Status of Black Drum in Texas

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INTRODUCTION

Black drum (*Pogonias cromis* Linnaeus) are a valuable commercial and recreational marine finfish in Texas. Previous management decisions have often focused on the conflict between commercial and recreational fishermen. Management has attempted to reduce these conflicts by addressing recreational concerns without appreciably affecting commercial harvest.

Historical management regulations included gear restrictions and seasonal and aerial net closures. Gear restrictions have included such limits as maximum sizes for trotlines and nets; minimum mesh sizes; and restricting hooks and baits used on trotlines. Summer and weekend prohibitions of trotline and net usage accompanied aerial closures (Heffernan and Kemp, 1980). Current management regulations are limited to gear restrictions.

Black drum populations have been adversely and significantly impacted in recent years by short-term adverse environmental changes such as the severe freeze during 1983-84 that killed 225,000 black drum in Texas bays (McEachron *et al.*, 1984), and the outbreak of the red tide organism *Ptychodiscus brevis*, during 1985-86 that killed approximately 3,800 black drum in Texas bays (Hammerschmidt, 1987).

The objective of this paper is to report on the current status of the black drum fishery in Texas.

MATERIALS AND METHODS

Trends in Abundance

Texas Parks and Wildlife Department (TPWD) gill net and bag seine data were used to analyze trends in relative abundance of black drum. The TPWD initiated a standardized fishery independent monitoring program in 1975 using gill nets and in 1977 using bag seines to assess the relative abundance, size, and species composition of finfishes in Texas bays (Hegen, 1983). Gill nets set during spring (the 10-week period beginning the second full week of April) and fall (the 10-week period beginning the second full week of September), and monthly bag seine samples provide a statistically consistent and cost efficient method for obtaining information on adult, sub-adult, and juvenile finfish populations (Hegen, 1983; Hegen *et al.*, 1983; Matlock *et al.*, 1978; Matlock *et al.*, 1982; McEachron and Green, 1986).

June-July bag seine catch rates, the months of highest catch rates for black

drum (McEachron and Green, 1984a), were analyzed to determine trends in a relative abundance of juvenile black drum in Texas bays. A non-parametric goodness-of-fit test (Kruskal-Wallis) was used to test for differences among years. *A posteriori* non-parametric comparisons of mean ranks (Zar, 1974) were used to determine where significant differences occurred. Parametric analyses were not used since no transformation was found to reduce inequalities of bag seine catch rate variances.

Seasonal, spring and fall, gill net catch rates were analyzed to determine trends in relative abundance of sub-adult and adult black drum in Texas bays. A three-way ANOVA was used to test for differences among seasons, years, and bay systems. Mean catch rates were log transformed to meet the assumption of equal variances required for ANOVA. *A posteriori* analyses (Duncan's multiple range test) of log transformed spring and fall catch rates were used to test where differences existed when significant interactions occurred.

Recreational Harvest Trends

The recreational black drum fishery is made up of various components including private boat, wade bank, pier, party-boat and headboat fishermen. Surveys to estimate landings have been made routinely of private sport-boat fishermen since 1974 and of headboat and party-boat fishermen since 1983 (Osburn *et al.*, 1988). Surveys of wade/bank and lighted pier fishermen were made during 1974-76 and during 1978-80 (McEachron *et al.*, 1981). Since May 1983, total landings of black drum, including those from wade/bank and lighted pier strata, were estimated from private sport-boat landings using a linear regression equation (McEachron and Green, 1984b).

Annual private sport-boat catch rates of black drum were analyzed using a non-parametric goodness-of-fit test (Kruskall-Wallis) for differences among years. *A posteriori* non-parametric comparisons of mean ranks (Zar, 1974) were used to determine where significant differences occurred.

Commercial Harvest Trends

Mortality estimates. Mortality estimates were made using a computer program (Brownie *et al.*, 1978) that estimates survival and recovery rates from tag release-recapture data using equations developed with maximum likelihood theory (Fisher and Ford, 1947). S, the survival rate, and F, the recovery rate for individuals killed and tags reported, are estimated as percents. The remaining percent includes natural mortality, emigration, and unreported mortality of tagged fish killed by sport and commercial fishermen. Z, the instantaneous mortality rate, was obtained from S using Ricker's (1975) conversion table. Percent F, total fishing mortality including reported and nonreported tags, was recalculated as the number of tags returned the first year after tagging divided by the total number of tags released, and adjusted for the known reporting rate of

17% (Green *et al.*, 1983). Therefore M, other mortality, includes natural mortality and emigration.

The computer estimation program tests the data with four models, each with different assumptions concerning differences among tagged cohorts, tag recovery, and survival rates among periods.

Tag release and recovery data were obtained from black drum tagged during TPWD gill net and trammel net sampling and recaptured and reported by sport and commercial fishermen. From 1975 to December 1981, gill and trammel net sampling was conducted year round. Beginning in 1982, trammel netting was discontinued and intensive gill net sampling was conducted during spring and fall seasons (Hegen *et al.*, 1983). For 1975-1981, release periods were defined as January-June and July-August. After 1981, release periods were spring and fall gill net sampling periods. Recovery periods were defined to begin at the end of each release period and continue to the end of the next release period. Recovery periods after 1981 corresponded closely with existing high- and low-use private sport-boat fishing patterns (15 May-20 November and 21 November-14 May, respectively; Osburn and Ferguson, 1987). Tags recaptured during TPWD routine sampling were excluded from both releases and recaptures. Tag releases were decreased by 3% for 1-3 month tagging mortality and 12% for 9 month tag shedding rates for red drum (Elam, 1971). Shedding rates and mortality rates for red drum were used because the majority of the black drum in the experiment died before 3 months of disease problems that were not tag related. Tags returned before the end of the period in which the fish were tagged were excluded and the tag releases were decreased by the same number. Inclusion of those tags would have violated the assumption of the model that recovery periods are of equal length. Estimates were made for 4 different groups of data because of limitations of the size of arrays in the computer program. There was some overlap of years to provide survival estimates for all periods. Groups were: the second half of 1975 through the first half of 1977, the second half of 1976 through all of 1980, 1978 through 1982, and 1981 through 1987.

