CLIMATE CHANGE EFFECTS ON FISH POPULATION AND ASSEMBLAGE DYNAMICS IN THE BAYS OF TEXAS

A Dissertation

by

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ABSTRACT

Climate change is affecting marine environmental conditions which can affect fish distributions, survival, and species interactions. The aim of this dissertation is to address how climate change may affect fish populations and community dynamics, using Texas as a study system. To address this issue, I first estimate a time series of fish species diversity, for spring and fall, in each of the eight major bays of Texas, and model diversity as a function of abiotic variables. I show that fish diversity has increased through time, and is significantly associated with climate-related variables. Next, I investigate impacts on populations of three abundant coastal species in Texas, Atlantic croaker (*Micropogonias undulatus*), black drum (*Pogonias cromis*), and spotted seatrout (*Cynoscion nebulosus*). I estimate a time series mortality rate for each species, and model mortality as a function of abiotic and biotic factors. I show that species diversity, temperature, salinity, and dissolved oxygen are significantly related to mortality and that increasing species diversity negatively impacts survival, likely due to competition and predation from expanding species. Finally, I investigate impacts on functional composition and diversity. I estimate two metrics of functional diversity through time and community weighted functional trait means to identify functional consequences of changing biodiversity. Additionally, I estimate interactions between commonly occurring and geographically expanding species using generalized additive models. I show that functional richness has increased, while functional dispersion has decreased (spring) or remained stable (fall), and that the assemblages are becoming more functionally homogeneous, with increasing abundance of long-lived, large, and higher in trophic level species. My research provides insight into climate effects on marine communities of Texas, and the results will be important for future conservation and management of the coastal ecosystems of Texas.

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CHAPTER I

INTRODUCTION

Species distributions and community assembly are generally recognized to be limited by abiotic filtering and competitive exclusion (Cody et al. 1975). Abiotic conditions filter species establishment within local habitats according to physiological limitations and habitat availability (MacArthur 1984), while competition determines which physiologically adapted species are able to coexist (Connell 1961, Macarthur and Levins 1967). Climate change has the potential to alter both abiotic and biotic conditions, through direct and indirect effects. In marine ecosystems, direct effects of climate change on abiotic conditions are expected to affect water temperature, salinity, acidity, dissolved oxygen, circulation, and stratification as well nutrient inputs (Doney et al. 2011, Seager et al. 2013). Indirect effects of climate change on biotic conditions can occur as a result of changing outcomes of species interactions in response to changing environmental conditions (Taniguchi et al. 1998, Grigaltchik et al. 2012). Climate change thus is expected to alter the distributions of marine species.

The mechanisms for how abiotic conditions can affect fish species can be direct physiological effects, or indirect effects on life history aspects such as phenology, competition, and predation. For example, in marine and aquatic species it has been widely demonstrated that abiotic conditions such as temperature, salinity, and pH directly affect condition, growth, and survival (Crecco and Savoy 1985, Claramunt and Wahl 2000, Fuiman and Werner 2009, Ohlberger et al. 2013). Temperature for example can directly affect growth rate due to increasing metabolic rate with increasing temperature (Jobling 1995). Meanwhile, salinity can affect metabolic rates via increased energetic cost of osmoregulation at high salinities (Swanson 1998). Additionally, ocean acidification may have the potential to impact fish via impacts on otolith growth, mitochondrial function, and metabolic rate (Heuer and Grosell 2014). As climate change leads to increasing ocean temperatures and acidity (Doney et al. 2011) and changing coastal salinities in response to changing surface-water availability and freshwater run-off (Seager et al. 2013), fish are expected to experience direct physiological impacts.

In addition to direct physiological impacts of abiotic conditions, indirect impacts may occur. For example, the match-mismatch hypothesis posits that for years in which peak resource availability (i.e., prey) occurs too early or too late in relation to reproduction, recruitment will be low as larvae are heavily resource limited (Cushing 1990). Indirect effects of changing abiotic conditions may also occur in the form of species interaction mediation, whereby abiotic conditions mediate the outcome of competition and predation. For example, brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and creek chub (*Semotilus atromaculatus*) showed varying competitive ability in response to an elevational and temperature gradient (Taniguchi et al. 1998). Meanwhile, differential responses to thermal stress by a predator species, Australian bass (*Macquana novemaculeata*), and its prey species, eastern mosquitofish (*Gambusia holbrooki*) led to changing outcomes of the predator-prey interaction (Grigaltchik et al. 2012).

The previous examples demonstrate the importance of both direct and indirect abiotic effects on the survival and distribution of fish species. Climate change is currently leading to changing abiotic conditions in many marine ecosystems (Doney et al. 2011), and as a result, species may shift their distributions to remain within optimal environmental conditions (Perry et al. 2005, Pinsky et al. 2013). As species shift their distributions, communities may experience changing species and functional diversity (Hiddink and Ter Hofstede 2008, McLean et al. 2018). Species and functional diversity are important community metrics, as they are often positively associated with ecosystem functioning, services, and stability (Hooper et al. 2005). It is therefore expected that as fish communities change in response to climate change, impacts on ecosystem functioning may occur. Understanding how ecosystem services and functioning may be altered in response to climate change will be crucial for identifying future conservation and management priorities for marine ecosystems.

Using the coastal bays of Texas as a study system, this work seeks to identify significant climate impacts on marine ecosystems, in order to better inform future conservation and management. In order to accomplish this, I approach the issue from species diversity, population-level, and functional diversity perspectives. In Chapter II, I identify how species diversity has changed through time in the bays of Texas and relate those changes to potential abiotic drivers. In Chapter III, I estimate mortality for three widely abundant species, Atlantic croaker (*Micropogonias undulatus*), black drum (*Pogonias cromis*), and spotted seatrout (*Cynoscion nebulosus*), and identify significant abiotic and biotic variables related to changing mortality rates. In Chapter IV, I determine how functional diversity and composition have changed through time in the bays of Texas and identify evidence of significant species interactions related to changing functional composition.

CHAPTER II

CLIMATE EFFECTS ON FISH DIVERSITY IN THE SUBTROPICAL BAYS OF TEXAS[1]

II.1 Introduction

Biodiversity is recognized as an important community metric for conservation and management due to positive associations with functional diversity and redundancy, and thus with ecosystem stability, resilience, and functioning (Tilman and Downing 1994, Tilman et al. 1997, Hooper et al. 2005, Stachowicz et al. 2007). Additionally, biodiversity has been shown to be associated with productivity (Hooper et al. 2005, Danovaro et al. 2008, Micheli et al. 2014). Therefore, the maintenance of biodiversity should be one of the top priorities for both conservation and fishery management purposes.

Despite the importance of maintaining marine fish diversity, it is currently changing at an unprecedented rate globally (Worm et al. 2006, Hutchings et al. 2010). Global marine biomass is predicted to decrease substantially over the next century in response to a changing climate especially at higher trophic levels (Jones et al. 2014, Lotze et al. 2019); this will likely negatively impact marine biodiversity (Bryndum-Buchholz et al. 2019). On the other hand, in some temperate coastal ecosystems, the changing climate has led to an expansion of tropical species leading to increased fish diversity (Murawski 1993, Beare et al. 2004, Collie et al. 2008, Hiddink and Ter Hofstede 2008). In general, the response of marine ecosystems to changing climate is highly variable among regions. Consequently, our ability to predict regional changes in biodiversity from climate change is still limited.

While many threats to biodiversity come directly from human interaction through habitat degradation (e.g., increased nutrient input from agriculture, pollution by pesticides and

[1]Reprinted with permission from "Climate effects on fish diversity in the subtropical bays of Texas." By Michaela Pawluk, Masami Fujiwara, and Fernando Martinez-Andrade, 2021. *Estuarine, Coastal and Shelf Science* **249**:107121, Copyright by Elsevier [2021].

microplastics, and loss of marshland due to development), fragmentation, and over-harvesting (Wood et al. 2000), the indirect effect of climate change is a particularly serious concern because of its large-scale effects on multiple environmental variables that affect marine ecosystems. Coastal ecosystems, in particular, experience increasing temperatures, sea-level rise, ocean acidification, and increased intensity of storms and extreme weather events (He and Silliman 2019). As the effects of climate change are thought to be reaching their tipping points, studies of climate impacts on coastal ecosystems are urgently needed. A variety of studies have sought to address this issue; however, relatively few have focused on fish species diversity (Nicolas et al. 2011, Hare et al. 2016, Poloczanska et al. 2016, Comte and Olden 2017). In particular, it is crucial to identify significant trends in fish diversity and quantify important drivers of fish community dynamics in order to properly manage and conserve these valuable and highly vulnerable marine ecosystems.

Environmental data from the bays of Texas suggested that abiotic conditions in the bays are shifting, with temperatures increasing, sea level rising, and salinity changing (Fujiwara et al. 2019). Additionally, studies in the Gulf of Mexico, including the Texas coast, have shown expansion of mangrove habitat, suggesting a shift in fish habitat availability (Comeaux et al. 2012, Armitage et al. 2015, Guo et al. 2017). These changes are likely to affect the distribution of fish species within the bays, and thus may affect the diversity and composition of the fish assemblages. Although a recent study focusing on juvenile fish in the bays of Texas found evidence for increasing fish diversity (Fujiwara et al. 2019), it is unclear whether the observed increase simply represents increased dispersal of juveniles to the bays without the subsequent establishment of adults.

Within the Gulf of Mexico, Texas is a major contributor to marine fisheries, with approximately 29 percent of the total fisheries value in the Gulf coming from Texas landings (NOAA Fisheries 2020). The coastal bays of Texas also serve as important nursery habitat for many juvenile fish and invertebrate species (Zimmerman and Minello 1984, Rozas et al. 2007), highlighting not only the economic importance but the ecological importance of this ecosystem as well. Understanding how climate change will affect marine fish biodiversity within Texas is thus of high importance.

Here, I investigate the change in biodiversity of adult fishes along the subtropical coast of Texas in order to address three main questions: 1) Has climate change affected the adult fish assemblages along the Texas coast? 2) What environmental variables are responsible for driving trends in adult fish diversity? 3) Do seasonal differences exist in the fish community response to the changing climate? I answer these questions using the intensive monitoring data along the Texas coast collected by the Texas Parks and Wildlife Department (TPWD) over a 33-year study period. In order to identify temporal, spatial, and seasonal trends in adult fish diversity, and relate those trends to changing climatic conditions, I estimated the Shannon diversity index for fish in eight major bays along the Texas coast, for spring and fall, in all years. The long-term intensive monitoring data along the Texas coast has provided a rare opportunity to study the change in fish biodiversity in the subtropics, which have been studied far less when compared with temperate and tropical systems.

II.2 Methods

II.2.1 Data Collection

The species data used for this study were collected by the Coastal Fisheries Division of the

TPWD from 1986 to 2018. Data consist of samples collected from Sabine Lake, Galveston Bay, Matagorda Bay, San Antonio Bay, Aransas Bay, Corpus Christi Bay, Upper Laguna Madre, and Lower Laguna Madre (Fig. 1). Sampling was conducted twice each year during a spring sampling season (April - June) and a fall sampling season (September-November). A total of 45 gillnet samples were collected for each bay in all sampling seasons. The gillnets used in sampling consisted of four equal length (45.7 m) panels of differing mesh sizes (76 mm, 102 mm, 127 mm, and 152 mm). Each sampling area was divided into a one-minute latitude by a one-minute longitude sample grid, with each grid square divided into 144 gridlets of five-second latitude by five-second longitude. Sampling was conducted following a stratified cluster sampling protocol, whereby grid locations were randomly selected without replacement from the predefined sample grid within each bay, and locations within each grid randomly selected for net placement. Nets were set perpendicular to the shoreline, with the smallest mesh size nearest to the shore, and allowed to soak from sunset to sunrise for an average of 13.5 hours (Martinez-Andrade 2015).

For each sample, all organisms were identified to the lowest taxonomic level possible (often species) and counted. The total catch for each species in each sample was recorded. Total catch data were converted to presence-absence (incidence) data for the sample-based rarefaction method (see Rarefaction Analysis). In addition to the species composition data, concurrent environmental data were recorded for each sample, as well as latitude and longitude of the sample location. Environmental data collected by TPWD included temperature (^{o} Celsius), salinity, dissolved oxygen (ppm), and turbidity (Nephelometric Turbidity Units).

In addition to the environmental data, sea level was included as a potential predictor of species diversity in this study. The monthly mean sea level was obtained from the NOAA Center for Operational Oceanographic Products and Services (CO-OPS 2018). The stations used for this study were selected based on data availability from 1986 to 2018 (Fig. 1). Sea level data were assigned to each bay based on the closest available station. For all environmental variables, seasonal averages over the sampling periods were calculated for each bay and then standardized using a z-score. Additionally, data were reduced to only include fish species; invertebrates and genus or family level data were excluded from analyses. Species for which fewer than 3 individuals were observed over the entire study period were considered to be too rare for inclusion and thus were excluded from further analyses. After filtering out invertebrates, genus and family level data, and extremely rare species, a total of 138 species were included in the analyses. A species list with total catch information is provided in Appendix C (Table 49). The removal of these species had very little effect on the outcome due to the diversity metric used in this study, Shannon diversity (Shannon 1948, Lewontin 1972, Chao et al. 2014), which takes into account the frequency of each species observed. Additionally, some concern may exist for uncertainty in the data inherent in long-term monitoring studies (Carstensen and Lindegarth 2016) for example, changes to sampling methodology/protocol, species identification, and sample effort; however, the sampling was done consistently based on the detailed sampling protocols as described by Martinez-Andrade (2015) and was overseen by a quality control committee. Additionally, the TPWD gillnet monitoring program has been recognized for its high quality (Grüss et al. 2018). All analyses conducted in this study were done using the R language and environment for statistical computing (R Core Team 2018).

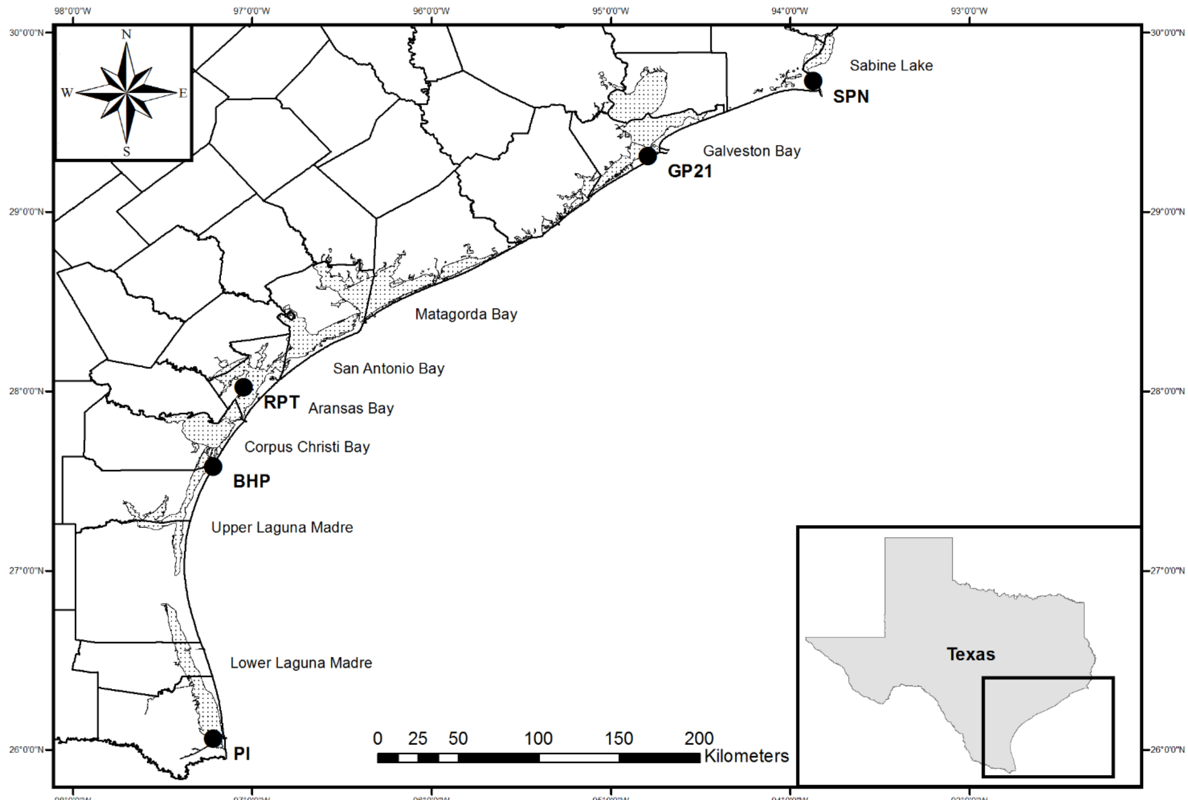

Fig. 1. Locations of the NOAA water level stations for the data used in this study. SPN: Sabine Pass North, station #8770570; GP21: Galveston Pier 21, station #8771450; RPT: Rockport, station #8774770; BHP: Bob Hall Pier, station #8775870; PI: Port Isabel, station #8779770.

II.2.2 Rarefaction Analysis

When comparing species diversity indices across multiple sites, it is necessary to account for the sampling effort at each site in order to make a comparison. This is due to the fact that as sampling effort increases, the number of species observed will also increase (Fisher et al. 1943, Sanders 1968, Simberloff 1972, Colwell and Coddington 1994). Although in this study sampling effort was standardized across bays, rarefaction analyses provide the additional benefit of being able to extrapolate the diversity of a given site to its asymptotic value, thereby estimating the "true" diversity of the system (i.e., diversity with infinite sampling effort). In order to assess the fish species diversity in each bay for each season and year, estimates for the asymptotic Shannon diversity index were calculated following the methods for sample-based rarefaction described by Chao et al. (2014), whereby a species accumulation curve is estimated using resampling methods and then extrapolated out to an asymptote. In order to estimate the asymptotic Shannon diversity, an unbiased estimator for Shannon diversity at infinite sampling effort ($\widehat{D}(\infty)$), which is given as the exponential of Shannon entropy at infinite sampling effort ($\widehat{H}(\infty)$) (Chao et al. 2014); is calculated using equation 1:

$$\widehat{H}(\infty) = \sum_{k=1}^{n-1} \frac{1}{k} \sum_{1 \le X_i \le n-k} \frac{X_i}{n} \frac{\binom{n - X_i}{k}}{\binom{n-1}{k}} + \frac{f_1}{n}(1-A)^{-n+1} \left\{ -\log(A) - \sum_{r=1}^{n-1} \frac{1}{r}(1-A)^r \right\} \tag{1}$$

where $A=2f_2/[(n-1)f_1+2f_2$, n is the sample size, X_i is the frequency of the ith species, and f_k is the number of species with observed frequency k (Chao et al. 2014). The asymptotic Shannon diversity estimate is thus ${}^1\widehat{D}(\infty) = \exp\,[\widehat{H}(\infty)]$. Asymptotic Shannon diversity estimates were calculated using the “iNEXT” package in the R statistical computing environment (Hsieh 2018). Once these estimates were calculated, along with an associated standard error for each estimate, they were used as the response variable for modeling the effects of environmental drivers on fish species diversity. Additionally, analysis of variance (ANOVA) was conducted on the diversity estimates in order to determine whether fish diversity was significantly different among bays and seasons.

II.2.3 Trend Analysis

A trend analysis was conducted in order to test the significance of observed trends in asymptotic

Shannon diversity. The response variable was an estimate and not an observed value; therefore, a parametric bootstrap method was used to test the significance of the trend (Efron and Tibshirani 1986). For each diversity estimate by bay, season, and year combinations, 999 additional estimates were randomly generated following a normal distribution with a mean equal to the value of the estimate, and the standard deviation equal to the standard error for the given estimate. This resulted in one thousand time-series for each season (x2) in each bay (x8). For each time-series, a simple linear regression was fit to bootstrapped data with the diversity estimates as the response variable and year as the explanatory variable. For each linear model, the slope and p-value of the slope were recorded. The number of slopes out of one thousand that were positive and significant ($p < 0.05$) were recorded for each bay in each season. If a bay had more than 950 significant positive slopes for a given season, it was considered to have a significant increasing trend over time. Spring and fall assemblages were modeled separately in order to account for differences in fish occupying the bays in different seasons.

II.2.4 Repeated Measures Analysis

In order to test for the effects of environmental variables on fish species diversity, repeated measures analysis was used (Laird and Ware 1982). Repeated measures models are appropriate when multiple measurements have been taken from the same subject (in this case, each bay is a subject) through time, and multiple subjects are being modeled concurrently. It is advantageous in that it accommodates a variety of covariance structures in the response variable, an important consideration for repeated measures data where independence and homogeneity assumptions are violated. Standard least squares methods cannot be employed in this case due to the fact that observations taken from a given bay will be more similar to one another than observations from other bays, and observations taken more closely together in time will be more similar than those taken farther apart (Laird and Ware 1982, Laird et al. 1987). Repeated measures analysis using mixed-effects models allows for the specification of both fixed and random effects, as well as a covariance structure, thereby accounting for between-individual variation, as well as within-individual autocorrelation. In this study, by specifying bay as a random factor, and environmental variables as fixed factors, I was able to model environmental driving variables with a constant effect (slope) across bays, while allowing for random intercepts for each bay, thereby accounting for differences in the diversity of each bay at the start of the study period.

For the repeated measures analysis, assemblages were again modeled by season, with a separate model estimated for spring and fall. For each model, all environmental variables were included in the initial model as well as lagged variables (lag 1 – last year's observation for the given variable, and lag 2 – observation from 2 years ago for the given variable) for temperature, salinity, and sea level (in the spring model, lag 1 of temperature would be last spring's temperature). Lags were included in order to account for the delayed response of the diversity metric to changing environmental conditions. A delayed response may be particularly likely in this system due to the fact that environmental variables will operate most strongly on larval and juvenile fishes, which require time to grow before they are large enough to be captured in a gillnet.

Each model was fit using maximum likelihood, and the fixed effects were reduced based on the associated p-values for parameter estimates (backward selection process). The maximum likelihood method is appropriate for comparing models with differing fixed effects, while the restricted maximum likelihood method is preferred for comparing candidate covariance structures and making final inferences on the significance and effect size of explanatory variables (Commenges and Jacqmin-Gadda 2016). Odds ratio tests were used after each removal of a variable in order to confirm the significance of a variable. If the p-value of the odds ratio test was not significant ($p > 0.05$), the removal of that variable did not significantly reduce the explanatory power, and thus it was permanently removed from the model. This process was conducted until all remaining variables had significant explanatory power.

Next, candidate covariance structures were tested in order to determine the covariance structure that best fits the data. Models were fit using the restricted maximum likelihood method with either no covariance structure specified or an auto-regressive process of order 1. Because the models were not nested (i.e., same fixed effects, only covariance structure differed), the Akaike Information Criterion (AIC) was used to select the best covariance structure. In the event that previously significant variables became non-significant after accounting for correlation structure (i.e., the p-value associated with the parameter estimate was no longer below 0.05), the model with specified covariance was fit using the maximum likelihood method and variables with non-significant p-values were removed. Odds ratio tests were then used to test the significance of the parameter removals (as previously described). Once the final model had been selected with all non-significant variables removed and correlation structure accounted for, the final model was fit using the restricted maximum likelihood method, and the results from this model were used for inference on parameter significance and effect sizes.

II.3. Results

II.3.1 Rarefaction and Trend Analysis

The results of the rarefaction analysis showed clear spatial differences in fish diversity (ANOVA $p < 0.001$). In spring, Galveston Bay, Matagorda Bay, Corpus Christi Bay, and San Antonio Bay, had consistently higher diversity compared to the other bays. In fall, the assemblages were less closely grouped; however, Matagorda, Corpus Christi, and San Antonio bays were consistently higher in diversity. Galveston Bay was slightly lower in diversity than Matagorda, Corpus Christi, and San Antonio bays, but still higher than the remaining bays (Figs. 2 & 16). Seasonal differences were also evident (ANOVA $p < 0.001$), with fish diversity being consistently higher in fall compared to spring assemblages (Fig. 2).

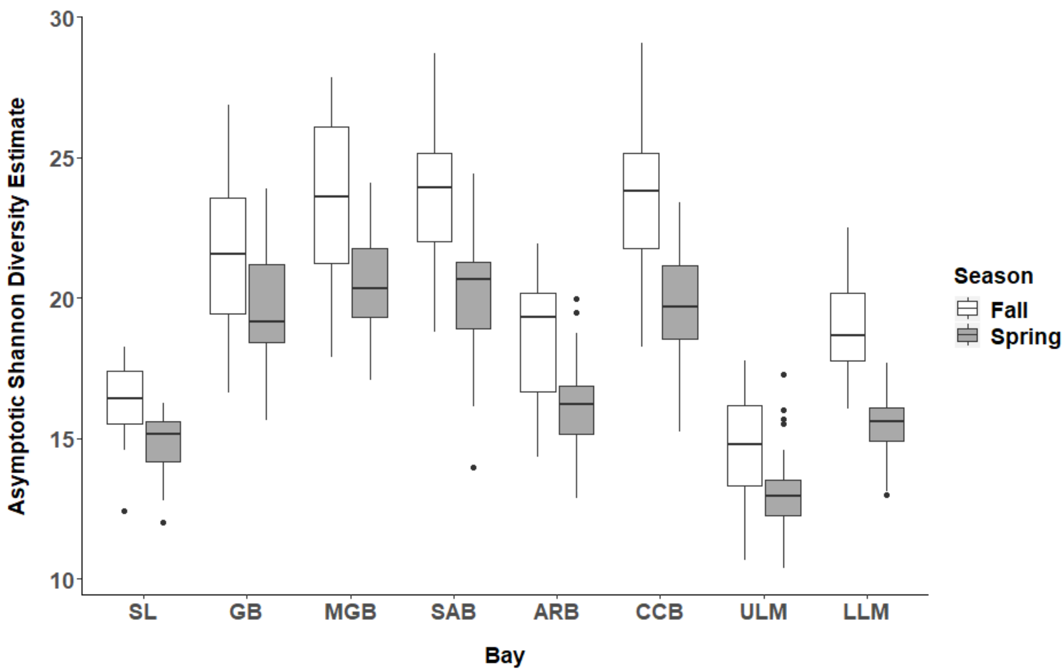

Fig. 2. Distributions of the asymptotic Shannon diversity estimates over the 33-year study period, by season. Fall diversity distributions are shown in white, and spring distributions in grey. Black dots represent outliers following the standard definition of Q1 and Q3 ±1.5IQR.

The trend analysis was conducted to determine the significance of temporal trends in fish diversity. The results showed that, for spring assemblages, six out of eight bays had significant increasing temporal trends in species diversity (950 or more out of 1000 significant positive slopes, $p < 0.05$); only Sabine Lake and Lower Laguna Madre were not significant (Fig. 3, Table 1). For fall assemblages, fish diversity increased in all eight bays over time (Fig. 4, Table 1).

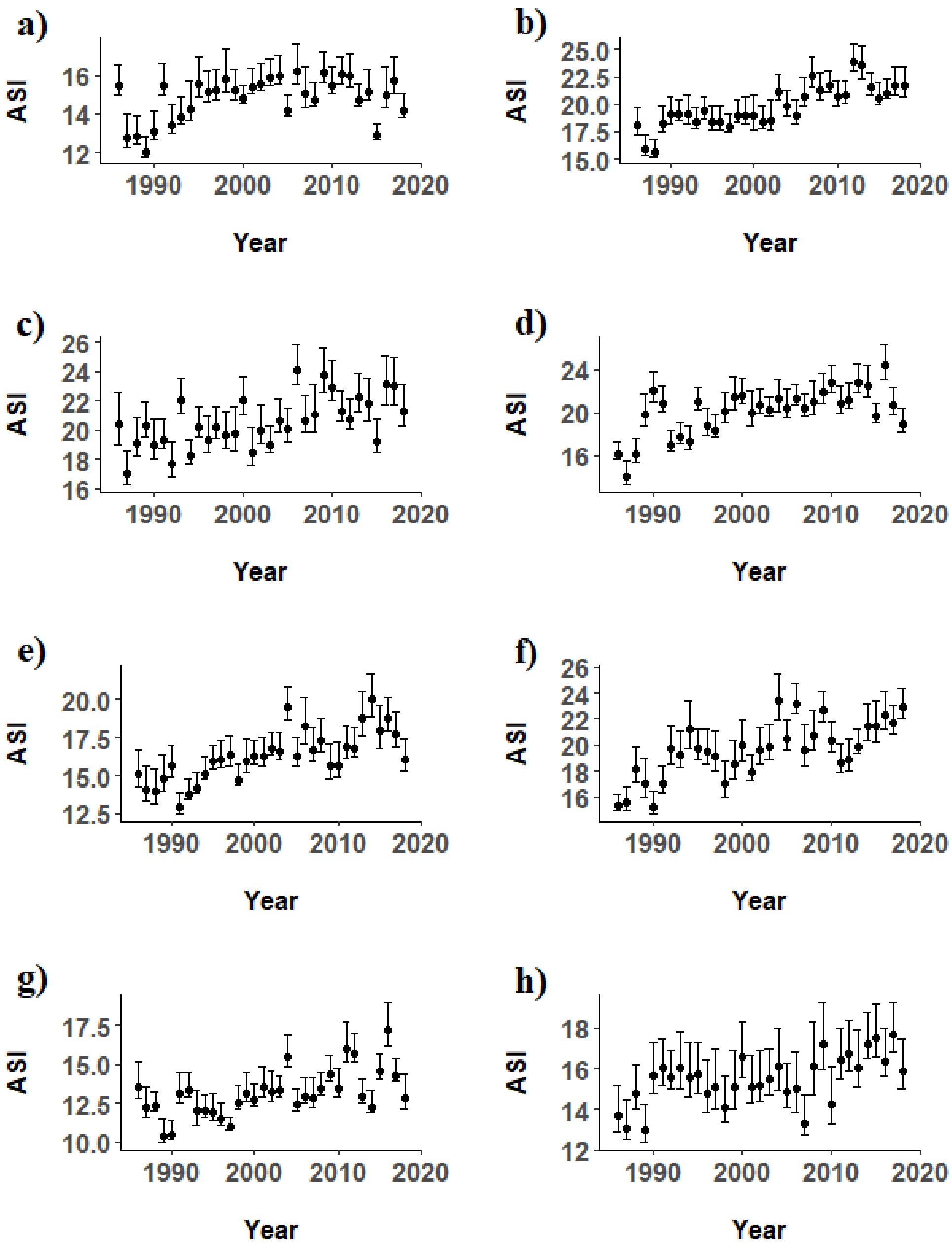

Fig. 3. Spring assemblage rarefaction analysis results. Asymptotic Shannon diversity estimates for spring fish assemblages in the bays of Texas from 1986 to 2018. Error bars show the 95% confidence interval for the diversity estimate. Panel a) Sabine Lake, b) Galveston Bay, c)

Matagorda Bay, d) San Antonio Bay, e) Aransas Bay, f) Corpus Christi Bay, g) Upper Laguna Madre, and h) Lower Laguna Madre.

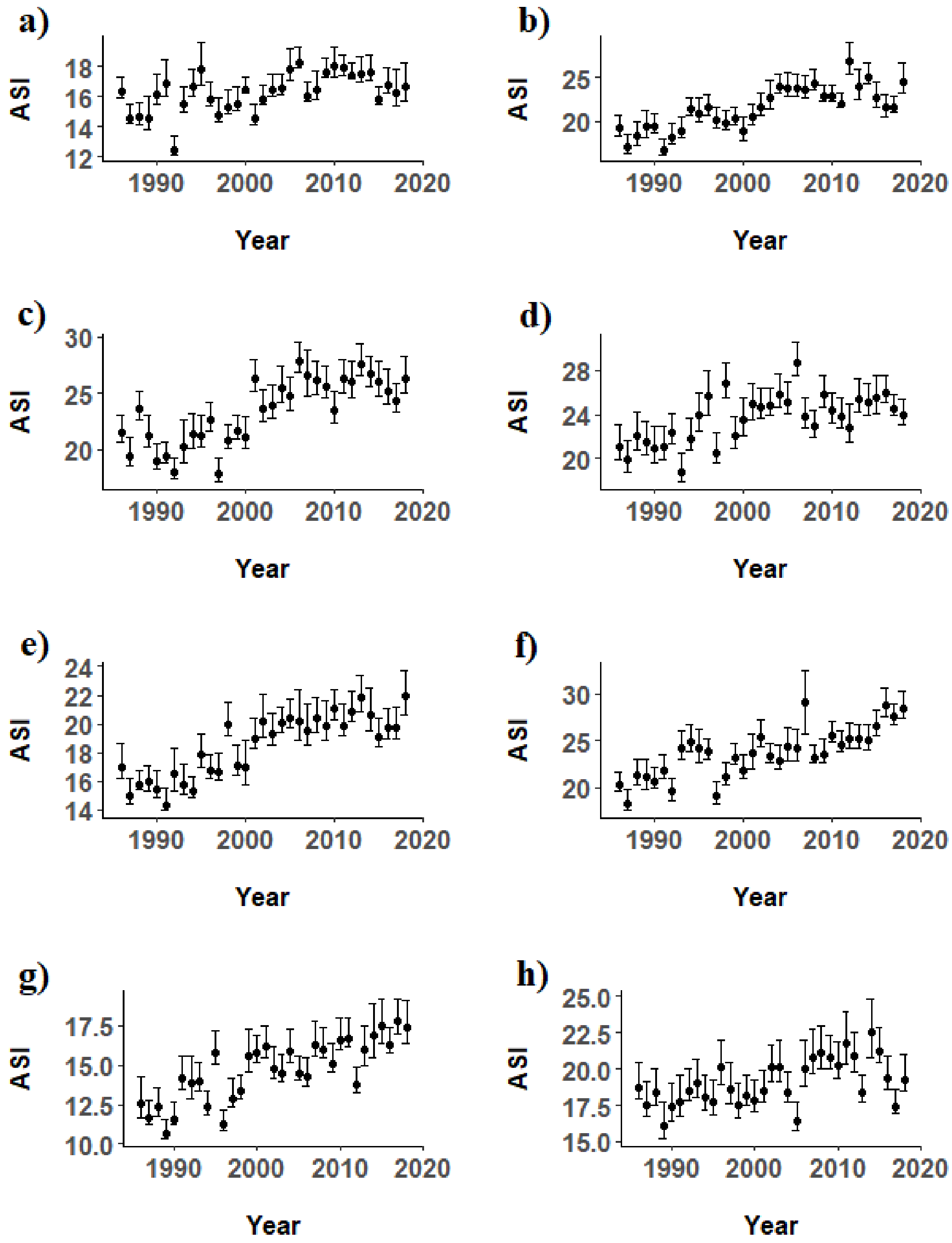

Fig. 4. Fall assemblage rarefaction analysis results. Asymptotic Shannon diversity estimates for fall fish assemblages in the bays of Texas from 1986 to 2018. Error bars show the 95% confidence interval for the diversity estimate. Panel a) Sabine Lake, b) Galveston Bay, c)

Matagorda Bay, d) San Antonio Bay, e) Aransas Bay, f) Corpus Christi Bay, g) Upper Laguna Madre, and h) Lower Laguna Madre.

The distributions of slopes from the trend analysis revealed clear differences in the rate of increase between bays for both spring and fall assemblages, with Sabine Lake, Upper Laguna Madre, and Lower Laguna Madre showing slower rates of increase than the other bays in spring, and Sabine Lake and Lower Laguna Madre showing the slowest increase in fall (Figs. 5 and 17).

Table 1. Trend analysis results. Columns show the number of linear regression models out of 1000 that had a significant positive slope (α = 0.05). A bay is considered to be significantly increasing if more than 950 trials resulted in a significant positive slope. Asterisks show bays with a significant increasing trend.

Major Area	Spring	Fall
Sabine Lake	596	980*
Galveston Bay	1000*	1000*
Matagorda Bay	998*	1000*
San Antonio Bay	1000*	1000*
Aransas Bay	1000*	1000*
Corpus Christi Bay	1000*	1000*
Upper Laguna Madre	999*	1000*
Lower Laguna Madre	937	984*

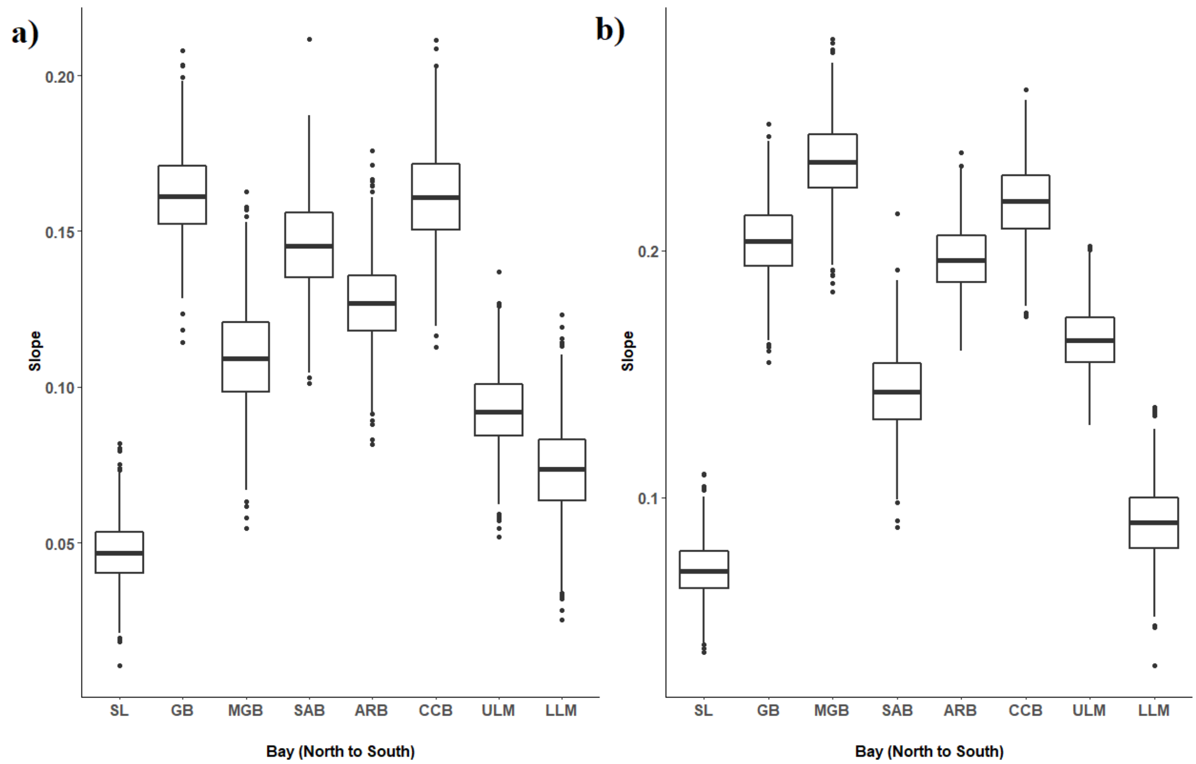

Fig. 5. Regression slope distributions from the bootstrapped data. Spring (a) and fall (b) slopes from the linear models fit to the bootstrapped data by bay. Boxplots for each bay are arranged from North to South. SL: Sabine Lake, GB: Galveston Bay, MGB: Matagorda Bay, SAB: San Antonio Bay, ARB: Aransas Bay, CCB: Corpus Christi Bay, ULM: Upper Laguna Madre, and LLM: Lower Laguna Madre.

