
San Antonio	4-170-220	5-24-83	1	20.6	96.0	96.0	100.0	100.0	98.0 ± 2.3
	4-170-219	5-25-83	1	17.5	96.0	96.0			96.0 ± 0.0
	4-300-284[a]	5-26-83	18	19.2	96.0	100.0	84.0	88.0	92.0 ± 7.3
	4-170-218	5-27-83	1	25.6	68.0	40.0	72.0	68.0	62.0 ± 14.8
Corpus Christi	6-260-212	9-07-83	1	26.8	96.0	92.0	92.0		93.3 ± 2.3
	6-260-209	9-08-83	1	22.0	76.0	72.0	80.0		76.0 ± 4.0
	6-260-212	9-09-83	1	25.1	100.0	100.0	92.0		97.3 ± 4.6
	6-260-209	9-10-83	1	23.7	96.0	92.0	96.0		94.7 ± 2.3
	6-260-212	9-11-83	1	25.5	96.0	100.0	100.0		98.7 ± 2.3
	6-260-209	9-12-83	1	24.1	96.0	92.0	92.0		93.3 ± 2.3
	6-260-209	9-13-83	1	25.7	68.0	84.0	68.0		73.3 ± 9.2
	6-260-209	11-09-83	1	24.1	100.0	88.0	96.0		94.7 ± 6.1
	6-260-213	11-12-83	1	23.6	96.0	96.0	100.0		97.3 ± 2.3
	6-260-212	11-13-83	1	22.4	96.0	76.0			86.0 ± 14.1
	6-260-209	11-14-83	1	24.7	84.0	84.0	76.0		81.3 ± 4.6
	6-260-209	11-16-83	1	24.0	100.0	93.9			97.0 ± 4.3

[a]Includes station 4-300-285.

Table 3. Summary of red drum (Sciaenops ocellatus) acclimation time and hydrology of hauling water and stocking site during 1983.

Table 3. Summary of red drum (Sciaenops ocellatus) acclimation time and hydrology of hauling water and stocking site during 1983.

Bay system	Stocking site number	Stocking date	Water Temperature (C)			Salinity (o/oo)			Acclimation time (h)[d]
			Trailer[a]	Initial[b]	Final[c]	Trailer[a]	Initial[b]	Final[c]	
San Antonio	4-170-220	5-24-83	27.0	28.0	26.0	35.0	23.0	23.0	1.2
	4-170-219	5-25-83	26.0	27.0	24.0	36.0	22.0	22.0	1.0
	4-300-284	5-26-83	25.0	26.0	23.0	37.0	28.0	28.0	1.7
	4-300-285	5-26-83	25.0	26.0	23.0	37.0	28.0	28.0	1.8
	4-170-218	5-27-83	27.0	27.0	29.0	40.0	23.0	23.0	2.2
Corpus Christi	6-260-212	9-07-83	29.0	27.5	26.0	36.0	32.0	28.0	0.8
	6-260-209	9-08-83	28.0	28.0	26.0	36.0	27.0	25.0	0.8
	6-260-212	9-09-83	27.5	27.0	27.0	34.0	28.0	28.0	0.8
	6-260-209	9-10-83	27.0	27.0	28.0	28.0	25.0	24.0	0.4
	6-260-212	9-11-83	26.0	26.0	28.0	25.0	26.0	21.0	0.3
	6-260-209	9-12-83	26.5	26.5	28.0	27.0	22.0	20.0	0.6
	6-260-209	9-13-83	27.0	28.0	29.0	24.0	20.0	20.0	0.7
	6-260-209	11-09-83	22.5	23.5	18.0	27.0	27.0	22.0	0.2
	6-260-213	11-12-83	19.0	19.5	19.0	30.0	31.0	25.0	0.1
	6-260-212	11-13-83	25.5	25.5	28.0	32.0	31.0	27.0	0.0
	6-260-209	11-14-83	23.5	24.0	21.0	33.0	27.0	22.0	0.4
	6-260-209	11-16-83	21.0	20.0	22.0	34.0	23.0	22.0	1.0

[a]Average water temperature and salinity in hauling trailers at time of delivery to stocking site.

[b]Average water temperature and salinity of stocking site on day fish were placed in cages.

[c]Average water temperature and salinity of stocking site on day of survival check.

[d]Average acclimation time of all trailer-loads of red drum; calculated from time of first water exchange in trailer or barge to time last fish was released.

Figure 1. Bay systems of the Texas coast.

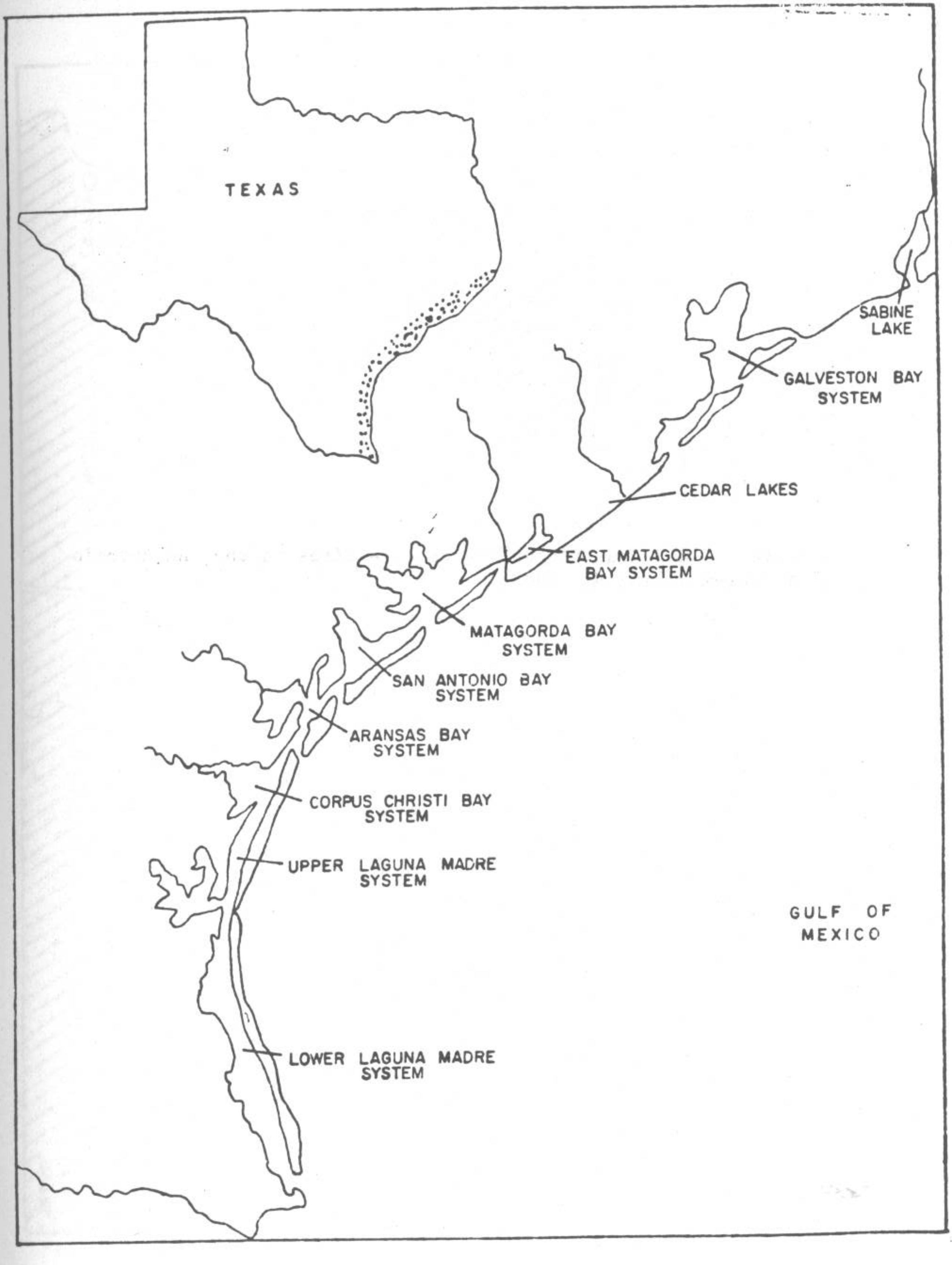
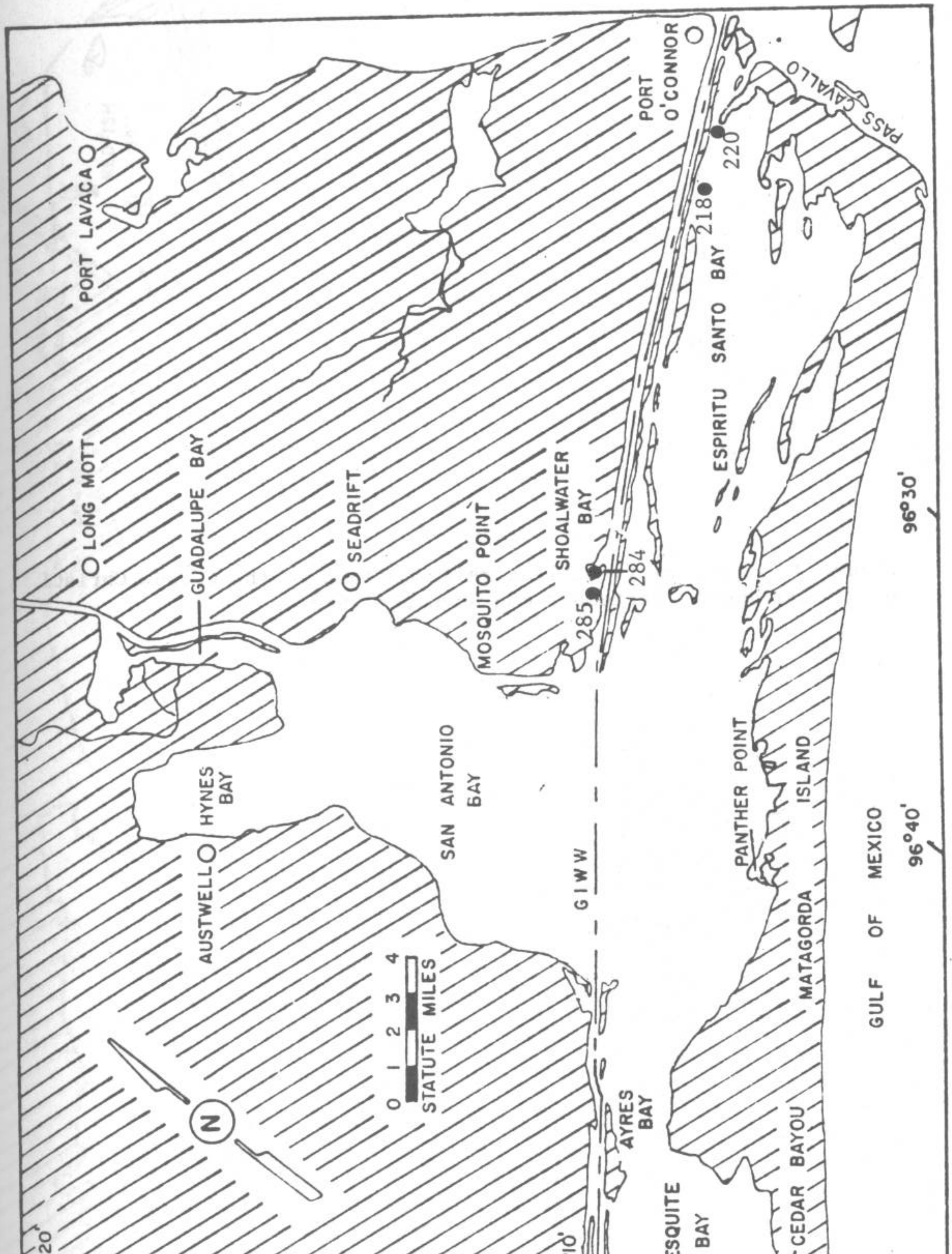