Distribution of mortality. The tag release-recapture estimate of mortality was partitioned into sport, commercial, and natural mortality.

RESULTS AND DISCUSSION

Trends in Relative Abundance

Results indicate that recent recruitment has not equaled the record 1981 levels. Black drum catch rates in bag seines ranged from 11/ha in 1986 to 16/ha in 1979 (Figure 1). Catch rates for the June-July season were significantly different among years ($\chi^2 = 91.56$, df = 9, $P \leq 0.01$). Recent catch rates (1985-1987) are significantly different from the high catch rate of 1979 (Table 1).

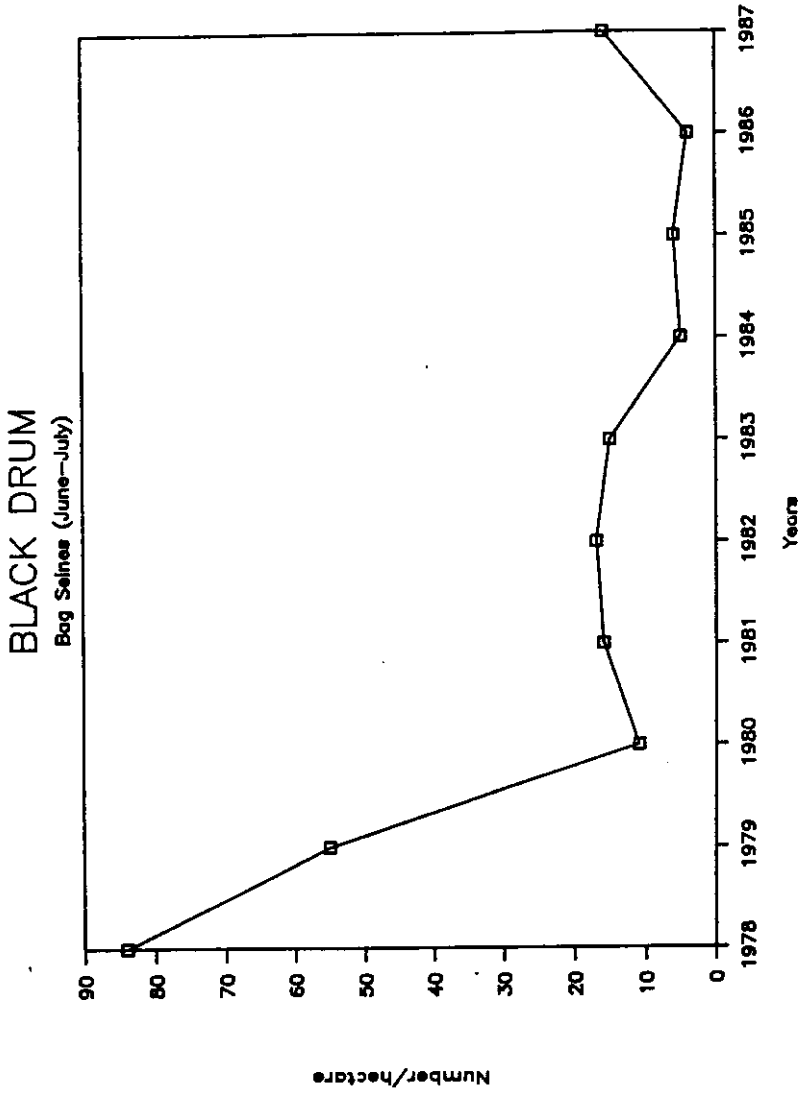

Figure 1. Catch rates of black drum in Texas Parks and Wildlife Department bag seines during season June-July. Catches are weighted by amount of shoreline in each bay system.

Table 1. Duncan's Multiple Range Test of the mean rank of seasonal (June-July) mean catch rate of black drum in TPWD bag seines from 1978-1987.

Ranked Year	Catch Rate No./ha	Duncan Grouping (P≤0.01)[a] 1	2	3
79	54	A		
78	84	A	B	
81	16	A	B	
82	17	A	B	
80	11	A	B	C
84	5		B	C
83	15		B	C
85	6			C
87	16			C
86	4			C

[a]Catch rates followed by the same letter are not significantly different.

Annual fall and spring gill net black drum catch rates varied among years (Figures 2 and 3). Catch rates were significantly different among years ($df = 11$, $F = 31.40$, $P \leq 0.01$), and bay systems ($df = 8$, $F = 17.38$, $P \leq 0.01$). *A posteriori* analysis of annual spring and fall catch rates indicates that the availability of black drum to TPWD gill nets is nowhere near previous high levels of 1976, 1980, 1982, and 1983. Lows after 1983 can be partially attributed to the freeze (Table 2).

Recreational Harvest Trends

An indirect measure of legal recreational fishing pressure is the number of fishing licenses sold each year. The number of recreational fishing licenses sold increased 315% from 1956, the initial year of sale, when 458,000 were sold, to 1983 when 1.9 million were sold (Figure 4). The number of licenses sold decreased by 5% from 1.9 million in 1982 to 1.8 million in 1984 due to reports of massive fish kills resulting from the December 1983 freeze. Since 1984 the number of licenses sold each year has generally increased. Of the total licensed fishermen in 1978-79, 38% fish in saltwater and only 8% of all fishermen restricted their activities to saltwater. In addition to licenses sold, 27% of all resident fishermen legally fished without a license (Green *et al.*, 1982).