II.3.2 Repeated Measures Analysis – Spring Model

The results from the repeated measures analysis using backward selection showed that spring fish assemblage diversity was best modeled by temperature, salinity, lag-1 salinity (salinity from 1 year ago), mean sea level, and lag-2 sea level (mean sea level from 2 springs ago). The final model for spring was:

$$\hat{\boldsymbol{y}}_{\boldsymbol{ij}} \sim \boldsymbol{\beta}_{\boldsymbol{0i}} + \boldsymbol{\beta}_{\boldsymbol{1}}\boldsymbol{T}_{\boldsymbol{ij}} + \boldsymbol{\beta}_{\boldsymbol{2}}\boldsymbol{S}_{\boldsymbol{ij}} + \boldsymbol{\beta}_{\boldsymbol{3}}\boldsymbol{S}_{\boldsymbol{ij-1}} + \boldsymbol{\beta}_{\boldsymbol{4}}\boldsymbol{L}_{\boldsymbol{ij}} + \boldsymbol{\beta}_{\boldsymbol{5}}\boldsymbol{L}_{\boldsymbol{ij-2}} \tag{2}$$

where $\hat{y}_{ij}$ is the predicted asymptotic Shannon diversity in the spring for bay i and year j, β_{0i} is the bay-specific intercept, $\beta_1$is the effect of temperature, T_{ij} is the observed mean spring temperature in bay *i* and year *j*, β_2 is the effect of salinity, S_{ij} is the observed mean spring sea level in bay *i* and year *j*, β_3 is the effect of the previous year's salinity, S_{ij-1} is the observed mean spring salinity in bay *i* and year *j-1*, β_4 is the effect of sea level, L_{ij} is the observed mean sea level in bay *i* and year *j*, β_5 is the effect of sea level from two years prior, and L_{ij-2} is the observed mean spring sea level in bay *i* and year *j-2*. The effect sizes and associated p-values for $\beta_1 - \beta_5$ are presented in Table 2. The lag-2 sea level had the largest effect size, followed by sea level, temperature, lag-1 salinity, and salinity. This highlights the importance of a delayed response to changes in sea level. The individual estimates for β_{0i} are presented in Table 3, and larger intercept values correspond to bays with higher diversity. It should be noted that the intercept value listed in Table 2 is simply the mean of the random factor intercepts (β_{0i}). The final model also included a first-order autoregressive covariance structure with autoregressive parameter (ϕ) = 0.332. This covariance structure accounted for temporal autocorrelation in the data within a given bay. It is important to note that the covariance structure is associated with the covariance matrix of the response, and is thus not a parameter in equation 2, and was not used in calculating $\hat{y}_{ij}$. The covariance structure is taken into account when fitting the model, and thus affects the parameter estimates and p-values of the parameter estimates but is not explicitly included in equation 2. Plotting the observed Shannon diversity estimates versus the fitted values (Fig. 6a) shows that the model has a good fit to the data.

Table 2. Repeated measures model results. Parameter estimates and associated p-values for the fixed effects of the repeated measures model for spring (a) and fall (b) fish assemblage diversity. All variables were standardized by z-score prior to analysis to control for effect size. The intercept listed here is the mean of the random factor intercepts estimated for each bay. Bay-specific intercepts are provided in Table 3.

Parameter	Estimate	Standard Error	Degrees of Freedom	t-value	p-value
a. Spring Model					
Mean of the random factor β_{0i}	17.597	1.053	232	16.708	<0.001
Temperature (β_1)	0.253	0.091	232	2.789	0.006
Salinity (β_2)	0.191	0.092	232	2.077	0.039
Lag-1 Salinity (β_3)	-0.196	0.085	232	-2.303	0.022
Sea Level (β_4)	0.435	0.111	232	3.920	<0.001
Lag-2 Sea Level (β_5)	0.533	0.107	232	4.980	<0.001
b. Fall Model					
Mean of the random factor β_{0i}	20.144	1.264	229	15.938	<0.001
Temperature (β_6)	0.307	0.112	229	2.741	0.007
Sea Level (β_7)	0.458	0.151	229	3.038	0.003
Lag-1 Sea Level (β_8)	0.680	0.152	229	4.463	<0.001
Dissolved Oxygen (β_9)	-0.296	0.120	229	-2.472	0.014
Lag-1 Salinity (β_{10})	0.278	0.113	229	2.459	0.015

Table 3. Bay-specific model intercepts. Parameter estimates for the intercepts for each bay. As previously noted, models were constructed assuming a constant effect of environmental variables across bays (i.e., same slope for environmental effects, regardless of bay).

Major Area	Spring Model Intercept	Fall Model Intercept
Sabine Lake	14.868	16.294
Galveston Bay	19.890	21.547
Matagorda Bay	20.634	23.390
San Antonio Bay	20.415	23.719
Aransas Bay	16.378	18.439
Corpus Christi Bay	19.866	23.875
Upper Laguna Madre	13.130	14.862
Lower Laguna Madre	15.592	19.026

II.3.3 Repeated Measures Analysis – Fall Model

The results from the repeated measures analysis for the fall assemblages showed that fish diversity was best modeled by temperature, sea level, lag-1 sea level, dissolved oxygen, and lag-1 salinity. The final model for fall was thus:

$$\boldsymbol{\hat{y}_{ij} \sim \beta_{0i} + \beta_6 T_{ij} + \beta_7 L_{ij} + \beta_8 L_{ij-1} + \beta_9 D_{ij} + \beta_{10} S_{ij-1}} \quad (3)$$

where $\hat{y}_{ij}$ is the asymptotic Shannon diversity in the fall for bay *i* and year *j*, β_{0i} is the bay-specific intercept, $\beta_6$is the effect of temperature, T_{ij} is the observed mean fall temperature in bay *i* and year *j*, β_7 is the effect of sea level, L_{ij} is the observed mean fall sea level in bay *i* and year *j*, β_8 is the effect of the previous year's sea level, L_{ij-1} is the observed mean fall sea level in bay *i* and year *j-1*, β_9 is the effect of dissolved oxygen, D_{ij} is the observed mean dissolved oxygen in bay *i* and year *j*, β_{10} is the effect of salinity from the previous year, and S_{ij-1} is the observed mean fall salinity in bay *i* and year *j-1*. The effect sizes and associated p-values for $\beta_6 - \beta_{10}$ are presented in Table 2. As with the spring model, current and past sea level had the largest effect size. The individual intercept values (β_{0i}) for the fall model are presented in Table 3. As with the spring model, the final model included a first-order autoregressive covariance structure. The autoregressive parameter for the fall model was (ϕ) = 0.430, which was a slightly larger magnitude compared to spring, and may be indicative of stronger temporal autocorrelation in fall assemblages when compared to spring. Fig. 6b shows the observed versus predicted plot for the fall model, and as with spring, the model fit appears strong.

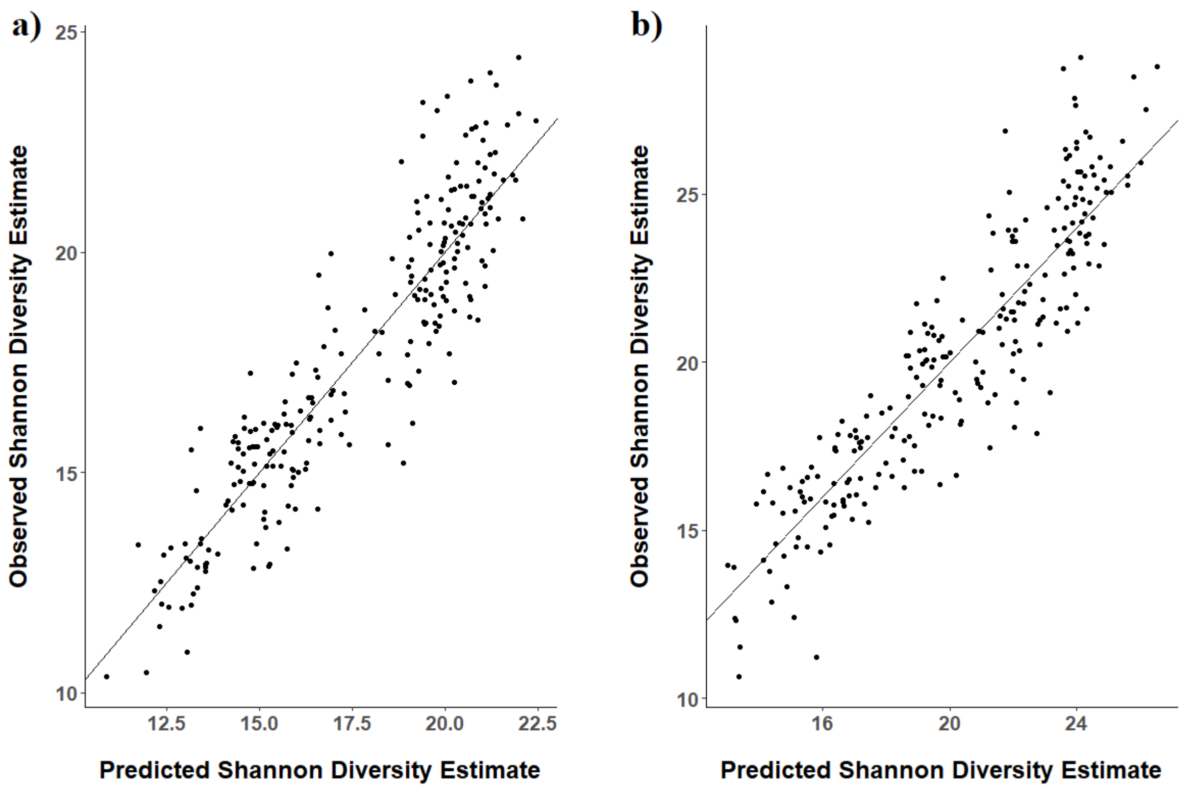

Fig. 6. Observed versus predicted plots for repeated measures models. Panel a) shows the observed versus predicted values for the spring assemblage model. Panel b) shows the observed versus predicted values for the fall assemblage model.

II.4. Discussion

My results show that species diversity has increased significantly through time in the bays of Texas (Figs. 2 & 3, Table 1). In addition to clear temporal trends, spatial and seasonal differences in fish diversity were evident (Fig. 4). Trend analysis showed significant increases in diversity in both spring and fall assemblages, with fall assemblages increasing at a faster rate than spring (Fig. 5). The higher underlying diversity in fall assemblages and a faster rate of increase may be the result of different mechanisms operating on fish entering and leaving the bays. Fall salinity is consistently higher than spring salinity (t-test of paired differences, p-val <0.001) suggesting that a minimum salinity threshold may be needed before tropical species will enter the bays, while retention within the bays may be mediated by winter water temperatures, with cold water forcing movement of tropical species out of the bays prior to spring sampling. Because there is a higher diversity of fish in the tropics compared to subtropics (Hillebrand 2004), it is predicted that fish diversity and production will shift poleward as species adjust their distributions to changing climate (Cheung et al. 2010, Barange et al. 2014), the results in this study are consistent with this prediction, showing increasing fish diversity through time.

While many studies have shown species diversity to have a positive relationship with ecosystem functioning (Naeem et al. 1994, Tilman and Downing 1994, Schlapfer and Schmid 1999, Tilman 1999, Chapin III et al. 2000, Hooper et al. 2005), this is not always the case, and in fact, an increase in species diversity can potentially lead to a decrease in functional diversity (Mayfield et al. 2010). These shifts in distribution, and thus in community structure, are also interesting in the Gulf of Mexico where species are limited in their ability to continue shifting northward due to the presence of the coastline. The inability of subtropical species in the Gulf of

Mexico to continue their shift northward may lead to novel interactions and unexpected functional consequences, highlighting the importance of not only determining how fish diversity is changing but also the implications of that change. This remains to be explored in the future research.

In order to better understand and predict future changes to fish assemblages in the face of climate change, it was necessary to identify the environmental variables which may be responsible for driving the observed increase in diversity. Repeated measures models identified several environmental covariates that are likely responsible for the observed increase. In particular, temperature, salinity, and sea level were identified as important covariates in both the spring and fall models, either as current or lagged variables. The importance of lagged variables in the repeated measures models highlights the delayed response of the adult fish assemblage to changing environmental factors. Due to the highly selective nature of gillnets (Hamley 1975), fish caught in this study were predominantly larger, consisting mainly of adult fish. It is thought that environmental filters tend to act most strongly on larval and juvenile fish (e.g. Fuiman and Werner (2009)); therefore, changes in the fish assemblage due to changing environmental variables may not be observed in gillnet samples until the fish have grown large enough to be available to the sampling gear, which may take a year or more.

Salinity showed a significant positive relationship with diversity for the spring assemblage, while lagged salinity showed a significant negative relationship in spring and a positive relationship in fall. Salinity may be responsible for seasonal and spatial differences in diversity, as it was consistently lower in spring than fall, suggesting more tropical species may be unable to enter the bays under brackish conditions. Salinity has been shown to affect the growth rate of many species, whether freshwater, marine, or estuarine (Bœuf and Payan 2001).

Ontogenetic shifts in species distribution have been shown to correlate with the development of salinity tolerance in many species (Varsamos et al. 2005). Additionally, some studies have shown distributional changes of fish within an estuary in response to salinity gradients (Martino and Able 2003, Barletta et al. 2005). Increasing salinity in the bays of Texas may be allowing for distributional changes in fish species, with increasing abundance of more marine species and potentially a decrease in abundance of fresh- and brackish-water associated species.

Temperature showed a significant positive relationship with diversity for both the spring and fall assemblages. Temperature has been shown to affect larval and juvenile fish growth, survival, and distribution (Fuiman and Werner 2009), and many studies have shown distributional shifts of temperate species in response to the warming climate (Murawski 1993, Perry et al. 2005, Collie et al. 2008, Wernberg et al. 2016). In the bays of Texas, temperatures are rising, thereby allowing for potential colonization by tropical species, which had previously been excluded from this system. Relaxation of an important environmental filter (temperature) combined with changing vegetation cover in the bays of Texas are likely working synergistically to drive the observed increase in fish diversity.

Sea level was also identified as a significant variable explaining fish diversity. One possible explanation could be related to changing vegetation type and cover in response to rising sea level. In both salt marshes and mangrove forests, stabilizing biophysical feedbacks allow for the expansion of these habitat types in response to sea-level rise (Kirwan and Megonigal 2013). In Texas, mangrove species appear to be competitively dominant over native salt marsh species, when not limited by cold winter air temperatures (Kirwan and Megonigal 2013, Armitage et al. 2015). Evidence from previous studies suggests that black mangrove (*Avicennia germinans*) cover has been increasing through time in the bays of Texas (Bianchi et al. 2013, Armitage et al.

2015), likely in response to both increasing winter minimum temperatures and rising sea level. Mangroves function as important nursery habitat for juvenile fishes (Beck et al. 2001, Lee 2008, Nagelkerken et al. 2008, Lee et al. 2014), provide refuge from predators (Nanjo et al. 2014, Guo et al. 2017), and may serve as a valuable feeding ground for larger fish (Lugendo et al. 2007). Additionally, black mangrove has been shown to affect species composition in comparison to salt marsh habitat (Scheffel et al. 2018).Thus, I hypothesize that in addition to changing abiotic filters (e.g., temperature and salinity), the changing biotic environment may have contributed to increasing fish diversity, via increased mangrove cover, for which sea level may be a reasonable proxy variable. However, further research to associate the change in sea level and vegetation coverage or other environmental factors is needed to draw a definitive conclusion.

Additionally, dissolved oxygen was found to have a significant negative relationship with diversity in fall. While dissolved oxygen was identified as being a significant predictor of fall assemblage diversity, this may be an artifact of the relationship among temperature, salinity, and dissolved oxygen. The mean dissolved oxygen in fall ranged between 6 – 12 ppm for 99% of observations, meaning the dissolved oxygen was not likely dropping out of normal ranges, though there was a consistent decreasing trend through time. The combined effect of increasing temperature and salinity is likely leading to a decreasing trend in dissolved oxygen, and thus, a significant negative correlation with the increasing diversity estimates.

Findings from this study are consistent with a previous study conducted by Fujiwara et al. (2019) in the bays of Texas. In their study, Fujiwara et al. (2019) analyzed data collected using bag seines, which target juvenile fishes. Diversity trend analyses and occupancy analyses were conducted, and the results showed that for small fishes and invertebrates occurring nearshore, abundance and diversity increased through time. The majority of species modeled showed increasing occupancy probability through time, with fewer species showing decreasing trends. Species showing increasing trends were predominantly tropical, and tended to be associated with submerged vegetation, suggesting a change in the aquatic habitat may be contributing to the change in prevalence. Additionally, their occupancy analyses found that salinity was the most important driver of differences among bays, while temperature and sea level were important in explaining temporal trends in a variety of species, which was consistent with the important abiotic drivers identified in the current study. These results are consistent with my hypothesis that relaxed abiotic filters (temperature and salinity), combined with increased mangrove cover due to rising sea level may be contributing to increasing fish diversity in the bays of Texas. These analyses together provide a better picture of the fish community dynamics in the bays of Texas, showing that the observed increases at the larval or juvenile stage are persisting, and new species are surviving and recruiting to the adult assemblages.

II.5 Conclusion

The results from this study demonstrate that adult fish diversity is increasing through time in the Gulf of Mexico, with distinct spatial and seasonal differences in the underlying diversity of the bays, and the rate of increase in diversity. The results of the modeling analysis suggest that the observed increase is likely the result of tropical species expanding their geographic ranges into the bays. While temperature is often assumed to be the most important driving variable in fish distribution shifts in response to climate change, this study identified rising sea level as an important contributing variable. These results may suggest that in subtropical systems where temperature is less limiting, habitat availability may be important in driving distribution shifts.

The goal of this study was to identify the effects of climate change on the subtropical fish communities of Texas, and the results have clearly answered the questions I had identified; however, it has also identified new questions. While increasing biodiversity is generally considered beneficial to the ecosystem, the fact that invasion of species is leading to the observed increase in this system suggests that there may be unintended functional consequences to this increase. In order to assess the impact of this increase on the functioning of this system, further studies will seek to investigate changes to the functional diversity and structure of this system and the potential effects of climate change on the assembly mechanisms of this system.

CHAPTER III

CLIMATE-INDUCED INCREASES IN FISH BIODIVERSITY NEGATIVELY IMPACT NATIVE FISH SURVIVAL

III.1 Introduction

In response to a changing climate, marine fish communities are expected to undergo dramatic changes (Poloczanska et al. 2016). According to range limit theory (RLT), species are limited at their poleward edge by abiotic conditions, and by biotic interactions at their equatorward edge (Brown et al. 1996). Therefore, it is expected that the distributions of many marine populations will shift poleward (Perry et al. 2005) as warmer-water species track increasing water temperatures and colder-water species are excluded due to biological interactions at the equator-ward edge of the distribution. With higher diversity occurring in the tropics (Hillebrand 2004), it is also expected that distribution shifts will lead to increasing regional biodiversity in temperate and polar ecosystems (Hiddink and Ter Hofstede 2008), potentially creating novel species interactions (Fredston-Hermann et al. 2020). Some such shifts have already been documented (Beare et al. 2004, Stefansdottir et al. 2010).

While biodiversity is considered to be associated with increased ecosystem functioning and stability (Hooper et al. 2005), increasing diversity due to species range expansion may lead to unexpected consequences (Wallingford et al. 2020). For marine species, poleward edges are expanding more rapidly than equatorward edges are contracting, causing species composition to change. Resultant novel species interactions may lead to increased competition and predation pressure on native species (Mack et al. 2000). In addition to the effect of changing fish diversity, changing abiotic conditions may affect native fish populations. Although RLT suggests abiotic conditions may not be a major limiting factor at their equatorward edge (Sirén and Morelli 2020), abiotic conditions may still negatively affect populations near their warm-water limits indirectly through species interactions as new species invade (Sanford 1999, Kishi et al. 2005). Therefore, the effect of climate change on ecological systems is expected to be more complex than simple poleward shifts of species. Here, I seek to answer the question of how climate change affects fish populations as abiotic and biotic environmental conditions change.

Along the Texas coast, it is known that temperature and salinity are increasing through time, and these changes have led to increased fish diversity within coastal ecosystems (Pawluk et al. 2021). To determine how climate-induced changes to abiotic and biotic conditions are affecting marine fish populations, I estimated the mortality rate of three abundant species: Atlantic croaker (*Micropogonias undulatus*), black drum (*Pogonias cromis*), and spotted seatrout (*Cynoscion nebulosus*). Total mortality rates were estimated for all three species in the bays of Texas over a 36-year study period and were modeled as a function of abiotic (temperature, salinity, dissolved oxygen, turbidity, and sea level) and biotic variables (fish diversity).

III.2 Methods

III.2.1 Data collection

The data consist of gillnet samples collected by the Coastal Fisheries Division of the Texas Parks and Wildlife Department from the eight major bays of Texas: Sabine Lake, Galveston Bay, Matagorda Bay, San Antonio Bay, Aransas Bay, Corpus Christi Bay, Upper Laguna Madre, and Lower Laguna Madre (Fig. 7). Sampling was conducted biannually from 1982 to 2019 (in all bays except Sabine Lake which began in 1986) and consisted of a spring sampling season (April - June) and a fall sampling season (September-November). A total of 45 gillnet samples were collected for each bay in all sampling seasons. Standardized gillnets with four equal length (45.7 m) panels of differing mesh sizes (76 mm, 102 mm, 127 mm, and 152 mm) were used. Nets were set perpendicular to the shoreline, with the smallest mesh size nearest to the shore, and allowed to soak from sunset to sunrise for an average of 13.5 hours (Martinez-Andrade 2015). For a detailed description of sample location selection see Appendix B.

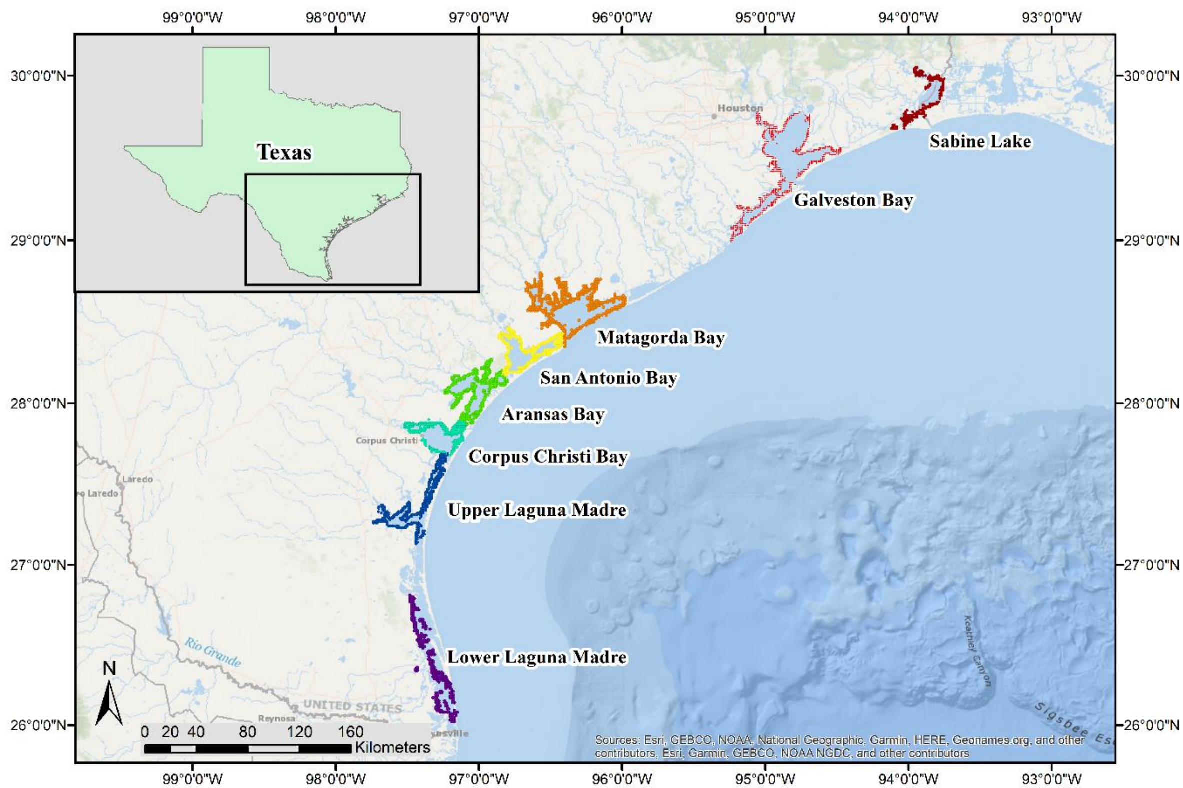

Fig. 7. Sample locations. Map of the Texas coast showing the major bays included in this study. The colored points correspond to sampling locations, with each bay represented by a different color for clarity.

All organisms are identified to the lowest taxonomic level possible (often species) and counted, and total length (mm) was recorded for up to 19 randomly selected individuals of each species. I used data for three common species: Atlantic croaker, black drum, and spotted seatrout. Catch per unit effort (CPUE) for each species was calculated as total catch divided by number of hours set. Concurrent environmental data were collected and include temperature (^{o}C), salinity, dissolved oxygen (ppm), and turbidity (Nephelometric Turbidity Units, NTU).

III.2.2 Selectivity correction

A length distribution (the distribution of CPUE for a given 1 mm length bin) for each mesh size in each sample was calculated by dividing the number caught at a given length in a given mesh size by the total number of fish measured for the mesh size. The calculated distribution was then multiplied by the total number of fish caught (measured and unmeasured) to give the adjusted length-frequency data. Because of the highly size-selective nature of gillnets (Hamley 1975), data were adjusted using selectivity correction, prior to utilizing data for age estimation. Eight different selectivity models were fitted to data using a likelihood method (Fujimori and Tokai 2001), and the best model was selected using Akaike information criterion (AIC) (Appendix B).

III.2.3 Length to age conversion

To estimate total instantaneous mortality (Z) using catch curve analysis, it is first necessary to convert the length data to age. The most commonly used method for estimating age from length is to fit the Von Bertalanffy Growth function (VBGF) to verified age-length data from age structures such as otoliths or scales (Von Bertalanffy 1938). When solved for age, the equation is: $Age = t_0 - \left(\frac{1}{k} * ln\left(1 - \frac{L}{L_\infty}\right)\right)$, where t_0 is the hypothetical age at length 0, k is the growth parameter, L is the observed length, and L_∞ is the asymptotic length. For species in which a growth curve has been established, age can be estimated from length by inputting the parameters and solving for age at length. For Atlantic croaker, the parameters were taken from Barger

(1985) (Northern Gulf of Mexico). For spotted seatrout, I used parameters from a study by Maceina et al. (1987) in Galveston Bay, TX. In their study, growth was found to be sexually dimorphic, and thus for this analysis separate equations were used for males and females. However, because I do not have separate data for females and males, the two equations were applied twice and the average was taken assuming 50:50 sex ratio. Parameters used for the Atlantic croaker and spotted seatrout VBGFs are provided in Appendix B (Table 7).

For black drum, the Gulf States Marine Fisheries Commission (GSMFC) found that a sloped-asymptote Gompertz model was a better fit to the data than the VBGF (Leard et al. 1993). In this study, the age length key provided as a table by the GSMFC report was used to calculate age from length. A cubic spline was used to both interpolate and extrapolate the age length key.

For all three species, the data were truncated at the younger and older ends. Typically, in catch curve analysis, a threshold for the minimum age to be included is the age at which fish have fully recruited to the fishing gear (Millar 2015). For Atlantic croaker and spotted seatrout, fish of length greater than L_∞ were binned to the oldest reported age for each respective growth study used, which resulted in disproportionately large catch frequencies at the oldest age after selectivity correction, an indication of over-inflation. For Atlantic croaker, ages 1 through 7 were included in the analysis, and for spotted seatrout, ages 2 through 11 were included. For black drum, it is known that offshore movement for spawning occurs after about age 5 (Pearson 1929), and thus, ages 2 through 5 were included.

III.2.4 Mortality estimation and modeling

To estimate mortality, an extension of the standard catch-curve method described by Millar (2015) was used. One caveat of catch curve analysis is that it relies on mortality being constant across age classes, and through time – at least in the short term – however, long-term changes in mortality may still be reflected in catch curve estimates. While it is not the most reliable method for accurately estimating mortality rate, it is widely used in fisheries due to the relative ease of implementation (Chapman and Robson 1960). The method involves fitting a Poisson generalized linear mixed-effects model (GLMM) to age-frequency data with a random effect to account for different intercepts (i.e., different recruitment levels) based on age cohort. The negative of the slope estimate from this model gives the estimate of instantaneous mortality (Z) for a given year, assuming constant mortality across the included ages. The GLMM was fit to age-frequency data in each of the 8 bays in each year to obtain a time series of Z estimates for each bay (bay-year estimates). In addition to bay-year estimates, age-frequency data were combined as follows 1) all data combined, 2) all years combined for each bay, 3) all bays combined for each year, and the GLMM was fit, resulting in a single overall mortality estimate, estimates for each bay assuming no temporal trend, and estimates for each year assuming no spatial differences. Linear regression of the year estimates (all bays combined) was conducted to test for a significant temporal trend in mortality.

For bay-year estimates, the total mortality (Z) showed heteroscedasticity. A transformation from Z to finite survival rates (S) using: $S = e^{-Z}$ successfully stabilized the variance. Estimates of S were then used as the response variable for simple linear regression to assess the effect of environmental variables and increasing fish diversity on survival rate. Additionally, analysis of variance was conducted for the bay-year estimates to test for spatial differences, and Tukey's Honestly Significant Difference (Tukey HSD) was used to test pairwise differences between bays. Average temperature, salinity, dissolved oxygen, and turbidity were calculated for each year in each bay. In order to incorporate the effect of fish diversity on survival, spring and fall Shannon diversity estimates were taken from a previous study (Pawluk et al. 2021). Fall and spring diversity were highly correlated, and thus they were added together to form a single diversity variable. All covariates (environmental variables and diversity index) were standardized taking z-score prior to the analysis. Models with up to three variables were considered, and the Bayesian Information Criterion (BIC) was used to select the best model because it selects more conservative models than AIC, alleviating the problem of overfitting. To ensure that the selected models have a good fit, the significance of variables was checked at an alpha level of 0.05. All data handling and analyses for this project were conducted in the R statistical environment (R Core Team 2018).

III.3 Results

Atlantic croaker had the highest total mortality rate (Z) for all years and bays combined (0.7819; 95% CI: 0.7802, 0.7836). Black drum total mortality was the lowest of the three species (0.6120; 95% CI: 0.6110, 0.6130). Spotted seatrout had a total mortality rate slightly higher than that of Black drum (0.6385; 95% CI: 0.6376, 0.6394). Results for all years combined by bay, and all bays combined by year are shown in Fig. 8. The total mortality of Atlantic croaker and black drum was variable across bays, while mortality of spotted seatrout showed less variability across bays (Fig. 8a, 8c, 8e). When looking at the estimates for all bays combined, total mortality of Atlantic croaker increased over time (linear regression, p-value < 0.001), while black drum total mortality decreased (p-value $= 0.026$). Total mortality of spotted seatrout showed a non-significant increase through time (p-value $= 0.063$) (Fig. 8b, 8d, 8f).

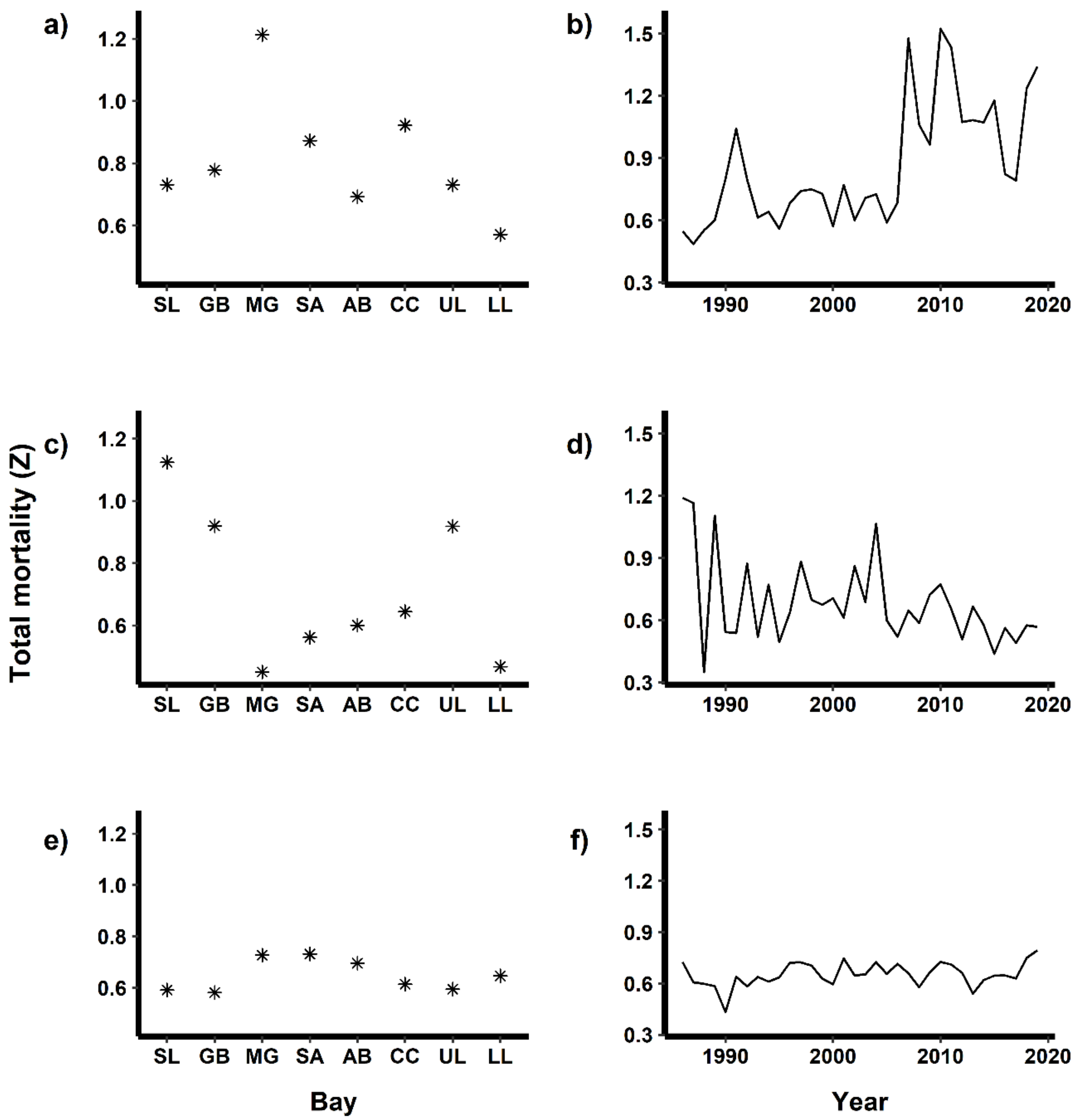

Fig. 8. Total mortality (Z) by bay and by year. Total mortality estimates for Atlantic croaker (a, b), black drum (c, d), and spotted seatrout (e, f) for all years combined in a given bay, and for all bays combined in a given year respectively. Bays are arranged from North to South going from left to right (a, c, e), abbreviations are as follows: SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

In addition to calculating total mortality for each species (i.e., all years and bays combined), and estimates by bay (all years combined) and by year (all bays combined), mortality was estimated for each species in each year in each bay (bay-year estimates). Mortality estimates by bay-year were converted to finite survival rates in order to stabilize the variance of the estimates. Catch curve data for all estimates are presented in Appendix B: Tables 8 – 19. Analysis of variance (ANOVA) was conducted to determine the significance of spatial differences in total mortality. For all three species, ANOVA identified significant differences in finite survival rates across bays. Tukey's honestly significant difference was used to find significant pairwise differences in mean finite survival rate between bays (Appendix B, Tables 20 – 22).

To identify potential drivers of spatial and temporal differences in mortality rates, linear regression models were used to relate finite survival rates to environmental variables (temperature, salinity, dissolved oxygen, turbidity) and fish diversity. Significant covariates from models with the lowest BIC, as well as those with ΔBIC less than 2, are shown in Fig. 9, and provided in Table format in Appendix B (Table 23). For black drum, although models with significant relationships were identified, the adjusted R^2 is essentially zero for both models, implying that for black drum the finite survival rate estimates were too variable to have any significant amount of variation explained.

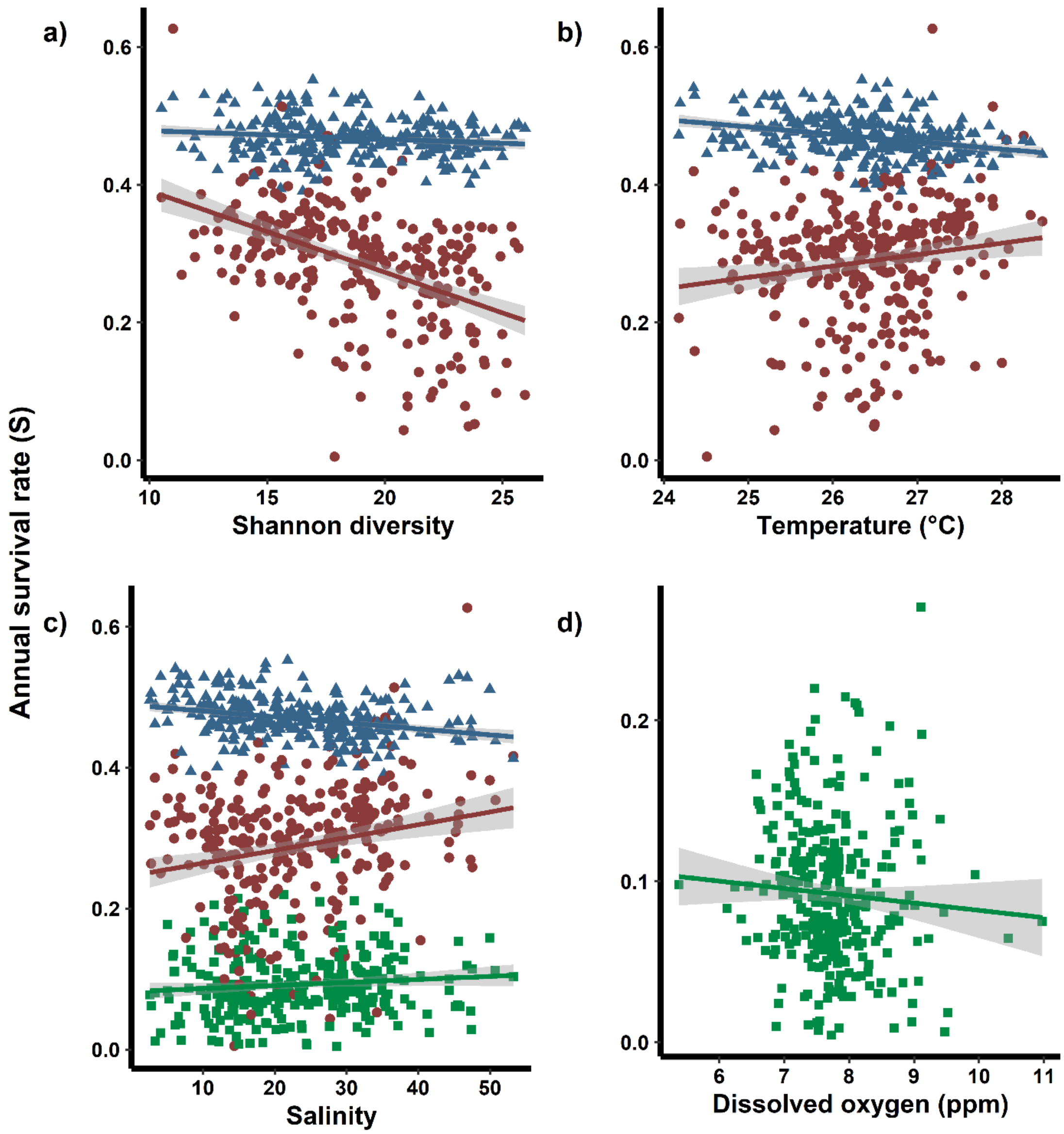

Fig. 9. Annual (finite) survival rate for Atlantic croaker – dark red circle; black drum – green square; and spotted seatrout – blue triangle; as a function of significant covariates: Shannon diversity (a), temperature (b), salinity (c), and dissolved oxygen (d). For Atlantic croaker, the top model (Adj. R^2 = 0.2399) included an intercept, fish diversity, and temperature (parameter estimates: 0.2875, -0.0404, and 0.0131 respectively); the second-best model (Adj. R^2 = 0.2363, ΔBIC = 1.2795) included an intercept, fish diversity, and salinity (parameter estimates: 0.2872, -0.0386, 0.0117). For black drum, the top model (Adj. R^2 = 0.0153) included an intercept and dissolved oxygen (parameter estimates: 0.0912, and -0.0063, respectively); the second-best model (Adj. R^2 = 0.0135, ΔBIC = 0.4968) included an intercept and salinity (parameter estimates: 0.0911, and 0.0051 respectively). For spotted seatrout the best model (Adj. R^2 = 0.1459) included an intercept, fish diversity, temperature, and salinity (parameter estimates:

0.4674, -0.0056, -0.0057, and -0.0060 respectively); there were no additional models within ΔBIC = 2.