TEXAS
SABINE LAKE
GALVESTON BAY SYSTEM
CEDAR LAKES
EAST MATAGORDA BAY SYSTEM
MATAGORDA BAY SYSTEM
SAN ANTONIO BAY SYSTEM
ARANSAS BAY SYSTEM
CORPUS CHRISTI BAY SYSTEM
UPPER LAGUNA MADRE SYSTEM
LOWER LAGUNA MADRE SYSTEM
GULF OF MEXICO

Figure 2. Red drum fingerling release sites in the San Antonio Bay system during May 1983.


PORT LAVACA
LONG MOTT
GUADALUPE BAY
SEADRIFT
MOSQUITO POINT
SHOALWATER BAY
PORT O'CONNOR
ESPIRITU SANTO BAY
PASS CAVALLO
220
218
284
285
AUSTWELL
HYNES BAY
SAN ANTONIO BAY
GIWW
PANTHER POINT
MATAGORDA ISLAND
GULF OF MEXICO
96°40'
96°30'
0 1 2 3 4
STATUTE MILES
N
AYRES BAY
MESQUITE BAY
CEDAR BAYOU
28°20'
28°10'

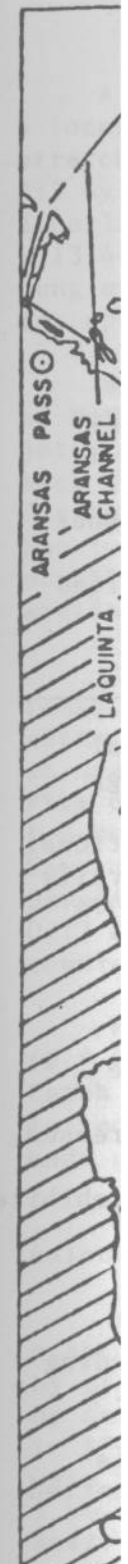
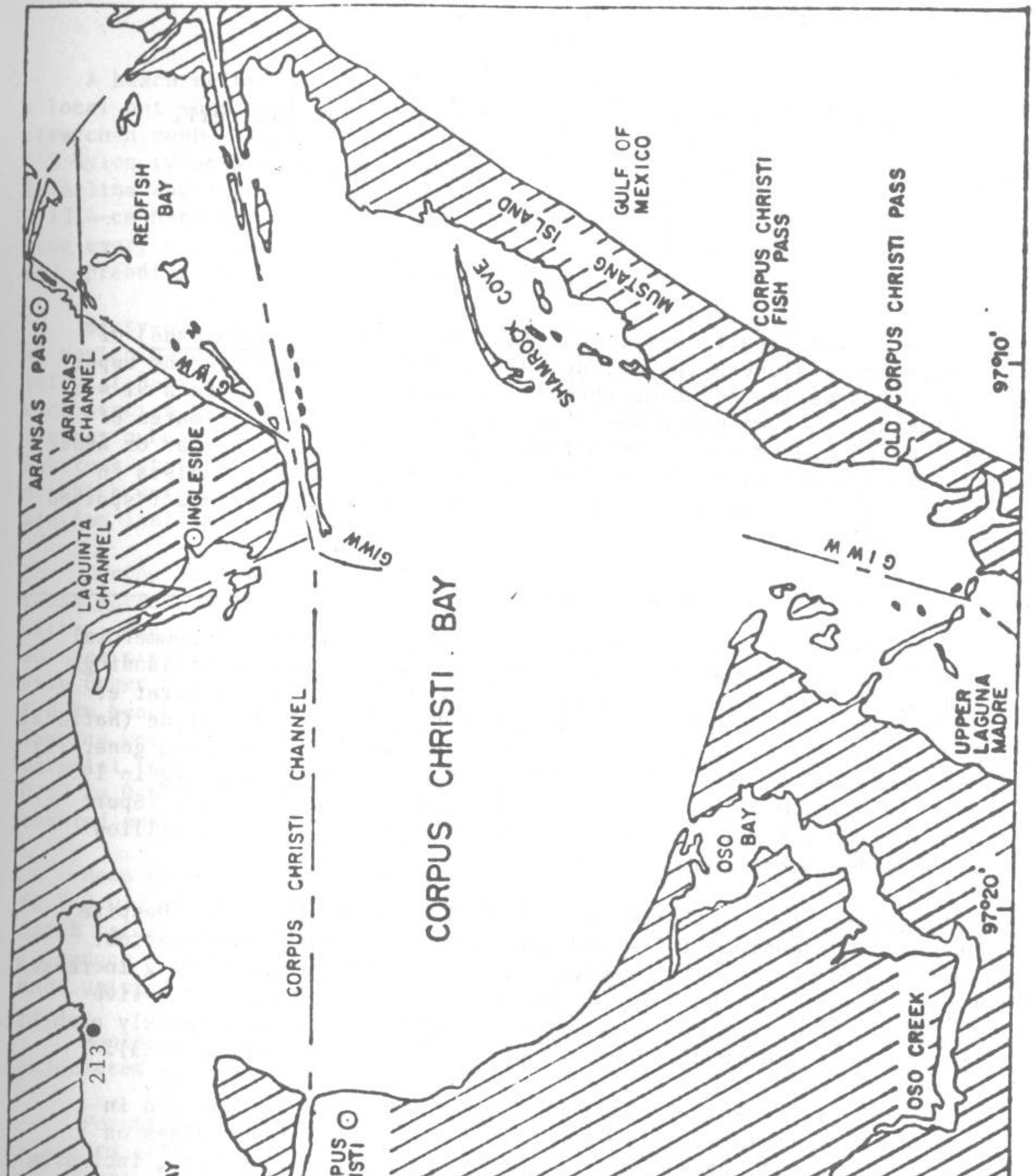


Figure 3. Red drum fingerling release sites in the Corpus Christi Bay system during September and November 1983.


ARANSAS PASS
ARANSAS CHANNEL
LAQUINTA CHANNEL
INGLESIDE
REDFISH BAY
GIWW
GIWW
GIWW
GULF OF MEXICO
MUSTANG ISLAND
SHAMROCK COVE
CORPUS CHRISTI FISH PASS
CORPUS CHRISTI PASS
OLD CORPUS CHRISTI PASS
97°10'
CORPUS CHRISTI CHANNEL
CORPUS CHRISTI BAY
UPPER LAGUNA MADRE
OSO BAY
97°20'
OSO CREEK
NUECES BAY
CORPUS CHRISTI
212
209
213
27°50'
27°40'
N
0 1 2 3 4
STATUTE MILES

SPOTTED SEATROUT CATCHES IN BEACH SEINES ON THE UPPER TEXAS COAST

by

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ABSTRACT

The potential impact on spotted seatrout (*Cynoscion nebulosus*) of sport beach seiners operating in the Gulf of Mexico surf along the upper Texas coast was estimated using the mean monthly catch rates in a 91.4-m beach seine and the estimated sport seining effort. Best estimates of potential catch ranged from 21,000 fish/year to 128,000 fish/year or about equal to the spotted seatrout harvest by weekend sport-boat anglers in Galveston Bay. Thus, unlimited beach seining may adversely impact spotted seatrout populations.

Spotted seatrout (*Cynoscion nebulosus*) support important commercial and sport fisheries along the Gulf of Mexico coast. Commercial landings averaged over 1.1 million kg/yr during the period 1950-1977 (Perret et al. 1980), and sport fishermen landed 5.6 million kg in 1979 alone (National Marine Fisheries Service 1984). In Texas, however, landings have generally declined since 1974. Commercial landings dropped from 905,000 kg in 1974 to less than 444,000 kg in 1980 (Anonymous 1979, Hamilton 1983). Sport fishermen landed 3.8 million fish/year in 1974-76 and only 1.4 million fish in 1979-80 (McEachron et al. 1981).

This decline is attributed to overfishing (Matlock 1982). Despite size, bag and possession limits and gear restrictions spotted seatrout availability decreased as the commercial value and illegal netting increased. To reverse this trend, the Texas Legislature prohibited sale of native fish in 1981. The use of nets by sport fishermen was simultaneously prohibited in some counties, and in all counties within 1 year (Anonymous 1983).

Displeased sport seiners attempted to reverse the prohibition in 1983. However, legislation allowing the use of 91.4-m long seines on Gulf beaches failed to pass. Available data indicated that nets, including seines, can impact spotted seatrout (Farley 1974, Matlock et al. 1978). However, the data did not specifically include seine catches by sport fishermen along the upper coast. Because of this, the objective of this study was to determine the potential impact of sport beach seines on spotted seatrout.

METHODS

A beach seine typically used by sport fishermen was purchased from a local net shop. The seine was 91.4-m long and 2.4-m deep with 7.6-cm stretched mesh. It was made with #9 nylon multifilament and hung with #12 nylon twine with 3 meshes per 15.2 cm without a pocket or bag. The floatline and leadline were 1-cm braided polypropylene, floats were 3.5 x 13.4-cm hard foam hung every 91.4 cm, and lead weights were 1 x 3.8 cm hung every 45.7 cm. A 2.4-m long 5 x 5-cm stake was attached to each end for spreading and pulling the seine.