Recreational private sport-boat landings estimates provide the most precise and longest term trend data for analyses of recreational fishing. Recreational private sport-boat fishing pressure has generally increased each year since 1976-1977 (Figure 5). There was a decrease in fishing pressure in 1984-1985 attributed to the December 1983 freeze. Fishing pressure in 1986-1987 was at its

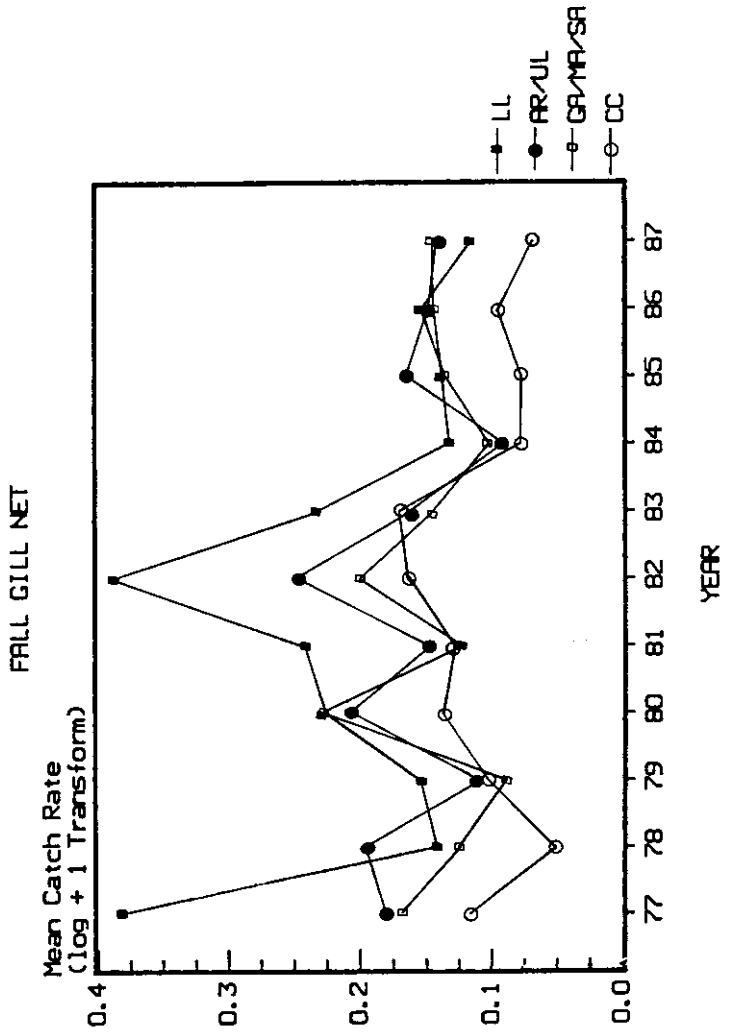

Figure 2. Fall gill net catch rates (+1 log transformed) by bay groupings, 1977-87. Key to abbreviations: AR = Aransas Bay, CC = Corpus Christi Bay, GA = Galveston Bay, LL = Lower Laguna Madre, MA = Matagorda Bay, SA = San Antonio Bay, UL = Upper Laguna Madre.

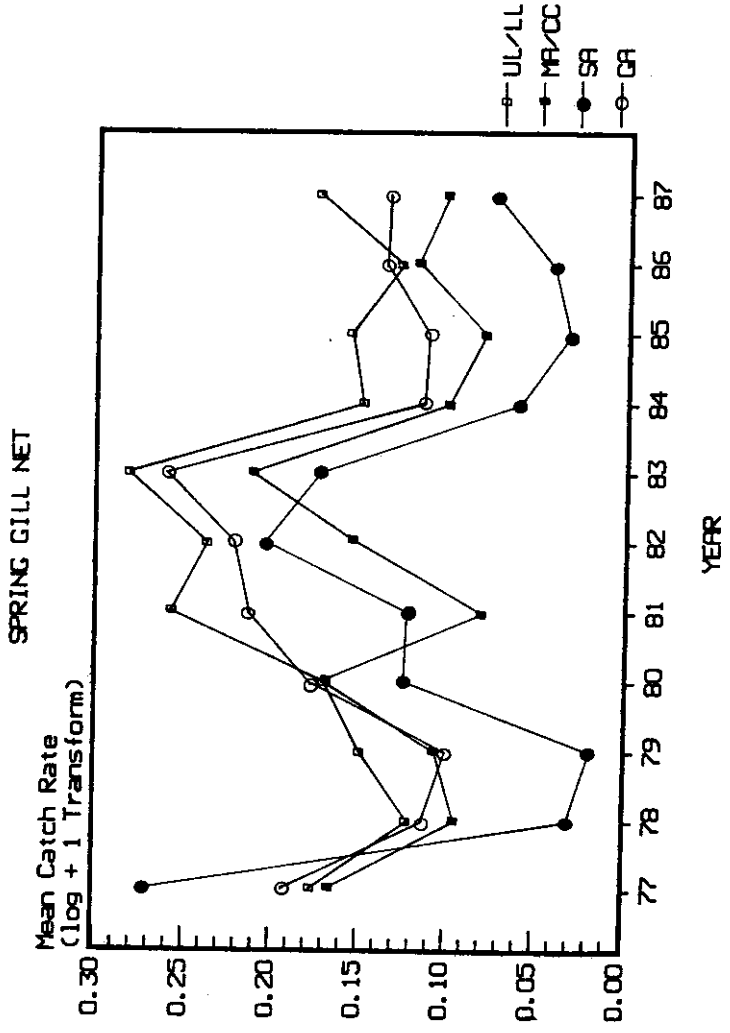

Figure 3. Spring gill net catch rates (+1 log transformed) by bay groupings 1977-1987. Key to abbreviations: CC = Corpus Christi Bay, GA = Galveston Bay, LL = Lower Laguna Madre, MA = Matagorda Bay, SA = San Antonio Bay, UL = Upper Laguna Madre.

Table 2. Duncan's Multiple Range Test of mean rank of seasonal (Fall, Spring) mean catch rate (+1 log transform) of black drum in TPWD gill nets from 1977-1987.