III.4 Discussion

For all three species, annual survival was significantly related to either the biotic environment, abiotic environment, or both (Fig. 9, Appendix B: Table 23). Atlantic croaker and spotted seatrout showed associations with both biotic (i.e., species diversity) and abiotic factors, while black drum showed associations only with abiotic conditions. Spatial heterogeneity in survival rate for all three species and temporal trends for Atlantic croaker and black drum were also significant (Fig. 8). Atlantic croaker and spotted seatrout both showed a negative association with species diversity. Range limit theory suggests that species are more affected by abiotic conditions at their poleward edges, and by biotic interactions at their equatorward edges (Brown et al. 1996). Both Atlantic croaker and spotted seatrout are far from their poleward limits, and in the case of spotted seatrout, at its southern limit, and therefore likely to be affected by biotic interactions. In the bays of Texas, temperature and salinity are increasing, and these changes are allowing the expansion of tropical species (Fujiwara et al. 2019). This in turn has increased both invertebrate and fish diversities in the study area (Fujiwara et al. 2019, Pawluk et al. 2021), potentially leading to novel interactions.

The three species investigated are at an intermediate trophic level, feeding primarily on invertebrates (e.g., polychaetes, crustaceans, bivalves, and gastropods), smaller fishes, and detritus (Simmons and Breuer 1962, Simons 1998, Russell 2005, Mendenhall 2015), while being eaten by larger predators such as sharks. Shark abundance and richness are increasing in the bays of Texas (unpublished results), along with overall fish diversity. The increased presence of predators could reduce the survival of fish at an intermediate trophic level. It is also plausible that increasing invertebrate and fish diversity is leading to increased competition for native species.

A variety of studies have shown competitive impacts on native fishes from the expansion of warmer-water species. For example, increasing temperature combined with increased densities of an invading warm-water wrasse led to a behavioral shift toward suboptimal habitat by a native cold-water wrasse species (Milazzo et al. 2013). Range expansion of an invading urchin species resulted in negative impacts on native species via resource and habitat competition (Strain and Johnson 2013). Additionally, a study on the effect of invading ruffe and perch on native whitefish in subarctic lakes found evidence of worsened body condition in some invaded lakes (Hayden et al. 2013). In Texas, the combination of increasing fish diversity due to tropical species expansion, and reduced temperature stress on the invading species, may therefore have led to an increase in competition for native species, especially for those species that are currently at their trailing range edge.

Of the three species, Atlantic croaker is most widely distributed, occurring all the way from Canada to the northern coast of Argentina, including throughout the tropics. Black drum is less common in tropical waters, but widespread throughout the subtropical and temperate regions of the east coast of the United States. Meanwhile, spotted seatrout is predominantly found along the east coast of the United States, with the southern edge of the range extending to the northern Gulf of Mexico. Therefore, I expected that spotted seatrout would be most negatively impacted by changing abiotic conditions among the three species, and Atlantic croaker would be least impacted by changing abiotic conditions.

Temperature was found to impact survival, with a significant negative correlation with the survival of spotted seatrout and a significant positive correlation with Atlantic croaker survival. The disparity in direction of the relationship may reflect the difference in the southern range limit for these species. Since spotted seatrout is currently near its southern limit in the Gulf of Mexico, temperature-mediated changes in biotic interactions may have more negatively affected them compared to Atlantic croaker. Temperature has been shown to affect biotic interactions in freshwater and marine ecosystems. In particular, increasing temperature has been shown in some cases to increase predation pressure. For example, a strong latitudinal gradient in predation on amphipods by fishes in eelgrass beds was found to be related to the mean annual water temperature (Reynolds et al. 2018). Additionally, the intensity of top-down control by Dolly Varden (*Salvelinus malma*) on a stream ecosystem (Kishi et al. 2005) and keystone predation by Ochre sea star (*Pisaster ochraceus*) (Sanford 1999) were both shown to depend on temperature. Therefore, it is plausible that predation pressure has increased due to increased temperature along the Texas coast.

While Atlantic croaker and spotted seatrout showed some consistency in the types of variables affecting their survival, black drum showed relationships to different variables, salinity and dissolved oxygen, and the associations were weakly supported. The lack of strong predictors for black drum survival may be attributable to poor estimates of total mortality. When comparing the results from this study with mortality estimates from previous studies, the total mortality estimates (Z) for Atlantic croaker (range across all mortality estimates: 0.47 – 5.28) and spotted seatrout (range across all mortality estimates: 0.59 – 0.94) fall reasonably within the ranges of previous studies (0.55 – 3.2; 0.65 – 1.42, respectively) suggesting that our estimates are likely reasonable, while those of black drum (range across all mortality estimates: 1.31 – 5.46) are dramatically higher than previous studies (0.08 – 0.43) suggesting our estimates for black drum may not be reasonable (Appendix B: Table 34). The higher estimates of mortality for Black drum may be the result of limiting this analysis to ages 2 – 5. Additionally, the majority of the data used in developing the age-length key came from models of older age classes which were excluded in this study due to offshore movement for reproduction. Thus, the growth function provided by Leard et al. (1993) may have been inconsistent with the fish in this study. In general, the age-length keys used in this study may have added some uncertainty to our estimates, as data were only available from relatively outdated age-length studies, however any bias was applied equally across all data for a given species, which should at least minimize the bias. While the main focus of this study was to determine how climate change affects fish mortality, it also allowed us to also assess how mortality changes across space and through time. In fisheries research, mortality is often assumed to be constant across ages and in some cases through time (Millar 2015). This analysis identified significant spatial and temporal heterogeneity in mortality. Additionally, the wide range in mortality estimates across studies suggests that Z is generally heterogeneous across space (and possibly through time) (Appendix B: Table 34), and consideration needs to be taken to account for this variation when managing fish populations.

III.5 Conclusion

My results show increasing temperature and fish diversity may be contributing to changes in mortality, possibly through the effect of temperature on predation, whereby predation increases with increasing temperature and through the effect of increasing diversity of predators and competitors, leading to novel interactions with these species. The trend of northern expansion of warm-water species has been documented across many locations, and is by no means unique to the bays of Texas, potentially suggesting that increased mortality of native fishes as a result of novel interactions with expanding species may be a widespread phenomenon. The broader implication of this result is that fish community dynamics are likely to become highly unpredictable and site-specific in the face of climate change. Increases in fish mortality due to novel interactions, if unaccounted for, could lead to mismanagement of fish stocks due to underestimation of mortality. While this study found a potential effect of expanding species on resident species mortality, there are likely many other factors affecting mortality rates that were not considered in this study. One important factor to consider is that of fishing mortality, which can have profound effects on population dynamics, however data from the recreational fishery in Texas suggest that landings have decreased through time for Atlantic croaker and spotted seatrout, and remained fairly stable for black drum (Green and Campbell 2010). Since Atlantic croaker and spotted seatrout mortality showed increasing trends in mortality, and black drum showed a decrease in mortality, it is unlikely that recreational fishing pressure was strongly contributing to the trends observed in this study. Further studies on the effects of fish range expansion on native species are needed, to understand the effects of climate change on marine communities, and incorporation of additional factors such as pollution, habitat degradation, and predator or competitor abundance may be needed to better understand the factors affecting fish mortality rates.

CHAPTER IV

CLIMATE CHANGE DRIVES FUNCTIONAL HOMOGENIZATION OF A SUBTROPICAL ESTUARY

IV.1 Introduction

Biodiversity is often associated with positive effects on ecosystem functions (Loreau 1998), however, depending on the specific function being considered, the relationship between species diversity and ecosystem functioning can be positive, neutral, or even negative (Schwartz et al. 2000). For example, a terrestrial mesocosm experiment examining the effect of diversity on ecosystem function found that some functions (e.g. community respiration, short-term decomposition, and productivity) were significantly different among diversity treatments, while others (e.g. nutrient retention – available ammonium, available nitrate, and available total nitrogen) had no significant difference among diversity treatments (Naeem et al. 1995). Evidence suggests that ecosystem functioning is more closely related to functional diversity (Hooper et al. 2005), and thus the observed relationship between biodiversity and ecosystem function is driven by the relationship between biodiversity and functional diversity for a given ecosystem and function (Mayfield et al. 2010). For ecosystems in which functional diversity and species diversity are positively correlated, ecosystem functioning is expected to increase with increasing taxonomic diversity (Petchey 2000). Understanding the relationship between taxonomic and functional diversity is thus critical for predicting the potential consequences of anthropogenic impacts to ecosystems.

In marine ecosystems, climate change is driving large-scale expansion and distribution shifts for many species (Sorte et al. 2010). For example, Perry et al. (2005) found that increasing sea temperatures over a 25 year period in the North Sea led to increasing mean latitude of occurrence, increasing depth of occurrence, or both, for nearly two-thirds of the fish species observed. While a meta-analysis of coastal survey data by Pinsky et al. (2013) found that climate velocity (the rate and direction of climate shifts) significantly explained fish and invertebrate distribution shifts. Many such distribution shifts and expansions have led to increasing fish species diversity in temperate and subtropical ecosystems (Hiddink and Ter Hofstede 2008, Fujiwara et al. 2019, Pawluk et al. 2021). It is therefore imperative to understand how changing diversity due to species range shifts or expansions relates to changing functional diversity, in order to understand how climate change will impact ecosystem functioning of marine ecosystems. Additionally, increasing taxonomic diversity as a result of species range expansion implies that more species have been added to the region than native species that were lost. This would allude to formation of novel communities, and thus potential novel interactions between native and invading species (Van der Putten et al. 2010). It is therefore also important to identify how expanding species may impact the dynamics of native species and drive trends in changing functional composition and diversity.

While previous studies have demonstrated evidence of climate-induced distribution shifts (Perry et al. 2005, Collie et al. 2008, Pinsky et al. 2013) and increasing taxonomic diversity of marine fish species (Stefansdottir et al. 2010), few studies to date have addressed impacts of climate-driven marine distribution shifts on functional composition and diversity (McLean et al. 2018, McLean et al. 2019). In this study, I address this knowledge gap by assessing the impact of expanding tropical species on fish functional diversity in the bays of Texas. Previous studies have indicated that fish and invertebrate diversity in the bays of Texas has increased during recent years due to the expansion of tropical species from the Gulf of Mexico (Fujiwara et al.

2019, Pawluk et al. 2021). However, it is not yet known how such expansion has affected the functional composition and diversity.

By analyzing a 37-year survey dataset from the bays of Texas plus species diversity data from a previous study, I assess the long-term trends in functional diversity and functional composition of a subtropical coastal ecosystem. A variety of metrics are proposed for characterizing the functional diversity and structure of a community (Cadotte et al. 2011), with trait-based approaches often being used for characterization of functional diversity without explicit a priori grouping of species (Laliberté and Legendre 2010, Villéger et al. 2010, Coleman et al. 2015, Silva-Júnior et al. 2017). Trait-based approaches allow for the incorporation of life history characteristics (e.g., age at maturation, maximum size, etc.), trophic characteristics (e.g., diet type, trophic level, feeding mode, etc.), and habitat characteristics (e.g., water column position, salinity preference, temperature preference, etc.), which allows for a more detailed characterization of a species position within the community, without the restrictive nature of broad functional groups. Two such trait-based metrics frequently used to characterize functional diversity include functional richness (FRic) and functional dispersion (FDis).

Functional richness measures the minimum convex hull volume for a multi-dimensional trait space (Villéger et al. 2008). Essentially, FRic measures the range of trait values along each trait axis, with higher functional richness implying more diverse trait types within the assemblage. Whereas FRic is informative as to the volume of trait space occupied, it does not incorporate relative abundances of trait values. Functional dispersion measures the abundance-weighted mean distance to the abundance-weighted centroid in trait space (Laliberté and Legendre 2010), and because it accounts for the relative abundance of different trait types it is informative on whether a community is dominated by a particular functional type, or by a variety of diverse functional types. Combining the two metrics allows for a determination of whether or not trait space has expanded or contracted, and whether any changes to trait space are significantly impacting the functioning of the system (i.e., whether new traits are occurring in high relative abundance). For this reason, it is useful to consider both metrics, allowing for insight into the expansion and contraction of trait space, while also taking into account how relative abundance is distributed within the trait space.

Although functional diversity indices provide some indication of how functional diversity has changed through time, they do not provide insight into which functional types have contributed to the observed changes, or how individual traits may be changing through time. To address this issue, community-weighted trait means can be used. Essentially, the mean value of each trait across all species within the community is calculated, weighted by the relative abundance of each species (Lavorel et al. 2008). By calculating traits means in each year, temporal trends in trait values can be inferred, allowing for interpretation of how functional composition has changed.

Using a trait-based approach, I seek to address four main questions: 1) *Has increasing species diversity due to climate driven expansion led to increasing functional diversity?* 2) *How has functional composition changed through time in response to species expansion?* 3) *Which species are contributing most to trends in functional diversity and composition?* 4) *Are trends in species abundance strongly influenced by species interactions?* I address these questions in three steps: 1) calculation of functional diversity indices for the bays of Texas in each year and season, 2) calculation of community weighted trait means to assess changes to functional structure, and 3) ordination and modeling of species abundances to identify those species contributing the most to trends and assess potential interactions between native and invading species.

IV.2 Methods

IV.2.1 Data collection

The abundance data for this project were collected over a 38-year period from 1982 to 2019 as a part of a gillnet survey program conducted by the Coastal Fisheries Division of the Texas Parks and Wildlife Department (TPWD) (Martinez-Andrade 2015). Samples were collected in spring (April – June) and fall (September – November) from each of the eight major bays of Texas: Sabine Lake, Galveston Bay, Matagorda Bay, San Antonio Bay, Aransas Bay, Corpus Christi Bay, Upper Laguna Madre, and Lower Laguna Madre. In all sampled seasons a total of 45 gillnet samples were collected from each bay. For each sample, the bays were divided into a one-minute latitude by a one-minute longitude sample grid, with each grid square divided into 144 gridlets of five-second latitude by five-second longitude. A stratified cluster sampling design was used to randomly select individual grid square locations without replacement from the predefined sample grid for each bay, and gridlet locations within the selected grid square for net placement. The sample gear consisted of gillnets comprised of four equal length (45.7 m) panels of differing mesh sizes (76 mm, 102 mm, 127 mm, and 152 mm). Gillnets were set perpendicular to the shoreline, with the smallest mesh size nearest to the shore, and allowed to soak from sunset to sunrise for an average of 13.5 hours. For all samples, each individual caught was identified to species, and concurrent latitude, longitude, and environmental data were recorded. The environmental data consist of temperature (Celsius), Salinity, dissolved oxygen (ppm), and turbidity (NTU).

In addition to species catch per unit effort (CPUE), functional trait data were obtained from existing sources for each species observed. Life history and trait data were collected from the database FishBase (Froese and Pauly 2020), and from the data-integrated predictive life history model developed by Thorson et al. (2017) available in the R package "FishLife" (R Core Team 2018, Thorson 2019). The "FishLife" package allows for estimation of life history parameters by incorporating existing data, life history correlations, and similarities among related species, into a multivariate random-walk model. The functional traits used in this study are shown in Table 4. These traits were selected to represent aspects of life history, diet, and niche utilization. All non-numeric traits were converted to numerical traits, following an ordinal scale, in order to simplify the calculation of functional diversity indices and mean trait values, as many analyses do not allow for mixed data types, as well as to improve interpretability for categorical trait means.

IV.2.2 Functional diversity indices

In order to assess the functional impact of tropical species expansion into the bays of Texas, estimates of two functional diversity indices were calculated for each bay and year for both spring and fall assemblages. Functional richness (FRic) provides a measure of the volume of trait space occupied by a community, with higher FRic implying a wider range of trait values along one or more trait axes (Villéger et al. 2008). While functional richness can provide interesting insight into the range of functional types within a community, it does not incorporate relative abundance of different trait types. Functional dispersion

Table 4. Fish functional traits. Trait abbreviations, descriptions, units (or scale for categorical variables), and the data source for all functional traits included in the analysis. FB: FishBase species page. For traits with multiple sources, the sources are listed in order of preference (i.e., if info is not available from source 1 it is taken from source 2, then 3 etc.). When trait data were not available from any of the listed sources the cell was left blank.

Trait abbreviation	*Trait description*	*Units or scale*	*Data source*
Lmax	Maximum observed length (TL)	mm	FB
Lcom	Commonly observed length (TL)	mm	FB
Lmat	Length at maturity (TL)	mm	1) FB life history tool, 2) R FishLife
Amat	Age at maturity	yrs	1) FB life history tool, 2) R FishLife
Tmax	Maximum reported age	yrs	1) FB, 2) FB life history tool, 3) R FishLife
Wmax	Maximum reported weight	kg	1) FB, 2) FB life history tool, 3) R FishLife
Linf	L infinity, von Bertalanffy asymptotic length	mm	1) FB life history tool, 2) R FishLife
K	von Bertalanffy growth parameter	unitless	1) FB life history tool, 2) R FishLife
t0	von Bertalanffy hypothetical age at length-0	yrs	1) FB life history tool, 2) R FishLife
M	Natural mortality rate	unitless	1) FB life history tool, 2) R FishLife
GenT	Generation time	yrs	1) FB life history tool, 2) R FishLife
TrLvl	Trophic level	unitless	1) FB, 2) R FishLife
MoPos	Mouth position	1(inferior), 2(subterminal), 3(terminal), 4(supraterminal), 5(superior)	Visual assessment
CauFin	Caudal fin shape	0(reduced), 1(rounded), 2(truncate), 3(emarginate), 4(lunate), 5(forked), 6(heterocercal)	Visual assessment
BdSh	Body shape	1(flat - dorsoventrally), 2(elongate - long and narrow), 3(moderate, fusiform), 4(deep - dorsoventrally)	Visual assessment

Table 4. continued.

Trait abbreviation	*Trait description*	*Units or scale*	*Data source*
CrossSec	Body cross-section	1(depressed - dorsoventral compression), 2(round), 3(oval), 4(compressed - lateral)	Visual assessment
piscivore	Consumes fish	1(Yes), 0(No)	FB
invertivore	Consumes invertebrates	1(Yes), 0(No)	FB
herbivore	Consumes algae or other plants	1(Yes), 0(No)	FB
detritivore	Consumes detritus	1(Yes), 0(No)	FB
Pos	Water column position	1(Near-shore/reef associated), 2(pelagic-neritic), 3(pelagic-oceanic), 4(benthopelagic), 5(demersal)	FB
RepGuild	Parental care (based on reproductive guild)	0(open water/substratum egg scatterers), 1(brood hiders), 2(nest guarders), 3(clutch tenders), 4(external brooders), 5(internal live bearers)	FB
Temp	Preferred temperature, mean temperatured of occurrence	Celsius	1) FB, 2) R FishLife
MinTemp	Minimum temperature in which species is observed	Celsius	FB
MaxTemp	Maximum temperature in which species is observed	Celsius	FB
TempRng	temperature range (Maximum - Minimum)	Celsius	calculated from other traits
Sal	Salinity preference	0(freshwater), 1(freshwater/brackish), 2(freshwater/marine/brackish), 3(marine/brackish), 4(marine)	FB

(FDis) addresses this issue by incorporating species relative abundance and their position in trait space to determine how clumped or dispersed community abundance is within the occupied trait space (Laliberté and Legendre 2010). Calculations for FRic and FDis were done using the dbFD function within the “FD” package in R (Laliberté et al. 2014, R Core Team 2018).

In order to assess the significance of any temporal trends in FRic and FDis, linear models were fit for each bay and season, with the metric as the dependent variable and year as the independent variable. For FRic, the natural log of FRic was used as the response variable to stabilize the variance. To assess spatial and seasonal differences in functional diversity, analysis of variance (ANOVA) was used with the following equation: metric ~ bay + season, where metric is either ln(FRic) or FDis, bay is a categorical variable distinguishing between bays (1 – 8 from north to south, with 1 being the northernmost bay (Sabine Lake) and 8 being the southernmost bay (Lower Laguna Madre), and season being a categorical variable, either spring or fall.

IV.2.3 Analysis of trait means

Calculation of functional diversity metrics is informative as to whether a community has become more or less functionally diverse, but provides no information on which traits predominate within the community, or how traits may be changing through time. In order to characterize the functional composition of Texas assemblages, and assess the significance of temporal trends in trait changes, community weighted mean (CWM) trait values were calculated for all functional traits in each year and bay for both spring and fall assemblages. Community weighted trait means are calculated as the mean trait value for all species within the community, weighted by species abundance (i.e., more abundant species have stronger influence on the mean trait value). Abundance-weighted trait means were calculated using the "functcomp" function within the "FD" package (Laliberté et al. 2014) in R, which takes a species by trait matrix, and site by species abundance matrix and returns the community-level weighted mean for each trait within the trait matrix at each site. For the purposes of this analysis, “sites” were a given year within a given bay, for each season.

After obtaining a time series of CWM trait values for each bay and season, it was possible to statistically test for significant changes in mean trait values within the community, thereby giving an indication of how the functional composition of the assemblage has changed through time. Because many traits showed non-linear trends, significance of trait changes was tested by grouping data by decade and performing analysis of variance (ANOVA) to test for significance differences in mean trait value among decades. To avoid excessive testing and inflated experiment-wise error rate, only selected traits were tested for temporal trends. In particular, traits that were related to life history strategy, trophic relationships and environmental relationships were tested in order to identify which life history types are contributing to changing functional diversity, and identify whether trait data were reflective of increasing presence of water-water associated predators. The traits selected were: trophic level, maximum temperature, piscivory, age at maturity, natural mortality, maximum age, L_∞, generation time, and parental care.

IV.2.4 Abundance analyses

Principal components analysis (PCA) was used on untransformed abundance data to identify which species that contributed most to changing abundances through time within each bay and season. Species were then ranked by the magnitude of their PC1 and PC2 loadings (i.e., highest magnitude has rank 1, second highest magnitude has rank 2, etc.). Ranks were summed across all bays for each season, with the species having the lowest rank sum contributing most to changing abundances within the bays. Temporal trends in abundance for species identified as important by

PCA were examined, and after noting an increase in relative abundance of several tropical species consisting of large predators, and potential competitor species, possible species interactions were investigated.

In order to determine whether trends in abundance of "important" species as identified by PCA were correlated with increasing predator or competitor abundance, generalized additive models (GAMs) were fit with the following structure: prey abundance ~ s(predator /competitor abundance), where s(x) is a smoothing spline with default setting of df=4, where df is the target equivalent degrees of freedom, after standardizing abundance using a Z-score for each species within each bay. The 15 species with the lowest rank sums in each season were tested for potential predator and/or competitor association. Several of the top ranked species have increased in prevalence through time and were thus identified as potential predator/competitor species and therefore not modeled for interactions (i.e., modeled as independent variable only, not as a response variable).

Models with a either a parametric or non-parametric ANOVA p-values less than 0.01 and a negative correlation coefficient were considered significant. Although it is possible for predators and prey to be positively associated, it is difficult to disentangle a positive correlation between predator and prey from a synchronous response to environment or resource availability, and therefore I focused only on negative correlations. I chose a slightly more conservative value of alpha (0.01) for this analysis to limit significant results to stronger associations. All significant models as defined above are presented in the results section.

IV.3 Results

IV.3.1 Functional diversity indices

For both spring and fall, functional diversity indices were found to vary across space and through time. Functional richness (FRic) showed an increasing trend across all bays in both spring and fall (logFRic ~ Year, $p=0.0018$ and $p<0.0001$ for spring and fall respectively, Fig. 10a). Functional dispersion (FDis) decreased significantly through time in spring ($p<0.0001$), but not fall ($p=0.404$). Although fall did not show a significant linear trend, there was a distinct non-linear trend in fall, with FDis initially decreasing, and subsequently increasing (Fig. 10b). Natural log of functional richness was significantly different among bays ($p<0.0001$), but not among seasons ($p=0.324$). Although significant differences in functional richness were evident among bays, no clear spatial pattern was evident (Fig. 10c). For functional dispersion, both among bay differences ($p<0.0001$) and between season differences ($p=0.0005$) were highly significant. There was a clear pattern of higher FDis in the north compared to the south (Fig. 10d), meaning that bays in the south were more strongly dominated by fewer trait types, while in the north assemblages were somewhat less clumped in trait space (although overall, FDis was relatively low for all bays). Functional dispersion was generally higher in fall than in spring, suggesting that for a given bay, the fall assemblage was less clumped in trait space.

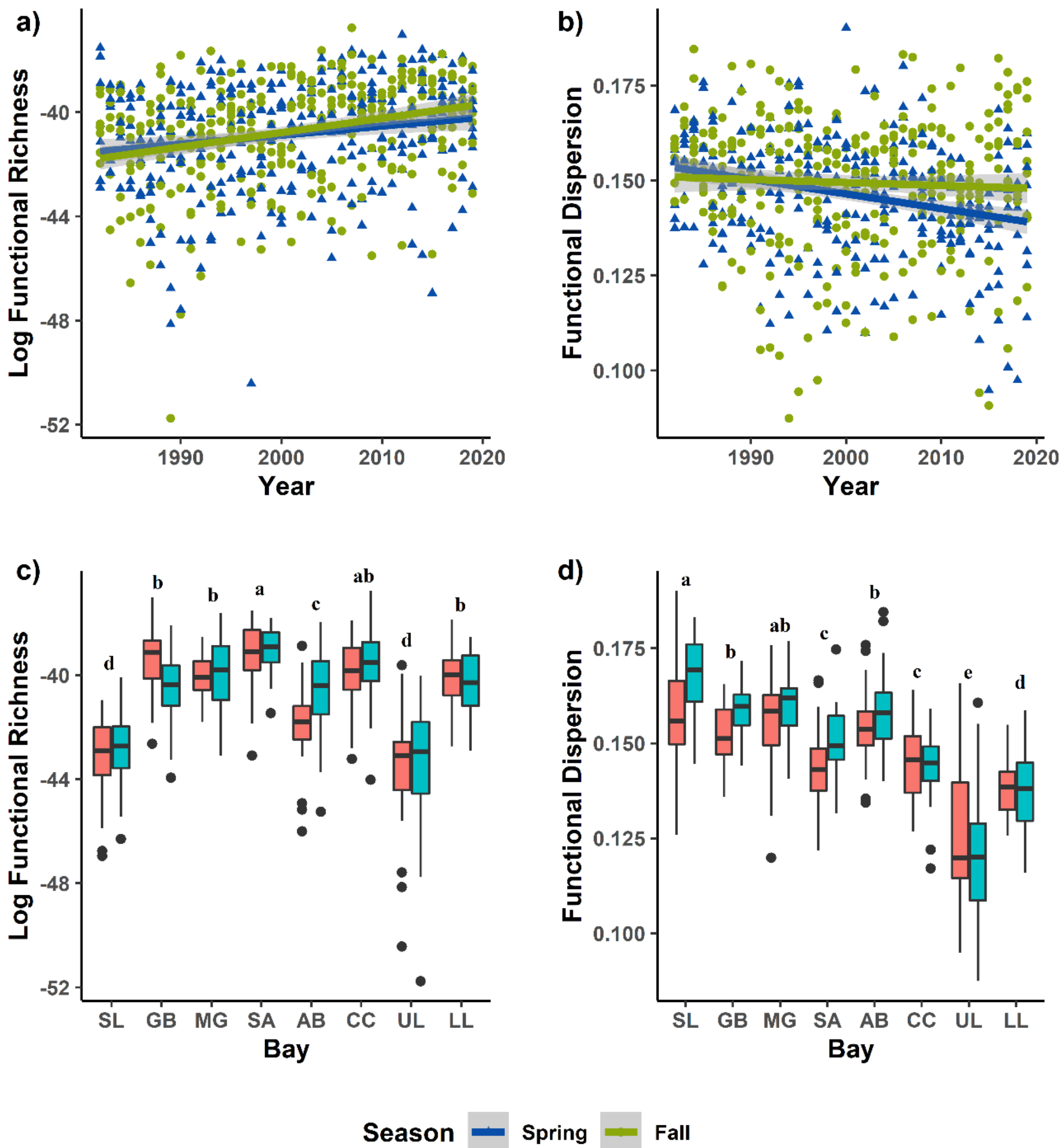

Fig. 10. Spatial and temporal trends in functional diversity. Temporal trends in a) log-functional richness, and b) functional dispersion are shown for spring and fall, with spring shown with blue triangles, and fall shown with green dots. Spatial differences in c) log-functional richness, and d) functional dispersion are shown for spring and fall, with spring shown in blue, and fall shown in green, with the bays arranged from north to south along the x-axis. Letters above boxplots represent groups of bays that are not significantly different. Bay abbreviations are as follows, SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

IV.3.2 Analysis of trait means

Community weighted mean trait values were calculated for all functional traits in each bay and year for each season separately, tables containing all community weight trait means are presented in Appendix C (Tables 47 & 48). Nine functional traits were selected for testing of significant temporal and seasonal trends: trophic level, maximum temperature, piscivory, age at maturity, natural mortality, maximum age, L infinity, generation time, and parental care. All nine traits had significant decade and season terms at an alpha of 0.05, with p-values ranging from a maximum of 0.0002 to a minimum of 2.56×10^{-104} (effectively 0). Results from the trait ANOVAs and Tukey's honestly significant difference are presented in Appendix C (Tables 29 – 46). Mean trophic level, maximum temperature, piscivory, maximum age, L infinity, and generation time all increased through time and were higher in spring than in fall (Fig. 11a-c, 11f-h). Natural mortality decreased through time and was significantly lower in spring than in fall (Fig. 11e), which was expected, given that larger, longer-lived individuals tend to have lower natural mortality rates. Age at maturity and parental care showed a "U" shaped trend (Fig. 11d, 11i), with initial decreases and subsequent increases, likely indicative of increased equilibrium strategists (i.e., species with well-developed parental care and delayed maturity) in more recent decades. Taken together the temporal and seasonal trends in trait means indicated an increase in relative abundance of longer-lived, larger individuals. The trends in parental care and age at maturity indicated an initial increase in the relative abundance of periodic strategists (long-lived, large, no parental care, and earlier maturing compared to equilibrium strategists), followed by an increase in both periodic and equilibrium strategists.

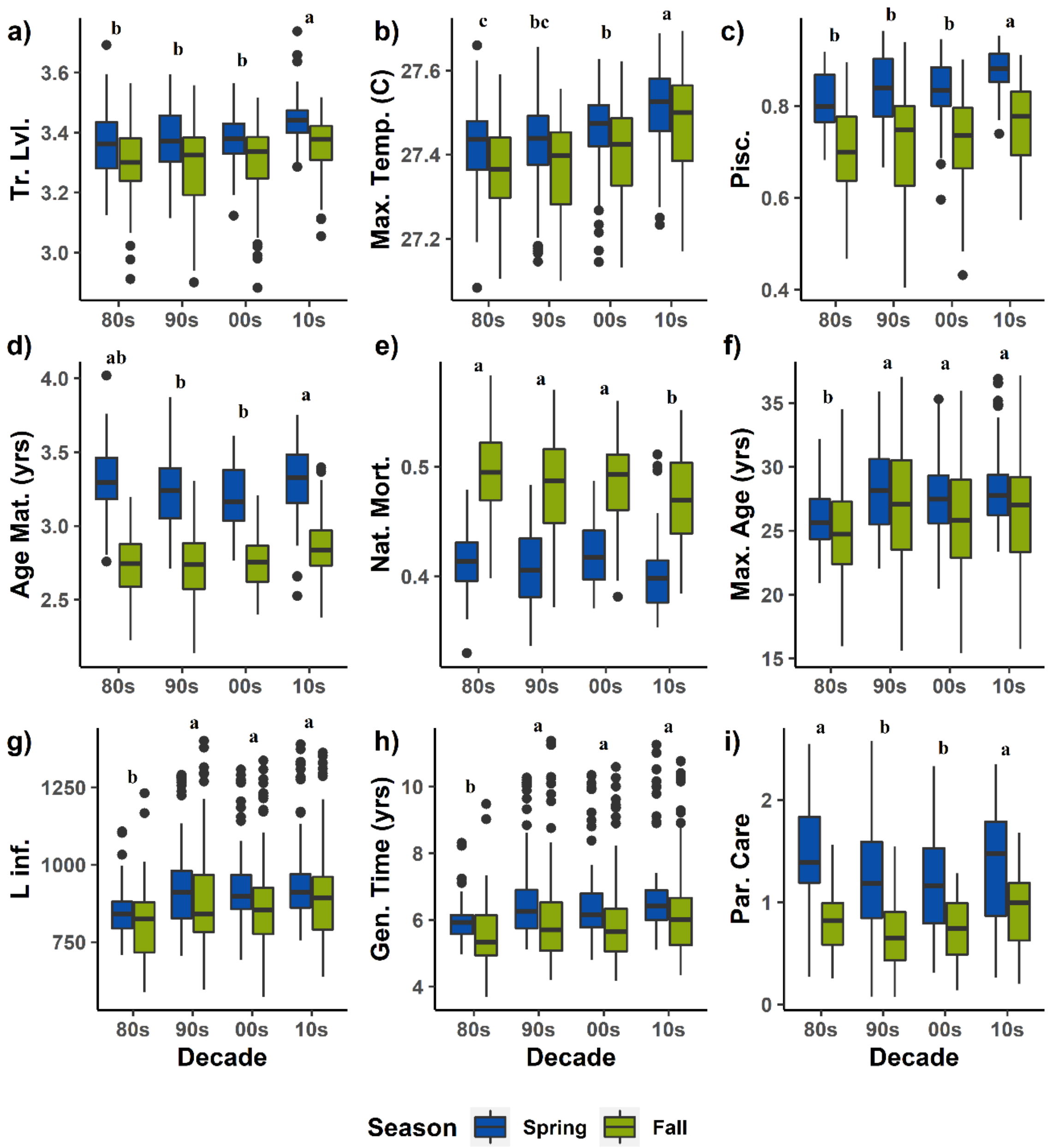

Fig. 11. Community-weighted mean trait values by decade. CWM trait values are shown with data grouped by decade for a) Trophic level, b) Maximum temperature observed (°C), c) Piscivory, d) Age at maturity (years), e) Natural mortality rate, f) Maximum age (years), g) L_∞ (mm), h) Generation time (years), and i) Parental care. Spring data is shown in blue, and fall data is shown in green. Letters above boxplots represent groups of decades that are not significantly different.

IV.3.3 Abundance analyses

Principal components analysis was run on the species abundance data for each season and bay, to identify which species were contributing most to temporal trends in functional diversity and trait means. Tables showing the total number of individuals caught throughout the study period for each species, and the proportion of total catch by species are presented in Appendix C (Tables 49 and 50). Species were ranked using PCA to identify the most important species contributing to changing assemblage structure in each season. The abundances for the 15 most important species in each season are shown in Fig. 12.

Generalized Additive Models (GAMs) were fit to the abundance data for the most important species to test for effects of predation and competition. The species tested as potential predators or competitors included: bonnethead shark (*Sphyrna tiburo*), bull shark (*Carcharhinus leucas*), blacktip shark (*Carcharhinus limbatus*), ladyfish (*Elops saurus*), and gray snapper (*Lutjanus griseus*). These species were chosen as predator/competitor species due to their increasing abundance throughout the study and thus their potential impact on other more abundant and commonly occurring species (e.g., red drum, black drum, spotted seatrout, etc.). Fourteen total models were identified as significant, seven in each season, with model results shown in Table 5. Ladyfish was the most common predator/competitor species appearing in significant models (5), followed by Gray snapper (4), Bonnethead (3), Blacktip shark (1) and Bull shark (1). Figs. 13 – 15 show three examples of the predator and prey (or competitor/competitor) species abundances where there are clear inverse fluctuations in abundance suggesting species interactions may be affecting abundance.

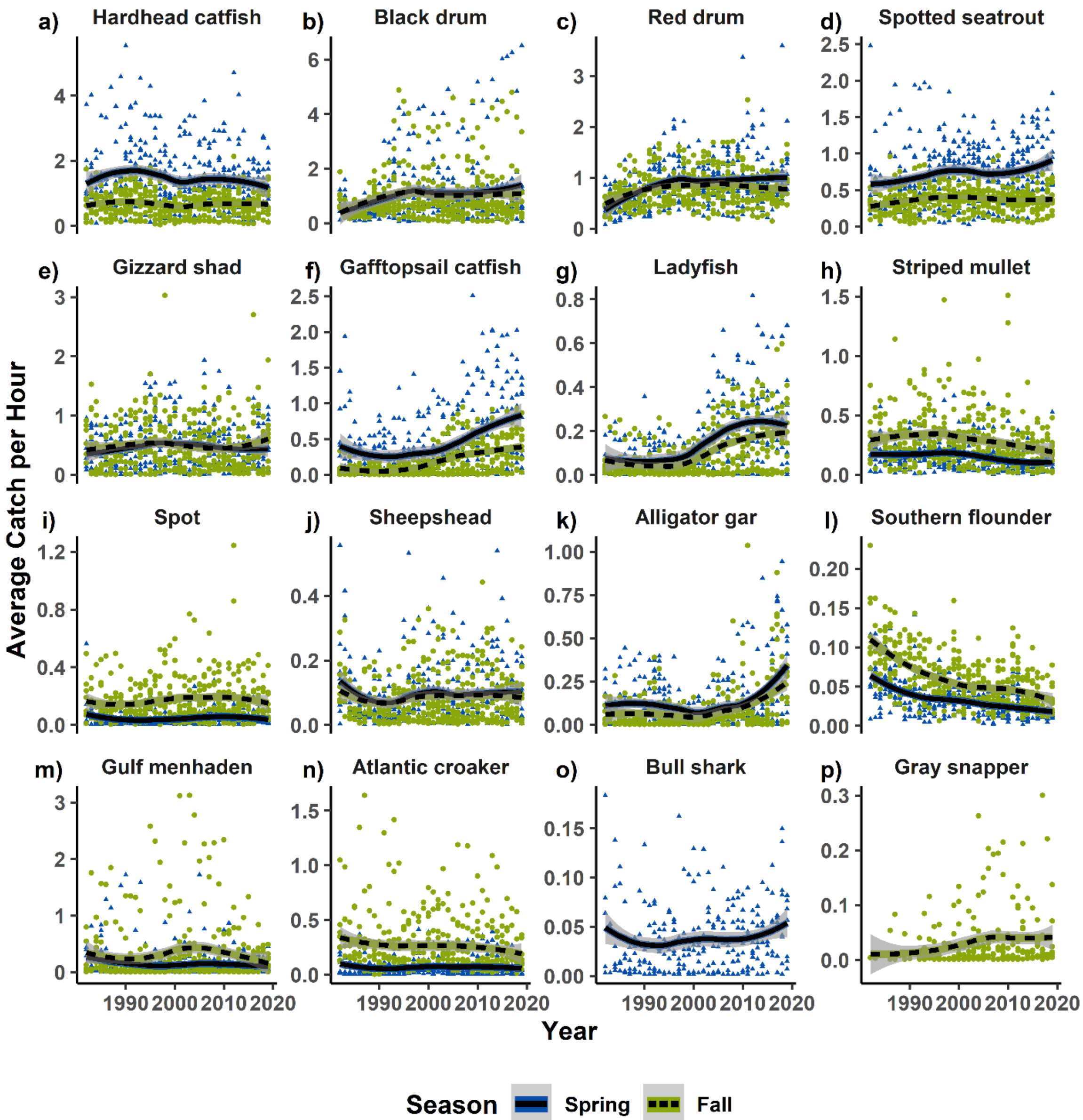

Fig. 12. Abundance of top-ranked species. Average catch per hour data and loess trend is shown for the top 15 ranked species, in spring (blue triangles, solid black line) and fall (green dots, dashed black line), for a) Hardhead catfish (*Ariopsis felis*), b) Black drum (*Pogonias cromis*), c) Red drum (*Sciaenops ocellatus*), d) Spotted seatrout (*Cynoscion nebulosus*), e) Gizzard shad (*Dorosoma cepedianum*), f) Gafftopsail catfish (*Bagre marinus*), g) Ladyfish (*Elops saurus*), h) Striped mullet (*Mugil cephalus*), i) Spot (*Leiostomus xanthurus*), j) Sheepshead (*Archosargus probatocephalus*), k) Alligator gar (*Atractosteus spatula*), l) Southern flounder (*Paralichthys lethostigma*), m) Gulf menhaden (*Brevoortia patronus*), n) Atlantic croaker (*Micropogonias undulatus*), o) Bull shark (*Carcharhinus leucas*), and p) Gray snapper (*Lutjanus griseus*) (note: there are 16 plots as Bull shark was in the top 15 in spring but not fall, and Gray snapper was in the top 15 in fall but not spring).