Sixty-one shoreline stations, 1.6-km long, were marked along the Gulf of Mexico beach (Figure 1) on the 1982 NOAA nautical chart from the south jetty at Sabine Pass to the north jetty at Galveston. The mid-point of each station was identified by latitude and longitude. Each station was further subdivided into four equal 0.4-km segments for sampling purposes. Fourteen stations which could not be reached in two-wheel drive vehicles or which were obstructed by rubble or channels were eliminated from the station list.

During April 1983 through March 1984, beach seines were pulled by Texas Parks and Wildlife Department (TPWD) personnel at six randomly chosen sites. One station was chosen at random each month from the Bolivar Pocket, an area previously closed by the Texas Parks and Wildlife Commission (TPWC). Five other stations were chosen at random each month from the remaining 1.6-km beach segments. The 0.4-km segment was also chosen at random. Samples were collected between 1000 and 1600 hours. The seine was pulled parallel to the beach with one end on shore. The area covered ranged from 0.12 to 0.65 ha (mean 0.4 ± 0.01 ha). All spotted seatrout caught were counted and measured to nearest mm total length (TL).

Mean monthly spotted seatrout catch rates (No./drag) were compared ($P \leq 0.05$) using a one-way analysis of variance (Sokal and Rohlf 1981). Catch rates (No./drag + 1) were transformed to $\log_{10}$ prior to analysis to reduce variance heterogeneity. Multiple comparisons among means were made using the T-Method (Sokal and Rohlf 1981).

Monthly spotted seatrout mean TL and appropriate standard errors were calculated (Sokal and Rohlf 1981) with each fish caught given equal weight.

Potential spotted seatrout catch by sport seiners with appropriate standard errors was estimated by multiplying mean monthly catch/effort by effort. A range of potential effort expressed in seine drags was determined by assuming: 1) all 1854 people signing a petition presented to the TPWC in 1982 opposing the beach seine prohibition were seiners; 2) 3 people were required to operate a seine (TPWD used 3 people); 3) each drag required 1 hour (TPWD took 43.4 ± 2.3 minutes); 4) 2 hours/day were spent in non-seining activities; 5) there was no night seining; and 6) there was no illegal seining (i.e., no seines were pulled on weekends). The best estimate of effort was from 100 to 600 seines operated annually.

The mean number of trips/year (18), and the seasonal distribution of trips (25% in June-July) by saltwater boat owners (Ferguson and Green, in preparation) were considered to be the same for beach seiners. An average trip length of 3.5 hours determined through interviews with former beach seiners corresponded to the average trip length of saltwater boat anglers (McEachron et al. 1981). Months with statistically similar catch/effort were combined to estimate a single mean before multiplying by effort during those months.

RESULTS

The best estimate of annual spotted seatrout catch in sport beach seines ranges from 21,000 to 128,000 fish (C.V. = 60%) (Table 1). However, an annual catch of over 4,000,000 trout by 600 seines is possible (Table 2). The exact catch depends primarily on the number of seines operated during June and July because the catch rate during this period is over 10 times higher than in the period August through May (Table 3). If 100 seines were pulled once/day on 44 days in June-July over 47,000 trout would be caught (Table 4). To catch this same number of fish during August-May would require at least 3 drags/day on 220 days by 100 seines (Table 5).

Spotted seatrout were caught during each month except April and November. However, the mean monthly catches varied significantly ($F = 5.850$; d.f. $= 11,60$). Catches in July were higher than in all other months except June (Figure 2).

Spotted seatrout were usually distributed throughout the sample area except during the period November through March. At least 50% of the collections each month during May through October contained trout (Figure 2).

Spotted seatrout mean lengths varied among months but always exceeded 375 mm. Lengths generally increased during June through October (Figure 3). Fish smaller than the legal minimum size limit (356 mm) comprised 7% of the catch and were collected in June, July, September, October, and February (Figure 4).

DISCUSSION

A sport beach seine fishery can impact spotted seatrout populations. Spotted seatrout caught in beach seines and released probably would not survive. Fish were stressed by exposure to wave action and abrasive sediments, by handling, and by being gilled or entangled in the net. This observation agrees with Hegen et al. (1982) who stated that mortality rates were too high to rely on net-caught spotted seatrout for tagging studies. Conversely, most hook and line caught spotted seatrout do survive when released. Hegen et al. (1984) estimated that 74 to 95% of hook-and-line caught spotted seatrout would survive being released. Capture of spotted seatrout in beach seines would increase mortality on the spawning stock.

Spotted seatrout are present in the surf year round but are most abundant in summer. Mature spawners in the 350-450 mm size class (Overstreet 1983) were present in large numbers in June and July. McFarland (1963) caught spotted seatrout each month over a 15-month period (no samples collected September-November). Highest frequency of occurrence was in spring and summer. Pitts (unpublished manuscript) caught 25 spotted seatrout in a jettied and open beach front on Galveston Island in a 12-month study. Seventy-two percent (18) were caught during June-August.

Harvest with seines could be greater with fewer people than in hook-and-line fishing. The best estimate of harvest of spotted seatrout by 1854 sport beach seiners ranges from 20 to 120% of the landings of 93,000 weekend sport-boat fishermen in Galveston Bay in 1982-83 (Ditton and Fedler 1983, McEachron and Green 1984). The sport beach seine catch is obtained by exerting only 14% of the effort of weekend sport-boat fishermen in Galveston Bay (McEachron and Green 1984).

The impacts of overfishing (Matlock 1982) and the loss of at least 567,000 spotted seatrout during the freeze of December 1983 (McEachron et al. 1984) have resulted in fewer fish being available for capture. The prohibition of the use of nets by sport beach seiners has distributed the available catch to the greatest number of users.

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Table 1. Best estimate of potential sport beach seine catches of spotted seatrout in 100 to 600 seines in 18 annual fishing trips at 3.5 hours per trip. Catches are adjusted for 25% of annual trips in June-July.

Period	Seines		
	100	300	600
June-July	17,057	51,171	102,343
August-May	4,252	12,757	25,515
Annual	21,309	63,928	127,858

[a]Number of trips per year and seasonality from Ferguson and Green (in preparation).

[b]Mean trip length from McEachron et al. (1981)

Table 2. Potential annual catch of spotted seatrout in 100 to 600 seines, 1 to 10 drags per day, and 2 to 264 days fished. A seine is a 91.4 m beach seine operated by 3 persons.

Drags/day	Days fished [a]	Seines 100	Seines 300	Seines 600
1	2	1,173	3,519	7,038
	66	16,863	50,589	101,178
	132	33,725	101,178	202,356
	264	67,452	202,356	404,712
3 [b]	2	3,519	10,557	21,114
	66	50,589	151,767	303,534
	132	101,178	303,534	607,068
	264	202,356	607,068	1,214,136
5	2	5,865	17,595	35,190
	66	84,315	252,945	505,890
	132	168,630	505,890	1,011,780
	265	337,260	1,011,780	2,023,560
10	2	11,730	35,190	70,380
	66	168,630	505,890	1,011,780
	132	337,260	1,011,780	2,023,560
	264	674,520	2,023,560	4,047,120

[a] Percentages of days fished in June-July and August-May are equal.

[b] Legal limit of spotted seatrout is reached in 3 drags in June-July.

Table 3. Catch rates of spotted seatrout in a 91.4 m beach seine.

Period	Catch/drag	Catch/man-hour
June-July	10.83	3.61
August-May	0.90	0.30
Annual	2.55	0.85

Table 4. Potential catches of spotted seatrout (nearest whole number) in 100 to 600 seines, 1 to 10 drags per day and 1 to 44 days fished in June-July.

Drags/day	Days fished	Seines 100	300	600
1	1	1,083	3,249	6,498
	11	11,913	35,739	71,478
	22	23,826	71,478	142,956
	44	47,652	142,956	285,912
3 [a]	1	3,249	9,747	19,494
	11	35,739	107,217	214,434
	22	71,478	214,434	428,868
	44	142,956	428,868	857,736
5	1	5,415	16,245	32,490
	11	59,565	178,695	357,390
	22	119,130	357,390	714,780
	44	238,260	714,780	1,429,560
10	1	10,830	32,490	64,980
	11	119,130	357,390	714,780
	22	238,260	714,780	1,429,560
	44	476,520	1,429,560	2,859,120

[a] Legal limit of spotted seatrout is reached in 3 drags during June-July.

Table 5. Potential catches of spotted seatrout (nearest whole number) in 100 to 600 seines, 1 to 10 drags per day and 1 to 220 days fished during August-May.

		Seines		
Drags/day	Days fished	100	300	600
1	1	90	270	540
	55	4,950	14,850	29,700
	110	9,900	29,700	59,400
	220	19,800	59,400	118,800
3	1	270	810	1,620
	55	14,850	44,550	89,100
	110	29,700	89,100	178,200
	220	59,400	178,200	356,400
5	1	450	1,350	2,700
	55	24,750	74,250	148,500
	110	49,500	148,500	297,000
	220	99,000	297,000	594,000
10	1	900	2,700	5,400
	55	49,500	148,500	297,000
	110	99,000	297,000	594,000
	220	198,000	594,000	1,188,000

Figure 1. Area in which beach seine samples were collected during April 1983-March 1984.