	Fall Bay[a] Groupings[b]				Spring Bay[a] Groupings[b]			
Years	**6**	**2, 3, 4**	**5, 7**	**8**	**2, 5**	**4**	**3, 6**	**7, 8**
1977	0.116 AB	0.168 ABCDE	0.180 ABCD	0.382 A	0.193 ABC	0.272 A	0.167 ABC	0.177 ABC
1978	0.051 B	0.124 DEF	0.195 ABC	0.141 B	0.113 C	0.030 CD	0.094 BC	0.121 C
1979	0.103 AB	0.088 F	0.108 CD	0.154 B	0.100 C	0.018 D	0.106 BC	0.150 BC
1980	0.137 AB	0.229 A	0.207 AB	0.225 B	0.179 ABC	0.125 BC	0.172 AB	0.171 ABC
1981	0.128 AB	0.122 DEF	0.146 BCD	0.241 B	0.214 AB	0.123 BC	0.079 C	0.258 AB
1982	0.163 A	0.200 ABC	0.248 A	0.389 A	0.222 AB	0.205 AB	0.151 ABC	0.237 ABC
1983	0.170 A	0.144 BCDEF	0.162 ABCD	0.232 B	0.261 A	0.173 B	0.212 A	0.282 A
1984	0.077 AB	0.101 EF	0.090 D	0.132 B	0.114 C	0.059 CD	0.100 BC	0.149 BC
1985	0.077 AB	0.135 CDEF	0.164 ABCD	0.137 B	0.112 C	0.031 CD	0.079 C	0.156 BC
1986	0.095 AB	0.152 BCDEF	0.147 BCD	0.144 B	0.137 BC	0.042 CVD	0.119 BC	0.127 C
1987	0.068 AB	0.115 DEF	0.141 BCD	0.145 B	0.135 BC	0.075 CD	0.102 BC	0.175 ABC

[a]2=Galveston Bay, 3=Matagorda Bay, 4=San Antonio Bay, 5=Aransas Bay, 6=Corpus Christi Bay, 7=upper Laguna Madre, 8=lower Laguna Madre.

[b]Catch rates with the same letter are not significantly different. Spring and Fall analyzed separately.

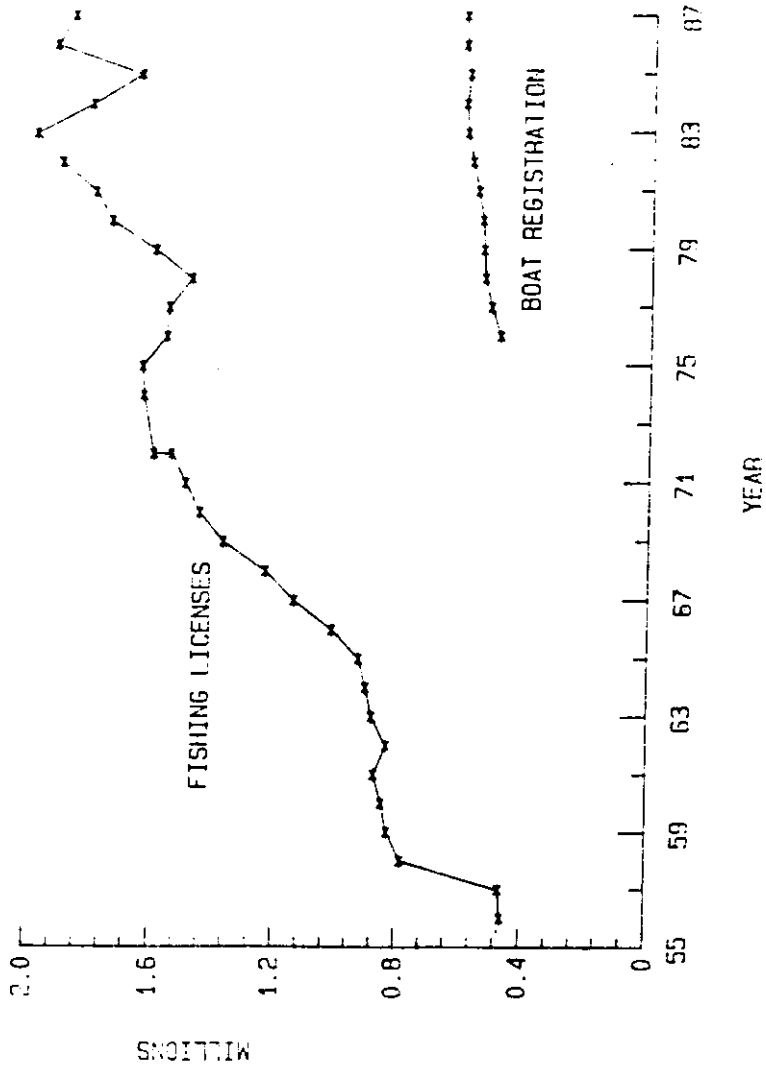

Figure 4. Number of recreational fishing licenses (1955-1987) and boat registrations (1975-1987) sold in Texas by fiscal year (1 September - 31 August).