Table 5. Generalized Additive Model results. Results for all significant models are shown, where a model is considered significant if either the parametric or nonparametric ANOVA yielded a p-value less than 0.01, and the correlation coefficient was negative. The species used as the response variable is listed in the “Response variable” column, while the species used as the independent variable is shown in the model column.

Response variable	*Season*	*Model*	*Parametric ANOVA p-value*	*Nonparametric ANOVA p-value*	*BIC*	*Correlation*
Gizzard shad	Spring	~ s(Blacktip shark)	0.0016	0.132	847.56	-0.1811
Southern flounder	Spring	~ s(Ladyfish)	<0.0001	0.086	823.54	-0.3324
Southern flounder	Spring	~ s(Gray snapper)	0.2238	0.001	847.74	-0.0689
Southern flounder	Spring	~ s(Bonnethead)	0.0001	0.812	849.12	-0.2226
Striped mullet	Spring	~ s(Ladyfish)	<0.0001	0.170	841.94	-0.2497
Striped mullet	Spring	~ s(Gray snapper)	0.4573	0.007	853.60	-0.0424
Striped mullet	Spring	~ s(Bonnethead)	0.0003	0.364	850.11	-0.2061
Atlantic croaker	Fall	~ s(Ladyfish)	0.0063	0.440	856.10	-0.1574
Southern flounder	Fall	~ s(Ladyfish)	<0.0001	0.321	815.23	-0.3792
Southern flounder	Fall	~ s(Gray snapper)	0.0002	0.122	845.37	-0.2142
Southern flounder	Fall	~ s(Bonnethead)	0.0041	0.489	854.57	-0.1653
Southern flounder	Fall	~ s(Bull shark)	0.0091	0.524	856.19	-0.1505
Striped mullet	Fall	~ s(Ladyfish)	0.0006	0.746	853.26	-0.1968
Striped mullet	Fall	~ s(Gray snapper)	0.0001	0.563	848.50	-0.2264

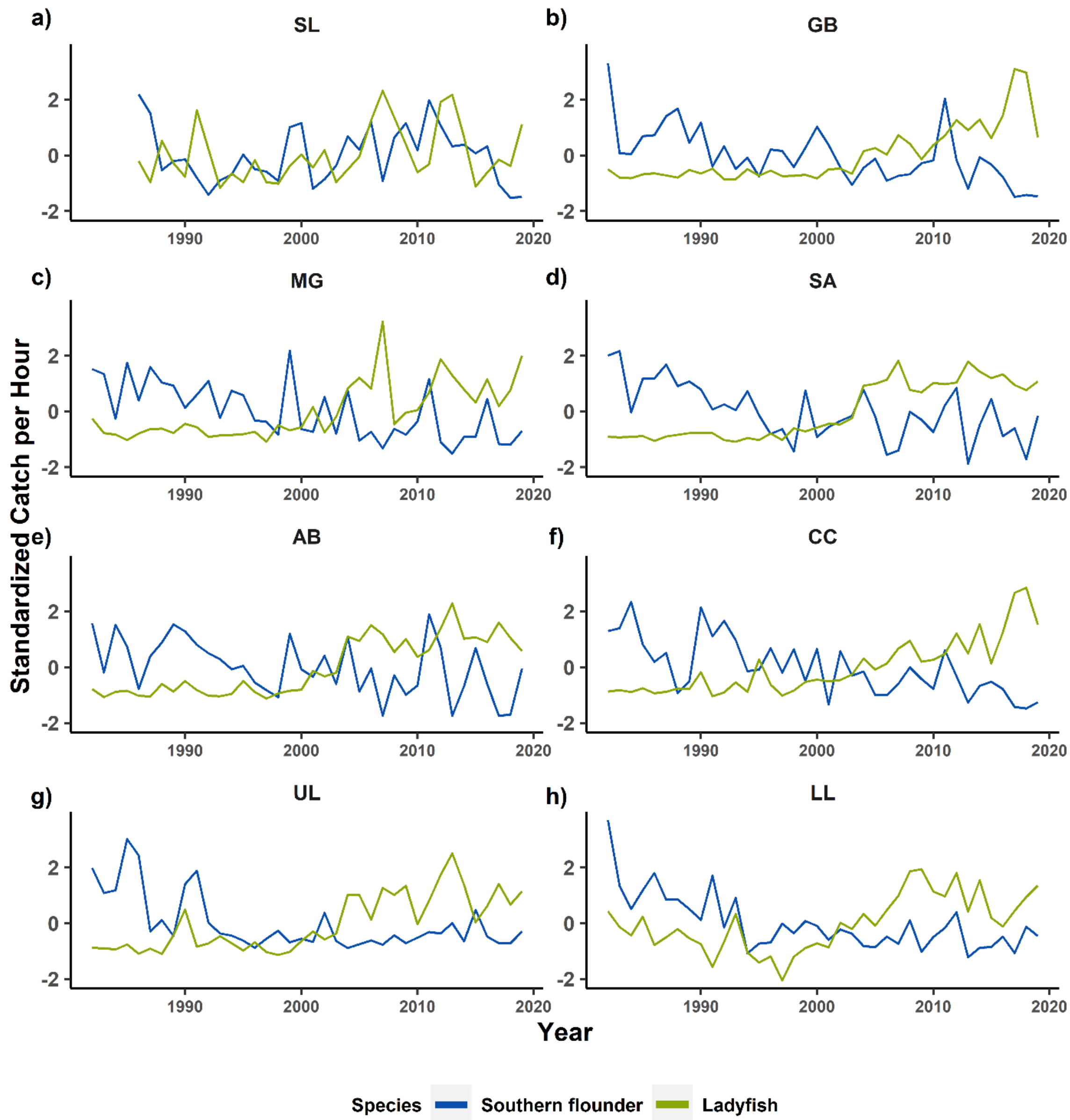

Fig. 13. Abundance by bay for potentially interacting southern flounder (*Paralichthys lethostigma*) and ladyfish (*Elops saurus*). The catch per hour (standardized by species) is shown for southern flounder shown in blue, and ladyfish shown in green, for a) Sabine Lake (SL), b) Galveston Bay (GB), c) Matagorda Bay (MG), d) San Antonio Bay (SA), e) Aransas Bay (AB), f) Corpus Christi Bay (CC), g) Upper Laguna Madre (UL), and h) Lower Laguna Madre (LL).

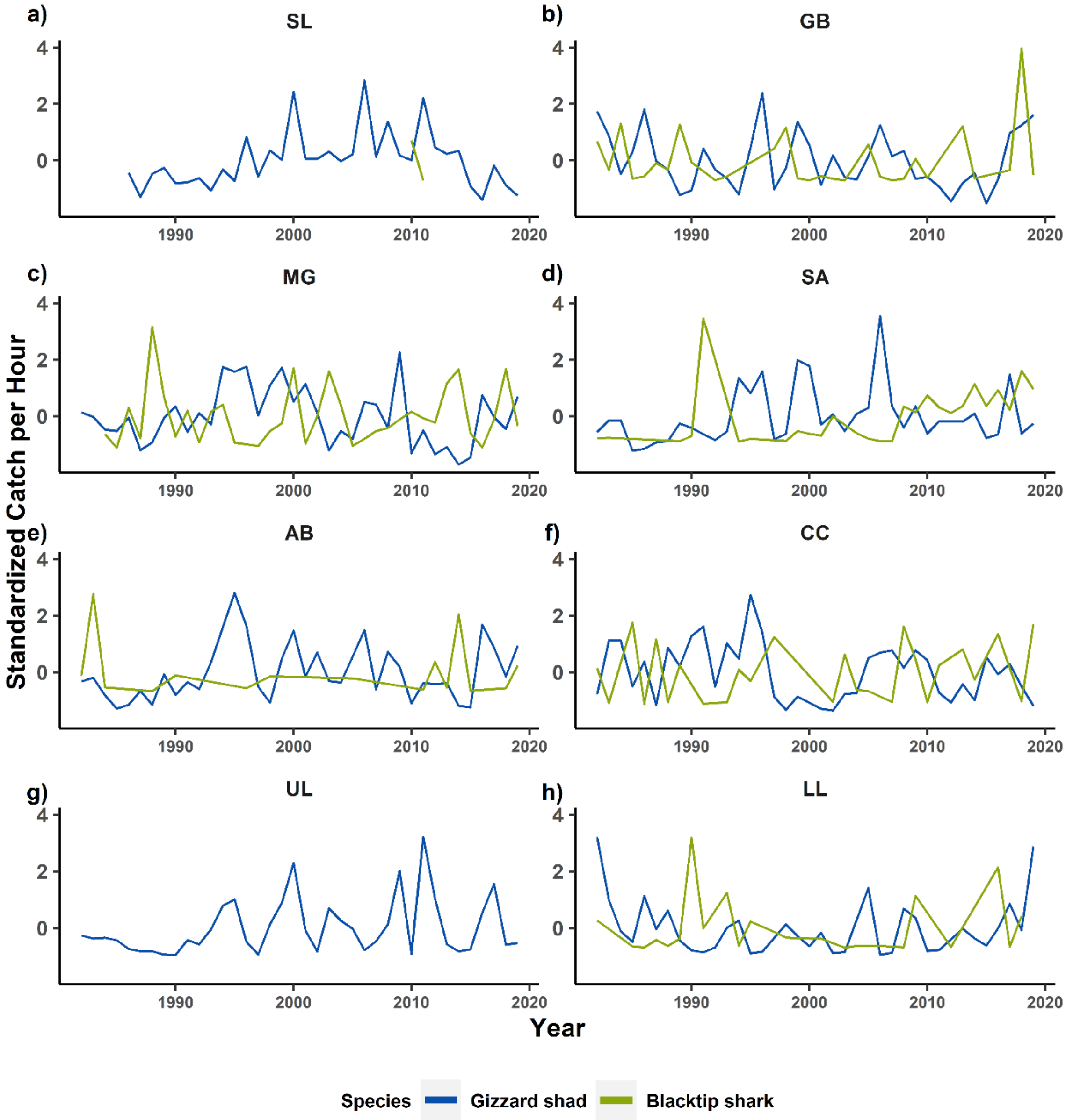

Fig. 14. Abundance by bay for potentially interacting gizzard shad (*Dorosoma cepedianum*) and blacktip shark (*Carcharhinus limbatus*). The catch per hour (standardized by species) is shown for gizzard shad shown in blue, and blacktip shark shown in green, for a) Sabine Lake (SL), b) Galveston Bay (GB), c) Matagorda Bay (MG), d) San Antonio Bay (SA), e) Aransas Bay (AB), f) Corpus Christi Bay (CC), g) Upper Laguna Madre (UL), and h) Lower Laguna Madre (LL).

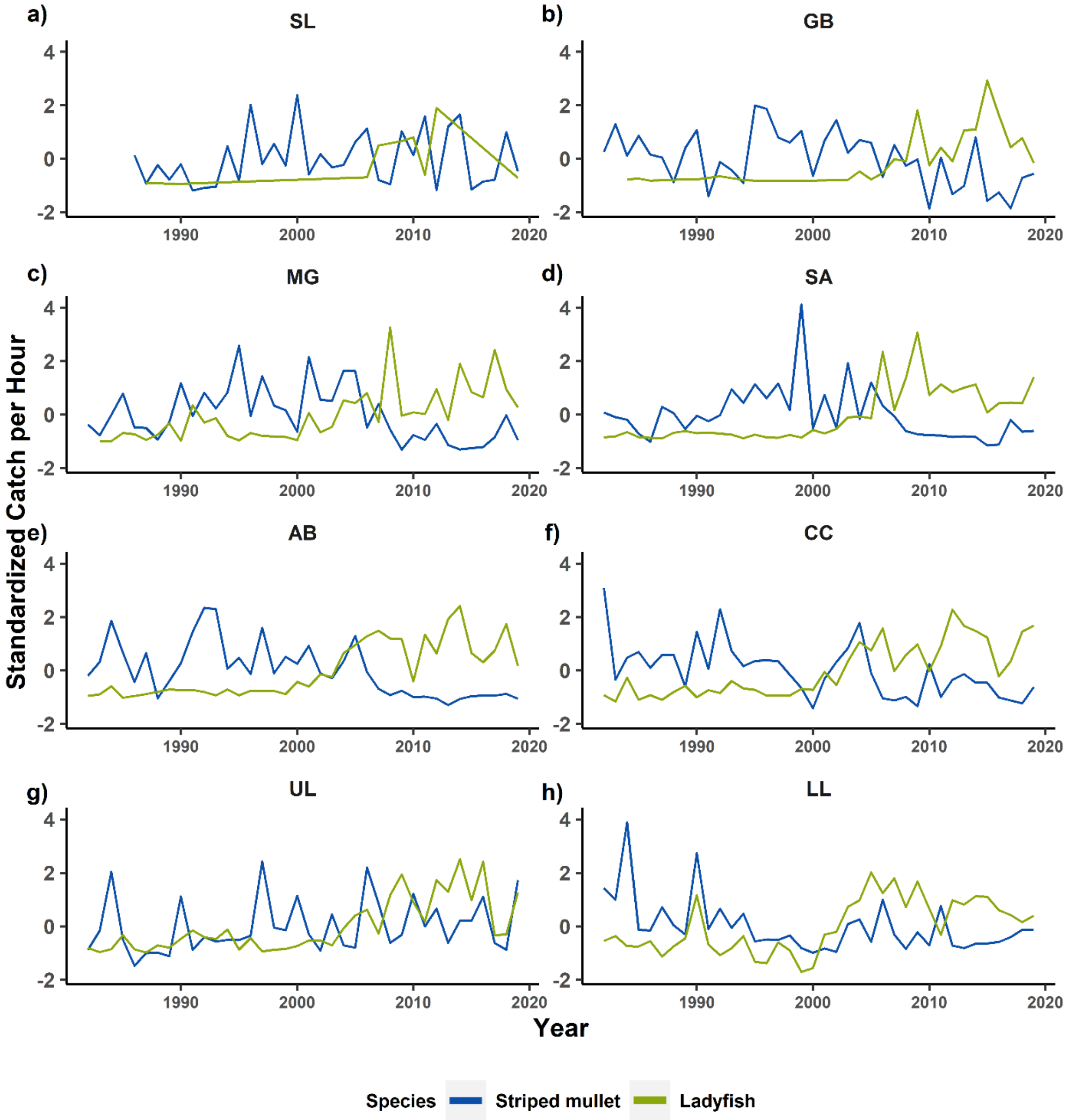

Fig. 15. Abundance by bay for potentially interacting striped mullet (*Mugil cephalus*) and ladyfish (*Elops saurus*). The catch per hour (standardized by species) is shown for striped mullet shown in blue, and ladyfish shown in green, for a) Sabine Lake (SL), b) Galveston Bay (GB), c) Matagorda Bay (MG), d) San Antonio Bay (SA), e) Aransas Bay (AB), f) Corpus Christi Bay (CC), g) Upper Laguna Madre (UL), and h) Lower Laguna Madre (LL).

IV.4 Discussion

In this study, I found that increasing species diversity is associated with increasing functional richness, but stable or decreasing functional dispersion (Fig. 10). The trait analysis indicated that these trends were predominantly driven by increasing prevalence of large, long-lived, later-maturing, and warm-water associated species (Fig. 11). Abundance analyses confirmed that these trends were driven both by greater abundance of resident species with these functional traits, as well as increasing prevalence of tropical species into the Texas bays (Fig. 12). Although species characterized as subtropical make up the vast majority of the assemblage, the proportion of total catch made up of tropical species increased 1.8-fold when comparing the period of 1982 – 2000 to 2001 – 2019 (Appendix C: Table 51). Generalized additive models indicated that the increasing predator and competitor species may be negatively affecting the population dynamics of some common resident species (Figs. 13 – 15).

In Texas, as in many marine ecosystems (Perry et al. 2005, Collie et al. 2008, Hiddink and Ter Hofstede 2008), climate change has led to shifts in the spatial distributions and abundances of invertebrates and fishes that yield an overall increase in species diversity (Fujiwara et al. 2019, Pawluk et al. 2021). While biodiversity is often thought to confer benefits on ecosystem functioning through a positive correlation with functional diversity (Hooper et al. 2005), the relationship between species and functional diversity often differs across ecosystems and functions considered (Cadotte et al. 2011). Therefore, an increase in species diversity does not guarantee increased ecosystem services and functioning. I therefore relied on measures of functional diversity to infer impact on ecosystem functioning. The observed increase in FRic found in this study implies new values along one or more trait axes within the fish assemblages of the Texas bays (Villéger et al. 2008). However, FRic does not incorporate the relative abundance of different trait types, and is therefore uninformative as to the potential influence of new trait types on ecological functions of local communities. Functional dispersion (FDis) addresses this issue by incorporating both the abundance and position within trait space for each species (Laliberté and Legendre 2010), with high FDis implying high relative abundance across multiple functional types, and low FDis implying dominance by a smaller subset of functional types. The observed increase in functional richness with a concurrent decrease in functional dispersion suggests that, while new functional types may have entered the bays, the majority of the species entering the bays are functionally redundant. Therefore, the functional benefit of the increasing biodiversity resultant from tropical species expansion may be somewhat limited. However, functional redundancy has been shown to increase ecosystem stability and resilience (Biggs et al. 2020), and therefore, increasing species diversity, coupled with stable or decreasing FDis, may indicate stability and resilience for those functions provided by the most abundant functional types.

The functional types increasing in prevalence, as determined by the trait analyses, were those whose trait values were associated with being larger, slower maturing, longer-lived, and associated with warmer temperatures (Fig. 11). These trait types correspond to periodic (e.g., black drum, red drum, ladyfish, gray snapper, etc.) and equilibrium (e.g. bull shark, cownose ray, bonnethead shark, etc.) strategists on the trilateral life history continuum (Winemiller and Rose 1992), or K-selected on the r-K continuum (Pianka 1970). Both periodic and equilibrium strategists are relatively large and long-lived, with the main distinction being between a higher investment in fecundity for periodic strategists, and in parental care for equilibrium strategists, producing fewer highly developed offspring. The trait analysis found an initial decrease in the community-weighted mean for parental care, followed by an increase, which suggests that initially, periodic strategists were increasing in relative abundance, followed by a period of increasing relative abundance of equilibrium strategists as well. An increase in k-selected species is consistent with previous findings that most Atlantic species fall more towards the periodic endpoint of the trilateral continuum (Vila-Gispert et al. 2002), as well as with a previous finding showing a shift in dominance from r-selected species to K-selected species in an estuary within the English channel response to climate warming coupled with the warm phase of the Atlantic Multi-decadal Oscillation (AMO) (McLean et al. 2019).

The observed increase in abundance of periodic and equilibrium strategists (e.g., as red drum, lady fish, bull shark, etc.) likely results from a bottom-up trophic cascade driven by two main mechanisms: 1) relaxed abiotic filter (increasing temperature) removing physiological barrier to expansion, and 2) relaxed biotic filter (increased abundance and diversity of invertebrates) minimizing competition with resident species, which would allow for successful establishment by expanding species. A previous study found invertebrates to be highly important forage species for abundant predators in the Gulf of Mexico (Fujiwara et al. 2016). In this study, approximately 97% of the species included in this study, for which diet data were available, incorporate invertebrates into their diet to some extent. The increasing invertebrate diversity and abundance within the bays (Fujiwara et al. 2019), coupled with increasing temperatures likely allowed for the expansion of both tropical and subtropical invertivores which likely led to greater abundance of piscivores within the bays.

The principal components analysis (PCA) identified which species were contributing most to changing abundance, and thus changing trait means (Fig. 12). The species contributing most to changing abundance consisted mainly of several common sciaenid species (e.g., Red drum, Black drum, Atlantic croaker, Spotted seatrout, etc.) as well as several expanding tropical species (e.g., Bull shark, Gray snapper, Gafftopsail catfish). Most species appear to show either stable or increasing trends, although Southern flounder (*Paralichthys lethostigma*) shows a strong decreasing trend. The fact that most species show stable or increasing trends is indicative that the changing trait means are due to increasing abundance of those trait types, as opposed to decreasing abundance of opposite trait types (e.g., decreasing abundance of small fish would increase the *relative* abundance of large fish without actually changing the abundance of large fish). The consistent decline in Southern flounder is likely due, at least in part, to rising temperatures. Southern flounder is known to exhibit temperature-dependent sex determination, whereby warmer temperatures can lead to masculinization of the population (Honeycutt et al. 2019), and temperature is known to affect recruitment in some estuaries (Erickson et al. 2021). However, temperature may not be solely responsible, as my results show evidence for possible species interactions, and both commercial and recreational fisheries significantly impact southern flounder populations through bycatch and target fishing, respectively (Matlock 1982). In general, the trait means for the most important species did not significantly differ from the overall trait means, suggesting that these species are likely contributing most to changing abundance due to their high relative abundance (i.e., most abundant species contribute most to changing abundance).

Generalized additive models (GAMs) were fit to the abundances of the most important species identified by PCA in order to test for potential species interactions. Several significant negative associations between species were identified, which may indicate significant predation or competition pressures by expanding species (Figs. 13 – 15, Table 5). Ladyfish were associated with Atlantic croaker (*Micropogonias undulatus*), Striped mullet (*Mugil cephalus*), and Southern flounder. There are documented instances of Ladyfish consuming Atlantic croaker and Stiped mullet, but not Southern flounder, suggesting in the latter case, Ladyfish may be a competitor. For example, the Gulf of Mexico Species Interactions database showed that for both Ladyfish and Southern flounder, ray-finned fishes (Actinopterygii), decapods (Decapoda), prawns (Dendrobranchiata), Penaeid shrimps (Penaeidae), Bay anchovy (*Anchoa mitchilli*), and various other prey items occurred with high frequency in their diets, suggesting there may be significant overlap (TAMUCC 2021). Gray snapper and Bonnethead may be either competitor or predator species, as they have not been documented consuming Southern flounder or Striped mullet in the Gulf of Mexico, but share some diet overlap (e.g. Gray snapper and Southern flounder: ray-finned fishes (Actinopterygii), Penaeid shrimps (Penaeidae), amphipods (Amphipoda), decapods (Decapoda); Bonnethead and Southern flounder: ray-finned fishes (Actinopterygii), prawns (Dendrobranchiata), Blue crab (Callinectes sapidus), Pleocyemata, decapods (Decapoda); Gray snapper and Striped mullet: Amphipods (Amphipoda); Bonnethead and Striped mullet: Detritus). Although Bull shark and Blacktip shark do not have specific documented instances of consuming Southern flounder and Gizzard shad, respectively, they are both voracious predators of similar and larger species and could reasonably be considered predators in this instance. In general, the results suggest significant predation and competition pressures from invading species contributing to the changing abundance of the most important species within the bays.

Climate change is expected to affect species interactions through a number of mechanisms (Domenici et al. 2019). Increasing temperature has been shown in some cases to affect predator-prey interactions by decreasing prey reactivity, and increasing predator attack rates, resulting in higher overall predation rates (Allan et al. 2017). Turbidity has also been shown to affect both predator and prey response, albeit in lentic ecosystems, for interactions involving visual predators, with increasing turbidity leading to decreasing reaction distance by the predator (i.e. predator had to be closer to prey to notice and react), and increasing escape distance by prey (Ranåker et al. 2012). Increasing temperature may also contribute to increasing competition pressure for resident species near their thermal limits, as expanding species better adapted to warmer temperatures could reasonably be expected to experience less physiological stress, potentially improving competitive ability (Taniguchi et al. 1998). In Texas, temperature and CO_2 have significantly increased through time (Fujiwara et al. 2019, Bugica et al. 2020, Kealoha et al. 2020) indicating that predation rates may have increased through time.

While my results indicate that climate change may be important in driving fish assemblage shifts in Texas, many other anthropogenic factors may be contributing to ecosystem change. For example, recreational and commercial fishing can significantly impact fish population dynamics (Radford et al. 2018) and thus, may impact local fish community composition and diversity (Farriols et al. 2017, Pérez-Matus et al. 2017). In Texas, total recreational fishing landings for sport boat anglers decreased through time from 1974 to 2008 (Green and Campbell 2010). A decrease in recreational fishing mortality for sport fish may have contributed to increasing abundance of large, long-lived species, which were shown to have increased in this study. Species such as red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), sheepshead (*Archosargus probatocephalus*), and black drum (*Pogonias cromis*) are commonly targeted by recreational fishers and were shown to be increasing in abundance in our study.

In addition to recreational fishing pressure, Texas coastal fish are impacted by commercial fishing pressure by the Gulf of Mexico shrimp fishery in the form of by-catch mortality. While total commercial fisheries landings (in lbs.) in Texas remained relatively stable for the period of 1981 – 2001, total finfish landings have increased through time, with species such as black drum, flounder species, and sheepshead being frequently caught as bycatch (Culbertson et al. 2004). Increasing fisheries pressure is generally thought to negatively impact biodiversity (Hall et al. 2006); however, the impact of bycatch mortality on a few widely abundant species may have allowed for proliferation of otherwise excluded species.

In addition to changes in fishing pressure, anthropogenic impacts to habitat may have contributed to changing community composition. For example, the number of oil platforms in the Gulf of Mexico increased dramatically through time peaking at approximately 4,000 active platforms in the Gulf of Mexico in 2007 (Priest 2007). Although active platforms have decreased to 1,862 as of April, 2019 according to the Bureau of Safety and Environmental Enforcement, many decommissioned platforms have been converted into artificial reef habitat (BSEE 2021). Both active and decommissioned oil platforms serve as important habitat for both reef-associated and pelagic species (Stanley and Wilson 1997, Reynolds 2015), and may serve as stepping stones, increasing species dispersal capacity (Sammarco et al. 2004). Tropical species may therefore have gained increased access to the bays of Texas through time as a result of the increasing presence of oil platforms; however, characterization of the communities present on oil platforms near Texas bays showed little overlap among the species observed at platforms, and those encountered in this study (Rooker et al. 1997). It is therefore unlikely that oil platforms are the main factor driving increasing species diversity in Texas bays, although it may be one contributing factor.

Another anthropogenic impact that may have contributed to changing coastal ecosystems is increased nutrient input through agricultural runoff. Increased fertilization from agriculture along the Mississippi River has led to increasing nitrogen loading in the Gulf of Mexico (Goolsby et al. 1999, Tian et al. 2020). If increased nutrient input led to increased primary productivity, it could feasibly lead to increased fish production, and possibly increasing diversity. An increase in abundance of prey fish species could potentially decrease competitive pressures, allowing for expansion of previously excluded species; however, data from the Gulf of Mexico show no evidence of long-term change in net primary production (Muller-Karger et al. 2015).

Overall, this study found that increasing species diversity of Texas Gulf coast fishes has been accompanied by a reduction in functional diversity, with long-lived, large, predatory species increasing in prevalence. Changes in community structure, including greater prevalence of tropical species, might have altered the intensity of species interactions, such as competition and predation, with negative effects on certain native species. Evidence from this study suggests that climate change may be one of the important factors contributing to the changing fish communities although the observed changes are likely the result of many factors acting in concert. The results observed in this study are likely not unique to Texas, as many coastal ecosystems are currently experiencing shifts in the geographic distributions of marine species (Perry et al. 2005, Wernberg et al. 2016). Future research is needed to identify whether the pattern of functional homogenization and/or decreasing functional diversity following species expansion is consistent across other subtropical and temperate coastal ecosystems.

CHAPTER V

CONCLUSION

In this dissertation, I investigated potential impacts of climate change on coastal fish communities of Texas. As climate change alters abiotic filters on fish species, species expansion and distribution shifts are expected. In Texas, increasing temperatures and salinities have allowed for the expansion of tropical species into the bays of Texas, as evidenced by the increasing Shannon diversity index along the Texas coast, as well as documented occurrences of species previously unobserved, or rarely observed in the bays. While increasing biodiversity is often considered to be beneficial to an ecosystem, I found evidence that observed changes to coastal fish assemblages have influenced interspecific interactions and local population dynamics. For example, greater species diversity is inversely correlated with fish survival for two widely abundant species (Atlantic croaker – *Micropogonias cromis*, and Spotted seatrout – *Cynoscion nebulosus*), which may be indicative of increasing competition and predation pressures from tropical invaders. At the community level, I have demonstrated that changing fish composition has led to greater functional homogenization in the bays of Texas, driven by increasing relative abundance of large, long-lived species at high trophic levels. I have demonstrated an increase in the relative abundance of predator species and provided evidence for both competitive and predation impacts of expanding species on the most abundant resident species.

Overall, this work has identified significant associations between climate change and fish population and community dynamics along the Texas Gulf coast. The results provide insight into the changes that have occurred to this system as a result of climate change and may be indicative of how the system may continue to change. Findings therefore are important for the conservation and management of coastal biodiversity and fisheries. For example, species life history strategies have been shown to affect the sustainable yields for exploited species, with long-lived iteroparous fishes having lower sustainable yields when compared to semelparous fishes, and delayed maturation corresponding to decreasing resilience of the stock to fishing pressure (Fujiwara 2012). Chapter IV demonstrated that the coastal fish assemblages of Texas are becoming increasingly dominated by long-lived, late maturing, iteroparous fishes, suggesting that sustainable yield of exploited species may decrease in response to climate change, and stocks may become less resilient to fishing pressure. Additionally, previous studies have shown that life-history traits influence competitive and predator-prey interactions (Fujiwara et al. 2011, Zhou et al. 2013, Fujiwara 2018) and extinction risk (Fujiwara 2007, Fujiwara and Takada 2017).The changing functional structure of Gulf coastal fish assemblages may have altered species interactions as inferred from findings in Chapters III and IV, which could affect species conservation and management. In particular, species of conservation concern may be subject to novel interactions, which could contribute to population decline, and exploited species may experience greater natural mortality than previously observed, which could lead to a need for reduced exploitation pressure.

While this work has addressed an important knowledge gap, further studies are needed to understand how climate change will continue to impact marine ecosystem dynamics. For example, although it is known that climate change can affect the outcome of species interactions (Taniguchi et al. 1998, Grigaltchik et al. 2012, Domenici et al. 2019), it is unclear how those impacts cascade through food webs. To understand the impact of climate on fish assemblages, it is important to understand how food webs are affected. It has recently been demonstrated that incorporating demographic diversity into food web models leads to more realistic simulated dynamics (Fujiwara 2016, 2018). Therefore, it is important to investigate how climate-related factors affect different life stages of fish populations, and in particular, how species interactions at different life stages may be altered in response to changing climate, in order to predict cascading effects of climate change on marine food webs. Future research should investigate how climate change differentially impacts various fish life stages and life history strategies.

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APPENDIX A

In this section I present supplementary results from chapter II.

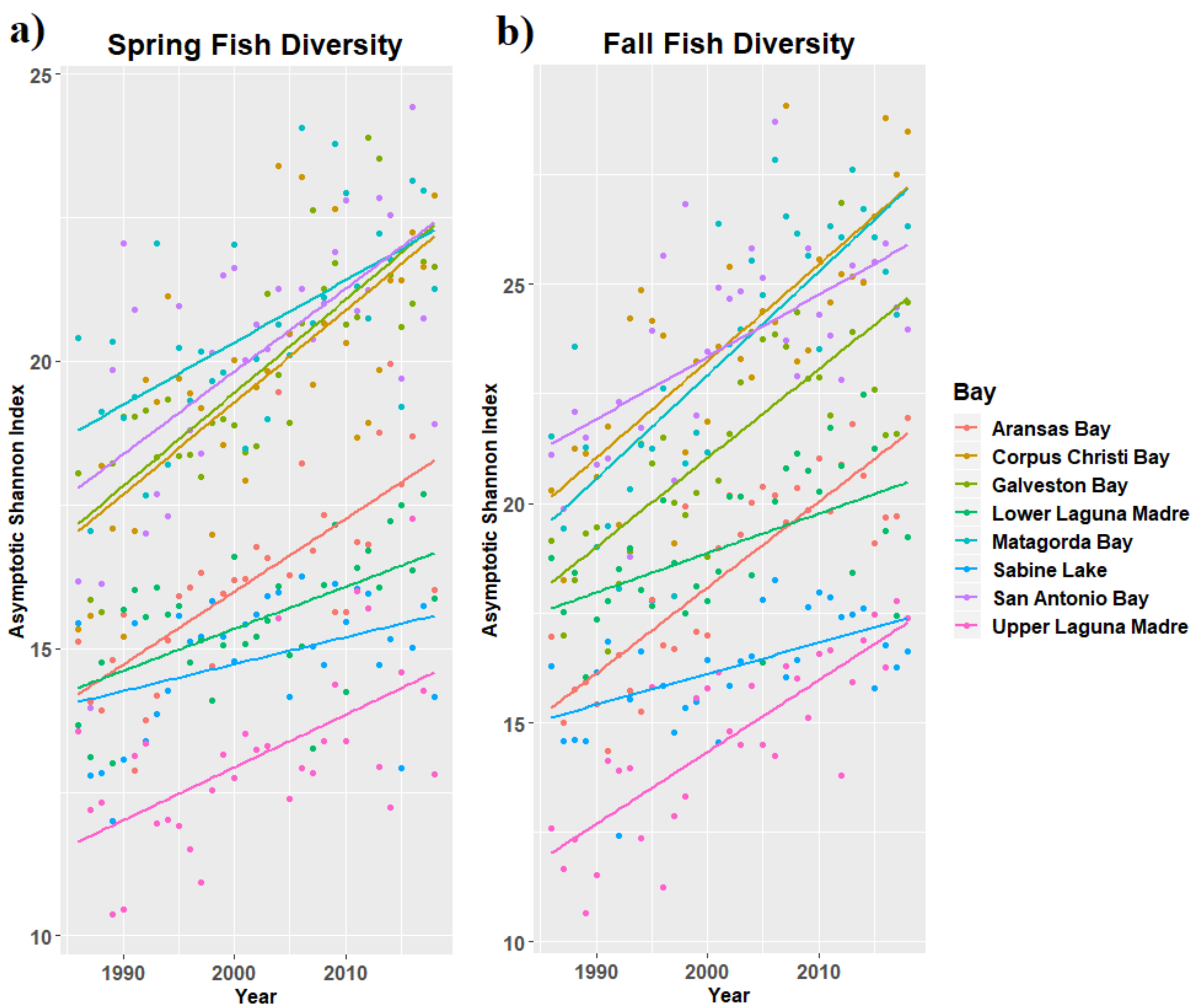
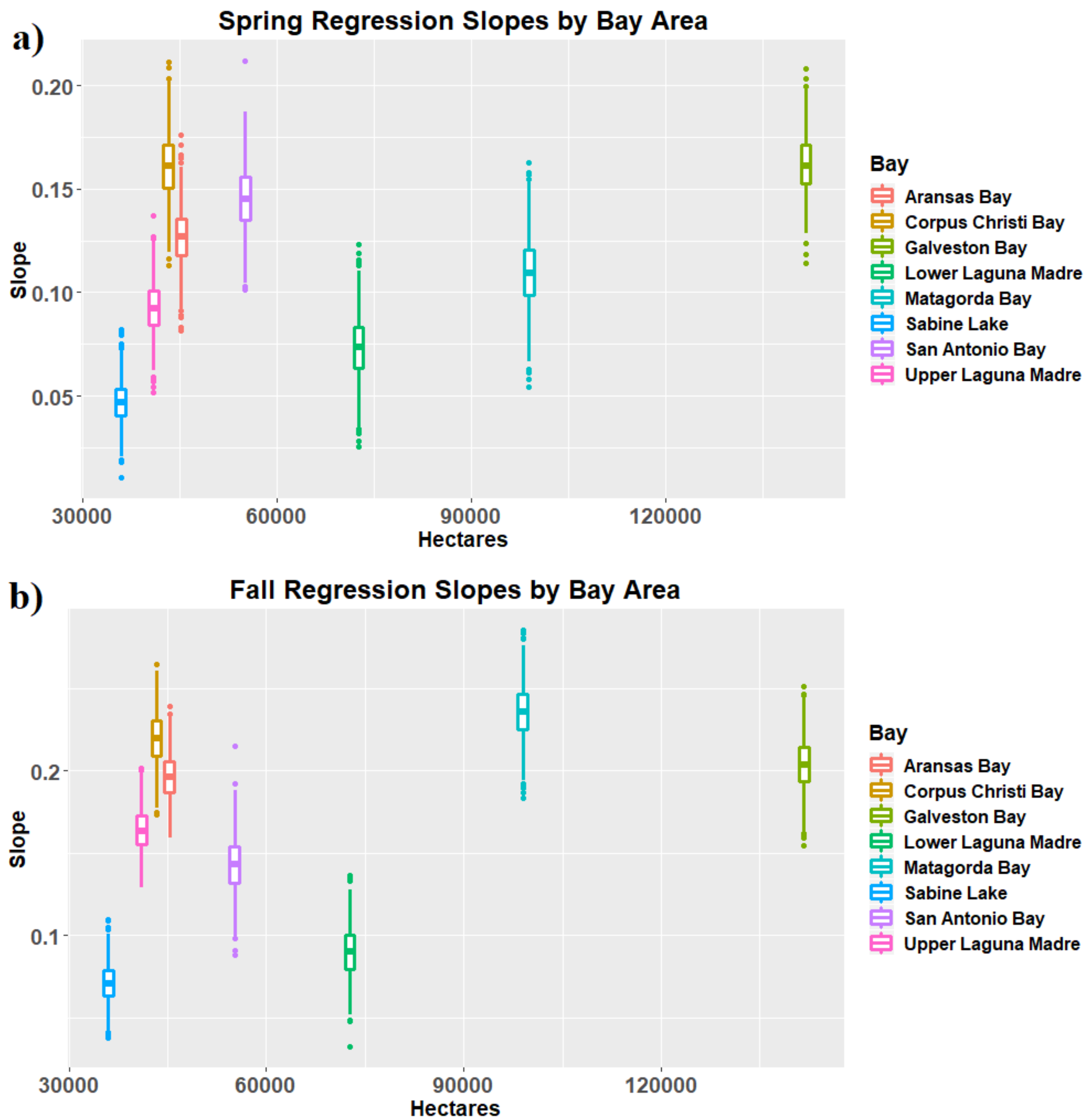


Fig. 16. Asymptotic Shannon Diversity Estimates for spring (a) and fall (b) assemblages with all bays shown on the same plot. Panels show the asymptotic diversity estimates for each bay through time. Spring assemblages appear to show a high-diversity and low-diversity grouping, while fall assemblages are less tightly grouped.

a)



b)

Fig. 17. Regression slope distributions from the bootstrapped data. Spring (a) and Fall (b) slopes from the linear models fit to the bootstrapped data by bay area (hectares). While the smallest bay by area (Sabine Lake) does appear to have the slowest increasing in diversity (smallest slope), there does not appear to be a clear pattern of slope and area, suggesting factors other than bay area alone are affecting the rate at which diversity is increasing.

APPENDIX B

In this section I present additional methods and results for Chapter III.

Sampling Locations

Detailed sample location selection protocol:

For each bay, a sample grid was defined, consisting of one-minute latitude by one minute longitude grid squares. Each grid square was sub-divided into 144 gridlets of five-second latitude by five-second longitude. Sampling was conducted following a stratified cluster sampling protocol, whereby grid locations were randomly selected without replacement from the predefined sample grid within each bay. Within the selected grid, a gridlet is selected at random for sampling. Within the selected gridlet, the shoreline is subdivided into 15.2m (50ft) sections from which a section is randomly selected for net placement (Martinez-Andrade 2015).