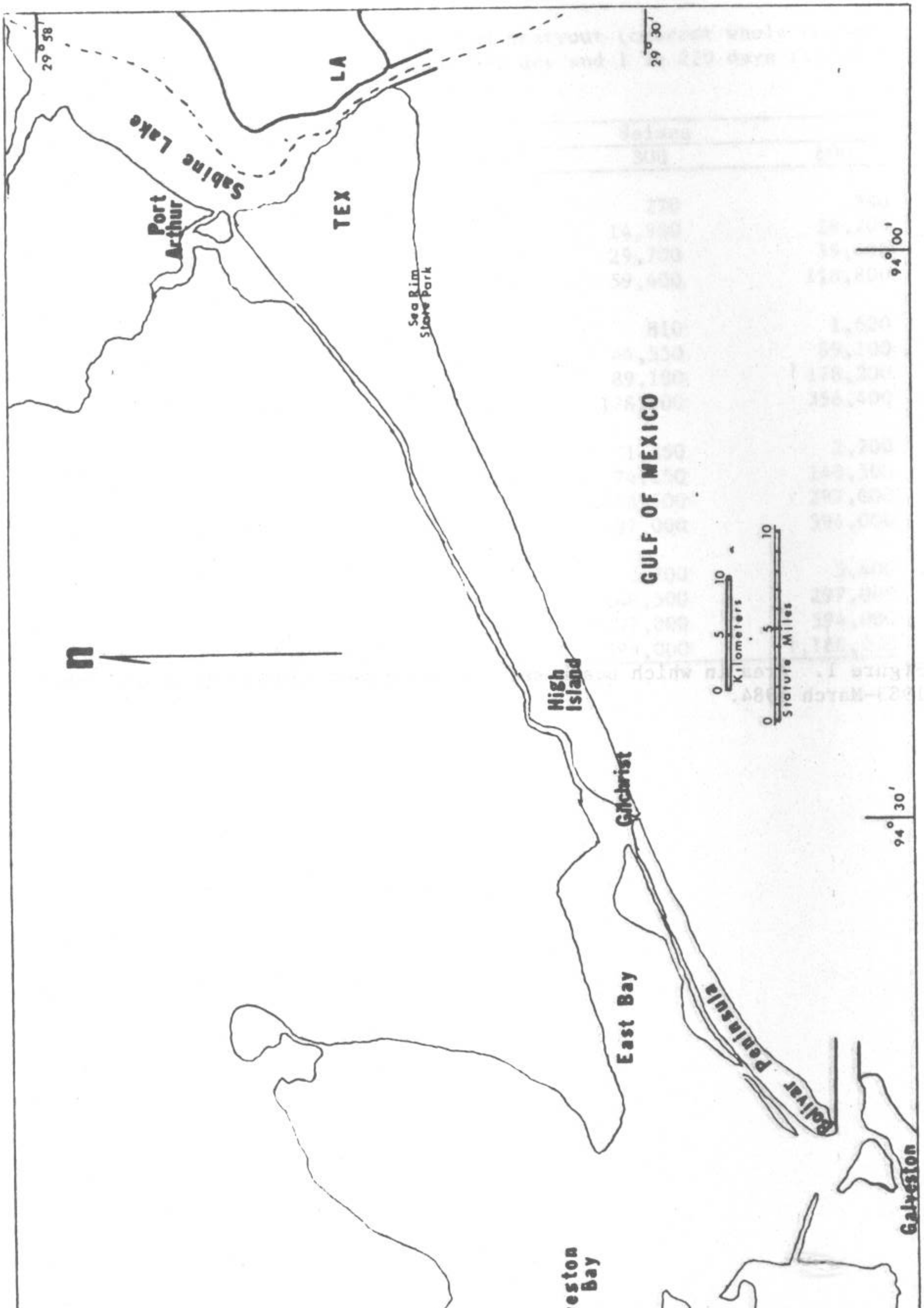
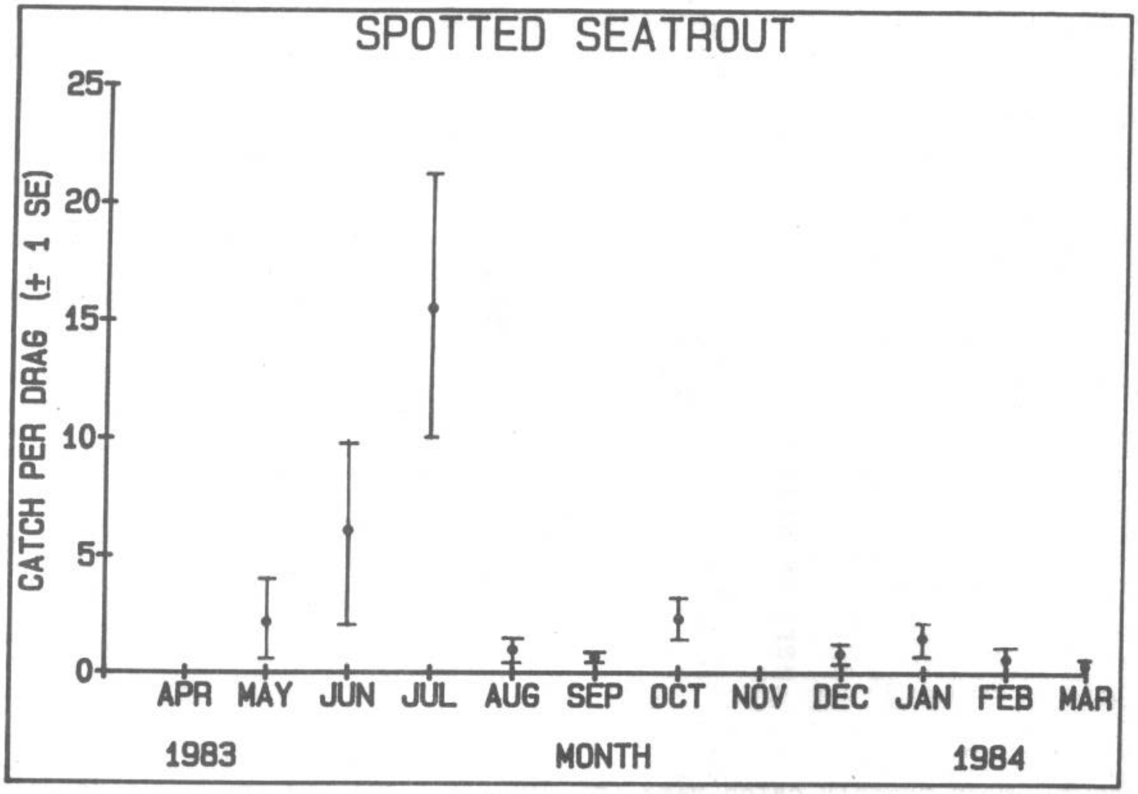

N
Sabine Lake
Port Arthur
LA
TEX
Sea Rim State Park
GULF OF MEXICO
High Island
Gilchrist
East Bay
Bolivar Peninsula
Galveston
Galveston Bay
0 5 10 Kilometers
0 5 10 Statute Miles
29°58'
29°30'
94°00'
94°30'

Figure 2. Mean monthly catch rate (No./drag ± 1 SE) and frequency of occurrence (%) of spotted seatrout in beach seines during April 1983-March 1984.


SPOTTED SEATROUT
CATCH PER DRAG (± 1 SE)
25
20
15
10
5
0
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
1983
MONTH
1984

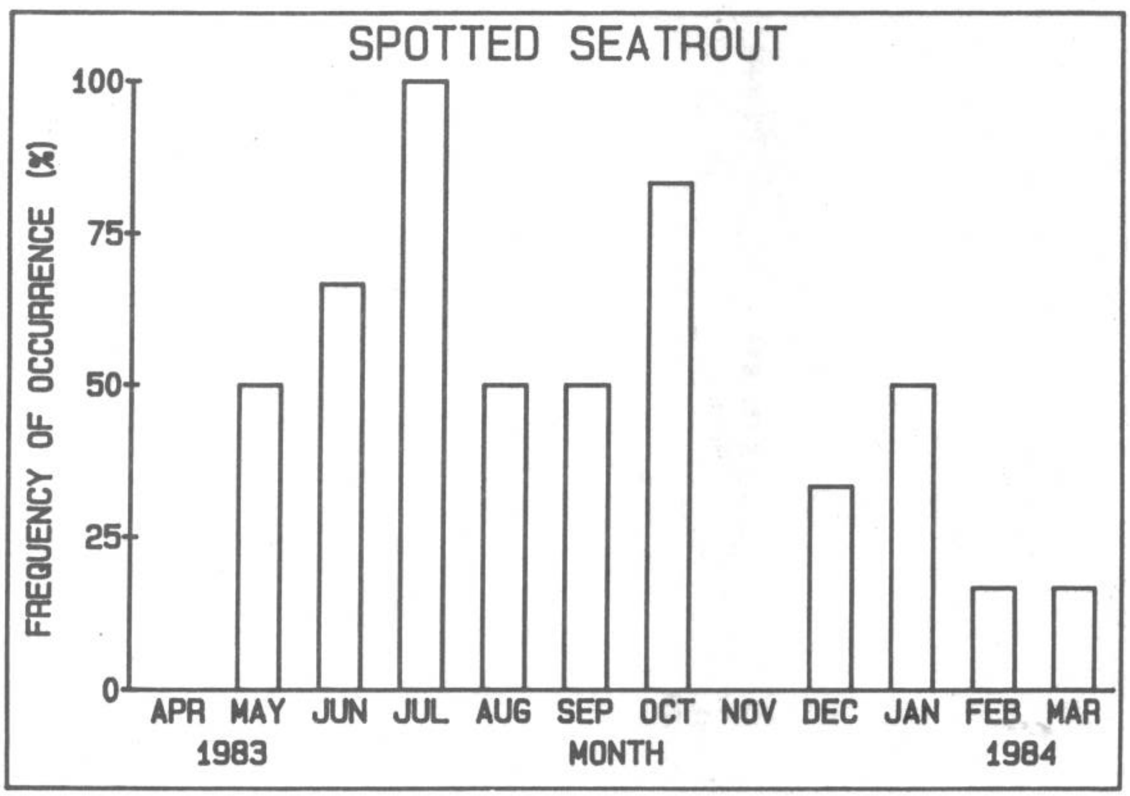

SPOTTED SEATROUT
FREQUENCY OF OCCURRENCE (%)
100
75
50
25
0
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
1983
MONTH
1984

Figure 3. Mean monthly TL (nearest mm ± 1 SE) of spotted seatrout in beach seines during April 1983-March 1984.