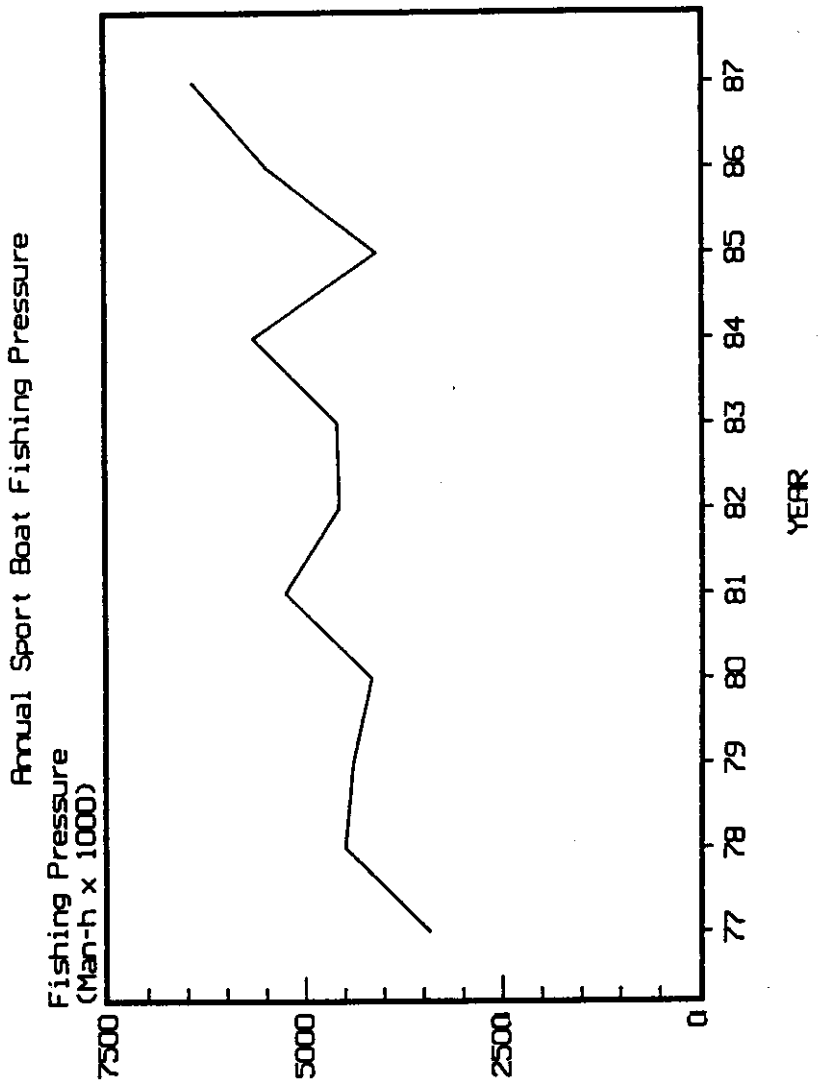

Figure 5. Annual private sport-boat fishing pressure (man-h x 1,000), 1977 - 1987.

highest level in 12 years and is expected to continue to increase.

Black drum were the sixth most often landed species by private sport-boat bay and pass fishermen. Although landings and CPUE for black drum decreased in 1983-84, recent landings and CPUE have leveled and 1986-87 estimates were similar to the three previous years at 57,900 fish and 0.1 fish/man-hour, respectively (Figures 6 and 7) (Osburn *et al.*, 1988). Catch rates for sport-boat fishermen were significantly different among years ($\chi^2 = 266.77$, df = 10, $P < 0.01$). Catch rates during years since the freeze are significantly lower than those before the freeze. This indicates black drum populations have not recovered to pre-freeze levels (Table 3).

Commercial Harvest Trends

A commercial fishery for black drum evolved in the 1920's. From 1977-84, commercial landings of black drum averaged 1.1 million lb annually; a high of 1.8 million were landed in 1978 (Osburn *et al.*, 1988). During 1977-87, annual ex-vessel value of black drum averaged $561,000 (Osburn *et al.*, 1988). Landings were greatest during winter and spring and occurred primarily in the Laguna Madre (Osburn *et al.*, 1988). The commercial pressure on black drum increased dramatically in 1981 when the Texas Legislature banned the commercial harvest of red drum and spotted seatrout. Most fishermen targeting those species shifted their emphasis to black drum (Figure 8).

Mortality Estimates

Model 1 (Table 4), assuming constant recovery rates for all tagged cohorts but varying survival and recovery rates among recovery periods, was clearly the best model for all data groups except 1976-1980. Both Model 0 and 1 were rejected at a probability of 0.02 (Table 5) while models 2 and 3 were rejected at even smaller probabilities; however, the survival estimates for individual recovery periods were similar to those estimated for other groupings of data with overlapping periods and the average estimate of survival was within the range of bounding groups. Survival estimates followed an upward trend; however, the three latest annual survival estimates are among the lowest five for all years (Table 6). Survival rates for spring 1982 and fall of 1983 exceeded 100% and for fall 1984 and spring 1986 were close to 100%. This is usually associated with poor data sets (recoveries), or in more adequate data sets where only a few fish were tagged in a particular year, or with long-lived species where the annual survival is normally high.

Variances and 95% confidence limits were very large. Examination of the tag releases and returns indicates adequate releases but very sparse returns with absence of any returned tags during the first recovery period in one case (Table 6). There has been a drop in the total number of tags returned since about 1981; this drop has apparently occurred for both sport and commercial fishermen. For