Selectivity correction

In order to correct for gear selectivity, the maximum likelihood method described by Fujimori and Tokai (2001) was employed to fit the candidate distributions. The maximum likelihood (*lik*) is calculated as follows:

$$lik = \prod_{j=1}^{n} \left[\frac{C_j!}{\prod_{i=1}^{k} C_{ij}!} \prod_{i=1}^{k} \left(p_i S(R_{ij}) / \sum_{i=1}^{k} p_i S(R_{ij}) \right)^{C_{ij}} \right]$$

where C_{ij} is the catch per unit effort of fish of length *j* caught in mesh size *i*, $R_{ij} = \frac{l_j}{m_i}$ where l_j is the observed fish length (mm) and m_i is the mesh size (mm), p_i is the fishing effort of mesh size *i*, *k* is the number of different mesh sizes used, *n* is the number of length bins in the data, and C_j is the total number of fish of length *j* caught across all mesh sizes. This method assumes that gear selectivity is dependent on the ratio of fish length to mesh-size (geometrical similarity theory (Baranov 1914)), meaning that if two fish of different lengths are caught in two different mesh sizes, but the ratio of length to mesh size is the same, the selectivity correction will be the same for both fish (Fujimori and Tokai 2001). Maximum likelihood for each distribution was calculated using the optimization routine “optim” in the R statistical computing environment (R Core Team 2018). In order to select the best distribution for the selectivity correction the Akaike Information Criterion (AIC) was used, and the model with the lowest AIC was selected for each species. Once the best distribution was selected, adjusted length frequency data were divided by the selectivity correction to give the corrected length-frequency data, which were used for age estimation.

Table 6. Distribution curves for gear-selectivity correction. The candidate curves considered for the selectivity correction are shown, along with the calculated AIC for each species. The lowest AIC value for each species is shown in bold. AC: Atlantic croaker, BD: Black drum, SS: Spotted seatrout.

DISTRIBUTION	**AIC**		
	AC	**BD**	**SS**
NORMAL: $S_N(R_{ij}) = exp\left(-\frac{(R_{ij} - R_0)^2}{2\sigma^2}\right)$	53336	492832	267463
LOGNORMAL: $S_L(R_{ij}) = exp\left(-\frac{\left(ln(R_{ij}) - ln(R_0)\right)^2}{2\sigma^2}\right)$	60584	419086	287265
SKEWNORMAL: $S_{SK}(R_{ij}) = \frac{2}{\sigma}\phi\left(\frac{R_{ij}-R_0}{\sigma}\right)\Phi\left(\beta\left(\frac{R_{ij}-R_0}{\sigma}\right)\right)$; WHERE: $\phi(x) = \frac{1}{\sqrt{2\pi}}exp\left(-\frac{x^2}{2}\right)$; $\Phi(x) = \frac{1}{2}\left[1 + erf\left(\frac{x}{\sqrt{2}}\right)\right]$	52591	407515	267465

Table 6. continued.

BINORMAL: $$S_B(R_{ij}) = \frac{1}{\delta}\left[exp\left(-\left(\frac{(R_{ij}-R_a)^2}{2\sigma_a^2}\right)\right) + \omega\left(exp\left(-\frac{(R_{ij}-R_b)^2}{2\sigma_b^2}\right)\right)\right]$$	**53344**	**492832**	**267504**
ERROR: $$S_E(R_{ij}) = exp\left(-\frac{\lvert R_{ij}-R_0\rvert^{\frac{2}{\delta}}}{2\sigma^2}\right)\Big/\left((2\sigma^2)^{\frac{\beta}{2}}\right) * \beta * \Gamma\left(\frac{\beta}{2}\right)$$	**45015**	411542	251227
EXTREME VALUE: $$S_{EV}(R_{ij}) = \left(\frac{1}{\sigma}\right) exp\left(-\frac{R_{ij}-R_0}{\sigma}\right) exp\left(-exp\left(-\frac{R_{ij}-R_0}{\sigma}\right)\right)$$	61229	**394931**	295001
LAPLACE: $$S_{LP}(R_{ij}) = \left(\frac{1}{2\sigma}\right) exp\left(-\frac{\lvert R_{ij}-R_0\rvert}{\sigma}\right)$$	45615	426085	**251225**

Table 6. continued.

CAUCHY:	**49066**	**404755**	**261972**

$$\boldsymbol{S_C(R_{ij}) = \left(\pi * \sigma * \left(1 + \left(\frac{R_{ij} - R_0}{\sigma}\right)^2\right)\right)^{-1}}$$

Footnote: $R_0, R_a,$ and R_b are location parameters; σ, σ_a, and σ_b are scale parameters; β is the shape parameter; δ and ω are weighting parameters. These are the parameters to be estimated by the optimization routine. Erf(x) is the error function $erf(x) = \frac{2}{\pi}\int_0^x e^{-t^2}\,dt$, and $\Gamma(z)$ is the gamma function $\Gamma(z) = \int_0^\infty x^{z-1}e^{-x}\,dx$.

Table 7. Von Bertalanffy Growth Function Parameters. Parameters used in the estimation of age from length for Atlantic croaker (*Micropogonias undulatus*) and Spotted seatrout (*Cynoscion nebulosus*). L_∞ is the asymptotic length in millimeters (mm), *k* is the growth parameter, and t_0 is the hypothetical age at length 0. For Spotted seatrout, growth was sexually dimorphic, and thus a separate growth function was used for males and females. Parameters taken from Barger (1985) and Maceina et al. (1987).

Parameter	Atlantic croaker	Spotted seatrout - females	Spotted seatrout - males
L_∞	419.2	687	663.5
k	0.273	0.512	0.179
t_0	-1.405	0.26	-1.939

Table 8. Atlantic croaker (*Micropogonias undulatus*) catch curve for all data combined. Parameter estimates, standard errors and p-values for the intercept and slope of the catch curve fit to all data combined for Atlantic croaker.

	Estimate	Std. Error	P-val
Intercept	13.8265	0.001934	<2e-16
Slope	-0.7819	0.0008694	<2e-16

Table 9. Atlantic croaker (*Micropogonias undulatus*) catch curves for bay estimates (all years combined). Parameter estimates, standard errors and p-values for the intercept and slope of the catch curves fit to all years combined for each bay for Atlantic croaker. SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

Intercept Estimate	Intercept Std. Error	Intercept P-val	Slope Estimate	Slope St. Error	Slope P-val	Bay
11.095	0.0071	0	-0.731	0.00303	0	SL
12.4452	0.00384	0	-0.778	0.00172	0	GB
11.7192	0.00916	0	-1.2132	0.00565	0	MG
11.0842	0.00852	0	-0.8724	0.00416	0	SA
11.1413	0.0066	0	-0.6924	0.0027	0	AB
12.8373	0.00376	0	-0.9222	0.00192	0	CC
10.957	0.00761	0	-0.7309	0.00324	0	UL
10.4174	0.00804	0	-0.5711	0.00281	0	LL

Table 10. Atlantic croaker (*Micropogonias undulatus*) catch curves for year estimates (all bays combined). Parameter estimates, standard errors and p-values for the intercept and slope of the catch curves fit to all bays combined for each year for Atlantic croaker.

Intercept Estimate	Intercept Std. Error	Intercept P-val	Slope Estimate	Slope St. Error	Slope P-val	Year
9.65349	0.01138	0	-0.5468	0.00384	0	1986
9.63069	0.01053	0	-0.486	0.00323	0	1987
9.45502	0.01266	0	-0.5524	0.00431	0	1988
8.93769	0.01756	0	-0.6009	0.0064	0	1989
9.23908	0.01959	0	-0.7994	0.00896	0	1990
10.4238	0.01443	0	-1.0404	0.00802	0	1991
10.2492	0.01179	0	-0.7971	0.00538	0	1992
10.2131	0.00944	0	-0.6132	0.0035	0	1993
9.58154	0.01345	0	-0.6411	0.00516	0	1994
9.16815	0.01475	0	-0.559	0.00507	0	1995
9.76267	0.01299	0	-0.6832	0.00525	0	1996
9.81973	0.01363	0	-0.7417	0.00588	0	1997
9.87453	0.01339	0	-0.7492	0.00582	0	1998
10.1552	0.01132	0	-0.7279	0.00481	0	1999
9.99865	0.00993	0	-0.5723	0.00348	0	2000
10.463	0.01025	0	-0.7707	0.00456	0	2001
9.45985	0.01353	0	-0.601	0.00493	0	2002
10.7892	0.00803	0	-0.708	0.00334	0	2003
9.95338	0.01249	0	-0.7257	0.00529	0	2004
9.63533	0.01219	0	-0.5895	0.00437	0	2005
10.0878	0.01107	0	-0.6854	0.00449	0	2006
11.4486	0.01391	0	-1.4762	0.00968	0	2007
11.0653	0.01073	0	-1.0614	0.00605	0	2008
10.4874	0.01282	0	-0.9654	0.00676	0	2009
12.1041	0.01053	0	-1.5226	0.00746	0	2010
11.9024	0.0106	0	-1.4334	0.00725	0	2011
10.5761	0.01389	0	-1.0738	0.0079	0	2012
10.889	0.01201	0	-1.0831	0.00686	0	2013
10.7647	0.01261	0	-1.0713	0.00715	0	2014
11.0323	0.01242	0	-1.1775	0.00751	0	2015
9.8936	0.01454	0	-0.8227	0.0068	0	2016
10.0171	0.01316	0	-0.7919	0.00597	0	2017
10.6352	0.01615	0	-1.2356	0.01008	0	2018
10.6271	0.01818	0	-1.3413	0.01195	0	2019

Table 11. Atlantic croaker (*Micropogonias undulatus*) catch curves for bay-year estimates. Parameter estimates, standard errors and p-values for the intercept and slope of the catch curves fit to each bay and year for Atlantic croaker. SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

Intercept Estimate	Intercept Std. Error	Intercept P-val	Slope Estimate	Slope St. Error	Slope P-val	Bay	Year
8.7559	1.14722	2.31E-14	-1.0492	0.21678	1.30E-06	SL	1986
8.56139	0.93553	5.62E-20	-0.9887	0.18253	6.08E-08	SL	1987
8.87787	0.81122	7.11E-28	-1.1841	0.20429	6.79E-09	SL	1988
7.8579	1.18542	3.38E-11	-1.0293	0.23238	9.45E-06	SL	1989
6.23791	0.72746	9.92E-18	-0.8683	0.16231	8.80E-08	SL	1990
8.1481	0.68724	2.00E-32	-1.3329	0.18536	6.44E-13	SL	1991
9.52131	0.92247	5.63E-25	-1.1019	0.18161	1.30E-09	SL	1992
9.52194	0.96813	7.92E-23	-1.3096	0.20407	1.38E-10	SL	1993
7.72824	0.99785	9.57E-15	-0.9535	0.20203	2.37E-06	SL	1994
8.48018	1.31761	1.23E-10	-1.3856	0.33992	4.57E-05	SL	1995
6.59597	1.33125	7.24E-07	-1.0718	0.30011	0.0003551	SL	1996
8.10478	1.15923	2.72E-12	-1.0689	0.2314	3.85E-06	SL	1997
7.05039	0.01241	0	-1.1884	0.01231	0	SL	1998
8.125	1.04965	9.89E-15	-0.9476	0.19957	2.05E-06	SL	1999
8.18292	0.78255	1.36E-25	-0.965	0.15721	8.34E-10	SL	2000
7.65686	1.10046	3.46E-12	-1.1012	0.24498	6.95E-06	SL	2001
7.24799	1.17831	7.69E-10	-1.0322	0.23845	1.50E-05	SL	2002
7.38423	0.79288	1.24E-20	-1.1296	0.19	2.76E-09	SL	2003
8.14852	1.09771	1.14E-13	-1.1127	0.24197	4.25E-06	SL	2004
8.95786	1.39646	1.41E-10	-1.368	0.31342	1.27E-05	SL	2005
8.58958	1.23215	3.14E-12	-1.0933	0.24319	6.94E-06	SL	2006
8.43618	1.00235	3.88E-17	-1.3405	0.27101	7.57E-07	SL	2007
8.33258	0.29972	4.21E-170	-1.3374	0.09997	8.09E-41	SL	2008
8.38926	0.71656	1.16E-31	-1.1105	0.16167	6.46E-12	SL	2009
9.27759	0.27997	8.62E-241	-1.2988	0.08592	1.27E-51	SL	2010
9.90684	1.04742	3.13E-21	-1.3253	0.22207	2.40E-09	SL	2011
8.68545	0.65591	5.03E-40	-1.1693	0.15576	6.06E-14	SL	2012
9.31944	0.6297	1.47E-49	-1.1618	0.13977	9.40E-17	SL	2013
8.35475	0.45997	1.00E-73	-1.0176	0.12846	2.35E-15	SL	2014
8.58477	0.70207	2.21E-34	-1.2064	0.16452	2.25E-13	SL	2015
6.58175	1.37214	1.61E-06	-0.9213	0.25726	0.0003421	SL	2016
8.35195	1.19885	3.25E-12	-1.1349	0.24043	2.36E-06	SL	2017

Table 11. continued.

7.65606	0.94509	5.46E-16	-1.1294	0.21815	2.25E-07	SL	2018
6.94777	0.68891	6.42E-24	-1.145	0.19836	7.81E-09	SL	2019
9.38109	0.88267	2.21E-26	-1.2657	0.19475	8.08E-11	GB	1982
10.3182	0.01127	0	-1.5586	0.0112	0	GB	1983
9.82734	0.87097	1.59E-29	-1.3222	0.2025	6.60E-11	GB	1984
10.3559	1.06191	1.81E-22	-1.5102	0.25303	2.39E-09	GB	1985
9.47889	1.08807	2.99E-18	-1.3566	0.25115	6.61E-08	GB	1986
9.27117	0.95075	1.82E-22	-1.1098	0.18744	3.20E-09	GB	1987
9.61754	0.80282	4.54E-33	-1.1979	0.17621	1.06E-11	GB	1988
7.80247	1.10193	1.43E-12	-0.942	0.2078	5.81E-06	GB	1989
9.35746	0.92294	3.72E-24	-1.2416	0.21225	4.92E-09	GB	1990
9.63328	1.28139	5.57E-14	-1.6099	0.33837	1.96E-06	GB	1991
9.28249	1.15797	1.09E-15	-1.1156	0.21996	3.93E-07	GB	1992
11.9619	0.78088	5.76E-53	-1.5775	0.17663	4.20E-19	GB	1993
9.31786	1.34835	4.83E-12	-1.2189	0.2631	3.61E-06	GB	1994
9.22033	0.80865	4.08E-30	-1.0384	0.16327	2.02E-10	GB	1995
9.62248	1.21605	2.51E-15	-1.235	0.23898	2.37E-07	GB	1996
9.19469	1.04183	1.09E-18	-1.3417	0.24307	3.39E-08	GB	1997
9.99777	1.04569	1.17E-21	-1.3608	0.2367	8.97E-09	GB	1998
9.43627	0.01064	0	-1.1354	0.01052	0	GB	1999
11.4191	0.95493	5.90E-33	-1.3019	0.18877	5.31E-12	GB	2000
10.4676	1.21752	8.15E-18	-1.2133	0.22956	1.26E-07	GB	2001
9.23086	1.27703	4.89E-13	-1.2578	0.27646	5.37E-06	GB	2002
10.1405	0.96126	5.13E-26	-1.6429	0.2641	4.95E-10	GB	2003
9.57468	1.04501	5.08E-20	-1.1292	0.20187	2.22E-08	GB	2004
10.8694	1.2563	5.06E-18	-1.2952	0.23844	5.57E-08	GB	2005
10.5341	1.51143	3.18E-12	-1.374	0.29371	2.90E-06	GB	2006
9.23283	0.01052	0	-1.1632	0.01009	0	GB	2007
9.29636	1.12078	1.09E-16	-1.1583	0.21789	1.06E-07	GB	2008
10.8792	1.10385	6.47E-23	-1.424	0.24786	9.18E-09	GB	2009
9.9061	1.09006	1.01E-19	-1.4155	0.23691	2.30E-09	GB	2010
11.0864	0.46807	5.10E-124	-1.4858	0.114	7.91E-39	GB	2011
9.59092	0.9001	1.65E-26	-1.0811	0.17832	1.34E-09	GB	2012
10.6459	0.4682	1.88E-114	-1.2959	0.11856	8.26E-28	GB	2013
10.5693	0.9969	2.91E-26	-1.2337	0.19531	2.67E-10	GB	2014
10.914	0.93964	3.45E-31	-1.6008	0.23081	4.04E-12	GB	2015
8.99084	0.92507	2.50E-22	-1.2797	0.21862	4.81E-09	GB	2016
11.1435	0.8679	9.83E-38	-1.7382	0.24367	9.79E-13	GB	2017
8.46338	0.96593	1.92E-18	-1.2853	0.23931	7.83E-08	GB	2018

Table 11. continued.

10.2971	0.13172	0	-1.7739	0.05794	7.98E-206	GB	2019
6.19884	0.9264	2.21E-11	-0.8836	0.19483	5.75E-06	MG	1982
9.07882	1.72145	1.34E-07	-1.9547	0.52609	0.0002028	MG	1983
6.76551	1.1809	1.01E-08	-1.2091	0.31316	0.000113	MG	1984
9.83468	1.11707	1.32E-18	-2.5795	0.4931	1.68E-07	MG	1985
10.5197	0.95865	5.12E-28	-2.5491	0.3691	4.97E-12	MG	1986
9.46408	1.2586	5.50E-14	-1.9933	0.41721	1.77E-06	MG	1987
8.45785	0.95026	5.56E-19	-1.1807	0.217	5.30E-08	MG	1988
11.0781	1.3168	4.00E-17	-3.1311	0.59988	1.79E-07	MG	1989
6.58965	1.42214	3.59E-06	-1.1729	0.36011	0.001126	MG	1990
8.59767	1.84261	3.07E-06	-1.3928	0.4094	0.0006688	MG	1991
16.5173	1.41513	1.77E-31	-5.2781	0.7053	7.24E-14	MG	1992
6.98968	1.31377	1.04E-07	-1.0913	0.29727	0.0002414	MG	1993
7.86911	1.69848	3.60E-06	-1.2033	0.35228	0.0006359	MG	1994
6.3239	1.01566	4.77E-10	-0.8315	0.19408	1.83E-05	MG	1995
9.74904	0.96259	4.16E-24	-1.7789	0.27467	9.39E-11	MG	1996
9.31112	0.31948	9.83E-187	-1.8428	0.13372	3.31E-43	MG	1997
8.58056	0.85712	1.36E-23	-1.5521	0.24688	3.24E-10	MG	1998
7.41965	1.19012	4.54E-10	-1.0708	0.26035	3.90E-05	MG	1999
9.06135	0.91858	5.93E-23	-1.7437	0.31408	2.83E-08	MG	2000
8.32998	0.99263	4.79E-17	-1.4463	0.27324	1.20E-07	MG	2001
7.71006	1.24179	5.34E-10	-1.134	0.27284	3.23E-05	MG	2002
7.60033	0.95674	1.96E-15	-1.2244	0.23395	1.66E-07	MG	2003
8.44693	0.90566	1.09E-20	-1.9001	0.33278	1.13E-08	MG	2004
6.42512	1.46764	1.20E-05	-1.4801	0.47009	0.0016407	MG	2005
10.014	1.03944	5.74E-22	-2.3562	0.38543	9.76E-10	MG	2006
6.64261	1.56218	2.12E-05	-1.0786	0.34136	0.00158	MG	2007
7.80864	1.43039	4.79E-08	-1.6811	0.4074	3.68E-05	MG	2008
9.20983	0.46448	1.70E-87	-2.3258	0.25463	6.59E-20	MG	2009
10.4398	2.89288	0.0003076	-2.0189	0.70919	0.0044158	MG	2010
11.8728	0.05014	0	-2.9448	0.0463	0	MG	2011
10.1179	0.08043	0	-2.5417	0.07135	5.71E-278	MG	2012
8.57979	0.95336	2.27E-19	-1.2173	0.21111	8.11E-09	MG	2013
8.70832	0.74389	1.18E-31	-1.9745	0.27716	1.05E-12	MG	2014
8.01167	0.87202	4.02E-20	-1.3898	0.2455	1.51E-08	MG	2015
7.40318	1.06887	4.32E-12	-1.9319	0.46877	3.77E-05	MG	2016
8.77652	0.78632	6.29E-29	-1.6479	0.23644	3.18E-12	MG	2017
9.28338	1.62998	1.23E-08	-1.7692	0.44908	8.16E-05	MG	2018
6.81439	1.43739	2.13E-06	-1.5901	0.47019	0.0007204	MG	2019

Table 11. continued.

7.77329	1.1811	4.66E-11	-1.0352	0.23399	9.68E-06	SA	1982
8.11929	1.07486	4.23E-14	-1.0123	0.2084	1.19E-06	SA	1983
8.76004	1.54815	1.53E-08	-1.9798	0.50902	0.0001005	SA	1984
5.99238	1.31094	4.85E-06	-1.0767	0.33424	0.0012755	SA	1985
7.53892	1.32315	1.21E-08	-1.2637	0.31155	4.99E-05	SA	1986
5.55641	1.61768	0.000593	-1.2891	0.50639	0.0109078	SA	1987
8.11734	1.17604	5.12E-12	-1.824	0.40169	5.61E-06	SA	1988
8.45579	1.04093	4.54E-16	-1.2817	0.23216	3.37E-08	SA	1989
6.48833	1.22053	1.06E-07	-1.3197	0.33106	6.71E-05	SA	1990
10.4842	1.04538	1.14E-23	-2.3789	0.37219	1.64E-10	SA	1991
8.2528	0.36876	6.16E-111	-1.2198	0.11291	3.31E-27	SA	1992
7.75949	1.20842	1.35E-10	-1.0704	0.2382	7.00E-06	SA	1993
8.68613	0.89625	3.27E-22	-1.4298	0.24858	8.82E-09	SA	1994
8.08344	0.90538	4.33E-19	-1.1891	0.20776	1.05E-08	SA	1995
7.94877	1.52957	2.03E-07	-1.0661	0.28159	0.0001532	SA	1996
7.90355	0.84698	1.04E-20	-1.2496	0.2167	8.09E-09	SA	1997
7.49275	1.07925	3.85E-12	-1.2053	0.26468	5.27E-06	SA	1998
8.28582	0.57063	8.98E-48	-1.2546	0.15721	1.46E-15	SA	1999
9.86781	0.85619	9.84E-31	-1.6184	0.2434	2.95E-11	SA	2000
10.3204	2.77058	0.0001953	-2.195	0.80902	0.0066651	SA	2001
10.4068	1.08792	1.11E-21	-1.6734	0.29363	1.21E-08	SA	2002
7.51566	0.00601	0	-1.6999	0.00583	0	SA	2003
8.08157	1.20172	1.76E-11	-1.1298	0.262	1.62E-05	SA	2004
9.88509	1.40431	1.93E-12	-1.9851	0.45243	1.15E-05	SA	2005
8.73779	0.82858	5.33E-26	-1.699	0.28663	3.07E-09	SA	2006
7.14296	2.75546	0.0095338	-2.3044	1.08513	0.033703	SA	2007
9.51594	1.84249	2.41E-07	-2.394	0.73846	0.0011876	SA	2008
8.09671	0.6663	5.61E-34	-1.6842	0.23303	4.92E-13	SA	2009
11.4073	1.20618	3.16E-21	-3.0087	0.52933	1.32E-08	SA	2010
8.81065	0.8072	9.76E-28	-2.0216	0.30495	3.37E-11	SA	2011
6.57029	0.1764	1.21E-303	-1.5719	0.1272	4.41E-35	SA	2012
6.81285	1.26606	7.40E-08	-1.0836	0.29034	0.0001897	SA	2013
7.69593	0.64122	3.47E-33	-1.4039	0.2058	9.00E-12	SA	2014
6.98496	1.04278	2.11E-11	-1.4738	0.35268	2.93E-05	SA	2015
8.76845	0.91013	5.73E-22	-1.9569	0.32598	1.94E-09	SA	2016
7.76557	1.37746	1.72E-08	-1.2188	0.30541	6.59E-05	SA	2017
9.2621	1.22125	3.35E-14	-2.0561	0.41281	6.33E-07	SA	2018
6.36698	1.27227	5.60E-07	-0.8901	0.24667	0.000308	SA	2019
8.76134	2.13901	4.20E-05	-1.1457	0.36406	0.0016503	AB	1982

Table 11. continued.

9.59579	1.28038	6.66E-14	-1.2224	0.24651	7.10E-07	AB	1983
5.52328	0.86374	1.61E-10	-0.9021	0.21757	3.38E-05	AB	1984
7.18339	1.1983	2.04E-09	-0.9945	0.23337	2.03E-05	AB	1985
7.31605	0.98481	1.09E-13	-1.0441	0.22305	2.86E-06	AB	1986
8.24868	0.56731	6.75E-48	-1.0708	0.13006	1.82E-16	AB	1987
8.77342	1.22719	8.73E-13	-1.0359	0.22797	5.52E-06	AB	1988
7.33437	0.8312	1.11E-18	-1.1473	0.19509	4.08E-09	AB	1989
7.87364	0.3987	8.30E-87	-1.3255	0.13561	1.45E-22	AB	1990
8.69163	0.92549	5.92E-21	-1.5647	0.27284	9.75E-09	AB	1991
8.95164	0.79684	2.78E-29	-1.2033	0.18732	1.33E-10	AB	1992
8.90833	1.06074	4.53E-17	-1.2155	0.23756	3.11E-07	AB	1993
6.39041	0.99735	1.48E-10	-0.9132	0.20855	1.19E-05	AB	1994
9.47857	1.01168	7.32E-21	-1.3073	0.2316	1.66E-08	AB	1995
8.11355	0.66166	1.44E-34	-1.157	0.17117	1.39E-11	AB	1996
8.53805	0.98971	6.31E-18	-1.1819	0.22419	1.35E-07	AB	1997
8.4801	0.78836	5.51E-27	-1.1267	0.18561	1.28E-09	AB	1998
7.68193	1.47899	2.06E-07	-1.2251	0.33037	0.0002086	AB	1999
6.64059	1.20063	3.19E-08	-1.005	0.25718	9.32E-05	AB	2000
9.02608	0.84793	1.84E-26	-1.2178	0.19763	7.19E-10	AB	2001
9.56851	0.56493	2.38E-64	-1.4835	0.15679	3.04E-21	AB	2002
11.7502	1.76641	2.89E-11	-1.9419	0.41779	3.35E-06	AB	2003
8.58731	0.72276	1.48E-32	-1.1675	0.17041	7.31E-12	AB	2004
8.20851	1.49109	3.69E-08	-1.0823	0.28323	0.0001328	AB	2005
7.86057	1.09647	7.55E-13	-0.9419	0.20687	5.28E-06	AB	2006
6.94217	1.09079	1.96E-10	-0.9959	0.22688	1.14E-05	AB	2007
7.52894	1.07963	3.09E-12	-1.1587	0.25772	6.92E-06	AB	2008
7.31996	1.56234	2.80E-06	-1.0707	0.30246	0.0004003	AB	2009
7.67367	1.23072	4.52E-10	-1.3717	0.32771	2.84E-05	AB	2010
9.08589	0.86786	1.20E-25	-1.5806	0.24875	2.10E-10	AB	2011
6.52446	1.30952	6.28E-07	-0.8915	0.25702	0.0005229	AB	2012
8.87324	1.20273	1.61E-13	-1.6922	0.3936	1.71E-05	AB	2013
5.91795	1.30686	5.94E-06	-0.8666	0.24556	0.0004173	AB	2014
8.89168	1.01277	1.64E-18	-1.8039	0.34286	1.43E-07	AB	2015
9.1966	0.07375	0	-1.9907	0.05987	1.90E-242	AB	2016
7.43461	0.01146	0	-1.1437	0.01137	0	AB	2017
9.17385	0.11022	0	-2.3859	0.09577	5.38E-137	AB	2018
7.24005	0.69791	3.26E-25	-1.1121	0.17145	8.79E-11	AB	2019
10.5801	1.46854	5.83E-13	-1.2456	0.26838	3.46E-06	CC	1982
10.6127	1.47054	5.32E-13	-1.249	0.26875	3.36E-06	CC	1983

Table 11. continued.

9.46351	0.81136	1.95E-31	-1.2082	0.17729	9.43E-12	CC	1984
9.13024	0.59998	2.70E-52	-1.012	0.12872	3.76E-15	CC	1985
9.52171	1.04922	1.14E-19	-1.0974	0.2017	5.31E-08	CC	1986
11.4654	1.59312	6.16E-13	-1.3435	0.28875	3.27E-06	CC	1987
9.93081	1.39365	1.04E-12	-1.1634	0.25505	5.08E-06	CC	1988
8.73531	1.36926	1.78E-10	-1.052	0.24972	2.52E-05	CC	1989
8.54	0.53276	7.92E-58	-0.9787	0.11465	1.38E-17	CC	1990
9.01667	0.59266	2.86E-52	-1.1742	0.13517	3.73E-18	CC	1991
10.7109	1.13883	5.20E-21	-1.4113	0.25408	2.78E-08	CC	1992
10.0329	1.3958	6.58E-13	-1.1826	0.25619	3.91E-06	CC	1993
10.5303	1.10208	1.24E-21	-1.2171	0.21165	8.91E-09	CC	1994
10.936	1.26549	5.54E-18	-1.2684	0.23663	8.32E-08	CC	1995
9.71857	1.29396	5.88E-14	-1.1434	0.2402	1.93E-06	CC	1996
9.7558	1.09131	3.91E-19	-1.1392	0.20907	5.07E-08	CC	1997
9.85736	1.03347	1.46E-21	-1.2172	0.20821	5.02E-09	CC	1998
10.4852	0.76089	3.36E-43	-1.2605	0.15689	9.39E-16	CC	1999
9.97442	1.30562	2.18E-14	-1.1738	0.24265	1.31E-06	CC	2000
10.7875	0.35471	3.80E-203	-1.3641	0.08758	1.08E-54	CC	2001
9.65436	1.31208	1.87E-13	-1.2452	0.2587	1.48E-06	CC	2002
10.6323	0.62275	2.35E-65	-1.2856	0.13729	7.66E-21	CC	2003
10.0356	0.72733	2.62E-43	-1.168	0.15009	7.11E-15	CC	2004
8.57187	0.93403	4.42E-20	-1.094	0.19603	2.39E-08	CC	2005
10.1514	1.00735	6.96E-24	-1.1793	0.19621	1.85E-09	CC	2006
10.2912	0.88652	3.73E-31	-1.3758	0.19361	1.19E-12	CC	2007
11.3014	0.64211	2.44E-69	-1.4217	0.14055	4.72E-24	CC	2008
8.97075	0.64579	7.16E-44	-1.0912	0.13659	1.36E-15	CC	2009
10.6414	1.09246	2.02E-22	-1.4628	0.23583	5.55E-10	CC	2010
9.69555	0.6794	3.33E-46	-1.4097	0.18826	7.00E-14	CC	2011
9.72649	0.67276	2.24E-47	-1.3102	0.15207	6.93E-18	CC	2012
9.44346	0.78064	1.10E-33	-1.2976	0.17464	1.09E-13	CC	2013
9.49716	0.34909	5.62E-163	-1.3501	0.09441	2.21E-46	CC	2014
9.89684	0.61392	1.83E-58	-1.3326	0.14412	2.33E-20	CC	2015
9.00322	1.07869	7.04E-17	-1.1528	0.21516	8.42E-08	CC	2016
9.09274	0.90332	7.81E-24	-1.0915	0.17968	1.24E-09	CC	2017
9.06759	1.3162	5.61E-12	-1.1784	0.25234	3.01E-06	CC	2018
8.74043	0.44086	1.78E-87	-1.2497	0.11662	8.61E-27	CC	2019
10.9755	1.92802	1.25E-08	-1.332	0.33827	8.22E-05	UL	1982
8.08757	1.11466	4.00E-13	-1.0684	0.22472	1.99E-06	UL	1983
7.64102	0.95133	9.60E-16	-1.1094	0.20602	7.25E-08	UL	1984

Table 11. continued.

9.24962	1.08776	1.84E-17	-1.1202	0.20974	9.25E-08	UL	1985
10.0661	1.23499	3.62E-16	-1.3011	0.24865	1.67E-07	UL	1986
9.80917	1.55408	2.76E-10	-1.2206	0.28217	1.52E-05	UL	1987
8.43862	2.02051	2.96E-05	-1.0975	0.34757	0.0015903	UL	1988
5.86144	1.88623	0.0018869	-0.9628	0.37789	0.0108375	UL	1989
1.78991	1.23715	0.1479512	-0.4675	0.30562	0.1261381	UL	1990
7.63726	0.65202	1.09E-31	-1.3422	0.19922	1.61E-11	UL	1991
7.93619	1.96012	5.15E-05	-1.2116	0.39583	0.0022073	UL	1992
7.81402	1.13294	5.31E-12	-1.1844	0.26739	9.44E-06	UL	1993
7.53356	1.60168	2.56E-06	-0.951	0.28149	0.0007293	UL	1994
7.0748	1.52658	3.58E-06	-0.9046	0.26974	0.0007979	UL	1995
8.46088	1.64413	2.66E-07	-1.3121	0.35022	0.0001792	UL	1996
7.91224	0.62952	3.14E-36	-1.1132	0.15439	5.57E-13	UL	1997
8.31376	0.97636	1.67E-17	-1.0445	0.19621	1.02E-07	UL	1998
8.87885	0.64088	1.20E-43	-1.146	0.14756	8.07E-15	UL	1999
9.07449	1.0911	9.03E-17	-1.2235	0.22648	6.58E-08	UL	2000
7.48037	0.72145	3.45E-25	-0.9441	0.15907	2.94E-09	UL	2001
7.31461	1.03369	1.48E-12	-0.8919	0.1967	5.77E-06	UL	2002
9.27853	1.13103	2.33E-16	-1.2804	0.2516	3.60E-07	UL	2003
6.75706	1.27934	1.28E-07	-0.8441	0.23168	0.0002688	UL	2004
6.33981	1.38048	4.38E-06	-1.014	0.28914	0.0004533	UL	2005
8.41746	0.56533	3.87E-50	-1.0428	0.1223	1.52E-17	UL	2006
7.55001	0.96408	4.83E-15	-1.1099	0.22065	4.91E-07	UL	2007
8.61163	1.19795	6.54E-13	-1.1444	0.23574	1.21E-06	UL	2008
9.11728	1.32223	5.37E-12	-1.3524	0.29358	4.09E-06	UL	2009
7.21113	1.43923	5.43E-07	-1.0682	0.27978	0.0001346	UL	2010
9.59923	0.79	5.67E-34	-1.865	0.27397	9.94E-12	UL	2011
7.7917	0.58238	8.02E-41	-1.0392	0.14984	4.05E-12	UL	2012
4.92895	0.98218	5.21E-07	-0.8759	0.25246	0.0005215	UL	2013
8.18819	1.45772	1.94E-08	-1.1753	0.29204	5.71E-05	UL	2014
8.43945	1.27785	3.99E-11	-1.1157	0.2536	1.09E-05	UL	2015
8.05935	0.78368	8.33E-25	-1.0333	0.1652	3.98E-10	UL	2016
8.22737	0.94	2.09E-18	-1.1407	0.20163	1.54E-08	UL	2017
5.55782	1.91498	0.0037045	-1.0574	0.45205	0.0193322	UL	2018
7.92585	1.45658	5.29E-08	-1.4329	0.38501	0.0001978	UL	2019
7.55298	1.71961	1.12E-05	-0.9938	0.30126	0.0009705	LL	1982
8.51721	1.35804	3.57E-10	-1.0712	0.25153	2.05E-05	LL	1983
8.21306	0.61185	4.42E-41	-1.1937	0.16093	1.19E-13	LL	1984
8.26731	0.66712	2.87E-35	-1.0972	0.15218	5.60E-13	LL	1985

Table 11. continued.

9.76624	1.30203	6.34E-14	-1.3265	0.26422	5.15E-07	LL	1986
9.74792	1.03676	5.34E-21	-1.1104	0.19992	2.79E-08	LL	1987
9.36176	1.17655	1.76E-15	-1.1013	0.22171	6.79E-07	LL	1988
7.98703	1.81402	1.07E-05	-1.1586	0.3664	0.0015661	LL	1989
8.16597	1.27018	1.28E-10	-1.4605	0.34239	1.99E-05	LL	1990
10.0704	1.11491	1.68E-19	-1.5558	0.29883	1.93E-07	LL	1991
8.10266	1.20384	1.69E-11	-1.0177	0.22761	7.78E-06	LL	1992
7.90429	1.27484	5.64E-10	-0.9746	0.23487	3.33E-05	LL	1993
8.12605	0.77641	1.23E-25	-1.0655	0.17026	3.90E-10	LL	1994
7.78568	1.50339	2.23E-07	-1.1254	0.2918	0.0001149	LL	1995
7.22524	0.63312	3.63E-30	-0.9697	0.14365	1.47E-11	LL	1996
8.74186	0.73451	1.16E-32	-1.2041	0.17789	1.30E-11	LL	1997
8.29186	0.96387	7.79E-18	-1.0691	0.20046	9.66E-08	LL	1998
8.38901	0.67567	2.14E-35	-0.9851	0.13894	1.34E-12	LL	1999
6.69363	0.85814	6.18E-15	-0.8427	0.17381	1.25E-06	LL	2000
7.37261	0.97126	3.18E-14	-0.9449	0.19353	1.05E-06	LL	2001
6.0013	1.30215	4.05E-06	-0.7656	0.23264	0.0009984	LL	2002
7.23056	1.07646	1.85E-11	-1.2101	0.2863	2.37E-05	LL	2003
7.15774	1.07912	3.29E-11	-1.0344	0.22443	4.04E-06	LL	2004
4.36625	0.58403	7.66E-14	-0.6665	0.13615	9.82E-07	LL	2005
5.03901	0.8803	1.04E-08	-0.7524	0.19459	0.0001102	LL	2006
7.69884	0.51486	1.48E-50	-1.0884	0.12705	1.06E-17	LL	2007
8.72956	0.64034	2.56E-42	-1.1639	0.1435	5.02E-16	LL	2008
6.92603	0.82009	3.03E-17	-0.9638	0.19007	3.97E-07	LL	2009
7.3565	0.81019	1.09E-19	-0.9627	0.18976	3.91E-07	LL	2010
7.2747	0.89676	4.97E-16	-1.0784	0.21386	4.59E-07	LL	2011
8.48392	1.00259	2.63E-17	-1.2553	0.24521	3.07E-07	LL	2012
5.89968	0.89029	3.43E-11	-1.0375	0.24319	1.99E-05	LL	2013
6.00437	1.16141	2.34E-07	-0.9083	0.25328	0.0003354	LL	2014
8.31532	1.27729	7.51E-11	-1.181	0.27751	2.09E-05	LL	2015
9.05908	0.82979	9.52E-28	-1.0586	0.16681	2.21E-10	LL	2016
8.11097	1.3178	7.51E-10	-0.9853	0.24073	4.26E-05	LL	2017
7.00486	1.55117	6.31E-06	-0.9028	0.2731	0.0009473	LL	2018
7.38776	1.08932	1.19E-11	-0.9962	0.21413	3.28E-06	LL	2019

Table 12. Black drum (*Pogonias cromis*) catch curve for all data combined. Parameter estimates, standard errors and p-values for the intercept and slope of the catch curve fit to all data combined for black drum.

	Estimate	St. Error	P-val
Intercept	14.7637	0.00181	<2e-16
Slope	-0.612	0.00052	<2e-16

Table 13. Black drum (*Pogonias cromis*) catch curves for bay estimates (all years combined). Parameter estimates, standard errors and p-values for the intercept and slope of the catch curves fit to all years combined for each bay for black drum. SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

Intercept Estimate	Intercept St. Error	Intercept P-val	Slope Estimate	Slope St. Error	Slope P-val	Bay
12.668	0.01397	0	-1.1245	0.00533	0	SL
12.0307	0.01306	0	-0.9202	0.00457	0	GB
12.1024	0.00493	0	-0.4507	0.00122	0	MG
12.8368	0.00428	0	-0.562	0.00118	0	SA
12.8684	0.00456	0	-0.6008	0.00129	0	AB
12.5322	0.00589	0	-0.6446	0.00173	0	CC
14.013	0.00483	0	-0.9185	0.00169	0	UL
12.5321	0.00412	0	-0.4678	0.00104	0	LL

Table 14. Black drum (*Pogonias cromis*) catch curves for year estimates (all bays combined). Parameter estimates, standard errors and p-values for the intercept and slope of the catch curves fit to all bays combined for each year for black drum.