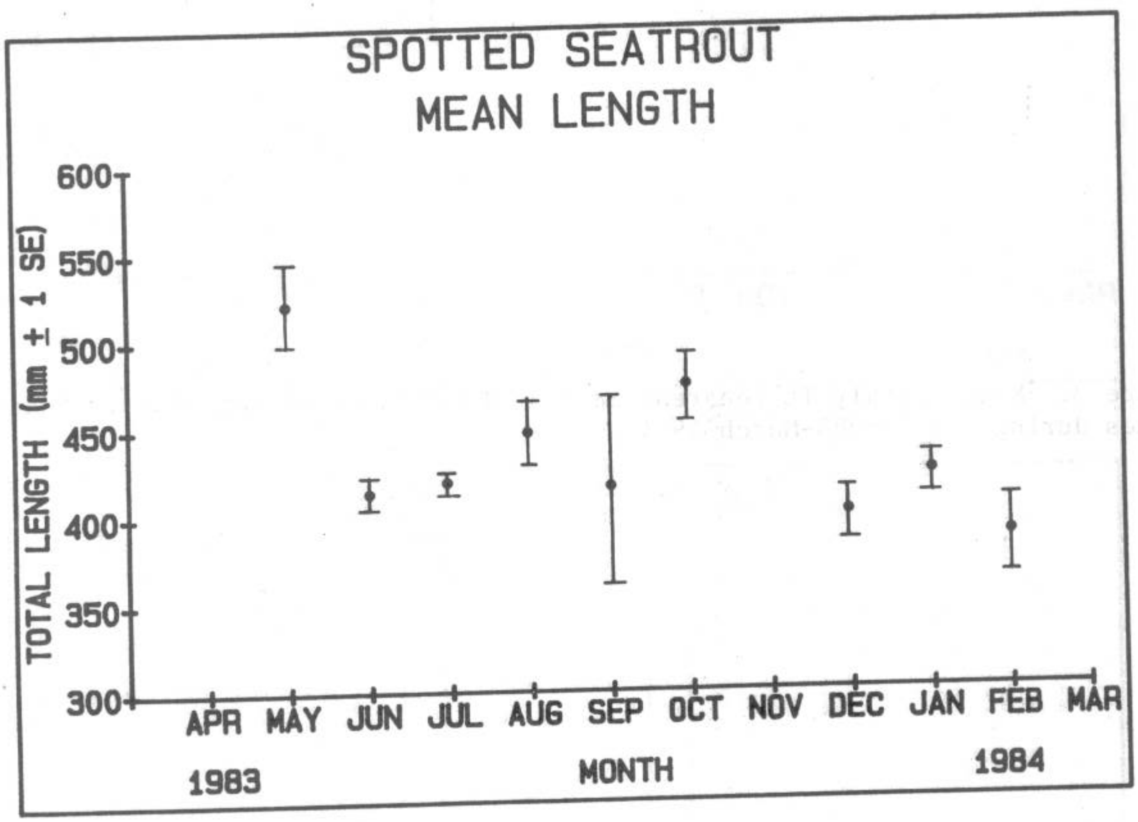
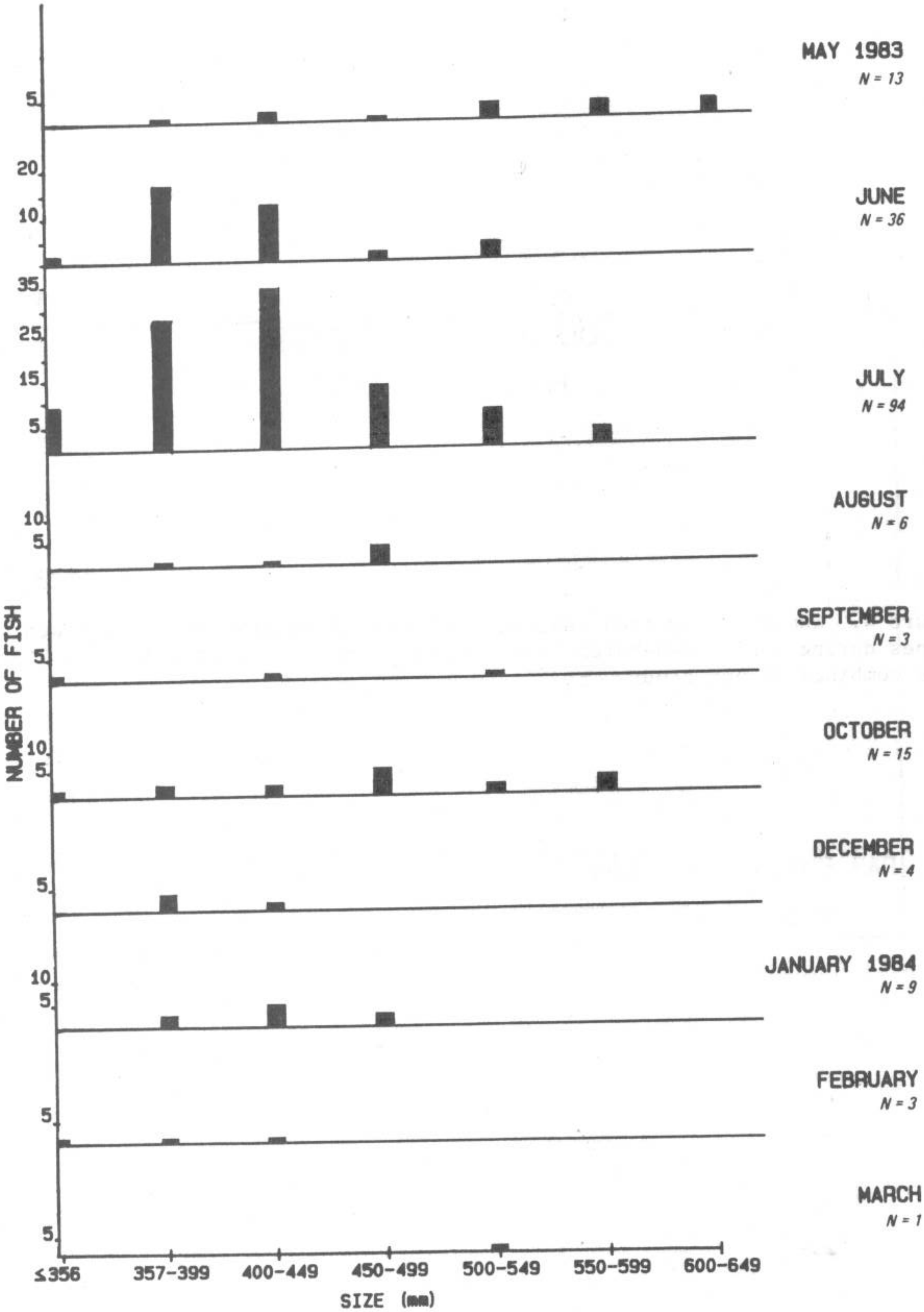

SPOTTED SEATROUT
MEAN LENGTH
TOTAL LENGTH (mm ± 1 SE)
600
550
500
450
400
350
300
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
1983
MONTH
1984

Figure 4. Number of spotted seatrout in 50-mm TL groups caught in beach seines during April 1983-March 1984. Fish $\leq$ 356 mm TL (minimum legal TL) were combined as one group.


MAY 1983
N = 13
JUNE
N = 36
JULY
N = 94
AUGUST
N = 6
SEPTEMBER
N = 3
OCTOBER
N = 15
DECEMBER
N = 4
JANUARY 1984
N = 9
FEBRUARY
N = 3
MARCH
N = 1
NUMBER OF FISH
≤356
357-399
400-449
450-499
500-549
550-599
600-649
SIZE (mm)

RESIDENCE OF CHARTER BOAT FISHERMEN IN TEXAS COASTAL WATERS

by

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ABSTRACT

Texas charter boat (headboat and party boat) fishermen were interviewed while the Texas Parks and Wildlife Department was surveying fishermen in three areas along the Texas coast: 1) Galveston Bay-Freeport area, 2) Aransas Bay-Corpus Christi Bay, and 3) lower Laguna Madre during September 1978-August 1981. The Galveston Bay-Freeport charter boats were primarily utilized year round by fishermen living in counties which border the bay or coast in that area. The majority of fishermen utilizing charter boats in the Aransas Bay-Corpus Christi Bay area were from non-coastal Texas counties. Charter boat utilization in the lower Laguna Madre area was dominated by non-coastal Texas county fishermen during the high use season and by out-of-state fishermen during the low use season.

The Texas charter boat (headboat and party boat) industry provides an economically important and popular form of recreation along the Gulf coast. Fishermen spent approximately $1.3 million in party boat fees during 1975 (Woods and Ditton 1979). Charter fishing continues to be successful in Texas with approximately 2.0 million fish being landed on bay and Gulf charter boats in 1981 (McEachron 1984).

The Texas Parks and Wildlife Department (TPWD) has been conducting surveys of the marine charter fishery since 1978. These surveys are designed to estimate a minimum annual total pressure and harvest by fishermen utilizing charter boats in Texas bays and in the Gulf of Mexico (McEachron 1984). The corresponding retention rates are utilized by fishery managers to monitor the status of the fishery. However, these rates are influenced by factors other than fish abundance, including fishermen's experience and preferences for size and species. Fishermen of different geographical origins (residence) may have different fishing success and expectations. Matlock (1983) and McConnel et al. (1978) showed that fish retention rates were significantly lower for resident than for non-resident sport fishermen along the Texas Gulf coast. Therefore, if changes in retention rates are to be used to reflect fish population changes, changes in the number of the fishermen in each residence category must be considered to explain possible variations in retention rates.

Texas coastal boat ramp, wade/bank and lighted pier fishermen were interviewed and the geographical origin data were presented by Heffernan et al. (1977), Breuer et al. (1977), and McEachron et al. (1981). Fishermen origin data for the charter fishery have not been previously published.

The objective of this study was to determine the geographic origin of fishermen utilizing the Texas marine charter fishery including the origin of weekday and weekend-day fishermen and bay and Gulf fishermen, in three charter fishing zones of the coast, to be used as a base to which comparisons can be made in determining changes in fishermen residences.

METHODS

Charter boats were surveyed by the TPWD on randomly selected days, from September 1978 through August 1979, and from September 1980 through August 1981, in three zones of the Texas Gulf coast: the upper zone (Galveston Bay-Freeport area), middle zone (Aransas and Corpus Christi Bays), and lower zone (lower Laguna Madre). The charter fleet, composed of at least 20 headboats and 175 party boats, was inventoried prior to the survey and was classified by capacity and fishing location as follows (McEachron 1980):

A. Capacity (Maximum number of fishermen carried):

1. Headboat: a boat, operated by a guide and crew, that carries >10 people for a fee;

2. Party boat: a boat, operated by a guide and crew, that carries ≤10 people for a fee.

B. Location of water area (relative to barrier islands and Gulf entrance of passes):

1. Gulf: that area seaward of the barrier islands and the pass entrances;

2. Bay: that area shoreward of barrier islands and the pass entrances.

Each year was divided into a high use season (15 May-20 November) and a low use season (21 November-14 May) on the basis of the distribution of annual fishing pressure (McEachron 1984, McEachron and Green 1984). During each season, interviews were conducted on 30 weekday and 14 weekend-days in the upper and middle zones, and 26 weekdays and 10 weekend-days in the lower zone.

Fishermen were interviewed aboard headboats during a trip, whereas fishermen interviews for party boats were conducted at the dock after a trip. Each fisherman was asked his/her state of residence; Texas fishermen were asked for their county of residence. Data were classified into "adjacent county", "other coastal county", "non-coastal county" or "out-of-state" categories. Counties considered adjacent in the upper zone were Brazoria, Chambers, Galveston, and Harris; adjacent counties in the middle zone were Aransas, Calhoun, Nueces, Refugio, and San Patricio; and adjacent counties in the lower zone were Cameron, Kenedy, and Willacy.