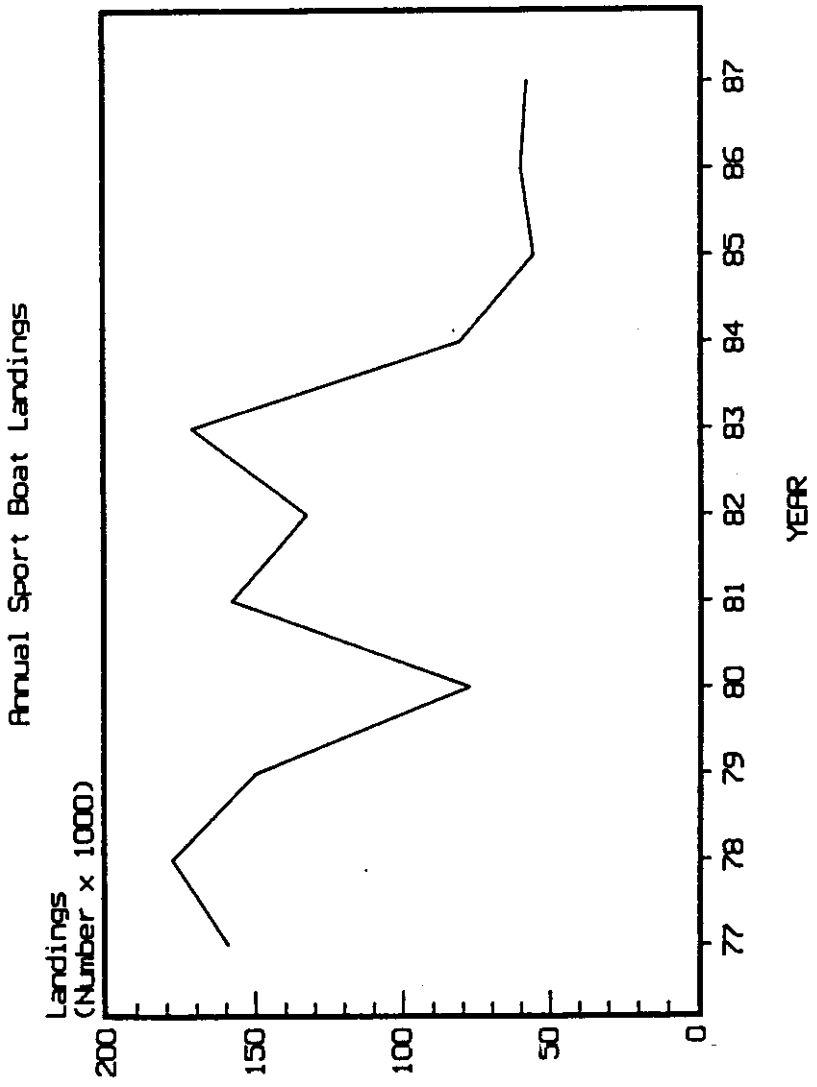

Figure 6. Private sport boat landings (number x 1,000), 1977 - 1987.

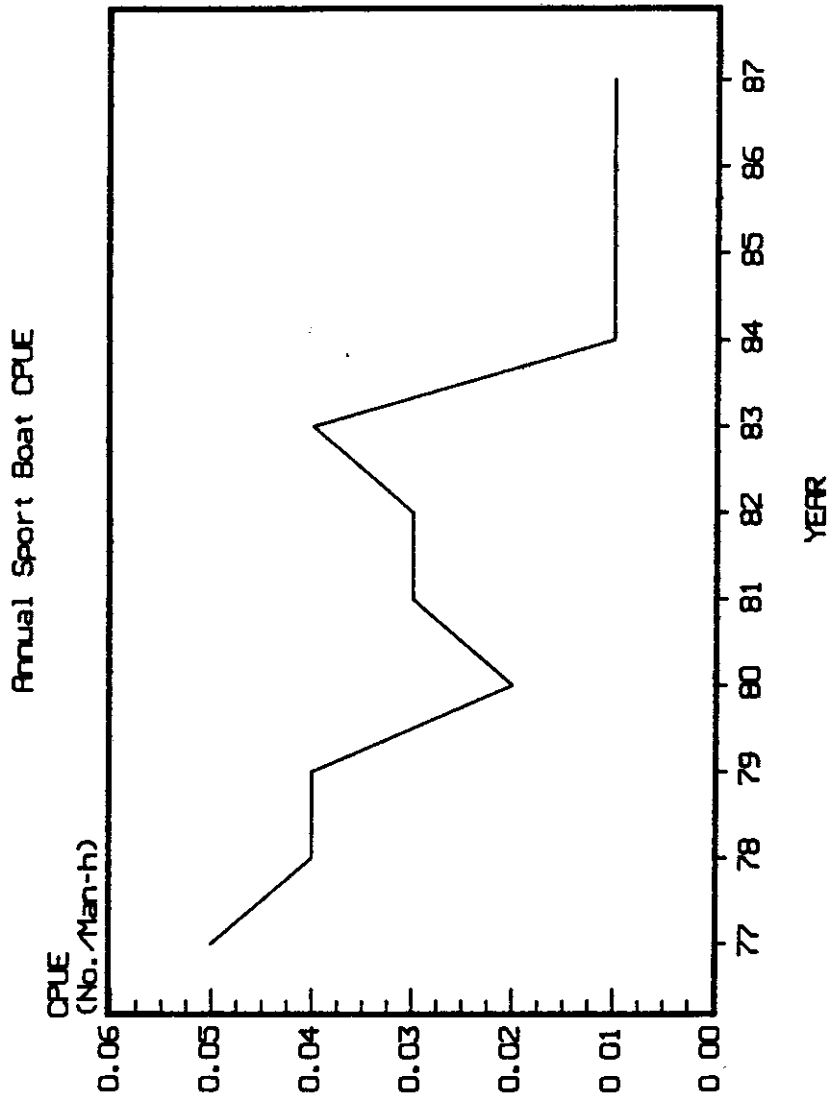

Figure 7. Sport boat fishermen catch rates (no./man-h), 1977 - 1987.

Table 3. Duncan's Multiple Range Test of the mean rank of annual sport-boat catch rates of black drum 1977-1987.

Ranked Year	Catch Rate No./man-hr	Duncan Grouping (P≤0.01)[a] 1	2	3	4
84	0.01	A			
86	0.01	A			
85	0.01	A			
87	0.01	A	B		
83	0.02		B	C	
81	0.03		B	C	
79	0.02		B	C	
80	0.02			C	
82	0.02			C	
78	0.02			C	D
77	0.03				D

[a]Catch rates followed by the same letter are not significantly different.

Table 4. Selected models and parameters estimated by the maximum likelihood theory release-recapture program (Brownie *et al.*, 1978).

Data set	Model	% survival Period	Annual S	%F	Instantaneous F	M	Z
7/1975 - 6/1977	1	45.8 ± 6.7	21.0	27.8	0.43		1.56
7/1976 - 12/1980		49.9 ± 3.6	24.9	30.0	0.42		1.39
1978 - 1982	1	53.9 ± 7.4	29.1	22.9			
1/1981 - 12/1986	1	55.3 ±13.4	30.6	10.8	0.13		1.18

example, the mean number of tags returned by sport fishermen during the first year after release was 14 from 1975-77 and 1976-78, in 1978-82 and only 4 in 1981-1986.

The estimates of fishing pressure declined through time; however, the adjustment for non-reporting was 17%. Tag reporting by commercial fishermen dropped to an extremely low rate beginning in 1981, when the sale of red drum and spotted seatrout was prohibited (Table 7). Even though the percent harvest by sport and commercial fishermen switched from an average of 34:66 during 1977-1983 to 66:34 during 1984-1987 the percent of tag returns changed from 41:59 sport to commercial to an 84:16 ratio since 1981.