Intercept Estimate	Intercept St. Error	Intercept P-val	Slope Estimate	Slope St. Error	Slope P-val	Year
11.1356	0.03393	0	-1.1905	0.01324	0	1986
11.105	0.03293	0	-1.1659	0.01275	0	1987
9.88922	0.01219	0	-0.351	0.00272	0	1988
11.5366	0.02366	0	-1.1037	0.00896	0	1989
10.4128	0.01386	0	-0.5439	0.00375	0	1990
10.0364	0.01654	0	-0.5382	0.00445	0	1991
11.3991	0.01635	0	-0.8735	0.00559	0	1992
11.3714	0.00819	0	-0.5207	0.00217	0	1993
12.0226	0.00981	0	-0.7723	0.00316	0	1994
11.4314	0.00755	0	-0.4955	0.00195	0	1995
11.4295	0.01011	0	-0.6391	0.00296	0	1996
11.8703	0.01318	0	-0.8835	0.00453	0	1997
11.173	0.01296	0	-0.6988	0.00397	0	1998
11.1773	0.01232	0	-0.6749	0.00371	0	1999
11.2247	0.0128	0	-0.7056	0.00394	0	2000
11.2736	0.01036	0	-0.6129	0.00297	0	2001
11.3507	0.01635	0	-0.861	0.00555	0	2002
11.4161	0.01123	0	-0.6879	0.00341	0	2003
12.1655	0.01606	0	-1.0645	0.00599	0	2004
11.7823	0.00782	0	-0.5992	0.00222	0	2005
11.1102	0.00935	0	-0.5214	0.00248	0	2006
11.227	0.01137	0	-0.6471	0.00335	0	2007
11.009	0.01122	0	-0.5869	0.00315	0	2008
11.5044	0.01155	0	-0.7241	0.0036	0	2009
11.7298	0.01137	0	-0.773	0.00366	0	2010
11.3353	0.01092	0	-0.6538	0.00324	0	2011
11.0338	0.00946	0	-0.5088	0.00248	0	2012
11.5658	0.00996	0	-0.6654	0.00298	0	2013
11.4463	0.00886	0	-0.5783	0.00247	0	2014
10.8806	0.00886	0	-0.4385	0.00217	0	2015
11.2005	0.00973	0	-0.5638	0.00268	0	2016
11.4801	0.00731	0	-0.4915	0.00188	0	2017
11.2762	0.0096	0	-0.5755	0.00267	0	2018
11.2862	0.00942	0	-0.5688	0.0026	0	2019

Table 15. Black drum (*Pogonias cromis*) catch curves for bay-year estimates. Parameter estimates, standard errors and p-values for the intercept and slope of the catch curves fit to each bay and year for black drum. SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

Intercept Estimate	Intercept St. Error	Intercept P-val	Slope Estimate	Slope St. Error	Slope P-val	Bay	Year
12.9763	1.85853	2.91E-12	-2.7412	0.57375	1.77E-06	SL	1986
16.3229	5.84915	0.00526	-4.3846	2.08842	0.0357761	SL	1987
8.83878	0.26441	5.37E-245	-1.709	0.11592	3.42E-49	SL	1988
12.641	0.50245	1.13E-139	-3.3142	0.24542	1.48E-41	SL	1989
12.9279	0.47358	4.43E-164	-3.3692	0.23161	6.13E-48	SL	1990
11.9494	0.31134	0	-2.7799	0.14946	3.22E-77	SL	1991
16.4585	4.83372	0.000662	-4.3335	1.73908	0.0127093	SL	1992
11.2229	0.28347	0	-2.4882	0.13409	7.25E-77	SL	1993
16.9703	4.48859	0.000156	-4.4279	1.62474	0.0064246	SL	1994
14.2844	0.43776	1.51E-233	-3.7623	0.21567	3.77E-68	SL	1995
12.6449	0.24818	0	-2.8578	0.11952	2.35E-126	SL	1996
13.1816	0.25985	0	-3.0611	0.12604	2.73E-130	SL	1997
10.1398	1.66797	1.21E-09	-1.7937	0.42923	2.93E-05	SL	1998
12.8006	0.307	0	-3.0456	0.14883	4.60E-93	SL	1999
13.0156	1.10648	6.05E-32	-2.5818	0.35392	2.99E-13	SL	2000
11.4285	0.26812	0	-2.5178	0.12705	2.08E-87	SL	2001
9.89517	1.33585	1.29E-13	-1.7302	0.34516	5.36E-07	SL	2002
11.1902	2.89079	0.000108	-2.0002	0.69327	0.0039123	SL	2003
10.8799	1.22184	5.36E-19	-2.0776	0.34927	2.71E-09	SL	2004
17.4297	4.45038	8.99E-05	-4.5356	1.61336	0.004935	SL	2005
11.6148	0.12299	0	-2.0876	0.05644	1.98E-299	SL	2006
12.4609	1.88239	3.60E-11	-2.4422	0.57211	1.97E-05	SL	2007
13.8158	1.95712	1.67E-12	-2.8588	0.59642	1.64E-06	SL	2008
11.6918	1.2615	1.89E-20	-1.9536	0.32658	2.20E-09	SL	2009
12.9661	1.21774	1.79E-26	-2.3311	0.34574	1.56E-11	SL	2010
11.5389	1.06703	2.95E-27	-1.8943	0.2839	2.52E-11	SL	2011
14.1874	2.74605	2.39E-07	-2.914	0.80591	0.0002995	SL	2012
12.9269	2.20427	4.51E-09	-2.5383	0.65728	0.0001125	SL	2013
14.7281	2.95011	5.96E-07	-2.4397	0.69587	0.0004549	SL	2014

Table 15. continued.

10.7105	0.23334	0	-2.2045	0.1082	2.83E-92	SL	2015
10.8444	0.64117	3.57E-64	-2.0252	0.20066	5.94E-24	SL	2016
11.8271	0.26312	0	-2.6329	0.12545	8.59E-98	SL	2017
12.3695	3.56357	0.000518	-2.1998	0.82272	0.0074993	SL	2018
12.1104	3.16492	0.00013	-2.5556	0.9071	0.0048421	SL	2019
12.1131	2.08277	6.03E-09	-1.9763	0.50619	9.45E-05	GB	1982
13.9473	2.44456	1.16E-08	-3.0329	0.74442	4.62E-05	GB	1983
11.9785	0.20338	0	-2.5172	0.09636	2.07E-150	GB	1984
10.2383	1.37373	9.13E-14	-1.8017	0.35786	4.79E-07	GB	1985
11.1498	0.67076	4.78E-62	-2.093	0.20819	8.89E-24	GB	1986
11.6695	1.14633	2.44E-24	-2.4434	0.37954	1.21E-10	GB	1987
12.3779	0.28231	0	-2.8549	0.13594	6.37E-98	GB	1988
14.7117	2.04955	7.07E-13	-3.142	0.63216	6.69E-07	GB	1989
12.0724	0.28828	0	-2.77	0.13833	3.35E-89	GB	1990
11.8312	0.21104	0	-2.4939	0.09986	1.16E-137	GB	1991
11.2675	0.21277	0	-2.3211	0.09955	3.09E-120	GB	1992
14.8048	2.46157	1.81E-09	-3.1849	0.74718	2.02E-05	GB	1993
10.9055	0.14257	0	-1.9604	0.06458	2.19E-202	GB	1994
10.7719	0.18469	0	-2.0784	0.08469	5.26E-133	GB	1995
11.9032	2.06447	8.13E-09	-2.3909	0.61819	0.0001099	GB	1996
10.1596	0.94851	9.03E-27	-1.5393	0.26646	7.62E-09	GB	1997
10.9235	0.71538	1.22E-52	-2.1333	0.24873	9.75E-18	GB	1998
9.63586	1.44513	2.60E-11	-1.6868	0.36814	4.60E-06	GB	1999
12.6837	2.70999	2.86E-06	-2.1633	0.64439	0.0007874	GB	2000
13.2494	0.22241	0	-2.9822	0.1076	4.40E-169	GB	2001
11.1295	1.91019	5.66E-09	-1.8245	0.46777	9.60E-05	GB	2002
12.8133	1.80737	1.35E-12	-2.627	0.55251	1.99E-06	GB	2003
11.2921	1.64218	6.14E-12	-1.7985	0.41131	1.23E-05	GB	2004
9.03535	0.87996	9.83E-25	-1.5154	0.23625	1.42E-10	GB	2005
11.5196	0.2888	0	-2.5943	0.13742	1.69E-79	GB	2006
9.65216	0.18588	0	-1.7417	0.08189	2.18E-100	GB	2007
17.7433	5.94572	0.002843	-4.7263	2.13175	0.0266175	GB	2008
10.3496	1.24828	1.12E-16	-1.8605	0.33011	1.74E-08	GB	2009
10.1524	2.34596	1.51E-05	-1.7567	0.55947	0.0016903	GB	2010
11.0226	0.17867	0	-2.1355	0.08236	3.13E-148	GB	2011
13.3758	4.753	0.00489	-2.5168	1.07584	0.0193142	GB	2012
12.7357	2.61472	1.11E-06	-2.5486	0.76194	0.0008234	GB	2013
12.1942	1.52028	1.05E-15	-2.4651	0.47174	1.74E-07	GB	2014
11.7118	1.20814	3.20E-22	-2.2401	0.38821	7.92E-09	GB	2015

Table 15. continued.

12.9563	1.83039	1.46E-12	-2.6023	0.55693	2.97E-06	GB	2016
10.5859	0.22493	0	-2.1429	0.10376	9.11E-95	GB	2017
10.8533	0.19338	0	-2.1321	0.08911	1.68E-126	GB	2018
9.22954	0.90814	2.90E-24	-1.5851	0.2421	5.86E-11	GB	2019
12.4203	2.12463	5.04E-09	-2.036	0.51628	8.02E-05	MG	1982
12.347	2.46209	5.31E-07	-2.4659	0.72197	0.0006367	MG	1983
11.089	0.37535	7.97E-192	-2.624	0.17888	1.01E-48	MG	1984
10.9578	1.65131	3.23E-11	-2.0504	0.43427	2.34E-06	MG	1985
12.3034	1.92333	1.59E-10	-2.2613	0.50609	7.88E-06	MG	1986
12.3869	2.59655	1.84E-06	-2.1557	0.62546	0.0005678	MG	1987
14.7023	5.3022	0.005556	-2.6573	1.17006	0.0231421	MG	1988
12.8398	2.6798	1.66E-06	-2.1353	0.63322	0.0007459	MG	1989
16.5444	5.19054	0.001436	-3.4632	1.42197	0.0148706	MG	1990
14.9816	2.96634	4.41E-07	-3.2065	0.88119	0.0002739	MG	1991
12.4009	1.60643	1.17E-14	-2.1723	0.41283	1.42E-07	MG	1992
16.8941	4.92059	0.000596	-2.9112	1.11325	0.0089215	MG	1993
16.3697	3.48361	2.61E-06	-2.7308	0.81714	0.0008322	MG	1994
16.8559	5.19558	0.001177	-2.9363	1.16636	0.011818	MG	1995
13.4917	2.71929	7.00E-07	-2.2355	0.64365	0.0005145	MG	1996
15.5867	3.29692	2.27E-06	-2.7978	0.80225	0.0004877	MG	1997
12.5386	1.41989	1.04E-18	-2.3792	0.45605	1.82E-07	MG	1998
11.674	0.67524	5.71E-67	-2.2747	0.23512	3.87E-22	MG	1999
12.2504	1.85064	3.60E-11	-2.32	0.48612	1.82E-06	MG	2000
13.2104	1.52165	3.90E-18	-2.3315	0.40143	6.32E-09	MG	2001
11.6572	0.14144	0	-2.1875	0.06549	1.32E-244	MG	2002
15.809	4.2845	0.000224	-2.693	0.97926	0.0059597	MG	2003
11.3034	1.42128	1.82E-15	-1.9048	0.36405	1.67E-07	MG	2004
15.2667	3.5059	1.33E-05	-2.5709	0.81822	0.0016774	MG	2005
13.9455	0.00566	0	-2.3397	0.00566	0	MG	2006
15.1038	3.3792	7.83E-06	-2.551	0.79248	0.0012866	MG	2007
11.6492	2.31359	4.78E-07	-2.0012	0.56039	0.0003557	MG	2008
15.4138	4.56565	0.000735	-2.6655	1.03355	0.0099106	MG	2009
13.3105	2.43672	4.70E-08	-2.1713	0.58292	0.0001954	MG	2010
12.2505	1.43101	1.12E-17	-2.2671	0.38317	3.28E-09	MG	2011
13.3935	2.60154	2.63E-07	-2.2576	0.63681	0.0003923	MG	2012
13.9518	2.5227	3.19E-08	-2.2868	0.60368	0.0001518	MG	2013
12.2028	1.15501	4.33E-26	-2.4435	0.36978	3.90E-11	MG	2014
13.3864	1.77161	4.15E-14	-2.362	0.45658	2.30E-07	MG	2015

Table 15. continued.

12.0666	1.66737	4.59E-13	-1.9598	0.41731	2.65E-06	MG	2016
17.8109	8.18392	0.02953	-4.9274	2.91949	0.091459	MG	2017
10.003	0.12874	0	-1.6278	0.05571	1.05E-187	MG	2018
14.2722	0.00569	0	-2.3852	0.00569	0	MG	2019
11.8445	2.03772	6.15E-09	-2.3228	0.61245	0.000149	SA	1982
17.3713	5.79656	0.002728	-4.6265	2.07759	0.0259575	SA	1983
8.16036	1.16243	2.22E-12	-1.3082	0.32854	6.84E-05	SA	1984
11.5268	0.82068	8.22E-45	-3.2708	0.40043	3.13E-16	SA	1985
9.92031	3.00585	0.000966	-1.8233	0.71321	0.0105725	SA	1986
11.1288	0.32392	1.13E-258	-2.543	0.1537	1.75E-61	SA	1987
11.7557	0.22767	0	-2.5181	0.10788	1.67E-120	SA	1988
13.0906	1.35044	3.21E-22	-2.7839	0.43869	2.21E-10	SA	1989
10.5267	0.24502	0	-2.1777	0.11336	3.07E-82	SA	1990
12.1757	4.71039	0.009742	-2.3128	1.05044	0.0276851	SA	1991
16.6328	5.12082	0.001162	-3.4749	1.40621	0.0134687	SA	1992
16.5255	3.11521	1.13E-07	-2.8939	0.75818	0.0001351	SA	1993
15.8391	3.11533	3.69E-07	-2.7176	0.74544	0.0002668	SA	1994
17.1978	5.09401	0.000735	-2.9722	1.14894	0.0096846	SA	1995
13.064	0.85226	4.93E-53	-2.0895	0.22893	7.00E-20	SA	1996
14.5804	1.55717	7.72E-21	-2.5776	0.41237	4.08E-10	SA	1997
15.4833	4.00412	0.00011	-2.6597	0.92427	0.0040069	SA	1998
16.9676	4.98902	0.000671	-3.5207	1.37527	0.0104663	SA	1999
20.585	6.66513	0.002012	-5.4585	2.40182	0.0230482	SA	2000
15.2969	2.56323	2.40E-09	-2.6088	0.62641	3.12E-05	SA	2001
12.285	1.19472	8.43E-25	-2.4246	0.34213	1.37E-12	SA	2002
15.0526	2.25702	2.57E-11	-2.9389	0.6747	1.33E-05	SA	2003
17.2095	3.09646	2.73E-08	-3.4951	0.90534	0.0001131	SA	2004
14.8515	2.64258	1.91E-08	-2.4745	0.63513	9.78E-05	SA	2005
16.2101	3.15957	2.89E-07	-2.6696	0.74648	0.0003487	SA	2006
14.3187	2.85691	5.39E-07	-2.3929	0.67746	0.0004122	SA	2007
14.603	4.52189	0.00124	-2.6039	1.02647	0.0111885	SA	2008
16.4733	2.36689	3.41E-12	-3.4228	0.71405	1.64E-06	SA	2009
14.2503	1.38273	6.62E-25	-2.4059	0.35841	1.91E-11	SA	2010
14.6031	1.76894	1.52E-16	-2.5705	0.46064	2.40E-08	SA	2011
16.288	4.3604	0.000187	-2.7703	0.99748	0.0054818	SA	2012
15.7584	3.24038	1.16E-06	-2.7688	0.78044	0.0003886	SA	2013
16.4771	3.37386	1.04E-06	-2.954	0.82407	0.0003375	SA	2014
16.9651	5.53032	0.002157	-3.5712	1.5067	0.0177788	SA	2015

Table 15. continued.

15.0535	2.79434	7.16E-08	-2.6249	0.6817	0.0001179	SA	2016
16.0187	3.38136	2.17E-06	-2.6611	0.79346	0.0007973	SA	2017
15.4674	3.37048	4.45E-06	-2.5931	0.79075	0.0010407	SA	2018
15.3537	3.08888	6.67E-07	-3.134	0.89695	0.0004758	SA	2019
13.4198	0.33044	0	-3.2948	0.16133	1.03E-92	AB	1982
11.2873	2.53845	8.73E-06	-1.9583	0.61837	0.0015405	AB	1983
17.1146	7.95327	0.031406	-4.7484	2.82865	0.0932133	AB	1984
9.22774	1.39438	3.65E-11	-1.6539	0.48751	0.0006922	AB	1985
11.8255	1.1788	1.10E-23	-2.5902	0.41094	2.92E-10	AB	1986
15.615	3.40954	4.65E-06	-4.0087	1.25823	0.0014425	AB	1987
16.1026	4.8601	0.000922	-3.353	1.33914	0.0122854	AB	1988
15.1869	3.12602	1.18E-06	-3.0716	0.90229	0.0006636	AB	1989
19.2526	5.41899	0.000381	-5.0491	1.95042	0.0096337	AB	1990
12.1285	0.27984	0	-2.7689	0.13427	1.76E-94	AB	1991
15.7224	2.86791	4.20E-08	-3.3023	0.85118	0.0001046	AB	1992
13.8081	1.70397	5.34E-16	-2.4666	0.44041	2.14E-08	AB	1993
17.4761	4.0539	1.63E-05	-3.5685	1.1468	0.0018601	AB	1994
15.2488	3.222	2.22E-06	-2.7358	0.78424	0.0004858	AB	1995
12.958	1.00852	8.76E-38	-2.135	0.26754	1.47E-15	AB	1996
13.4007	1.79732	8.92E-14	-2.1508	0.44744	1.53E-06	AB	1997
14.158	1.6435	7.02E-18	-2.8691	0.50713	1.54E-08	AB	1998
13.5366	1.2702	1.62E-26	-2.3812	0.34362	4.21E-12	AB	1999
15.1412	4.51267	0.000793	-2.7236	1.03445	0.0084655	AB	2000
11.8695	0.47563	1.87E-137	-1.8233	0.13757	4.31E-40	AB	2001
17.1029	5.41887	0.001599	-3.5919	1.48293	0.0154291	AB	2002
15.3802	2.07951	1.40E-13	-3.188	0.63261	4.67E-07	AB	2003
13.8819	1.3108	3.30E-26	-2.2581	0.33879	2.64E-11	AB	2004
15.8092	2.93334	7.07E-08	-2.6454	0.70004	0.0001575	AB	2005
14.0052	2.4525	1.13E-08	-2.3577	0.59475	7.36E-05	AB	2006
14.3334	2.92907	9.91E-07	-2.48	0.70244	0.0004148	AB	2007
15.0559	2.40255	3.69E-10	-2.4204	0.57927	2.94E-05	AB	2008
16.5139	2.13277	9.71E-15	-3.4442	0.65023	1.18E-07	AB	2009
15.5025	2.55261	1.25E-09	-2.5869	0.61887	2.92E-05	AB	2010
14.2904	2.23158	1.52E-10	-2.3051	0.54196	2.11E-05	AB	2011
15.3957	2.85247	6.76E-08	-2.7387	0.70499	0.0001024	AB	2012
15.4638	2.68535	8.48E-09	-2.5385	0.64289	7.86E-05	AB	2013
16.6955	3.68566	5.90E-06	-2.8163	0.86288	0.0010989	AB	2014
15.2963	4.57206	0.000821	-2.6657	1.03574	0.0100618	AB	2015

Table 15. continued.

15.3706	3.5574	1.56E-05	-2.6048	0.83092	0.0017196	AB	2016
16.0421	3.76294	2.02E-05	-2.7293	0.87732	0.0018652	AB	2017
14.1001	2.86912	8.90E-07	-2.4628	0.69236	0.000375	AB	2018
15.9558	3.31612	1.50E-06	-2.6854	0.78306	0.000605	AB	2019
12.1661	0.28252	0	-2.7871	0.13566	8.64E-94	CC	1982
12.7449	1.66437	1.90E-14	-2.4457	0.51924	2.47E-06	CC	1983
14.6374	2.92879	5.80E-07	-3.7238	1.09654	0.000684	CC	1984
8.26507	0.98639	5.33E-17	-1.5638	0.28599	4.55E-08	CC	1985
10.0977	0.17183	0	-1.8284	0.07661	7.06E-126	CC	1986
11.6961	0.01525	0	-2.3995	0.01516	0	CC	1987
11.4906	1.11223	5.10E-25	-1.8268	0.29228	4.10E-10	CC	1988
10.8908	0.48802	2.55E-110	-1.6445	0.14268	9.75E-31	CC	1989
11.3745	0.67426	7.54E-64	-2.0284	0.201	6.02E-24	CC	1990
10.6811	1.35235	2.83E-15	-1.736	0.34657	5.47E-07	CC	1991
12.8358	1.37124	7.92E-21	-2.2203	0.36545	1.24E-09	CC	1992
11.9899	0.46728	3.34E-145	-1.8389	0.13073	6.05E-45	CC	1993
13.4884	2.08818	1.05E-10	-2.2423	0.51342	1.26E-05	CC	1994
13.2866	1.68825	3.55E-15	-2.1181	0.42365	5.75E-07	CC	1995
15.012	2.5112	2.26E-09	-2.5429	0.61233	3.28E-05	CC	1996
13.5102	2.25083	1.95E-09	-2.2289	0.54682	4.58E-05	CC	1997
13.4739	2.11972	2.06E-10	-2.3668	0.53534	9.82E-06	CC	1998
10.9345	0.89164	1.43E-34	-1.7831	0.24383	2.61E-13	CC	1999
12.1487	1.08891	6.64E-29	-1.8986	0.28992	5.81E-11	CC	2000
13.3089	2.14368	5.35E-10	-2.1731	0.52233	3.18E-05	CC	2001
12.411	0.85408	7.67E-48	-1.9932	0.23031	4.96E-18	CC	2002
16.8572	5.15315	0.001071	-3.5139	1.41417	0.0129625	CC	2003
11.2148	0.67803	1.88E-61	-1.9162	0.1918	1.68E-23	CC	2004
14.7692	3.32861	9.12E-06	-2.6259	0.79653	0.0009784	CC	2005
12.3882	2.36437	1.61E-07	-2.0254	0.56501	0.0003373	CC	2006
11.6181	2.32822	6.03E-07	-1.9154	0.55565	0.0005664	CC	2007
13.988	2.7245	2.83E-07	-2.3058	0.64593	0.0003574	CC	2008
13.5813	2.27413	2.34E-09	-2.193	0.54907	6.50E-05	CC	2009
14.8945	2.75859	6.69E-08	-2.6479	0.68215	0.0001037	CC	2010
12.7359	1.95408	7.14E-11	-2.0547	0.47999	1.86E-05	CC	2011
14.5399	2.63779	3.54E-08	-2.4801	0.63907	0.0001041	CC	2012
15.4343	3.53275	1.25E-05	-2.6022	0.82494	0.0016082	CC	2013
14.1644	2.39577	3.37E-09	-2.2962	0.57647	6.80E-05	CC	2014

Table 15. continued.

15.7912	3.33948	2.26E-06	-2.7593	0.79785	0.0005432	CC	2015
15.5733	4.53394	0.000593	-2.691	1.0289	0.0089115	CC	2016
15.6083	3.35236	3.23E-06	-2.6163	0.78774	0.0008961	CC	2017
13.8131	2.89412	1.82E-06	-2.428	0.69798	0.0005041	CC	2018
12.9449	2.11758	9.77E-10	-2.1284	0.51668	3.80E-05	CC	2019
11.2835	0.7333	2.00E-53	-1.911	0.21661	1.12E-18	UL	1982
16.2776	4.92723	0.000955	-3.3989	1.35847	0.0123478	UL	1983
17.7078	5.86994	0.002555	-3.7342	1.59274	0.0190537	UL	1984
10.0374	0.91447	4.98E-28	-1.7098	0.24294	1.95E-12	UL	1985
12.0691	0.18256	0	-2.4774	0.0863	3.09E-181	UL	1986
11.7294	0.98451	1.00E-32	-2.0209	0.27466	1.87E-13	UL	1987
10.8872	1.31445	1.20E-16	-1.8734	0.34015	3.64E-08	UL	1988
11.3748	0.54085	3.38E-98	-1.8442	0.151	2.65E-34	UL	1989
13.0129	2.00854	9.25E-11	-2.1287	0.49318	1.59E-05	UL	1990
12.036	0.01303	0	-1.9354	0.01292	0	UL	1991
12.4965	0.12925	0	-2.3942	0.06078	0	UL	1992
14.7993	2.63903	2.05E-08	-2.5807	0.6475	6.73E-05	UL	1993
13.2047	0.22409	0	-2.0868	0.07068	1.37E-191	UL	1994
15.5436	1.28242	8.22E-34	-2.7708	0.34177	5.18E-16	UL	1995
15.4886	1.35908	4.36E-30	-2.9072	0.37441	8.17E-15	UL	1996
15.7583	1.30906	2.25E-33	-3.1831	0.41233	1.17E-14	UL	1997
14.1569	1.11351	4.96E-37	-2.4029	0.29691	5.82E-16	UL	1998
15.0852	2.30434	5.89E-11	-2.6641	0.5828	4.85E-06	UL	1999
13.7074	0.91268	5.53E-51	-2.3045	0.24404	3.62E-21	UL	2000
17.3736	4.59474	0.000156	-3.5713	1.28258	0.0053616	UL	2001
12.822	0.58517	2.02E-106	-2.0659	0.16148	1.79E-37	UL	2002
15.8497	1.74465	1.04E-19	-2.8422	0.45991	6.41E-10	UL	2003
13.8513	1.08076	1.33E-37	-2.2125	0.28512	8.50E-15	UL	2004
17.9218	3.25858	3.80E-08	-3.0028	0.77553	0.000108	UL	2005
16.5446	2.98117	2.86E-08	-2.7927	0.7155	9.49E-05	UL	2006
14.6954	1.67187	1.50E-18	-2.3696	0.42141	1.88E-08	UL	2007
14.2476	2.30217	6.06E-10	-2.2993	0.55668	3.62E-05	UL	2008
13.6795	0.85438	1.07E-57	-2.1694	0.22964	3.48E-21	UL	2009
16.4163	0.00563	0	-2.6867	0.00563	0	UL	2010
14.1	1.70769	1.50E-16	-2.2606	0.42871	1.34E-07	UL	2011
13.1658	0.55868	8.62E-123	-2.1936	0.15849	1.44E-43	UL	2012
14.0896	1.6677	2.95E-17	-2.2717	0.41994	6.32E-08	UL	2013

Table 15. continued.

14.5966	0.98605	1.40E-49	-2.7976	0.32043	2.53E-18	UL	2014
13.3872	1.43168	8.71E-21	-2.2112	0.36677	1.65E-09	UL	2015
15.9794	2.2885	2.90E-12	-2.6316	0.56091	2.71E-06	UL	2016
16.1511	3.88775	3.26E-05	-2.7605	0.90427	0.0022674	UL	2017
14.3846	1.57735	7.55E-20	-2.3222	0.39998	6.41E-09	UL	2018
16.6359	3.84638	1.52E-05	-2.8027	0.89493	0.0017373	UL	2019
12.3216	1.5803	6.34E-15	-2.1935	0.40946	8.46E-08	LL	1982
13.7708	2.45836	2.12E-08	-2.2409	0.58862	0.0001407	LL	1983
11.9266	1.6716	9.69E-13	-1.9581	0.41833	2.86E-06	LL	1984
13.6158	2.73819	6.61E-07	-2.7442	0.79729	0.0005777	LL	1985
11.6966	2.06947	1.59E-08	-1.9083	0.50218	0.0001447	LL	1986
10.2067	0.77506	1.33E-39	-1.5572	0.21709	7.34E-13	LL	1987
12.415	2.0579	1.61E-09	-2.0368	0.50234	5.02E-05	LL	1988
10.4012	0.80252	2.04E-38	-1.6063	0.22001	2.86E-13	LL	1989
15.5517	4.60786	0.000738	-2.6946	1.04339	0.009807	LL	1990
10.835	0.37859	3.88E-180	-1.8027	0.11694	1.28E-53	LL	1991
13.8868	1.6307	1.65E-17	-2.2358	0.41143	5.50E-08	LL	1992
16.7731	4.17135	5.79E-05	-2.8181	0.96058	0.0033485	LL	1993
13.8645	1.77243	5.19E-15	-2.2178	0.44264	5.43E-07	LL	1994
13.9098	1.41492	8.30E-23	-2.2598	0.36293	4.77E-10	LL	1995
16.6866	4.4932	0.000204	-2.8462	1.02707	0.0055856	LL	1996
13.5184	1.70573	2.28E-15	-2.2179	0.42854	2.27E-07	LL	1997
14.8173	2.96692	5.91E-07	-2.4628	0.70058	0.0004391	LL	1998
16.2038	3.60904	7.13E-06	-2.714	0.84296	0.0012838	LL	1999
13.2361	2.75889	1.61E-06	-2.1825	0.64901	0.0007714	LL	2000
17.2481	4.53721	0.000144	-2.9195	1.03811	0.0049182	LL	2001
13.2478	0.00558	0	-2.2002	0.00559	0	LL	2002
13.8828	2.75485	4.67E-07	-2.3142	0.65412	0.0004034	LL	2003
12.2596	1.75761	3.06E-12	-2.0039	0.43748	4.64E-06	LL	2004
12.237	2.52723	1.28E-06	-2.032	0.59949	0.0007002	LL	2005
15.6097	4.87681	0.001371	-2.7261	1.09616	0.0128847	LL	2006
14.9324	3.51405	2.14E-05	-2.5101	0.81728	0.0021311	LL	2007
13.5406	2.19151	6.46E-10	-2.2026	0.53258	3.54E-05	LL	2008
14.2935	0.00564	0	-2.3741	0.00565	0	LL	2009
12.5217	2.24252	2.35E-08	-2.0321	0.53984	0.000167	LL	2010
15.7688	4.20868	0.000179	-2.7051	0.96604	0.0051078	LL	2011
15.492	3.58898	1.58E-05	-2.6021	0.83561	0.0018456	LL	2012
15.0273	3.25492	3.90E-06	-2.489	0.76185	0.0010869	LL	2013

Table 15. continued.

15.3282	3.52164	1.35E-05	-2.569	0.82049	0.0017418	LL	2014
16.0665	4.31035	0.000193	-2.7316	0.98589	0.0055929	LL	2015
14.581	0.00578	0	-2.401	0.0056	0	LL	2016
17.6728	4.84604	0.000265	-3.0145	1.10279	0.0062665	LL	2017
16.8412	3.90377	1.60E-05	-2.824	0.90655	0.0018387	LL	2018
15.7577	3.68839	1.94E-05	-2.651	0.85764	0.0019947	LL	2019

Table 16. Spotted seatrout (*Cynoscion nebulosus*) catch curve for all data combined. Parameter estimates, standard errors and p-values for the intercept and slope of the catch curve fit to all data combined for spotted seatrout.

	Estimate	**St. Error**	**P-val**
Intercept	15.0358	0.0016	<2e-16
Slope	-0.6385	0.00046	<2e-16

Table 17. Spotted seatrout (*Cynoscion nebulosus*) catch curves for bay estimates (all years combined). Parameter estimates, standard errors and p-values for the intercept and slope of the catch curves fit to all years combined for each bay for spotted seatrout. SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

Intercept Estimate	**Intercept St. Error**	**Intercept P-val**	**Slope Estimate**	**Slope St. Error**	**Slope P-val**	**Bay**
11.5495	0.00819	0	-0.5911	0.00225	0	SL
12.5069	0.00496	0	-0.5811	0.00135	0	GB
12.8373	0.00582	0	-0.7268	0.0018	0	MG
13.3395	0.00457	0	-0.7314	0.00142	0	SA
13.1364	0.00468	0	-0.6955	0.00141	0	AB
12.9007	0.00439	0	-0.6134	0.00123	0	CC
12.679	0.00469	0	-0.5944	0.00129	0	UL
13.5117	0.00348	0	-0.6461	0.00101	0	LL

Table 18. Spotted seatrout (*Cynoscion nebulosus*) catch curves for year estimates (all bays combined). Parameter estimates, standard errors and p-values for the intercept and slope of the catch curves fit to all bays combined for each year for spotted seatrout.

Intercept Estimate	Intercept St. Error	Intercept P-val	Slope Estimate	Slope St. Error	Slope P-val	Year
11.4048	0.01186	0	-0.7248	0.00366	0	1986
11.1969	0.01011	0	-0.6062	0.00282	0	1987
11.1658	0.01008	0	-0.598	0.00279	0	1988
11.018	0.01052	0	-0.5844	0.00287	0	1989
10.4391	0.00967	0	-0.4323	0.00216	0	1990
11.181	0.011	0	-0.6397	0.00317	0	1991
11.3527	0.00887	0	-0.583	0.00241	0	1992
11.4298	0.00967	0	-0.6378	0.00278	0	1993
11.3857	0.0093	0	-0.6109	0.0026	0	1994
11.288	0.01033	0	-0.6356	0.00296	0	1995
11.9269	0.00907	0	-0.7218	0.0028	0	1996
11.7724	0.00983	0	-0.7232	0.00304	0	1997
11.866	0.009	0	-0.7042	0.00274	0	1998
11.6324	0.00854	0	-0.6275	0.00243	0	1999
11.3748	0.00903	0	-0.5955	0.00249	0	2000
12.0311	0.00907	0	-0.746	0.00285	0	2001
11.393	0.01005	0	-0.6468	0.00291	0	2002
11.4518	0.00988	0	-0.6524	0.00288	0	2003
11.9356	0.00908	0	-0.724	0.0028	0	2004
11.5713	0.00938	0	-0.6555	0.00274	0	2005
11.7262	0.00986	0	-0.7139	0.00302	0	2006
11.6417	0.00913	0	-0.6592	0.00267	0	2007
11.1041	0.00992	0	-0.5779	0.00269	0	2008
11.5879	0.0095	0	-0.6651	0.0028	0	2009
11.5673	0.01094	0	-0.7252	0.00338	0	2010
11.631	0.01026	0	-0.71	0.00313	0	2011
11.5977	0.00939	0	-0.662	0.00276	0	2012
11.1044	0.00908	0	-0.5404	0.00236	0	2013
11.438	0.00924	0	-0.6192	0.00261	0	2014
11.3893	0.01005	0	-0.646	0.00291	0	2015
11.2838	0.0106	0	-0.6463	0.00307	0	2016
11.2769	0.01023	0	-0.6289	0.00292	0	2017
11.7376	0.01058	0	-0.7496	0.00333	0	2018
11.8388	0.01104	0	-0.7939	0.00358	0	2019

Table 19. Spotted seatrout (*Cynoscion nebulosus*) catch curves for bay-year estimates. Parameter estimates, standard errors and p-values for the intercept and slope of the catch curves fit to each bay and year for spotted seatrout. SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

Intercept Estimate	Intercept St. Error	Intercept P-val	Slope Estimate	Slope St. Error	Slope P-val	Bay	Year
8.05374	0.42736	3.20E-79	-0.693	0.06398	2.45E-27	SL	1986
7.61354	0.82819	3.82E-20	-0.768	0.11884	1.03E-10	SL	1987
8.05911	0.87145	2.29E-20	-0.7998	0.12805	4.21E-10	SL	1988
7.47623	0.58642	3.16E-37	-0.634	0.08022	2.72E-15	SL	1989
6.59041	0.9622	7.42E-12	-0.6152	0.12245	5.07E-07	SL	1990
6.22785	0.38486	6.76E-59	-0.682	0.07474	7.23E-20	SL	1991
8.15695	0.73807	2.15E-28	-0.8627	0.1261	7.83E-12	SL	1992
8.5511	0.79664	7.05E-27	-0.767	0.11608	3.92E-11	SL	1993
8.16468	0.6136	2.13E-40	-0.7725	0.08901	3.98E-18	SL	1994
7.12558	0.72637	1.02E-22	-0.6363	0.10118	3.21E-10	SL	1995
7.76485	0.55771	4.61E-44	-0.7167	0.0845	2.23E-17	SL	1996
8.09222	0.54943	4.24E-49	-0.6565	0.07735	2.12E-17	SL	1997
9.56379	0.39512	1.99E-129	-0.9297	0.06904	2.47E-41	SL	1998
8.53866	0.67987	3.53E-36	-0.6905	0.08887	7.89E-15	SL	1999
9.03389	0.00851	0	-0.728	0.00816	0	SL	2000
8.74973	0.70255	1.32E-35	-0.7159	0.09317	1.54E-14	SL	2001
8.99333	0.8189	4.66E-28	-0.7316	0.10746	9.90E-12	SL	2002
8.13305	0.47953	1.61E-64	-0.7201	0.07546	1.38E-21	SL	2003
8.91399	0.8133	5.93E-28	-0.6848	0.10213	2.02E-11	SL	2004
8.28754	0.56865	4.11E-48	-0.637	0.0759	4.78E-17	SL	2005
9.04549	0.60542	1.79E-50	-0.7227	0.08264	2.22E-18	SL	2006
8.89959	0.54435	4.41E-60	-0.6593	0.07326	2.26E-19	SL	2007
8.18579	0.566	2.09E-47	-0.6375	0.07748	1.90E-16	SL	2008
9.26827	0.93187	2.63E-23	-0.7056	0.11446	7.08E-10	SL	2009
8.62007	0.50653	6.04E-65	-0.6561	0.06927	2.78E-21	SL	2010
8.42161	0.30992	1.35E-162	-0.5937	0.04696	1.22E-36	SL	2011
8.50689	0.68225	1.10E-35	-0.6479	0.08802	1.82E-13	SL	2012
8.84068	0.53179	4.63E-62	-0.6539	0.07202	1.09E-19	SL	2013
9.37981	0.65151	5.40E-47	-0.726	0.08615	3.54E-17	SL	2014
9.21061	0.98792	1.13E-20	-0.7219	0.12054	2.11E-09	SL	2015
8.0885	0.77422	1.51E-25	-0.6723	0.1004	2.13E-11	SL	2016
7.81391	0.57535	5.17E-42	-0.7223	0.0862	5.28E-17	SL	2017

Table 19. continued.