The residential origins of charter boat fishermen were determined only for identified charter boat fishermen fishing during the day on non-private boats. The residential category of a party boat interview was determined by the party's representative. Party boat surveys during the low use season were omitted due to small sample sizes.

Fishermen origin data were pooled by years, within zone, day type, and season. Interviews of the same boat type conducted on the same day in the same zone were treated as one interview. Data were pooled on a daily basis and daily mean percents of adjacent county fishermen were calculated and compared statistically for significant differences ($P \leq 0.05$) among zones, between day types (weekday-weekend-day), and between water areas (bay-Gulf) utilizing one-way analyses of variance with unequal sample size (Sokal and Rohlf 1982). Percents were converted to arcsine for the analysis to reduce variance heterogeneity. When significant differences were found, a GT2-method of multiple comparisons among pairs of means based on unequal sample sizes was used to determine similarities (Sokal and Rohlf 1982). A mean percent, using pooled data, was calculated when no differences were found between day types or between water areas.

RESULTS

Interviews were obtained from 107 headboat trips (3079 fishermen) and 186 party boat trips (726 fishermen) in the three different zones of the Texas coast during the high use season and from 52 headboat trips (1587 fishermen) during the low use season (Table 1).

The upper zone charter boats were dominated by adjacent county residents. Middle zone charter boats were dominated by non-coastal participants, whereas, the origin of participants of lower zone charter boats varied among other coastal and non-coastal counties and out-of-state (Tables 2 and 3).

During the high use season, no significant differences in the mean percentages of adjacent county fishermen on headboats and party boats were found between water areas or between day types within any zone except in the lower zone (Table 4) between bay and Gulf weekday headboat fishermen (Table 5). In the upper zone, the majority of headboat (55 ± 4%) and party boat (76 ± 6%) fishermen resided in adjacent counties (Table 2). Headboat and party boat fishermen from non-coastal counties accounted for 46 ± 8% to 69 ± 7% of the fishermen interviewed in the middle and lower zones (Table 2). Coastwide, fishermen from non-coastal counties accounted for 44 ± 1% of the total charter boat fishermen; adjacent counties accounted for 33 ± 1%; and out-of-state accounted for 14 ± 1% (Table 2).

In the low use season, the origin of upper zone headboat fishermen varied significantly between water areas and between day types except between bay and Gulf weekday fishermen and between bay and Gulf weekend-day fishermen (Table 6). Fishermen from adjacent counties constituted 76 ± 6% of the total number of upper zone weekend-day headboat fishermen (Table 3). In the middle zone, significant differences were found between day types for bay headboat fishermen and between water areas for weekday headboat fishermen (Table 7). Non-coastal residences constituted 53 ± 5% of the total number of bay weekend-day and Gulf weekday headboat fishermen (Table 3). No significant differences were found among water areas or day types for headboat fishermen in the lower zone (Table 8). Fishermen from out-of-state made up 62 ± 8% of all headboat fishermen in the lower zone (Table 3). Coastwide, fishermen from adjacent counties during the low use season accounted for 35 ± 1% of all bay and Gulf headboat fishermen; 34 ± 1% were from out-of-state; and 25 ± 1% were from non-coastal counties (Table 3).

DISCUSSION

The charter boat fishery on the Texas coast provides the opportunity for successful marine fishing. Charter boat fishermen have higher catch rates than non-charter fishermen (McEachron and Green 1983), because the guides' knowledge of the fishing areas and fishing methods exceed those of the average fishermen (Caillouet and Higman 1978).

Fisheries managers utilize catch rates to monitor the status of a fishery, but catch rates may be influenced by factors other than the abundance of fish. One important factor are the expectations of the fishermen. Catch rates are also influenced by charter operators who cater to their clients' desires (Ditton et al. 1978, McConnel et al. 1981). Matlock (1983) stated that non-resident private sport boat fishermen in Texas are generally more successful and have higher retention rates than Texas resident fishermen. One residential group of fishermen may obtain satisfaction with the quality of the fishing and others only with the quanity of the fish caught (Matlock 1983). Since different residential groups of fishermen may have different fishing expectations, fisheries managers should identify these groups and their associated expectations.

The Galveston Bay-Freeport charter boats were dominated by adjacent county residents, unlike the charter boats in the middle and lower zones. This may be due to the influence of Houston residents who utilized the convenience of the charter fishery rather than investing in their own vessels.

The majority of the charter boat fishermen in the middle zone were from non-coastal counties. This is similar to the findings of McEachron et al. (1981) for sport-boat fishermen. Ditton et al. (1978) stated that the majority of charter boat fishermen resided in the larger urban cities of the state: Dallas, Fort Worth, Houston, San Antonio and Austin.

The lower zone, with its warm climate and proximity to Mexico, was influenced by a seasonal variety of non-resident fishermen. The majority of the charter boat fishermen during the high use season were from non-coastal counties. This may indicate the popularity of the South Padre Island area to vacationing Texans during the summer. During the low use season, the largest percent of headboat fishermen were from out-of-state. This indicates the fishery is being utilized by the large population of tourists visiting the Port Isabel-Harlingen areas during the winter (Rush 1983).

Other coastal county fishermen did not play a major role in any zone. This may indicate coastal fishermen seek fishing opportunities primarily in areas where they have knowledge or experience.

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Figure 1. Three zones of Texas headboat and party boat activity (September 1978-August 1981).

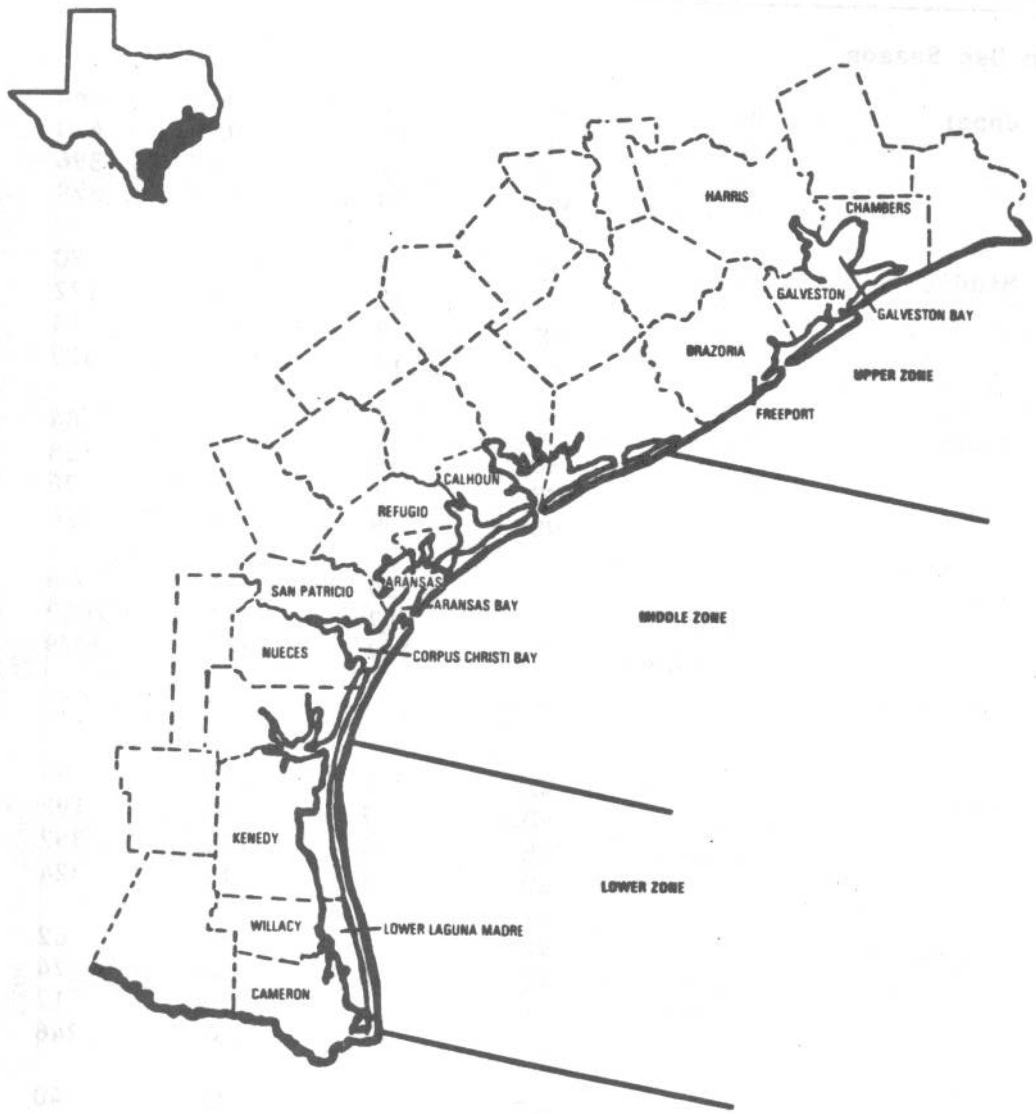
HARRIS
CHAMBERS
GALVESTON
GALVESTON BAY
BRAZORIA
UPPER ZONE
FREEPORT
CALHOUN
REFUGIO
ARANSAS
SAN PATRICIO
ARANSAS BAY
MIDDLE ZONE
NUECES
CORPUS CHRISTI BAY
KENEDY
LOWER ZONE
WILLACY
LOWER LAGUNA MADRE
CAMERON

Table 1. Total number of Texas bay and Gulf headboat (HB) and party boat (PB) interviews and total number of fishermen by weekday (WD) and weekend-day (WE) in the upper, middle, and lower zones during the high and low use seasons (September 1978-August 1981). ND indicates no data.