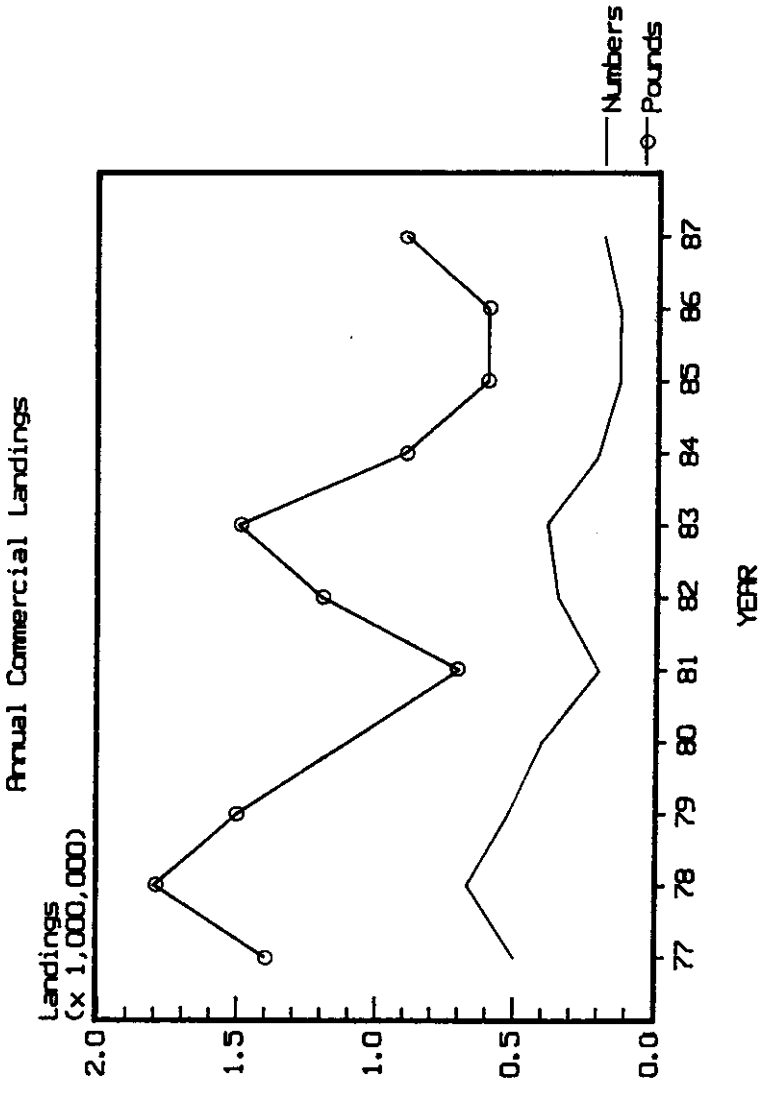

Figure 8. Commercial harvest trends (pounds x 1,0000,000 and number x million), 1977-1987.

Table 5. Results of goodness of fit tests for selecting the best model.

Year	Test 1a	2b	3c
1975-1977	χ^2 = 4.09, P > 0.05, df=3	χ^2 = 36.52, P < .01, df = 3	χ^2 = 8.05, P > 0.05, df = 7
1976-1980	χ^2 =16.13[d], P = 0.04, df=8	χ^2 = 50.56, P < 0.01, df = 8	χ^2 = 25.4[d], P > 0.02, df = 13
1978-1982	χ^2 = 13.66, P > 0.05, df=9	χ^2 = 37.06, P < .01, df = 9	χ^2 =18.10, P > 0.05, df =6
1981-1987	χ^2 = 11.85, P > 0.05, df=13	χ^2 = 27.79, P < .01, df =13	χ^2 =5.7, P > 0.05, df =14

[a] Test of the null hypothesis that 1st year recovery rates and/or survival rates are the same as those for cohorts tagges in previous year. (Model 1 vs. Model 0).

[b] Tes of null hypothesis that 1st year recovery rates are constant each year (an assumption of Models 2 and 3).

[c] Test of the null hypothesis that data fit Model 1.

[d] Eventhough the null hypothesis of test 1 was rejected at a P of 0.04 and the null hypothesis of test 3 was rejected, Model 0 was also rejected at P = 0.02 either and the simpler model (Model 1) is preferred (Brownie et al. 1978)

Table 6. Survival estimates by recovery period and annual % survival, % tags reported and % landings by sport and commercial fishermen.

Year Season	% S/ period	Annual % S	%tags reported		% landings (No.)	
			Sport	Commercial	Sport	Commercial
1976						
Spring	49.13					
Fall	24.62	12.10	54	46		
1977						
Spring	50.81					
Fall	60.61	30.8	34	66	25	75
1978						
Spring	59.67					
Fall	33.69	20.10	43	57	26	74
1979						
Spring	57.84					
Fall	61.97	35.84	33	67	29	71
1980						
Spring	14.53					
Fall	51.72	7.51	39	61	32	68
1981						
Spring	30.61					
Fall	56.44	17.28	65	35	57	43
1982						
Spring	138.17					
Fall	50.45	69.71	76	24	34	66
1983						
Spring	21.10					
Fall	123.65	26.09	91	9	36	64
1984						
Spring	14.67					
Fall	99.44	14.29	86	14	63	37
1985						
Spring	12.37					
Fall	46.70	5.78	94	6	64	36
1986						
Spring	90.82					
Fall	5.17	4.70	93	7	72	28
1987[a]						
Spring	62.92					
			84	16	66	34

[a]prelimanary estimate

Table 7. Number of tagged black drum released and recaptured, by recovery period.