7.43195	0.30498	3.71E-131	-0.6984	0.05381	1.62E-38	SL	2018
7.71949	0.80637	1.04E-21	-0.7024	0.11445	8.41E-10	SL	2019
9.36053	0.91524	1.49E-24	-0.7188	0.11293	1.96E-10	GB	1982
8.89801	0.78309	6.41E-30	-0.6648	0.0992	2.07E-11	GB	1983
9.30218	0.7268	1.67E-37	-0.701	0.09333	5.88E-14	GB	1984
9.97944	1.15765	6.67E-18	-0.7806	0.13821	1.63E-08	GB	1985
8.66417	0.36385	2.47E-125	-0.6441	0.05256	1.58E-34	GB	1986
8.97038	0.67588	3.36E-40	-0.6811	0.08754	7.23E-15	GB	1987
9.5868	0.56727	4.50E-64	-0.7131	0.07603	6.65E-21	GB	1988
8.91679	0.3828	5.18E-120	-0.6485	0.05458	1.47E-32	GB	1989
8.71143	0.6621	1.54E-39	-0.6603	0.08615	1.80E-14	GB	1990
8.63743	0.48835	5.28E-70	-0.6302	0.06747	9.57E-21	GB	1991
9.81819	0.40318	5.55E-131	-0.7466	0.05619	2.72E-40	GB	1992
9.68965	0.97765	3.72E-23	-0.7508	0.11974	3.60E-10	GB	1993
9.95419	1.02122	1.89E-22	-0.7721	0.12443	5.47E-10	GB	1994
10.1873	0.80214	5.91E-37	-0.7599	0.10178	8.26E-14	GB	1995
9.98565	0.809	5.30E-35	-0.7684	0.10238	6.09E-14	GB	1996
10.0604	0.61272	1.39E-60	-0.7584	0.08134	1.12E-20	GB	1997
10.0766	0.55686	3.46E-73	-0.7604	0.07544	6.74E-24	GB	1998
9.74116	0.70962	6.97E-43	-0.7482	0.09166	3.27E-16	GB	1999
9.80317	0.78925	2.01E-35	-0.7455	0.1001	9.52E-14	GB	2000
9.8535	0.62997	3.81E-55	-0.7343	0.08308	9.68E-19	GB	2001
10.2816	0.80969	6.06E-37	-0.777	0.10253	3.49E-14	GB	2002
9.45656	0.69965	1.25E-41	-0.7125	0.09044	3.33E-15	GB	2003
9.47234	0.51542	1.97E-75	-0.7035	0.07006	9.98E-24	GB	2004
9.99715	0.72262	1.58E-43	-0.7604	0.09317	3.30E-16	GB	2005
9.48825	0.73952	1.11E-37	-0.7236	0.09471	2.17E-14	GB	2006
10.7711	0.89334	1.78E-33	-0.8176	0.11163	2.40E-13	GB	2007
9.74388	0.72351	2.43E-41	-0.7217	0.09349	1.17E-14	GB	2008
10.1495	1.05575	7.01E-22	-0.7802	0.12786	1.05E-09	GB	2009
10.0926	0.88817	6.36E-30	-0.7641	0.11063	4.95E-12	GB	2010
9.87015	0.77065	1.49E-37	-0.7467	0.09818	2.84E-14	GB	2011
10.0951	0.61648	2.86E-60	-0.7525	0.08163	3.01E-20	GB	2012
9.49224	0.6922	8.48E-43	-0.6976	0.09034	1.15E-14	GB	2013
10.4567	0.79097	6.72E-40	-0.7894	0.10065	4.41E-15	GB	2014
9.96293	0.45768	4.62E-105	-0.7196	0.06487	1.37E-28	GB	2015
9.99829	0.82055	3.74E-34	-0.7592	0.10359	2.32E-13	GB	2016
9.51747	0.58013	1.74E-60	-0.7102	0.07741	4.56E-20	GB	2017
9.92275	0.54877	4.44E-73	-0.739	0.07375	1.25E-23	GB	2018

Table 19. continued.

8.79166	0.53173	2.09E-61	-0.719	0.07373	1.80E-22	GB	2019
9.33718	0.00814	0	-0.6893	0.00753	0	MG	1982
9.32727	0.52924	1.62E-69	-0.725	0.07445	2.10E-22	MG	1983
8.73695	0.96939	2.01E-19	-0.7404	0.12367	2.13E-09	MG	1984
8.38839	0.52607	3.07E-57	-0.6611	0.072	4.27E-20	MG	1985
9.5608	0.4378	1.01E-105	-0.7474	0.06105	1.84E-34	MG	1986
9.4079	0.61693	1.66E-52	-0.748	0.08225	9.51E-20	MG	1987
9.11416	0.72448	2.71E-36	-0.7242	0.09408	1.38E-14	MG	1988
9.07881	0.62291	4.06E-48	-0.7608	0.08756	3.65E-18	MG	1989
8.58813	0.71766	5.30E-33	-0.695	0.09448	1.89E-13	MG	1990
8.97768	0.83234	4.00E-27	-0.7492	0.11489	6.99E-11	MG	1991
9.86461	0.78567	3.70E-36	-0.8091	0.11017	2.06E-13	MG	1992
9.50651	0.77083	6.03E-35	-0.7617	0.09958	2.02E-14	MG	1993
9.83174	0.97908	9.98E-24	-0.8356	0.12528	2.57E-11	MG	1994
8.60322	0.22302	0	-0.6943	0.03738	5.19E-77	MG	1995
9.7236	0.60297	1.67E-58	-0.8019	0.08201	1.40E-22	MG	1996
8.92192	0.10027	0	-0.6353	0.02071	1.35E-206	MG	1997
9.57079	0.18448	0	-0.7028	0.02872	3.11E-132	MG	1998
9.88258	0.1952	0	-0.8385	0.00806	0	MG	1999
10.1817	0.97729	2.05E-25	-0.8184	0.12237	2.27E-11	MG	2000
10.3037	0.89454	1.06E-30	-0.8484	0.11475	1.43E-13	MG	2001
9.29687	0.64499	4.23E-47	-0.7521	0.08622	2.69E-18	MG	2002
9.54434	0.51441	7.55E-77	-0.7848	0.07184	8.75E-28	MG	2003
9.64201	0.6532	2.60E-49	-0.7809	0.08731	3.76E-19	MG	2004
9.44357	0.51882	4.98E-74	-0.7376	0.07168	7.83E-25	MG	2005
8.81792	0.78741	4.14E-29	-0.7304	0.10278	1.19E-12	MG	2006
10.4451	0.80063	6.69E-39	-0.9146	0.11129	2.06E-16	MG	2007
9.20474	0.68326	2.29E-41	-0.8079	0.09364	6.28E-18	MG	2008
9.09656	0.65292	4.04E-44	-0.7354	0.08974	2.51E-16	MG	2009
9.15954	0.3417	2.75E-158	-0.8004	0.05309	2.36E-51	MG	2010
9.85372	0.59535	1.57E-61	-0.8817	0.08729	5.51E-24	MG	2011
9.55333	0.49642	1.57E-82	-0.7864	0.06888	3.43E-30	MG	2012
9.72677	1.06979	9.70E-20	-0.7895	0.13134	1.84E-09	MG	2013
9.95395	0.76397	8.35E-39	-0.8496	0.10442	4.06E-16	MG	2014
8.94213	0.29136	7.62E-207	-0.8577	0.05348	6.74E-58	MG	2015
9.01922	0.70569	2.10E-37	-0.7433	0.09461	3.97E-15	MG	2016
9.01189	0.71479	1.92E-36	-0.711	0.09259	1.61E-14	MG	2017
9.34866	0.37586	1.46E-136	-0.7476	0.05341	1.63E-44	MG	2018
9.01544	0.48941	8.94E-76	-0.7003	0.06672	9.00E-26	MG	2019

Table 19. continued.

9.80579	0.54583	3.67E-72	-0.781	0.07403	5.10E-26	SA	1982
9.46617	0.62175	2.41E-52	-0.7082	0.08202	5.92E-18	SA	1983
9.10768	1.05025	4.25E-18	-0.7292	0.12732	1.02E-08	SA	1984
7.75267	0.30752	3.07E-140	-0.6024	0.04637	1.37E-38	SA	1985
9.59818	0.65293	6.43E-49	-0.7389	0.08521	4.28E-18	SA	1986
9.65603	0.81402	1.86E-32	-0.7865	0.10468	5.74E-14	SA	1987
9.67735	0.46191	1.85E-97	-0.7667	0.06395	4.09E-33	SA	1988
10.0532	0.74842	3.90E-41	-0.7541	0.09596	3.87E-15	SA	1989
8.69107	0.4732	2.44E-75	-0.6384	0.06534	1.50E-22	SA	1990
9.53577	0.37444	4.60E-143	-0.8012	0.05913	7.86E-42	SA	1991
9.47473	0.51355	5.27E-76	-0.7422	0.07007	3.27E-26	SA	1992
9.45077	0.39804	1.28E-124	-0.7288	0.05584	6.16E-39	SA	1993
9.77117	0.71926	4.91E-42	-0.7363	0.09264	1.89E-15	SA	1994
9.82568	0.59879	1.64E-60	-0.7235	0.08002	1.54E-19	SA	1995
10.3186	0.36849	1.53E-172	-0.7839	0.0523	8.63E-51	SA	1996
10.132	0.60431	4.30E-63	-0.7917	0.08001	4.38E-23	SA	1997
10.6806	0.21218	0	-0.8643	0.03414	1.95E-141	SA	1998
11.0916	1.47181	4.84E-14	-0.9067	0.17324	1.66E-07	SA	1999
10.7712	1.20429	3.75E-19	-0.8674	0.1456	2.56E-09	SA	2000
9.8186	0.49914	3.82E-86	-0.7619	0.0689	2.00E-28	SA	2001
9.90379	0.44722	1.16E-108	-0.7556	0.0624	9.33E-34	SA	2002
10.4857	0.95355	3.97E-28	-0.8246	0.11846	3.38E-12	SA	2003
9.72997	0.2032	0	-0.7752	0.03325	3.19E-120	SA	2004
11.1406	0.76073	1.46E-48	-0.8594	0.09858	2.84E-18	SA	2005
10.5344	0.48152	4.25E-106	-0.8183	0.06559	1.03E-35	SA	2006
9.62757	0.7372	5.60E-39	-0.7606	0.0958	2.04E-15	SA	2007
9.38801	0.33223	1.15E-175	-0.6781	0.04922	3.47E-43	SA	2008
10.2773	0.497	5.37E-95	-0.7935	0.06717	3.32E-32	SA	2009
9.448	0.49741	1.89E-80	-0.8122	0.0706	1.25E-30	SA	2010
9.77665	0.40366	1.37E-129	-0.7967	0.05812	9.02E-43	SA	2011
10.2612	0.7588	1.14E-41	-0.7829	0.09702	7.10E-16	SA	2012
10.3068	0.85259	1.21E-33	-0.7772	0.10708	3.94E-13	SA	2013
9.72674	0.46175	1.67E-98	-0.7202	0.06402	2.32E-29	SA	2014
9.7568	0.83833	2.63E-31	-0.78	0.1075	3.99E-13	SA	2015
9.80417	0.00795	0	-0.7541	0.00766	0	SA	2016
10.2148	0.63725	7.96E-58	-0.7903	0.08363	3.37E-21	SA	2017
9.68066	0.71053	2.86E-42	-0.7686	0.09259	1.03E-16	SA	2018
9.75296	0.62961	4.03E-54	-0.7755	0.08316	1.11E-20	SA	2019
9.99956	0.8927	4.01E-29	-0.7725	0.11138	4.04E-12	AB	1982

Table 19. continued.

9.4708	0.65758	5.00E-47	-0.712	0.0859	1.15E-16	AB	1983
8.06834	0.77595	2.53E-25	-0.6702	0.10053	2.62E-11	AB	1984
8.3053	0.00821	0	-0.6171	0.00775	0	AB	1985
9.2059	0.18252	0	-0.7546	0.03178	1.18E-124	AB	1986
9.73539	0.53522	6.25E-74	-0.708	0.07335	4.82E-22	AB	1987
9.61125	0.78228	1.07E-34	-0.7655	0.10005	1.99E-14	AB	1988
10.2139	0.88602	9.55E-31	-0.8039	0.11117	4.78E-13	AB	1989
9.57946	0.57387	1.48E-62	-0.7199	0.07652	5.08E-21	AB	1990
10.1777	0.77695	3.31E-39	-0.7799	0.09937	4.22E-15	AB	1991
9.54518	0.35869	5.07E-156	-0.7094	0.05075	2.15E-44	AB	1992
9.80403	0.61731	8.46E-57	-0.7399	0.08134	9.32E-20	AB	1993
10.097	0.7206	1.32E-44	-0.7899	0.09335	2.64E-17	AB	1994
9.59729	0.66488	3.13E-47	-0.725	0.08653	5.35E-17	AB	1995
10.7683	0.93281	7.92E-31	-0.8577	0.11694	2.22E-13	AB	1996
9.78659	0.2204	0	-0.7432	0.03296	1.38E-112	AB	1997
9.93226	0.41434	5.58E-127	-0.7359	0.05879	5.93E-36	AB	1998
10.4136	0.85508	4.05E-34	-0.7902	0.10741	1.88E-13	AB	1999
10.8859	0.87406	1.32E-35	-0.8391	0.10995	2.32E-14	AB	2000
10.4185	0.73165	5.19E-46	-0.7935	0.09411	3.42E-17	AB	2001
9.20125	0.20942	0	-0.6568	0.03113	8.40E-99	AB	2002
10.1631	0.74287	1.32E-42	-0.7834	0.09568	2.67E-16	AB	2003
10.5846	0.7003	1.30E-51	-0.7804	0.09135	1.32E-17	AB	2004
10.0346	0.79159	7.98E-37	-0.7554	0.1005	5.66E-14	AB	2005
9.89302	0.67063	3.00E-49	-0.7733	0.08782	1.30E-18	AB	2006
9.9403	0.55846	7.15E-71	-0.7483	0.07449	9.53E-24	AB	2007
9.49176	0.69069	5.66E-43	-0.7135	0.08952	1.58E-15	AB	2008
9.33584	0.37859	2.90E-134	-0.7593	0.05429	1.93E-44	AB	2009
9.27398	0.67588	7.57E-43	-0.7302	0.08807	1.12E-16	AB	2010
9.68252	0.52769	3.36E-75	-0.7666	0.07195	1.64E-26	AB	2011
9.53867	0.50922	2.72E-78	-0.7668	0.06934	1.98E-28	AB	2012
10.2925	0.84984	9.22E-34	-0.788	0.10689	1.69E-13	AB	2013
10.2816	0.83254	4.89E-35	-0.7864	0.10507	7.19E-14	AB	2014
9.55247	0.4445	1.92E-102	-0.7644	0.06207	7.59E-35	AB	2015
9.24926	0.46761	4.44E-87	-0.7463	0.06479	1.06E-30	AB	2016
9.78629	0.76582	2.15E-37	-0.7448	0.09756	2.27E-14	AB	2017
10.112	0.56815	7.30E-71	-0.7523	0.07607	4.66E-23	AB	2018
10.1485	0.68973	5.26E-49	-0.7853	0.08966	1.98E-18	AB	2019
10.3317	0.84911	4.62E-34	-0.774	0.10672	4.08E-13	CC	1982
10.1275	0.87474	5.34E-31	-0.7601	0.10925	3.45E-12	CC	1983

Table 19. continued.

8.73012	0.25473	2.08E-257	-0.6773	0.03906	2.38E-67	CC	1984
10.0647	0.79535	1.06E-36	-0.7727	0.10132	2.41E-14	CC	1985
9.49347	0.59737	7.19E-57	-0.6985	0.07983	2.13E-18	CC	1986
10.3543	0.98576	8.29E-26	-0.796	0.12104	4.83E-11	CC	1987
10.4664	0.73616	7.13E-46	-0.7832	0.0948	1.44E-16	CC	1988
10.2636	0.85372	2.71E-33	-0.7684	0.10717	7.52E-13	CC	1989
10.3358	0.65168	1.19E-56	-0.7665	0.0858	4.14E-19	CC	1990
9.86874	0.54415	1.65E-73	-0.7198	0.07428	3.30E-22	CC	1991
11.1514	1.01675	5.46E-28	-0.8436	0.12455	1.26E-11	CC	1992
10.788	0.79787	1.17E-41	-0.8146	0.1015	1.02E-15	CC	1993
10.3485	0.86939	1.14E-32	-0.8165	0.10979	1.03E-13	CC	1994
10.8077	0.78879	9.91E-43	-0.807	0.10063	1.07E-15	CC	1995
10.2139	0.63502	3.29E-58	-0.7778	0.08358	1.32E-20	CC	1996
10.68	0.6859	1.15E-54	-0.8182	0.08951	6.21E-20	CC	1997
10.1679	0.47543	1.78E-101	-0.7567	0.06507	2.96E-31	CC	1998
10.1925	0.66233	1.94E-53	-0.7498	0.08722	8.18E-18	CC	1999
9.53681	0.65431	4.03E-48	-0.707	0.08584	1.78E-16	CC	2000
10.1191	0.52815	8.04E-82	-0.7735	0.07109	1.43E-27	CC	2001
10.0902	0.59046	1.80E-65	-0.7472	0.07887	2.68E-21	CC	2002
9.8772	0.47458	3.33E-96	-0.7279	0.06554	1.17E-28	CC	2003
10.2244	0.82784	4.82E-35	-0.7837	0.10451	6.46E-14	CC	2004
9.36412	0.37352	1.07E-138	-0.6706	0.05381	1.23E-35	CC	2005
9.89763	0.56161	1.62E-69	-0.7213	0.07637	3.54E-21	CC	2006
10.0447	0.80257	6.12E-36	-0.789	0.10308	1.94E-14	CC	2007
10.1856	0.94714	5.67E-27	-0.7812	0.11692	2.36E-11	CC	2008
9.80769	0.81333	1.75E-33	-0.7624	0.1029	1.27E-13	CC	2009
9.32545	0.60312	6.26E-54	-0.725	0.07956	8.04E-20	CC	2010
9.57891	0.29982	5.68E-224	-0.7023	0.04505	8.79E-55	CC	2011
10.2378	0.80835	9.24E-37	-0.7945	0.1028	1.09E-14	CC	2012
10.1932	1.02291	2.17E-23	-0.7856	0.12469	2.97E-10	CC	2013
9.91187	0.7792	4.54E-37	-0.7604	0.09915	1.74E-14	CC	2014
10.2929	0.83934	1.43E-34	-0.7753	0.10566	2.17E-13	CC	2015
9.71547	0.7149	4.59E-42	-0.722	0.09246	5.75E-15	CC	2016
10.3857	0.81191	1.82E-37	-0.7875	0.10284	1.89E-14	CC	2017
9.73274	0.50117	5.24E-84	-0.7174	0.06855	1.25E-25	CC	2018
9.95276	0.40785	1.59E-131	-0.7528	0.05641	1.26E-40	CC	2019
10.0425	0.81305	4.77E-35	-0.7518	0.10282	2.65E-13	UL	1982
9.96036	0.9694	9.16E-25	-0.7565	0.1188	1.92E-10	UL	1983
6.90664	0.77173	3.57E-19	-0.8057	0.13637	3.45E-09	UL	1984

Table 19. continued.

8.09662	0.7425	1.10E-27	-0.7653	0.10563	4.31E-13	UL	1985
8.30891	0.46185	2.31E-72	-0.6466	0.06276	6.87E-25	UL	1986
9.34027	0.97737	1.22E-21	-0.7569	0.12135	4.46E-10	UL	1987
8.65167	0.55643	1.63E-54	-0.6336	0.07535	4.12E-17	UL	1988
8.87066	0.58602	9.22E-52	-0.6711	0.07762	5.32E-18	UL	1989
7.97702	0.52816	1.54E-51	-0.6396	0.0731	2.15E-18	UL	1990
9.18583	0.00757	0	-0.6573	0.00723	0	UL	1991
10.6107	0.94669	3.72E-29	-0.7941	0.11691	1.10E-11	UL	1992
9.39447	0.59501	3.73E-56	-0.6844	0.08011	1.30E-17	UL	1993
10.5909	0.89675	3.45E-32	-0.8223	0.11238	2.54E-13	UL	1994
9.52509	0.82997	1.73E-30	-0.7284	0.10426	2.82E-12	UL	1995
9.8786	0.59181	1.49E-62	-0.789	0.0791	1.95E-23	UL	1996
9.74325	0.31564	3.15E-209	-0.7952	0.04663	3.34E-65	UL	1997
9.88297	0.58973	4.92E-63	-0.7383	0.0785	5.25E-21	UL	1998
10.2631	0.92951	2.41E-28	-0.7922	0.11533	6.49E-12	UL	1999
10.0556	1.02534	1.05E-22	-0.7753	0.1248	5.23E-10	UL	2000
9.91719	0.61484	1.58E-58	-0.7629	0.08078	3.59E-21	UL	2001
10.0123	0.97069	6.06E-25	-0.8118	0.12105	1.99E-11	UL	2002
9.75873	0.78334	1.27E-35	-0.7626	0.09974	2.08E-14	UL	2003
10.0575	0.5112	3.60E-86	-0.7353	0.07023	1.19E-25	UL	2004
9.75514	0.71945	6.99E-42	-0.7216	0.09309	9.09E-15	UL	2005
10.6702	1.12452	2.34E-21	-0.827	0.13557	1.06E-09	UL	2006
10.2814	1.38769	1.27E-13	-0.8274	0.16218	3.37E-07	UL	2007
10.263	0.90006	4.06E-30	-0.7788	0.11198	3.53E-12	UL	2008
10.4127	0.9141	4.62E-30	-0.814	0.11412	9.81E-13	UL	2009
9.86811	0.73082	1.51E-41	-0.7428	0.09394	2.64E-15	UL	2010
10.4422	0.90034	4.22E-31	-0.8002	0.11224	1.01E-12	UL	2011
10.8378	1.01547	1.37E-26	-0.8267	0.12432	2.93E-11	UL	2012
11.4179	1.11312	1.09E-24	-0.8852	0.13537	6.18E-11	UL	2013
10.148	0.18337	0	-0.8213	0.0308	1.27E-156	UL	2014
9.94498	0.91308	1.26E-27	-0.8027	0.11503	2.98E-12	UL	2015
9.99673	0.96136	2.52E-25	-0.773	0.11835	6.53E-11	UL	2016
9.72035	0.88253	3.26E-28	-0.7649	0.1105	4.44E-12	UL	2017
9.17894	0.89345	9.27E-25	-0.7004	0.11052	2.35E-10	UL	2018
9.16657	0.57625	5.63E-57	-0.7015	0.07623	3.48E-20	UL	2019
11.948	1.20217	2.83E-23	-0.9142	0.1443	2.37E-10	LL	1982
11.3851	0.96434	3.63E-32	-0.8565	0.11928	6.97E-13	LL	1983
10.3065	0.62501	4.32E-61	-0.7673	0.08257	1.52E-20	LL	1984
10.6672	0.79192	2.35E-41	-0.7956	0.10092	3.20E-15	LL	1985

Table 19. continued.

10.6573	0.79125	2.38E-41	-0.7969	0.1008	2.67E-15	LL	1986
11.3713	0.94521	2.46E-33	-0.8597	0.11737	2.39E-13	LL	1987
11.2753	0.68877	3.12E-60	-0.829	0.09038	4.61E-20	LL	1988
10.715	0.71084	2.42E-51	-0.7868	0.09272	2.14E-17	LL	1989
11.8928	1.36987	3.90E-18	-0.9398	0.16253	7.38E-09	LL	1990
10.6915	0.48248	8.41E-109	-0.774	0.06766	2.61E-30	LL	1991
11.8413	1.13351	1.52E-25	-0.8992	0.13705	5.33E-11	LL	1992
11.1869	0.93462	5.14E-33	-0.8568	0.11635	1.79E-13	LL	1993
10.8904	0.62485	4.99E-68	-0.809	0.08295	1.78E-22	LL	1994
10.0392	0.38911	8.69E-147	-0.7475	0.05496	3.90E-42	LL	1995
10.9414	0.79548	4.79E-43	-0.8493	0.10187	7.64E-17	LL	1996
10.2526	0.30796	5.03E-243	-0.7921	0.04521	9.90E-69	LL	1997
11.0741	1.01443	9.60E-28	-0.8601	0.12496	5.87E-12	LL	1998
10.6899	0.35391	2.04E-200	-0.8059	0.05009	3.03E-58	LL	1999
10.17	0.39715	1.27E-144	-0.736	0.05665	1.34E-38	LL	2000
11.2803	1.11419	4.31E-24	-0.8754	0.13533	9.90E-11	LL	2001
10.1191	0.46836	1.60E-103	-0.7683	0.06388	2.56E-33	LL	2002
10.5686	0.5512	6.13E-82	-0.8008	0.07412	3.33E-27	LL	2003
11.2922	0.60639	2.13E-77	-0.8983	0.08097	1.35E-28	LL	2004
11.0709	0.88721	9.80E-36	-0.8438	0.11122	3.29E-14	LL	2005
10.1469	0.54214	3.64E-78	-0.7669	0.07303	8.55E-26	LL	2006
10.9248	0.7726	2.15E-45	-0.8309	0.09894	4.51E-17	LL	2007
11.0844	0.7518	3.38E-49	-0.8352	0.09663	5.49E-18	LL	2008
10.9877	0.91782	5.01E-33	-0.842	0.11446	1.88E-13	LL	2009
10.6487	0.67091	9.89E-57	-0.8191	0.08756	8.42E-21	LL	2010
10.4667	0.78785	2.82E-40	-0.7812	0.10041	7.27E-15	LL	2011
10.7339	0.91777	1.34E-31	-0.8103	0.11409	1.22E-12	LL	2012
9.92369	0.57929	8.73E-66	-0.7598	0.07694	5.35E-23	LL	2013
10.8347	0.91159	1.41E-32	-0.8454	0.1141	1.27E-13	LL	2014
10.6321	0.54761	5.71E-84	-0.8119	0.07367	3.01E-28	LL	2015
10.7641	0.71359	2.05E-51	-0.8118	0.0924	1.55E-18	LL	2016
10.4228	0.69171	2.62E-51	-0.7808	0.08991	3.81E-18	LL	2017
10.5146	0.73525	2.17E-46	-0.8073	0.09458	1.39E-17	LL	2018
10.6081	0.41232	5.71E-146	-0.8526	0.05767	1.83E-49	LL	2019

Pairwise Comparisons of Mortality by Bay – Tukey HSD

Table 20. Pairwise differences in Finite Survival Rate (S) for Atlantic croaker (*Micropogonias undulatus*). The adjusted p-value from Tukey's HSD pairwise comparisons between bays. Bay pairs whose mean finite survival rate are significantly different at an alpha of 0.05 are shaded in green. SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SAB = San Antonio Bay, AB = Aransas Bay, CCB = Corpus Christi Bay, ULM = Upper Laguna Madre, LLM = Lower Laguna Madre.

	GB	MG	SA	AB	CC	UL	LL
SL	0.0379	<0.0001	<0.0001	0.7959	0.6761	0.9994	0.7559
GB		0.0020	0.2722	0.7037	0.8216	0.0043	0.0001
MG			0.7159	<0.0001	<0.0001	<0.0001	<0.0001
SA				0.0019	0.0040	<0.0001	<0.0001
AB					1	0.3982	0.0324
CC						0.2798	0.0171
UL							0.9623

Table 21. Pairwise differences in Finite Survival Rate (S) for Black drum (*Pogonias cromis*). The adjusted p-value from Tukey's HSD pairwise comparisons between bays. Bay pairs whose mean finite survival rate are significantly different at an alpha of 0.05 are shaded in green. SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SAB = San Antonio Bay, AB = Aransas Bay, CCB = Corpus Christi Bay, ULM = Upper Laguna Madre, LLM = Lower Laguna Madre.

	GB	MGB	SAB	AB	CCB	ULM	LLM
SL	0.0821	0.9626	0.9622	0.9534	0.0896	0.9906	0.6982
GB		0.5828	0.0016	0.0014	1	0.4236	0.9244
MGB			0.3529	0.3272	0.6067	1	0.9984
SAB				1	0.0019	0.5054	0.0906
AB					0.0016	0.4759	0.0808
CCB						0.4464	0.9346
ULM							0.9887

Table 22. Pairwise differences in Finite Survival Rate (S) for Spotted seatrout (*Cynoscion nebulosus*). The adjusted p-value from Tukey's HSD pairwise comparisons between bays. Bay pairs whose mean finite survival rate are significantly different at an alpha of 0.05 are shaded in green. SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SAB = San Antonio Bay, AB = Aransas Bay, CCB = Corpus Christi Bay, ULM = Upper Laguna Madre, LLM = Lower Laguna Madre.

	GB	**MGB**	**SAB**	**AB**	**CCB**	**ULM**	**LLM**
SL	0.3163	<0.0001	<0.0001	0.0017	0.0002	0.0003	<0.0001
GB		0.1100	0.0480	0.6023	0.2463	0.3137	<0.0001
MGB			1	0.9828	1	0.9997	0.0004
SAB				0.9192	0.9977	0.9932	0.0013
AB					0.9992	0.9999	<0.0001
CCB						1	0.0001
ULM							<0.0001

Model Results

Table 23. Linear Regression Models for Finite Survival Rate. Best models according to BIC are shown for Atlantic croaker (*Micropogonias undulatus*), Black drum (*Pogonias cromis*), and Spotted seatrout (*Cynoscion nebulosus*), along with the parameter estimates, ΔBIC, and adjusted R^2 for each model. For Spotted seatrout, only the best model is shown, as no other models had a ΔBIC less than 2.

Species	***Variable***	***Parameter Estimate***	***ΔBIC***	***Adjusted R^2***
Atlantic croaker	Intercept	0.2875	0	0.2399
	Fish Diversity	-0.0404		
	Temperature	0.0131		
	Intercept	0.2872	1.2795	0.2363
	Fish Diversity	-0.0386		
	Salinity	0.0117		
Black drum	Intercept	0.0912	0	0.0153
	Dissolved oxygen	-0.0063		
	Intercept	0.0911	0.4968	0.0135
	Salinity	0.0051		
Spotted seatrout	Intercept	0.4674	0	0.1459
	Fish Diversity	-0.0056		
	Temperature	-0.0057		
	Salinity	-0.0060		

Mortality Estimates from Previous Studies

Table 24. Comparison of Total Mortality from previous studies. Total mortality estimates (Z) from previous studies are shown in comparison to the results from the present study. In addition to the mortality estimate, location of each study as well as the citation for each study are provided.

Species	***Total Mortality***	***Location***	***Study***
Atlantic croaker			
	3.2	Texas and Louisiana	White and Chittenden Jr. (1977)
	1.3	North Carolina	Ross (1988)
	0.55 - 0.63	Chesapeake Bay	Barbieri et al. (1993)
	0.47 - 5.28	Texas	**Present study**
Black drum			
	0.08 - 0.13	Chesapeake Bay	Jones and Wells (1998)
	0.085 - 0.53	Texas and Louisiana	Leard et al. (1993)
	1.31 - 5.46	Texas	**Present study**
Spotted seatrout			
	0.65 - 1.42	Florida	Murphy and Taylor (1994)
	1.4	Louisiana	Nieland et al. (2002)
	0.59 - 0.94	Texas	**Present study**

APPENDIX C

In this section I present additional results from Chapter IV.

Tukey's Honestly Significant Difference for pairwise comparisons among bays for FRic and FDis for each season.

Table 25. Tukey's HSD for Spring FRic. Tukey's honestly significant difference among bays for spring functional richness. Table shows the adjusted p-value for a given comparison (e.g., difference in FRic between Sabine Lake and Galveston Bay). Cells containing p-values significant at the 0.05 significance level are shaded green. Bay abbreviations are as follows, SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

	GB	**MG**	**SA**	**AB**	**CC**	**UL**	**LL**
SL	<0.0001	0.2160	<0.0001	0.9992	0.0017	1	0.0920
GB		0.0007	0.9907	<0.0001	0.1450	<0.0001	0.0030
MG			<0.0001	0.5184	0.7312	0.2376	0.9999
SA				<0.0001	0.0132	<0.0001	0.0001
AB					0.0095	0.9998	0.2832
CC						0.0017	0.9146
UL							0.1008

Table 26. Tukey's HSD for Fall FRic. Tukey's honestly significant difference among bays for fall functional richness. Table shows the adjusted p-value for a given comparison (e.g., difference in FRic between Sabine Lake and Galveston Bay). Cells containing p-values significant at the 0.05 significance level are shaded green. Bay abbreviations are as follows, SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

	GB	**MG**	**SA**	**AB**	**CC**	**UL**	**LL**
SL	0.5681	0.0015	<0.0001	0.3980	<0.0001	1	0.3856
GB		0.3195	0.0001	1	0.0016	0.5222	1
MG			0.1967	0.4842	0.6241	0.0009	0.4979
SA				0.0003	0.9966	<0.0001	0.0003
AB					0.0044	0.3522	1
CC						<0.0001	0.0048
UL							0.3402

Table 27. Tukey's HSD for Spring FDis. Tukey's honestly significant difference among bays for spring functional dispersion. Table shows the adjusted p-value for a given comparison (e.g., difference in FDis between Sabine Lake and Galveston Bay). Cells containing p-values significant at the 0.05 significance level are shaded green. Bay abbreviations are as follows, SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

	GB	**MG**	**SA**	**AB**	**CC**	**UL**	**LL**
SL	0.6385	0.9937	<0.0001	0.9678	0.0004	<0.0001	<0.0001
GB		0.9720	0.0259	0.9951	0.1272	<0.0001	<0.0001
MG			0.0006	1	0.0059	<0.0001	<0.0001
SA				0.0018	0.9991	<0.0001	0.5148
AB					0.0145	<0.0001	<0.0001
CC						<0.0001	0.1875
UL							0.0005

Table 28. Tukey's HSD for Fall FDis. Tukey's honestly significant difference among bays for fall functional dispersion. Table shows the adjusted p-value for a given comparison (e.g., difference in FDis between Sabine Lake and Galveston Bay). Cells containing p-values significant at the 0.05 significance level are shaded green. Bay abbreviations are as follows, SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

	GB	**MG**	**SA**	**AB**	**CC**	**UL**	**LL**
SL	0.0032	0.0142	<0.0001	0.0003	<0.0001	<0.0001	<0.0001
GB		0.9999	0.0060	0.9989	<0.0001	<0.0001	<0.0001
MG			0.0012	0.9698	<0.0001	<0.0001	<0.0001
SA				0.0421	0.1320	<0.0001	<0.0001
AB					<0.0001	<0.0001	<0.0001
CC						<0.0001	0.1050
UL							<0.0001

Trait ANOVA results and Tukey's Honestly Significant Difference for decade and season.

Trophic Level

Table 29. ANOVA results for Trophic level. Standard ANOVA table for the model of Trophic level ~ Decade and Season, showing degrees of freedom, sum of squares, mean squared error, F-statistic, and P-value for the given factor.

	Degrees of Freedom	*Sum of Squares*	*Mean Squared Error*	*F – value*	*Pr(>F)*
Decade	3	0.587	0.1957	14.87	2.4×10^{-9}
Season	1	1.025	1.0246	77.84	$< 2.0 \times 10^{-16}$
Residuals	595	7.832	7.832		

Table 30. Tukey's HSD for Trophic level – Decade. Tukey's honestly significant difference among decades for Trophic level. Table shows the adjusted p-value for a given comparison (e.g., difference between 1980s and 1990s). Cells containing p-values significant at the 0.05 significance level are shaded green.

	1990s	**2000s**	**2010s**
1980s	0.9257	0.4616	<0.0001
1990s		0.8002	<0.0001
2000s			0.0001

For season, there was only a single comparison, spring – fall. The Tukey's HSD adjusted p-value for season was $<2 \times 10^{-16}$.

Maximum Temperature

Table 31. ANOVA results for Maximum Temperature. Standard ANOVA table for the model of Maximum Temperature ~ Decade and Season, showing degrees of freedom, sum of squares, mean squared error, F-statistic, and P-value for the given factor.

	Degrees of Freedom	*Sum of Squares*	*Mean Squared Error*	*F – value*	*Pr(>F)*
Decade	3	0.874	0.2914	23.31	2.82×10^{-14}
Season	1	0.399	0.3991	31.92	2.49×10^{-8}
Residuals	595	7.439	0.0125		

Table 32. Tukey's HSD for Maximum temperature – Decade. Tukey's honestly significant difference among decades for maximum temperature. Table shows the adjusted p-value for a given comparison (e.g., difference between 1980s and 1990s). Cells containing p-values significant at the 0.05 significance level are shaded green.

	1990s	**2000s**	**2010s**
1980s	0.9775	0.0321	<0.0001
1990s		0.0578	<0.0001
2000s			<0.0001

For season, there was only a single comparison, spring – fall. The Tukey's HSD adjusted p-value for season was $<2x10^{-16}$.

Piscivore

Table 33. ANOVA results for Piscivore. Standard ANOVA table for the model of Piscivore ~ Decade and Season, showing degrees of freedom, sum of squares, mean squared error, F-statistic, and P-value for the given factor.

	Degrees of Freedom	*Sum of Squares*	*Mean Squared Error*	*F – value*	*Pr(>F)*
Decade	3	0.304	0.1013	13.32	$2.0x10^{-8}$
Season	1	1.992	1.9921	261.88	$< 2x10^{-16}$
Residuals	595	4.526	0.0076		

Table 34. Tukey's HSD for Piscivore – Decade. Tukey's honestly significant difference among decades for Piscivore. Table shows the adjusted p-value for a given comparison (e.g., difference between 1980s and 1990s). Cells containing p-values significant at the 0.05 significance level are shaded green.

	1990s	**2000s**	**2010s**
1980s	0.1659	0.1647	<0.0001
1990s		1	0.0001
2000s			0.0002

For season, there was only a single comparison, spring – fall. The Tukey's HSD adjusted p-value for season was $<2x10^{-16}$.

Age at maturity

Table 35. ANOVA results for Age at maturity. Standard ANOVA table for the model of Age at maturity ~ Decade and Season, showing degrees of freedom, sum of squares, mean squared error, F-statistic, and P-value for the given factor.

	Degrees of Freedom	*Sum of Squares*	*Mean Squared Error*	*F – value*	*Pr(>F)*
Decade	3	1.07	0.36	7.075	0.0001
Season	1	36.18	36.18	717.707	$< 2.0 \times 10^{-16}$
Residuals	595	29.99	0.05		

Table 36. Tukey's HSD for Age at maturity – Decade. Tukey's honestly significant difference among decades for Age at maturity. Table shows the adjusted p-value for a given comparison (e.g., difference between 1980s and 1990s). Cells containing p-values significant at the 0.05 significance level are shaded green.

	1990s	**2000s**	**2010s**
1980s	0.5570	0.2094	0.1884
1990s		0.9013	0.0021
2000s			0.0001

For season, there was only a single comparison, spring – fall. The Tukey's HSD adjusted p-value for season was $<2 \times 10^{-16}$.

Natural mortality

Table 37. ANOVA results for Natural mortality. Standard ANOVA table for the model of Natural mortality ~ Decade and Season, showing degrees of freedom, sum of squares, mean squared error, F-statistic, and P-value for the given factor.

	Degrees of Freedom	*Sum of Squares*	*Mean Squared Error*	*F – value*	*Pr(>F)*
Decade	3	0.0350	0.0117	8.561	1.43×10^{-5}
Season	1	0.7662	0.7662	562.561	$< 2.0 \times 10^{-16}$
Residuals	595	0.8104	0.0014		

Table 38. Tukey's HSD for Natural mortality – Decade. Tukey's honestly significant difference among decades for Natural mortality. Table shows the adjusted p-value for a given comparison (e.g., difference between 1980s and 1990s). Cells containing p-values significant at the 0.05 significance level are shaded green.

	1990s	**2000s**	**2010s**
1980s	0.1256	0.7883	<0.0001
1990s		0.5213	0.0452
2000s			0.0004

For season, there was only a single comparison, spring – fall. The Tukey's HSD adjusted p-value for season was $<2x10^{-16}$.

Maximum age

Table 39. ANOVA results for Maximum age. Standard ANOVA table for the model of Maximum age ~ Decade and Season, showing degrees of freedom, sum of squares, mean squared error, F-statistic, and P-value for the given factor.

	Degrees of Freedom	*Sum of Squares*	*Mean Squared Error*	*F – value*	*Pr(>F)*
Decade	3	454	151.4	9.496	$3.90x10^{-9}$
Season	1	357	357.2	22.396	$2.77x10^{-6}$
Residuals	595	9489	15.9		

Table 40. Tukey's HSD for Maximum age – Decade. Tukey's honestly significant difference among decades for Maximum age. Table shows the adjusted p-value for a given comparison (e.g., difference between 1980s and 1990s). Cells containing p-values significant at the 0.05 significance level are shaded green.

	1990s	**2000s**	**2010s**
1980s	<0.0001	0.0041	<0.0001
1990s		0.4290	0.9991
2000s			0.5142

For season, there was only a single comparison, spring – fall. The Tukey's HSD adjusted p-value for season was $<2.8x10^{-6}$.

Asymptotic length (L_∞)

Table 41. ANOVA results for L_∞. Standard ANOVA table for the model of L infinity ~ Decade and Season, showing degrees of freedom, sum of squares, mean squared error, F-statistic, and P-value for the given factor.