Zone	Water area	Day type[a]	Interview (No.)		Fishermen (No.)	
			HB	PB	HB	PB
High Use Season						
Upper	Bay	WE	2	6	64	14
	Bay	WD	11	10	428	34
	Gulf	WE	7	13	396	71
	Gulf	WD	20	20	829	114
Middle	Bay	WE	7	28	80	113
	Bay	WD	12	11	172	44
	Gulf	WE	3	10	73	39
	Gulf	WD	17	37	515	125
Lower	Bay	WE	4	11	84	38
	Bay	WD	14	29	238	99
	Gulf	WE	1	2	26	5
	Gulf	WD	9	9	174	30
Total	Bay		50	95	1066	342
	Gulf		57	91	2013	384
	Combined		107	186	3079	726
Low Use Season						
Upper	Bay	WE	2	ND	45	ND
	Bay	WD	9	ND	192	ND
	Gulf	WE	5	ND	352	ND
	Gulf	WD	8	ND	324	ND
Middle	Bay	WE	4	ND	62	ND
	Bay	WD	4	ND	74	ND
	Gulf	WE	1	ND	17	ND
	Gulf	WD	7	ND	246	ND
Lower	Bay	WE	2	ND	40	ND
	Bay	WD	4	ND	72	ND
	Gulf	WE	1	ND	32	ND
	Gulf	WD	5	ND	131	ND
Total	Bay		25	ND	485	ND
	Gulf		27	ND	1102	ND
	Combined		52	ND	1587	ND

Table 2. Percentage (± 1SE) of fishermen from adjacent county, other coastal county, non-coastal county and out-of-state encountered while surveying Texas bay and Gulf headboats (HB) and party boats (PB) by weekday (WD) and weekend-day (WE) in the upper, middle, and lower zones during the high use season (September 1978-August 1981). Number in parenthesis indicates number of surveys.

Zone	Water area	Boat type	Day type[a]	Adjacent (%)	Other Coastal (%)	Non-Coastal (%)	Out-of-State (%)
Upper	Bay (2)	HB	WE	38 ± 6	0	59 ± 7	3 ± 1
	Bay (11)	HB	WD	46 ± 8	3 ± 2	32 ± 7	18 ± 4
	Gulf (7)	HB	WE	62 ± 8	4 ± 2	29 ± 7	6 ± 2
	Gulf (19)	HB	WD	57 ± 5	2 ± 1	24 ± 4	17 ± 2
	Combined (39)			55 ± 4	2 ± 1	28 ± 3	14 ± 2
	Bay (6)	PB	WE	100	0	0	0
	Bay (9)	PB	WD	91 ± 9	9 ± 9	0	0
	Gulf (7)	PB	WE	60 ± 13	8 ± 9	25 ± 11	6 ± 5
	Gulf (13)	PB	WD	77 ± 8	0	10 ± 6	13 ± 7
	Combined (35)			76 ± 6	4 ± 3	12 ± 5	8 ± 4
Middle	Bay (7)	HB	WE	19 ± 11	16 ± 5	62 ± 9	2 ± 2
	Bay (11)	HB	WD	15 ± 7	5 ± 3	69 ± 8	11 ± 4
	Gulf (3)	HB	WE	8 ± 9	3 ± 4	73 ± 3	16 ± 11
	Gulf (17)	HB	WD	7 ± 2	10 ± 4	60 ± 5	24 ± 5
	Combined (38)			10 ± 2	10 ± 3	63 ± 4	18 ± 4
	Bay (11)	PB	WE	6 ± 3	42 ± 8	53 ± 10	0
	Bay (10)	PB	WD	25 ± 14	23 ± 13	52 ± 14	0
	Gulf (3)	PB	WE	13 ± 5	0	72 ± 12	15 ± 6
	Gulf (16)	PB	WD	11 ± 5	11 ± 6	55 ± 10	22 ± 8
	Combined (40)			11 ± 3	22 ± 6	56 ± 6	11 ± 4

Table 2. (Cont'd.).

Zone	Water area	Boat type	Day type[a]	Adjacent (%)	Other Coastal (%)	Non-Coastal (%)	Out-of-State (%)
Lower	Bay (4)	HB	WE	26 ± 8	14 ± 5	46 ± 10	13 ± 8
	Bay (12)	HB	WD	7 ± 5	7 ± 3	57 ± 10	28 ± 7
	Combined (16)			12 ± 5	9 ± 3	54 ± 8	24 ± 6
	Gulf (1)	HB	WE	46	0	54	0
	Gulf (9)	HB	WD	33 ± 6	1 ± 1	44 ± 10	9 ± 4
	Combined (10)			35 ± 6	1 ± 1	46 ± 8	8 ± 4
	Bay (9)	PB	WE	0	37 ± 20	63 ± 20	0
	Bay (23)	PB	WD	7 ± 5	18 ± 7	67 ± 9	8 ± 6
	Gulf (2)	PB	WE	0	60 ± 48	40 ± 48	0
	Gulf (8)	PB	WD	0	10 ± 10	90 ± 10	0
	Combined (42)			4 ± 3	22 ± 7	69 ± 7	5 ± 3
Coastwide	Bay (47)	HB		32 ± 2	5 ± 1	49 ± 2	14 ± 1
	Bay (68)	PB		21 ± 3	26 ± 3	52 ± 3	1 ± 1
	Combined (115)			28 ± 1	10 ± 1	50 ± 1	11 ± 1
	Gulf (56)	HB		38 ± 1	4 ± 1	41 ± 1	16 ± 1
	Gulf (49)	PB		32 ± 2	8 ± 1	45 ± 2	14 ± 2
	Combined (105)			36 ± 1	5 ± 1	42 ± 1	16 ± 1
	Bay and Gulf (103)	HB		36 ± 2	5 ± 1	42 ± 1	16 ± 1
	Bay and Gulf (117)	PB		24 ± 1	18 ± 2	49 ± 2	9 ± 2
	Combined (220)			33 ± 1	8 ± 1	44 ± 1	14 ± 1

Table 3. Percentage (± 1SE) of fishermen from adjacent county, other coastal county, non-coastal county and out-of-state encountered while surveying Texas bay and Gulf headboats (HB) by weekday (WD) and weekend-day (WE) in the upper, middle, and lower zones during the low use season (September 1978-August 1981). Number in parenthesis indicates number of surveys.

Zone	Water area	Boat type	Day type[a]	Adjacent (%)	Other Coastal (%)	Non-Coastal (%)	Out-of-State (%)
Upper	Bay (2)	HB	WE	76 ± 10	0	7 ± 5	18 ± 4
	Gulf (5)	HB	WE	76 ± 7	1 ± 1	16 ± 4	7 ± 4
	Combined (7)			76 ± 6	1 ± 0	15 ± 4	8 ± 4
	Bay (9)	HB	WD	35 ± 5	0	17 ± 6	48 ± 6
	Gulf (8)	HB	WD	42 ± 5	3 ± 1	13 ± 2	36 ± 5
	Combined (17)			40 ± 4	2 ± 1	14 ± 3	41 ± 4
Middle	Bay (4)	HB	WE	2 ± 2	22 ± 14	61 ± 8	14 ± 10
	Gulf (7)	HB	WD	6 ± 1	5 ± 4	51 ± 6	38 ± 8
	Combined (11)			6 ± 1	8 ± 5	53 ± 5	33 ± 7
	Bay (4)	HB	WD	30 ± 9	0	50 ± 20	20 ± 14
	Gulf (1)	HB	WE	35	0	35	29
	Combined (5)			31 ± 7	0	47 ± 16	22 ± 11
Lower	Bay (2)	HB	WE	11 ± 12	0	12 ± 15	30 ± 11
	Bay (4)	HB	WD	1 ± 1	0	12 ± 6	60 ± 23
	Gulf (1)	HB	WE	16	0	12	72
	Gulf (5)	HB	WD	21 ± 8	2 ± 1	6 ± 3	71 ± 7
	Combined (12)			14 ± 4	1 ± 1	9 ± 3	62 ± 8
Coastwide	Bay (25)	HB		32 ± 1	2 ± 1	24 ± 2	36 ± 2
	Gulf (27)	HB		35 ± 1	3 ± 1	27 ± 1	34 ± 2
				35 ± 1	2 ± 1	25 ± 1	34 ± 1

Table 4. Results of one-way analyses of variance comparing percents of adjacent county fishermen/boat trip on bay and Gulf weekday and weekend-day headboat and party boats in the upper, middle, and lower coastal zones during the high use season (September 1978–August 1981).

Zone	Source of variation	Headboat			Party boat		
		Mean square	Degree of freedom	F	Mean square	Degree of freedom	F
Upper	Total	285.178	38		1308.784	34	
	Boat day type	165.212	3	0.559	2649.093	3	2.246
	Error	295.460	35		1179.077	31	
Middle	Total	419.834	37		582.348	39	
	Boat day type	344.191	3	0.806	1395.432	3	2.711
	Error	426.509	34		514.591	36	
Lower	Total	137.593	25		37.844	41	
	Boat day type	534.902	3	6.412*	21.301	3	0.544
	Error	83.415	22		39.151	38	

* $P \leq 0.05$

Table 5. Results of multiple comparisons (GT2method) among mean pair for adjacent county fishermen on bay and Gulf weekday (WD) and weekend-day (WE) headboats in the lower zone during the high use season (September 1978-August 1981). [$X_j - X_i$] is given below the diagonal and MSD_{ij} above the diagonal.

		Headboat (ordered by magnitude of mean)						
		Bay WD	Bay WE	Gulf WD	Gulf WE	X	n_i	S^2
Bay	WD	-	15.28	11.67	27.54	3.42	12	52.99
Bay	WE	7.58	-	15.89	29.58	11.0	4	104.67
Gulf	WD	16.14*	8.56	-	27.89	19.56	9	117.28
Gulf	WE	23.58	16.0	7.44		27.0	1	1.0

* Significant at $P \leq 0.05$

Table 6. Results of multiple comparisons (GT2-method) among mean pair for adjacent county fishermen on bay and Gulf weekday (WD) and weekend-day (WE) headboats in the upper zone during the low use season (September 1978-August 1981). [$X_j - X_i$] is given below the diagonal and MSD_{ij} above the diagonal.

		Headboat (ordered by magnitude of mean)						
		Bay WD	Gulf WD	Gulf WE	Bay WE	X	n_i	S^2
Bay	WD	-	14.81	16.99	23.81	19.33	9	175.25
Gulf	WD	4.67	-	17.38	24.10	24.0	8	66.0
Gulf	WE	31.27*	26.60*	-	25.49	50.60	5	42.30
Bay	WE	33.17*	28.50*	1.90	-	52.50	2	180.50

* Significant at $P \leq 0.05$

Table 7. Results of multiple comparisons (GT2-method) among mean pair for adjacent county fishermen on bay and Gulf weekday (WD) and weekend-day (WE) headboats in the middle zone during the low use season (September 1978-August 1981). [$\bar{X}_j - X_i$] is given below the diagonal and MSD_{ij} above the diagonal.

		Headboat (ordered by magnitude of mean)						
		Bay WE	Gulf WD	Gulf WE	Bay WD	X	n_i	S^2
Bay	WE	-	11.82	21.08	13.33	0.75	4	2.25
Gulf	WD	2.68	-	20.16	11.82	3.43	7	5.62
Gulf	WE	19.25	16.57	-	21.08	20.0	1	1.0
Bay	WD	20.75*	18.07*	1.50	-	21.5	4	135.00

* Significant at $P \leq 0.05$

Table 8. Results of one-way analyses of variance comparing percent of adjacent county fishermen/boat trip on bay and Gulf weekday and weekend-day headboats in the upper, middle, and lower zones during the low use season (September 1978-August 1981).