RELEASES		RECAPTURES																								
PERIOD	NO.	752	761	762	771	772	781	785	791	792	801	802	811	812	821	822	831	832	841	842	851	852	861	862	871	872
752	399		4	5	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1					
761	1001			18	12	7	6	1	1																	
762	724				43	13	12	2	5																	
771	824					17	27	9	5	2	1															
772	422						25	7	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
781	1327							22	31	1	3	1	0	1	0	1										
782	1071								50	8	20	2	1	0	0	0	0	0	0	0	0	0	0	1		
791	487									9	8	2														
792	435										10	5	0	2												
801	225											9	5	0	0	1										
802	401												13	0	3	2	0	0	0	0	0	0	0	1		
811	355												5	8	2	2										
812	267													8	3	3	1	0	0	0	0	0	1			
821	268														3	1	0	0								
822	337															2	1	1								
831	319																2	0	0	2	0	1				
832	283																	0	0	1						
841	243																		2	1	0	1				
842	232																			1	0	0	1			
851	225																				4	2	0			
852	466																					11	3	1		
861	394																						2	0	1	
862	518																							12	4	
871	439																								5	
872	500																									3
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

CONCLUSIONS

Texas Parks and Wildlife data indicate that black drum populations may be in trouble in Texas. Bag seine data indicate a continued low recruitment while gill net data show that the availability of black drum has not recovered since the freeze of 1983-84. Catch rates of recreational fishermen are at historical lows.

The management of an important commercial and recreational species should be conservative. Based on this principle and on TPWD's long-term monitoring data, the Texas Parks and Wildlife Commission (TPWC) found it advisable in July 1988 to impose significant regulations on the hitherto basically unregulated black drum fishery. Regulations now require that recreational fishermen be limited to a 5 fish daily bag and 10 fish possession limit. A size slot limit of 14 inches total length minimum and 30 inches maximum was placed on both recreational and commercial fishermen.

In an historical move, the TPWC also banned the use of nets in all Texas bays as an added measure to protect the black drum. These regulations were designed to produce reductions in black drum fishing mortality of about 50% for recreational and about 40% for commercial fishermen.

TPWD will continue to monitor and manage black drum stocks in Texas marine waters in an effort to prevent depletion while maximizing the opportunities for harvest by all user groups.

LITERATURE CITED

Brownie, C., D.R. Anderson, K.P. Burrham, and D.S. Robson. 1978. Statistical inference from band recovery data: a handbook. U.S. Department of the Interior, Fish and Wildlife Service Research Publication Number 131.

Elam, L. 1971. An evaluation of fish tagging methods. Texas Parks and Wildlife Department Coastal Fisheries Project Report. **1971**:39-55.

Fisher, R.A. and E.B. Ford. 1947. The spread of genes in natural conditions in a colony of the moth *Paxaxiadomiula* l. *Heredity*. **1**:173-174.

Green, A.W., L.Z. Barrington, and G.C. Matlock. 1982. An estimation of the total number of Texas fishermen, 1 September 1978-31 August 1979. Proceedings of the 36th Annual Conference Southeastern Association of Fish & Wildlife Agencies. **36**: 241-251.

Green, A.W., G.C. Matlock, and J.E. Weaver. 1983. A method for directly estimating the tag reporting rate of anglers. *Transactions of the American Fisheries Society*. **112**(3): 412-415.

Hammerschmidt, P.C. 1987. Tide of the red death. *Texas Parks and Wildlife Magazine*. **45**(9):10-15.

Heffernan, T.L. and R.J. Kemp. 1980. Management of the red drum resource in Texas. *Proceedings of the colloquim on biological management of red drum and seatrout*. Gulf States Marine Fisheries Publication Number 5.

Hegen, H.E. 1983. Monitoring of coastal finfish resources for sport fish

Crew members do not seem to remain with one boat for long periods of time. During the summer, many schoolchildren were also employed on boats and had to be replaced when school reopened in October. In addition, crew members may or may not show up for work each voyage. It is not rare for a seine boat owner to find some of his crew missing at sailing time. On whim, crew members might attend festivals, take a day of rest, or go to the doctor. Fortunately, there are usually extra persons willing to join a crew for a trip. This flexibility and day-to-day workstyle is deeply ingrained in the fishing community both on and off the sea. In contrast, fish farming requires a very steady work commitment. Trips to cages must be made regularly to ensure production results.

COSTS

The cost of initiating a captural fishing venture in Fort Liberté is high. New boats cost over $250. Used boats cost $100 and up, depending on condition. Boats must be purchased with cash, not credit. Sometimes a boatbuilder will accept one-half down and the balance on delivery. Nets are made locally by the owner himself together with hired help who are paid per unit net sewn. The estimated total cost for beach seines is $500 to $600. These capital costs must be considered in the context of an average national per capita income of $300, with estimates as low as $100 for the rural sector.

Fort Liberté fishermen have made these investments in the past. At the present time, they rarely make new purchases. Instead, they conduct continual maintenance to keep boats and gear in operation. They patch their boats with cold tar every three to four months to prevent any major holes which would require professional repair by a local boatbuilder. Similarly, fishermen purchase net twine by the individual 1 pound spool ("boule") and repair holes in their seines every afternoon and all day Sunday. They rarely replace entire sections. No habit of saving money for future repairs was evidenced among the fishermen. If a boat is disabled, it might sit on the shore for over a month until the owner finds enough money for repairs. Whereas Pollnac *et al.* (1975) and Pollnac and Poggie (1978) interpret continual preventative maintenance as evidence of a deferred gratification orientation, we interpret this as short-term orientation. This orientation, as discussed later in this paper, influences fishermen's potential for engaging in cage culture .

Fishermen claim a lifespan of 25+ years for their boats and nets if properly maintained. We estimate that cages, as presently designed, must be replaced every five years by comparison. That life span could conceivably be prolonged if, as mariculturists, fishermen have the same commitment to maintenance. Lack of investment power and/or savings will constrain mariculture development. In order to make saltwater cage culture more economically feasible for the local population, our project is working to reduce the costs of material inputs.

by sport-boat fishermen in Texas marine waters. May 1974-May 1987. Management Data Series Number 150. Texas Parks and Wildlife Department, Coastal Fisheries Branch. Austin, Texas.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. *Bulletin of the Fisheries Research Board of Canada.* **191**:1-382.

Zar, J.H. 1974. *Biostatistical analysis.* Prentice-Hall, Englewood Cliff, New Jersey.