Zone	Source of variation	Headboat Mean square	Headboat Degrees of freedom	F
Upper	Total	306.927	23	11.339*
	Boat day type	1481.877	3	
	Error	130.685	20	
Middle	Total	111.562	15	11.026*
	Boat day type	409.324	3	
	Error	37.122	12	
Lower	Total	97.363	11	1.294
	Boat day type	116.666	3	
	Error	90.125	8	

* $P \leq 0.05$

PHOTOPERIOD AND TEMPERATURE MANIPULATION TO INDUCE MATURATION OF A WARMWATER TROUT

by

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ABSTRACT

Rainbow trout (Salmo gairdneri) broodfish from the Firehole River, Wyoming were subjected to controlled photoperiod and water temperature cycles to induce sexual maturation at the Heart of the Hills Research Station, Ingram, Texas. During two annual cycles simulating conditions in the Firehole River, fish reached maturity when the decreasing photoperiod went below nine hours and water temperatures went below 14°C. Spawns were obtained both years by stripping, however, hatching success was very low.

Selected tailraces in Texas are stocked annually with rainbow trout (Salmo gairdneri) to provide put-and-take fisheries. Although water temperatures in these areas (13-20°C) are usually suitable for rainbow trout maintenance, temperatures can increase to 27°C (White 1968) thus limiting over-summer survival. Rainbow trout in these waters seldom achieve gonadal maturation because water temperatures rarely fall below 12.8°C, the upper limit for natural spawning (MacCrimmon 1971).

In an effort to furnish Texas trout fishermen with year-long fishing and a possible self-sustaining fishery, a search for a rainbow trout that could tolerate warmwater was initiated. In sections of the Firehole River receiving geothermal effluents, in Yellowstone National Park, Wyoming, rainbow trout survive summertime temperatures of 28.0-28.8°C and spawn in the fall at approximately 13.0°C (Kaya 1977). These rainbow trout are not genetically different from populations in cooler sections of the river, nor from the hatchery strains of rainbow trout used to originally stock the river (Fisher et al. 1982). Historically, stocked fish were spring spawners but in the heated environment they now spawn in fall (November-December) on a decreasing temperature and photoperiod (Kaya 1977). Fall spawning eliminates detrimental effects of high water temperatures on trout eggs and young (Hokanson et al. 1973). Firehole River rainbow trout thus appeared an ideal candidate for use in the Texas trout program because of their reported heat tolerance and fall spawning characteristic.

METHODS

Fifty rainbow trout (302 mm mean total length; 309 g mean weight), were captured from the Firehole River by electrofishing in May 1980 and transported with no mortalities to the Heart of the Hills Research Station, Ingram, Texas. In June an outbreak of Chilodon sp. caused 76% mortality. The remaining 12 fish were used to evaluate the effectiveness of photoperiod and temperature manipulation to induce maturation of trout in an indoor closed system.

Fish were fed live fathead minnows (Pimephales promelas) and goldfish (Carassius auratus) at a rate of 2-5% body weight/day. After 16 months the diet was changed and fish were fed a mixture of ground liver and artificial pelleted feed at a rate of 0.50-0.75% body weight/day. Diet was changed because deaths of three fish were believed due to nutritional deficiences (C. Smith, Fish Cultural Development Center, Bozeman, Montana, personal communication). Six trout (three of each sex) were then available for study.

Initially, fish were held in 800-liter circular fiberglass tanks at 10-15 ^{o}C with a 12-hour photoperiod. After 6 weeks they were transferred to two, 1,800-liter circular fiberglass tanks; the same photoperiod was maintained but temperature was increased 1 ^{o}C/day to ambient (20 ± 1 ^{o}C). Water was recycled through a gravel and rock filter. Four flourescent lights (40 W, 1.2 m) were placed 1.5 m above each tank.

In September 1980 a photoperiod and temperature regime (Table 1) was implemented to approximate seasonal environmental conditions in the Firehole River to provide stimuli for sexual maturation. Photoperiod was adapted from the Nautical Almanac Office (1965) and water temperatures were modified from Burkhalter (1979). Temperature was maintained with a chilling unit placed in the filter box of each tank and photoperiod was regulated with automatic timers.

Fish were weighed and examined monthly to adjust feed rates and to determine gonadal development. Daily or weekly examinations were made during spawning seasons to determine optimum time to strip-spawn fish. Females were considered ripe and stripped when the vent protruded, the abdomen became noticeably soft, and eggs flowed easily with only slight pressure. Males were considered ripe when the genital papilla protruded and milt flowed easily. Fish were stripped and eggs subsequently fertilized according to the dry method (Leitritz and Lewis 1980, Piper et al. 1982).

RESULTS AND DISCUSSION

In 1980 during the traditional fall spawning season (November-December), the rainbow trout were maturing and developing secondary sex characteristics. In November males developed hooked jaws and increased coloration while the abdomen of females protruded. By the third week in December a few developing eggs were obtained from two of the females and milt from one male. The fish were examined 1 week later and eggs could easily be stripped from females; however, several eggs were clear, a characteristic of overripeness (Leach 1923). Consequently, no eggs were collected. More frequent examination of these fish probably would have yielded ripe eggs. Flowing milt could be obtained from males for several weeks into January.

Prior to the next spawning season in 1981 males started to show signs of increased coloration. These signs of approaching sexual maturity commenced as temperatures decreased from 15.5°C in mid-September to 14.0°C in October. Females were ripe by the second week of December when two lots of mature eggs were taken (Table 2) and fertilized with milt from two males; water temperature at this time was 13.2°C and the photoperiod 9 hours. Two additional lots of eggs were collected in January 1982 at 13.8°C with a 9-hour photoperiod; however, these eggs were determined to be overripe.

In July 1982 male trout displayed secondary sex characteristics and were ripe during September-November. Abdomens of females became enlarged with eggs in August and they appeared nearly ripe by the end of October. During the first week in November one female appeared ripe and three lots of eggs were collected (Table 2). The eggs were fertilized with milt from two males, water hardened and incubated, however, all died within 10 days. The remaining females were examined every other day during the next 2 weeks and approximately 25-50% of their eggs were overripe; these fish were not stripped.

When stripping eggs, timing is obviously critical. Under the photoperiod and temperature cycle used in this study females apparently produce viable eggs for only 24-48 hours. Examination of maturing female fish at daily intervals is necessary so as not to miss individuals as they reach the critical point when eggs are capable of being fertilized. Males, however, apparently produce viable sperm for several weeks.

Other researchers have successfully used photoperiod to control spawning of rainbow trout (Kunesh et al. 1974, Harris 1979, Buss 1980) and brook trout (Salvelinus fontinalis) (Hoover and Hubbard 1937, Hazard and Eddy 1950, Allison 1951). However, the high incidence of egg mortality and deformed fry observed in this study (Table 2) are similar to results of Corson (1955) and Combs et al. (1959) who used artificially controlled lighting to spawn brook trout and salmon (Oncorhynchus nerka), respectively.

Rainbow trout in this study reached sexual maturity under a decreasing photoperiod and temperature regime similar to that described by Kaya (1977) for rainbow trout in the Firehole River. The fall spawning characteristic of the Firehole River trout was retained after translocation to Texas when provided with photoperiod and temperature conditions simulating that of their natal stream. This was the first known documentation of artificial breeding of rainbow trout in Texas. Hatching success of eggs was low but the results show sufficient promise to warrant further effort to develop practical procedures for rearing rainbow trout in Texas.

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Table 1. Photoperiod (hours) and water temperature (C) schedule used to induce maturation in Firehole River rainbow trout in the laboratory, Heart of the Hills Research Station, Ingram, Texas.

1980-1981			1982		
Date	Photoperiod	Temperature	Date	Photoperiod	Temperature
Sep 16	15	22.0	Jan* 01	09	13.5
23	14	22.0	10	09	15.0
30	13	20.0	20	10	15.0
Oct 07	12	19.0	Feb 10	11	16.0
14	11	18.0	20	12	16.0
21	10	17.0	Mar 01	12	17.0
28	09	16.0	15	13	18.0
Nov 04	08	15.0	Apr 01	14	19.0
11	07	14.0	15	15	20.0
18	06	14.0	May 15	15	21.0
25	05	13.0	Jun 01	15	20.0
Dec 02	05	12.0	10	15	19.0
09	05	11.0	15	14	19.0
16	05	10.0	20	13	18.0
Jan 01	09	13.0	Jul 10	12	16.0
Feb 01	10	15.0	15	11	15.0
Mar 01	12	16.0	20	11	14.0
Apr 01	13	18.0	Aug 10	11	13.0
May 01	15	18.0	Sep 01	10	14.0
Jun 01	15	17.0	10	09	14.0
Jul 01	15	17.0	30	08	14.0
Aug 01	14	17.0	Oct 01	08	13.5
Sep 01	10	16.0	08	08	12.5
15	09	15.5	Nov* 01	08	13.0
Oct 01	09	14.0	Dec 01	09	14.0
Nov 21	09	13.5			
Dec* 07	09	13.0			

* Indicates month eggs were collected.

Table 2. Summary of spawning activity for Firehole River rainbow trout induced to spawn with water temperature and photoperiod manipulation, Heart of the Hills Research Station, Ingram, Texas.

Spawning and development indices	1981	1982	
	Dec	Jan	Nov
No. egg lots collected	2	2	3
No. females stripped	2	2	1
Mean femal weight (kg)	0.99	1.02	0.79
No. eggs/kg female weight	1128	1842	2547
Spawning temperature (C)	13.2	13.8	12.8-13.0
Incubation temperature (C)	13.2	13.8	13.0
No. days to eyed eggs	15	-	-
Eyed eggs (mean %)	20.7	0	0
No. days to hatch (mean)	24	-	-
Hatch rate (mean %)	9.8	0	0
Deformed fry (mean % of those hatched)	14.4	-	-

Titles of Presentations Made During Panel Discussion on Freshwater Inflow

Introduction - Dr. Ed Klima; NMFS Galveston

Inland Needs - John Specht, Guadalupe-Blanco River Authority

The Role of the Texas Department of Water Resources - Gary Powell, Texas Department of Water Resources

Coastal Needs - Dr. Jeff Matthews, USFWS Galveston

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TEXAS CHAPTER

OF THE

AMERICAN FISHERIES SOCIETY

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