	Degrees of Freedom	*Sum of Squares*	*Mean Squared Error*	*F – value*	*Pr(>F)*
Decade	3	742723	247574	10.97	5.08×10^{-7}
Season	1	310067	310067	13.74	0.0002
Residuals	595	13426370	22565		

Table 42. Tukey's HSD for L_∞ – Decade. Tukey's honestly significant difference among decades for L_∞. Table shows the adjusted p-value for a given comparison (e.g., difference between 1980s and 1990s). Cells containing p-values significant at the 0.05 significance level are shaded green.

	1990s	**2000s**	**2010s**
1980s	<0.0001	0.0002	<0.0001
1990s		0.9645	0.8788
2000s			0.6141

For season, there was only a single comparison, spring – fall. The Tukey's HSD adjusted p-value for season was 0.0002294.

Generation time

Table 43. ANOVA results for Generation time. Standard ANOVA table for the model of Generation time ~ Decade and Season, showing degrees of freedom, sum of squares, mean squared error, F-statistic, and P-value for the given factor.

	Degrees of Freedom	*Sum of Squares*	*Mean Squared Error*	*F – value*	*Pr(>F)*
Decade	3	48.6	16.18	8.38	1.83×10^{-5}
Season	1	38.9	38.85	20.12	8.73×10^{-6}
Residuals	595	1149.0	1.93		

Table 44. Tukey's HSD for Generation time – Decade. Tukey's honestly significant difference among decades for Generation time. Table shows the adjusted p-value for a given comparison (e.g., difference between 1980s and 1990s). Cells containing p-values significant at the 0.05 significance level are shaded green.

	1990s	**2000s**	**2010s**
1980s	0.0003	0.0039	<0.0001
1990s		0.8734	0.9217
2000s			0.5064

For season, there was only a single comparison, spring – fall. The Tukey's HSD adjusted p-value for season was 8.7×10^{-6}.

Parental care

Table 45. ANOVA results for Parental care. Standard ANOVA table for the model of Parental care ~ Decade and Season, showing degrees of freedom, sum of squares, mean squared error, F-statistic, and P-value for the given factor.

	Degrees of Freedom	*Sum of Squares*	*Mean Squared Error*	*F – value*	*Pr(>F)*
Decade	3	4.38	1.46	7.05	0.0001
Season	1	39.49	39.49	190.61	$< 2.0 \times 10^{-16}$
Residuals	595	123.29	0.21		

Table 46. Tukey's HSD for Parental care – Decade. Tukey's honestly significant difference among decades for Parental care. Table shows the adjusted p-value for a given comparison (e.g., difference between 1980s and 1990s). Cells containing p-values significant at the 0.05 significance level are shaded green.

	1990s	**2000s**	**2010s**
1980s	0.0060	0.0082	0.9965
1990s		0.9997	0.0054
2000s			0.0075

For season, there was only a single comparison, spring – fall. The Tukey's HSD adjusted p-value for season was $<2 \times 10^{-16}$.

Table 47. Community weighted means for functional traits, part one. Community weighted trait means for maximum length in mm (Lmax), common length in mm (Lcom), length at maturity (Lmat), age at maturity (Amat), maximum age (Tmax), maximum weight (Wmax), asymptotic length (Linf), von Bertalanffy growth parameter (K), hypothetical age at length 0 (t0), natural mortality rate (M), generation time (GenT), trophic level (TrLvl), and mouth position (MoPos). Season abbreviations are SP: spring, FA: fall. Bay abbreviations are as follows, SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

Season	**Bay**	**Year**	**Lmax**	**Lcom**	**Lmat**	**Amat**	**Tmax**	**Wmax**	**Linf**	**K**	**t0**	**M**	**GenT**	**TrLvl**	**MoPos**
SP	SL	1986	1328.73	789.87	633.06	3.43	24.42	22.38	1032.59	0.23	-0.62	0.36	6.15	3.60	2.93
		1987	1530.92	929.91	709.44	3.32	27.25	34.87	996.86	0.24	-0.59	0.38	6.44	3.69	2.94
		1988	1269.39	749.48	577.93	3.00	25.00	25.43	887.86	0.28	-0.55	0.44	5.49	3.47	2.87
		1989	1320.08	763.83	586.23	2.76	27.54	30.19	891.92	0.30	-0.51	0.47	5.65	3.41	2.77
		1990	1420.26	856.37	625.72	2.95	28.53	30.99	974.24	0.28	-0.52	0.44	5.64	3.55	2.78
		1991	1477.79	871.25	667.32	3.12	28.14	32.65	1041.62	0.26	-0.55	0.40	6.29	3.59	2.77
		1992	1320.60	754.58	552.77	2.78	30.60	34.10	843.91	0.31	-0.53	0.48	5.35	3.43	2.70
		1993	1420.94	783.11	617.77	3.08	29.54	36.63	923.14	0.27	-0.58	0.44	6.39	3.56	2.82
		1994	1242.82	654.42	550.19	2.95	26.60	28.24	885.05	0.28	-0.57	0.45	6.08	3.35	2.83
		1995	1364.51	801.23	582.14	2.80	28.36	31.82	913.80	0.30	-0.51	0.47	5.43	3.47	2.75
		1996	1393.59	830.48	605.97	2.71	28.31	28.52	1008.58	0.30	-0.47	0.46	5.49	3.50	2.71
		1997	1333.05	746.03	585.09	2.85	27.82	29.31	970.76	0.29	-0.52	0.46	5.99	3.47	2.75
		1998	1257.90	698.67	553.54	3.02	26.20	22.11	1016.87	0.27	-0.56	0.43	5.75	3.50	2.86
		1999	1176.58	663.56	531.23	3.05	23.42	20.60	949.95	0.27	-0.58	0.44	5.66	3.44	2.89
		2000	1085.00	608.65	492.80	2.77	20.89	17.71	902.52	0.29	-0.54	0.48	5.38	3.20	2.92
		2001	1212.43	653.05	538.40	3.04	26.50	24.33	958.63	0.28	-0.59	0.44	6.12	3.48	2.85
		2002	1146.34	588.06	501.99	2.89	27.12	25.09	893.13	0.28	-0.58	0.46	5.95	3.31	2.79
		2003	1210.99	669.82	547.85	3.07	25.84	26.74	945.77	0.28	-0.59	0.44	6.15	3.39	2.80
		2004	1243.00	668.75	535.30	2.99	27.89	30.83	980.52	0.29	-0.58	0.46	6.29	3.40	2.73
		2005	1308.88	682.44	589.40	2.86	28.27	28.79	1008.91	0.28	-0.53	0.45	6.71	3.42	2.74
		2006	1116.89	597.99	510.24	2.92	23.86	22.47	860.94	0.29	-0.58	0.46	5.85	3.29	2.87
		2007	1237.87	672.88	525.61	2.88	30.78	28.83	909.47	0.29	-0.57	0.46	5.82	3.44	2.73
		2008	1171.39	620.27	515.22	2.80	27.68	27.32	869.25	0.30	-0.56	0.48	5.97	3.31	2.76
		2009	1358.07	760.15	582.18	2.79	30.99	35.45	939.00	0.29	-0.53	0.47	6.16	3.43	2.67

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		2010	1418.55	816.41	557.44	2.53	36.53	39.48	908.99	0.33	-0.48	0.51	5.31	3.54	2.52
		2011	1262.29	723.85	527.69	2.66	30.16	31.18	854.79	0.32	-0.51	0.50	5.31	3.43	2.67
		2012	1330.62	776.19	550.40	2.66	31.73	34.53	861.34	0.32	-0.51	0.50	5.26	3.46	2.67
		2013	1257.95	681.03	542.95	3.03	29.29	29.99	904.98	0.28	-0.59	0.45	6.04	3.53	2.76
		2014	1427.72	837.64	604.49	2.90	32.62	36.77	930.30	0.30	-0.53	0.46	5.73	3.57	2.68
		2015	1408.99	811.31	610.23	3.05	30.33	34.24	946.17	0.28	-0.57	0.44	6.00	3.64	2.78
		2016	1469.56	852.05	665.51	3.42	29.39	33.11	1043.36	0.24	-0.63	0.38	6.67	3.74	2.85
		2017	1423.52	796.38	658.19	3.22	28.48	34.44	991.62	0.25	-0.60	0.40	6.97	3.57	2.81
		2018	1462.22	815.03	644.53	3.10	32.14	39.02	990.36	0.27	-0.58	0.42	6.82	3.55	2.71
		2019	1547.39	879.34	693.88	3.19	32.62	39.42	1063.41	0.25	-0.57	0.39	7.12	3.66	2.71
SP	GB	1982	895.55	421.11	416.91	3.29	24.39	14.36	757.78	0.25	-0.69	0.41	5.40	3.21	2.91
		1983	890.51	402.12	415.37	3.27	24.02	14.21	769.82	0.24	-0.69	0.41	5.62	3.19	2.91
		1984	967.36	456.75	429.52	3.11	25.80	18.35	791.43	0.26	-0.65	0.43	5.49	3.23	2.86
		1985	876.85	405.58	410.97	3.36	23.20	14.03	732.72	0.23	-0.72	0.41	5.50	3.17	3.01
		1986	875.99	430.82	389.37	3.06	23.62	14.24	708.46	0.26	-0.66	0.45	4.96	3.16	2.95
		1987	808.40	359.48	387.42	3.49	22.17	10.82	718.42	0.22	-0.75	0.39	5.46	3.15	3.06
		1988	897.96	397.52	425.70	3.61	25.24	14.36	785.87	0.22	-0.75	0.37	5.77	3.28	2.95
		1989	830.52	369.54	396.25	3.47	22.57	11.98	732.88	0.21	-0.76	0.38	5.57	3.12	3.08
		1990	792.12	356.93	388.29	3.59	22.04	10.51	713.62	0.20	-0.78	0.37	5.59	3.11	3.10
		1991	905.64	396.48	443.15	3.65	23.76	15.72	770.71	0.21	-0.76	0.37	6.08	3.23	2.98
		1992	976.36	467.61	439.57	3.42	25.79	19.75	781.95	0.23	-0.72	0.40	5.64	3.26	2.95
		1993	873.42	422.02	403.20	3.40	23.72	14.93	705.38	0.22	-0.74	0.40	5.30	3.16	3.04
		1994	914.48	403.24	433.89	3.78	23.73	16.32	775.53	0.20	-0.79	0.36	6.02	3.25	3.03
		1995	910.47	411.28	425.68	3.71	24.22	16.32	768.08	0.22	-0.77	0.37	5.77	3.26	2.97
		1996	959.23	478.00	415.46	3.09	25.54	18.07	767.66	0.27	-0.64	0.45	5.12	3.26	2.84
		1997	1074.55	537.05	453.74	3.23	27.88	22.30	846.91	0.26	-0.66	0.43	5.55	3.41	2.84
		1998	946.73	468.87	412.04	3.31	23.80	17.32	763.11	0.25	-0.70	0.43	5.30	3.29	2.96
		1999	956.30	465.38	420.10	3.24	24.46	16.83	787.71	0.26	-0.67	0.43	5.44	3.29	2.92
		2000	907.46	419.88	420.88	3.35	23.47	14.73	790.76	0.24	-0.70	0.42	5.78	3.31	2.92

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		1992	1137.16	605.39	487.06	3.12	28.18	26.04	816.95	0.28	-0.62	0.45	5.37	3.33	2.80
		1993	1048.87	522.17	472.73	3.54	25.77	22.01	814.19	0.24	-0.72	0.39	5.79	3.32	2.90
		1994	1022.13	506.25	459.03	3.34	23.70	21.53	810.20	0.26	-0.68	0.43	5.81	3.23	2.92
		1995	1041.76	503.07	449.56	3.11	24.42	21.73	818.97	0.28	-0.64	0.45	5.75	3.15	2.88
		1996	942.85	454.16	421.78	3.14	25.03	16.71	785.73	0.27	-0.65	0.44	5.31	3.21	2.86
		1997	1083.09	489.66	472.17	3.24	25.18	21.47	877.13	0.26	-0.66	0.42	6.25	3.28	2.91
		1998	1052.38	522.58	447.94	3.32	25.76	23.13	848.02	0.27	-0.67	0.43	5.69	3.31	2.86
		1999	933.28	447.60	429.39	3.32	22.84	17.28	812.42	0.26	-0.68	0.43	5.76	3.22	2.94
		2000	1055.04	509.76	470.27	3.44	23.93	22.96	901.99	0.25	-0.69	0.42	6.20	3.34	2.86
		2001	959.89	453.53	443.87	3.44	24.51	17.66	838.16	0.24	-0.70	0.40	6.06	3.26	2.91
		2002	1000.71	465.05	463.92	3.55	25.74	20.70	880.03	0.23	-0.72	0.39	6.42	3.30	2.85
		2003	1088.98	530.34	484.08	3.43	27.32	24.03	919.02	0.24	-0.69	0.40	6.42	3.39	2.84
		2004	1118.00	545.10	483.11	3.35	26.48	23.57	898.94	0.25	-0.67	0.41	6.03	3.38	2.87
		2005	1048.94	519.95	469.49	3.46	25.27	21.15	877.72	0.23	-0.71	0.39	6.08	3.33	2.91
		2006	1024.85	527.43	465.10	3.46	23.09	21.60	856.25	0.25	-0.70	0.42	5.98	3.32	2.95
		2007	1083.75	557.01	479.73	3.36	25.21	24.23	848.38	0.26	-0.68	0.42	6.06	3.31	2.91
		2008	1067.80	528.38	488.43	3.28	26.34	22.94	899.03	0.25	-0.66	0.42	6.33	3.38	2.82
		2009	906.14	478.19	425.89	3.26	22.91	16.20	787.85	0.26	-0.68	0.43	5.66	3.23	2.89
		2010	1037.77	520.67	488.52	3.66	24.86	20.05	913.87	0.21	-0.74	0.37	6.49	3.44	2.90
		2011	966.68	519.27	451.86	3.69	23.97	18.07	850.83	0.22	-0.76	0.38	6.06	3.40	2.95
		2012	1042.89	513.22	486.82	3.54	27.15	20.84	904.44	0.22	-0.72	0.37	6.57	3.41	2.83
		2013	1044.31	527.63	484.97	3.51	27.44	21.50	911.51	0.23	-0.71	0.38	6.54	3.42	2.78
		2014	1019.92	530.16	478.32	3.60	25.85	20.00	908.59	0.22	-0.73	0.37	6.31	3.47	2.83
		2015	1172.29	616.50	502.48	3.21	29.41	28.66	889.91	0.26	-0.64	0.43	6.00	3.45	2.76
		2016	979.18	502.46	461.94	3.46	23.41	19.23	839.87	0.24	-0.70	0.41	6.14	3.30	2.94
		2017	1122.29	584.34	517.16	3.34	26.07	25.20	895.48	0.25	-0.67	0.41	6.38	3.40	2.85
		2018	1189.52	638.69	544.39	3.58	27.80	30.78	899.63	0.23	-0.72	0.39	6.70	3.46	2.85
		2019	1193.81	662.42	543.76	3.31	26.95	30.43	841.27	0.26	-0.66	0.42	6.20	3.37	2.86
SP	SA	1982	994.84	480.87	471.54	3.75	25.22	19.68	840.12	0.21	-0.77	0.36	6.56	3.37	2.98

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		1983	969.93	495.71	447.87	3.57	25.19	17.29	821.37	0.22	-0.74	0.38	6.01	3.38	2.92
		1984	900.09	466.82	434.89	3.75	22.52	15.30	782.46	0.21	-0.78	0.37	5.80	3.30	3.00
		1985	1020.42	499.23	472.96	4.02	24.40	21.82	803.28	0.18	-0.84	0.33	6.25	3.39	3.06
		1986	1007.58	506.82	442.12	3.62	27.68	19.29	795.19	0.22	-0.75	0.38	5.57	3.43	2.93
		1987	1113.28	558.85	463.92	3.28	28.92	23.70	866.49	0.26	-0.66	0.42	5.56	3.41	2.84
		1988	1262.17	659.54	535.82	3.30	31.87	32.60	852.13	0.26	-0.66	0.41	5.96	3.47	2.79
		1989	1075.80	526.11	495.60	3.67	27.47	23.37	801.76	0.22	-0.75	0.37	6.05	3.38	2.93
		1990	975.04	449.35	462.59	3.87	24.90	18.37	813.13	0.20	-0.79	0.35	6.15	3.35	2.96
		1991	1018.46	446.95	474.46	3.87	25.05	19.20	859.90	0.19	-0.79	0.34	6.40	3.40	2.99
		1992	1251.39	635.31	541.82	3.36	32.67	32.16	926.21	0.25	-0.66	0.40	6.53	3.46	2.70
		1993	1237.70	583.61	552.36	3.37	32.35	30.95	973.13	0.24	-0.67	0.38	7.24	3.42	2.67
		1994	1056.64	515.37	476.27	3.35	28.12	22.06	865.28	0.25	-0.68	0.41	6.24	3.32	2.79
		1995	1016.28	480.07	445.77	3.62	26.17	20.38	829.52	0.24	-0.74	0.39	5.95	3.31	2.89
		1996	1062.19	495.16	455.79	3.25	28.07	20.90	853.40	0.26	-0.66	0.43	5.78	3.37	2.82
		1997	1101.67	483.28	508.40	3.73	28.94	24.69	970.40	0.21	-0.75	0.35	7.36	3.42	2.80
		1998	1064.31	463.50	478.14	3.54	27.51	20.35	913.69	0.22	-0.72	0.38	6.72	3.46	2.90
		1999	1119.44	479.88	476.24	3.49	25.37	24.04	892.79	0.25	-0.70	0.41	6.62	3.28	2.88
		2000	1049.84	465.01	474.69	3.49	25.01	21.34	899.53	0.24	-0.71	0.41	6.66	3.34	2.91
		2001	1227.81	475.43	554.87	3.52	28.99	28.42	1076.72	0.22	-0.70	0.37	8.38	3.37	2.73
		2002	1092.82	459.95	498.66	3.54	28.33	21.94	955.53	0.22	-0.71	0.37	7.16	3.40	2.82
		2003	1093.07	490.16	491.27	3.48	27.97	22.35	918.49	0.23	-0.71	0.38	6.74	3.40	2.87
		2004	1141.61	503.94	520.54	3.34	29.55	25.20	969.91	0.23	-0.67	0.39	7.23	3.39	2.75
		2005	1106.73	498.20	497.64	3.42	28.01	23.38	912.28	0.24	-0.69	0.39	6.69	3.38	2.84
		2006	1060.20	524.29	461.13	3.19	25.02	21.29	828.28	0.27	-0.64	0.44	5.51	3.29	2.88
		2007	1088.25	529.72	477.36	3.40	28.62	23.07	879.66	0.24	-0.69	0.40	6.16	3.40	2.78
		2008	1061.60	507.15	484.12	3.51	27.82	21.81	905.99	0.23	-0.71	0.38	6.38	3.42	2.81
		2009	1159.72	548.48	512.00	3.28	28.82	26.99	966.41	0.25	-0.65	0.41	6.65	3.42	2.72
		2010	1144.24	520.13	516.73	3.48	29.00	24.54	973.19	0.22	-0.70	0.37	7.01	3.47	2.76
		2011	1039.90	492.67	487.00	3.51	25.59	18.61	917.70	0.22	-0.71	0.38	6.52	3.44	2.89

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		2012	1097.31	518.59	492.28	3.39	27.74	21.75	911.22	0.24	-0.68	0.40	6.41	3.47	2.86
		2013	1070.43	533.90	490.31	3.56	25.86	17.68	927.65	0.22	-0.71	0.37	6.22	3.52	2.91
		2014	1104.83	543.26	490.10	3.31	26.68	21.11	925.18	0.24	-0.66	0.40	6.20	3.47	2.84
		2015	1009.30	519.33	456.00	3.63	26.77	17.64	861.60	0.22	-0.74	0.37	5.93	3.50	2.91
		2016	1016.58	520.26	456.58	3.70	25.06	17.02	827.57	0.22	-0.75	0.37	5.64	3.54	2.98
		2017	1175.10	576.54	522.99	3.53	26.77	27.70	891.13	0.23	-0.71	0.39	6.64	3.42	2.89
		2018	1168.45	546.88	518.53	3.75	28.59	28.49	943.19	0.21	-0.75	0.35	6.94	3.45	2.80
		2019	1136.80	544.16	512.05	3.43	27.78	24.04	942.77	0.23	-0.69	0.39	6.57	3.46	2.81
SP	AB	1982	1154.82	564.15	540.58	3.47	27.54	27.55	920.54	0.23	-0.70	0.38	7.24	3.38	2.88
		1983	1114.02	523.56	513.24	3.30	27.61	24.93	934.12	0.24	-0.67	0.41	7.11	3.34	2.82
		1984	1000.30	538.83	455.06	3.33	23.77	20.63	722.25	0.25	-0.70	0.42	5.44	3.22	3.00
		1985	1167.35	635.97	522.46	3.26	26.10	28.39	754.71	0.25	-0.68	0.42	5.98	3.27	3.05
		1986	1128.94	583.59	494.03	3.21	28.13	25.80	826.14	0.26	-0.66	0.43	6.01	3.36	2.91
		1987	1176.86	576.86	502.74	2.99	29.20	26.23	872.23	0.28	-0.59	0.45	6.06	3.36	2.81
		1988	1165.03	579.88	512.99	3.26	28.87	26.45	852.46	0.25	-0.66	0.42	6.23	3.44	2.89
		1989	1087.40	517.17	478.62	3.11	27.72	22.88	852.00	0.27	-0.63	0.44	5.96	3.32	2.84
		1990	1043.00	484.15	488.36	3.51	27.27	21.18	846.12	0.23	-0.71	0.38	6.46	3.33	2.87
		1991	1033.41	445.45	483.65	3.48	26.59	19.12	887.26	0.22	-0.71	0.38	6.77	3.33	2.91
		1992	1183.42	595.33	509.17	3.20	30.79	27.93	857.86	0.26	-0.64	0.42	5.93	3.37	2.77
		1993	1266.47	607.71	556.74	2.99	31.44	31.35	949.43	0.27	-0.58	0.43	6.90	3.35	2.68
		1994	1136.70	556.20	501.35	3.05	28.17	24.42	878.91	0.28	-0.60	0.44	6.05	3.33	2.81
		1995	1037.73	490.92	463.13	2.90	25.89	21.16	821.26	0.29	-0.58	0.47	5.82	3.18	2.82
		1996	1112.39	551.31	466.59	2.89	29.98	24.01	859.99	0.29	-0.58	0.47	5.53	3.34	2.73
		1997	1159.57	530.88	508.39	3.13	30.61	25.16	945.41	0.25	-0.63	0.42	6.64	3.39	2.72
		1998	1134.02	504.02	500.80	3.28	30.46	23.82	937.90	0.24	-0.66	0.40	6.66	3.43	2.78
		1999	1153.66	523.65	505.97	3.03	28.37	24.54	937.54	0.27	-0.60	0.44	6.61	3.36	2.80
		2000	1091.97	496.99	478.72	2.98	27.17	22.44	900.43	0.28	-0.60	0.46	6.27	3.31	2.82
		2001	1198.10	496.39	536.83	3.08	30.28	26.71	1028.96	0.25	-0.61	0.42	7.62	3.38	2.73
		2002	1057.18	476.31	469.57	3.12	27.29	20.72	893.60	0.26	-0.63	0.43	6.24	3.34	2.82

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		2003	1105.92	485.16	490.61	3.13	28.41	22.52	925.89	0.25	-0.63	0.43	6.60	3.37	2.81
		2004	1230.44	582.86	542.66	3.16	30.24	28.83	976.20	0.26	-0.62	0.42	6.87	3.45	2.75
		2005	1238.49	584.63	553.42	3.03	29.86	29.90	955.13	0.27	-0.59	0.43	6.93	3.37	2.72
		2006	1144.04	569.03	511.93	3.00	27.33	26.66	873.16	0.28	-0.60	0.45	6.17	3.29	2.80
		2007	1155.08	567.20	510.73	3.26	29.28	25.57	895.34	0.25	-0.65	0.41	6.15	3.44	2.82
		2008	1113.50	532.52	509.11	3.16	27.41	24.87	913.89	0.26	-0.63	0.42	6.55	3.32	2.80
		2009	1148.87	513.45	520.64	3.04	30.77	25.82	988.11	0.26	-0.60	0.42	7.01	3.34	2.62
		2010	1376.17	578.19	633.59	3.22	33.85	36.31	1132.20	0.23	-0.62	0.38	8.90	3.45	2.58
		2011	1114.22	538.88	508.64	3.32	27.53	24.30	906.86	0.24	-0.67	0.41	6.55	3.41	2.86
		2012	1117.22	540.36	503.16	3.16	29.00	24.42	904.83	0.26	-0.63	0.42	6.40	3.38	2.75
		2013	1011.62	467.80	481.58	3.47	27.10	19.18	902.88	0.22	-0.70	0.38	6.59	3.37	2.82
		2014	1064.41	515.08	502.61	3.49	27.17	21.25	935.95	0.22	-0.71	0.37	6.88	3.44	2.85
		2015	1067.93	514.56	499.44	3.44	27.75	21.83	923.38	0.22	-0.70	0.38	6.83	3.39	2.83
		2016	1079.08	582.00	484.57	3.15	25.24	24.13	779.20	0.28	-0.64	0.45	5.57	3.31	2.92
		2017	1257.74	661.74	574.28	3.13	28.59	33.59	875.56	0.26	-0.62	0.43	6.76	3.37	2.82
		2018	1267.76	665.60	576.51	3.37	29.47	33.58	904.36	0.25	-0.67	0.40	6.85	3.48	2.84
		2019	1196.51	598.47	548.19	3.28	28.55	28.97	916.41	0.25	-0.65	0.41	6.92	3.40	2.82
SP	CC	1982	1022.21	483.98	450.88	3.21	24.42	19.07	796.30	0.26	-0.65	0.45	5.61	3.48	2.94
		1983	982.56	426.37	450.41	3.06	24.19	17.94	828.81	0.27	-0.62	0.45	6.07	3.31	2.85
		1984	972.53	479.99	424.16	2.81	25.28	17.33	798.67	0.29	-0.57	0.48	4.98	3.24	2.80
		1985	857.41	398.27	391.02	3.31	22.85	12.58	719.93	0.23	-0.71	0.41	5.11	3.18	3.04
		1986	924.24	428.53	415.10	3.17	23.48	14.60	780.51	0.25	-0.67	0.44	5.50	3.33	2.96
		1987	1052.44	475.21	462.85	3.46	27.20	18.68	879.78	0.23	-0.71	0.39	6.15	3.50	2.98
		1988	936.34	400.95	438.92	3.37	24.89	15.01	830.89	0.24	-0.69	0.40	6.01	3.29	2.91
		1989	941.13	421.49	426.12	3.24	24.07	14.70	803.37	0.26	-0.66	0.43	5.48	3.34	2.95
		1990	968.83	451.06	428.16	3.24	25.70	16.33	805.51	0.26	-0.66	0.43	5.47	3.34	2.91
		1991	945.38	461.25	416.65	3.12	24.59	15.04	782.24	0.27	-0.64	0.45	5.12	3.32	2.94
		1992	1136.65	488.01	504.14	3.24	29.39	23.53	963.70	0.24	-0.65	0.41	6.91	3.46	2.79
		1993	1176.43	469.31	546.07	3.13	30.57	26.15	1057.87	0.24	-0.62	0.40	7.91	3.37	2.65

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		1994	1088.89	429.43	518.09	3.30	27.98	22.18	995.39	0.23	-0.66	0.39	7.60	3.35	2.76
		1995	944.31	411.39	429.29	3.02	23.57	15.66	812.19	0.28	-0.61	0.46	5.68	3.26	2.88
		1996	1095.09	497.12	478.04	2.97	29.22	23.10	916.19	0.28	-0.59	0.45	6.25	3.36	2.70
		1997	1082.55	493.70	476.52	3.32	29.04	21.29	909.53	0.24	-0.67	0.40	6.28	3.46	2.83
		1998	1080.81	470.90	480.41	3.32	29.35	21.57	918.70	0.24	-0.67	0.41	6.42	3.48	2.75
		1999	1066.87	471.82	473.64	3.25	27.02	19.90	904.41	0.25	-0.66	0.43	6.28	3.50	2.85
		2000	1180.25	524.27	518.89	3.16	30.24	26.60	1001.11	0.26	-0.63	0.42	6.92	3.51	2.71
		2001	1165.07	553.45	497.10	3.08	30.51	25.72	955.05	0.26	-0.62	0.44	6.22	3.50	2.72
		2002	1168.30	472.00	532.22	3.22	29.60	25.11	1031.77	0.23	-0.64	0.40	7.64	3.52	2.72
		2003	1099.34	524.98	459.35	2.95	27.99	21.31	871.40	0.28	-0.60	0.47	5.45	3.52	2.82
		2004	1098.75	557.59	468.01	3.10	27.23	22.27	844.59	0.27	-0.62	0.45	5.26	3.49	2.87
		2005	1071.45	545.81	454.54	3.02	26.42	21.74	818.61	0.28	-0.61	0.46	5.06	3.42	2.86
		2006	1019.06	480.55	467.22	3.08	22.92	18.50	857.03	0.26	-0.62	0.45	5.77	3.41	2.94
		2007	994.93	458.94	450.78	3.19	25.82	17.58	849.43	0.26	-0.65	0.43	5.77	3.36	2.86
		2008	1008.25	459.20	463.42	3.12	25.27	18.98	880.23	0.25	-0.64	0.43	6.11	3.36	2.85
		2009	1006.79	483.61	456.09	3.01	24.82	18.65	864.53	0.27	-0.61	0.46	5.72	3.38	2.83
		2010	1053.09	486.48	473.25	3.02	25.92	21.11	895.23	0.26	-0.63	0.44	6.34	3.29	2.87
		2011	1055.82	478.43	481.66	3.20	26.20	19.66	919.82	0.24	-0.65	0.41	6.28	3.43	2.84
		2012	1098.58	513.32	498.55	3.24	27.27	21.60	945.55	0.24	-0.64	0.41	6.24	3.49	2.80
		2013	993.18	456.03	470.05	3.34	23.35	16.44	896.67	0.23	-0.68	0.40	6.21	3.42	2.91
		2014	1057.14	480.29	488.88	3.31	25.81	20.07	937.48	0.23	-0.67	0.40	6.56	3.42	2.86
		2015	1017.02	476.85	466.27	3.25	24.92	18.55	888.35	0.25	-0.66	0.42	6.02	3.39	2.89
		2016	958.72	441.89	448.19	3.55	24.11	15.05	848.21	0.22	-0.73	0.39	6.01	3.43	2.98
		2017	920.05	435.16	433.41	3.32	23.33	14.28	812.05	0.24	-0.69	0.41	5.64	3.33	2.92
		2018	1007.02	480.31	467.83	3.51	23.94	17.51	872.86	0.22	-0.72	0.39	6.07	3.48	3.02
		2019	1106.79	524.27	494.54	3.37	27.18	21.14	928.28	0.23	-0.68	0.40	6.21	3.55	2.89
SP	UL	1982	902.88	385.88	411.65	3.03	20.91	14.81	777.95	0.26	-0.64	0.47	5.72	3.35	2.90
		1983	984.07	380.71	463.40	3.39	25.04	16.88	885.03	0.22	-0.69	0.40	6.77	3.36	2.85
		1984	1002.22	427.71	443.14	3.07	26.46	17.55	841.85	0.26	-0.62	0.43	5.96	3.16	2.73

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		1985	1001.48	418.53	468.40	3.10	25.91	18.94	896.33	0.25	-0.62	0.43	6.45	3.34	2.68
		1986	1058.63	433.44	487.89	3.21	26.46	20.64	937.39	0.24	-0.64	0.42	6.85	3.47	2.71
		1987	1249.05	493.46	566.36	3.11	32.15	28.91	1103.54	0.24	-0.61	0.40	8.23	3.43	2.61
		1988	1095.41	471.79	490.19	3.20	29.22	22.23	940.43	0.24	-0.64	0.41	6.62	3.42	2.70
		1989	1234.38	478.03	568.09	3.25	31.82	27.87	1107.91	0.23	-0.64	0.38	8.32	3.44	2.61
		1990	1235.61	458.16	573.82	3.10	31.06	27.79	1121.14	0.23	-0.60	0.38	8.62	3.29	2.57
		1991	1369.29	481.41	652.18	3.05	33.81	34.53	1290.98	0.22	-0.58	0.37	10.20	3.42	2.49
		1992	1380.70	515.31	636.82	2.97	34.94	35.24	1256.37	0.24	-0.57	0.39	9.64	3.43	2.40
		1993	1356.89	513.05	622.04	2.94	34.51	33.97	1224.25	0.24	-0.56	0.40	9.33	3.42	2.46
		1994	1380.42	498.08	647.02	2.99	34.88	35.24	1279.47	0.24	-0.57	0.38	10.01	3.41	2.44
		1995	1342.78	460.85	644.09	3.11	34.27	33.80	1274.32	0.22	-0.60	0.36	10.27	3.36	2.46
		1996	1380.97	491.58	650.19	3.06	35.25	35.24	1286.40	0.23	-0.58	0.37	10.13	3.40	2.41
		1997	1344.70	469.67	627.27	3.13	33.44	32.61	1237.71	0.22	-0.60	0.37	9.89	3.37	2.52
		1998	1399.80	505.98	648.57	2.98	35.91	36.15	1283.30	0.24	-0.57	0.38	10.05	3.42	2.40
		1999	1358.32	476.13	640.70	3.04	34.16	34.24	1267.08	0.23	-0.58	0.38	10.10	3.41	2.46
		2000	1260.11	469.79	582.21	2.96	31.24	29.42	1141.61	0.25	-0.58	0.41	8.81	3.32	2.56
		2001	1372.54	493.89	640.90	3.05	34.90	34.76	1266.64	0.23	-0.58	0.38	9.96	3.42	2.47
		2002	1400.01	494.60	660.23	3.06	35.30	36.11	1308.15	0.23	-0.58	0.37	10.33	3.44	2.41
		2003	1373.90	474.73	651.02	2.99	34.12	35.01	1289.91	0.23	-0.57	0.38	10.35	3.36	2.43
		2004	1357.27	479.85	644.72	3.04	34.23	34.74	1274.38	0.23	-0.58	0.38	10.11	3.42	2.42
		2005	1368.10	493.89	643.71	3.05	34.91	34.76	1272.27	0.23	-0.58	0.38	9.92	3.43	2.44
		2006	1316.87	498.32	603.56	3.03	32.96	31.39	1185.54	0.24	-0.59	0.39	8.99	3.40	2.53
		2007	1364.36	485.22	640.04	3.04	34.07	34.18	1265.18	0.23	-0.58	0.38	9.97	3.39	2.45
		2008	1241.80	466.43	588.74	3.02	30.69	29.27	1154.83	0.24	-0.59	0.40	8.80	3.38	2.54
		2009	1289.58	476.77	612.29	2.97	32.19	31.23	1205.25	0.24	-0.57	0.40	9.23	3.36	2.49
		2010	1407.93	490.34	669.00	3.04	35.17	36.16	1327.05	0.22	-0.58	0.36	10.52	3.40	2.40
		2011	1266.10	464.00	595.15	3.01	31.14	29.99	1168.21	0.24	-0.59	0.40	9.11	3.36	2.58
		2012	1271.39	471.30	596.89	3.02	30.82	29.64	1172.22	0.24	-0.58	0.40	8.94	3.40	2.56
		2013	1379.00	495.27	648.90	3.05	34.89	34.87	1283.23	0.23	-0.58	0.37	10.00	3.45	2.45

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		2014	1393.96	497.85	660.92	3.04	33.45	34.69	1309.06	0.22	-0.58	0.37	10.16	3.46	2.49
		2015	1432.87	503.46	672.07	3.04	35.17	36.79	1333.06	0.22	-0.57	0.37	10.52	3.48	2.45
		2016	1384.54	510.23	645.35	2.95	33.64	34.68	1276.30	0.24	-0.56	0.39	9.79	3.43	2.47
		2017	1452.66	488.12	697.42	2.92	36.61	39.16	1389.81	0.23	-0.55	0.37	11.26	3.37	2.31
		2018	1453.60	498.25	690.47	3.01	36.89	38.80	1373.71	0.22	-0.57	0.36	11.01	3.43	2.34
		2019	1417.09	496.68	667.06	2.87	34.76	37.03	1324.48	0.23	-0.55	0.39	10.52	3.35	2.40
SP	LL	1982	1045.12	441.92	457.77	3.32	25.08	17.79	869.89	0.24	-0.67	0.43	6.14	3.52	2.99
		1983	1071.25	438.36	483.81	3.22	26.66	20.20	924.47	0.24	-0.65	0.42	6.73	3.46	2.82
		1984	1056.41	469.76	457.02	3.27	26.79	18.75	866.98	0.24	-0.66	0.41	5.90	3.36	2.88
		1985	965.00	437.63	425.92	3.33	22.55	15.36	790.82	0.23	-0.72	0.42	5.72	3.37	3.22
		1986	1030.80	471.73	447.09	3.44	25.96	16.99	841.84	0.24	-0.70	0.41	5.60	3.52	3.06
		1987	1047.07	469.87	448.15	3.51	26.60	17.42	847.55	0.23	-0.72	0.40	5.77	3.54	3.09
		1988	1066.09	500.80	452.01	3.47	27.19	19.52	856.21	0.24	-0.70	0.41	5.59	3.53	3.02
		1989	1060.06	479.51	459.58	3.39	27.80	18.97	871.92	0.24	-0.68	0.41	5.77	3.51	2.94
		1990	1104.72	494.26	479.58	3.32	26.32	19.95	915.72	0.24	-0.67	0.41	6.09	3.50	2.95
		1991	1091.31	462.21	488.19	3.53	28.21	20.23	932.44	0.22	-0.71	0.38	6.64	3.54	2.94
		1992	1215.65	501.15	540.75	3.32	31.45	26.42	1038.08	0.23	-0.66	0.39	7.59	3.53	2.77
		1993	1195.57	485.47	540.35	3.40	30.65	25.51	1037.11	0.22	-0.67	0.38	7.64	3.53	2.80
		1994	1264.01	512.03	566.63	3.21	33.05	29.16	1100.04	0.24	-0.63	0.39	8.08	3.50	2.66
		1995	1156.14	457.57	532.22	3.39	30.84	24.60	1028.54	0.22	-0.68	0.37	7.68	3.46	2.74
		1996	1231.22	450.74	580.40	3.44	31.84	27.58	1133.92	0.21	-0.68	0.35	8.84	3.48	2.70
		1997	1170.96	511.82	507.93	3.28	30.24	24.12	975.81	0.24	-0.66	0.41	6.71	3.56	2.83
		1998	1120.10	522.61	471.31	3.12	28.92	21.60	897.76	0.26	-0.63	0.44	5.72	3.52	2.81
		1999	1131.68	496.45	486.45	3.33	28.94	22.18	930.65	0.24	-0.67	0.41	6.40	3.58	2.90
		2000	1127.72	481.97	499.16	3.38	28.99	22.40	958.11	0.23	-0.68	0.40	6.77	3.54	2.86
		2001	1168.78	472.90	532.53	3.41	29.18	23.97	1030.39	0.22	-0.68	0.38	7.58	3.53	2.85
		2002	1072.59	486.21	467.60	3.31	27.42	19.80	889.70	0.24	-0.67	0.41	5.91	3.51	2.93
		2003	1126.94	543.73	467.83	3.08	28.99	22.07	889.75	0.27	-0.62	0.45	5.44	3.56	2.83
		2004	1143.02	571.07	457.11	2.84	29.24	23.23	867.61	0.29	-0.56	0.49	4.96	3.56	2.75

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		2005	1033.70	509.31	432.90	3.06	25.71	17.64	815.76	0.27	-0.62	0.46	4.79	3.50	2.93
		2006	1051.74	472.74	464.71	3.06	27.53	20.70	886.07	0.26	-0.60	0.45	5.82	3.39	2.77
		2007	1068.29	509.76	456.66	3.22	28.02	19.81	856.00	0.26	-0.65	0.43	5.38	3.52	2.88
		2008	1129.75	505.88	495.32	3.21	28.75	22.36	948.62	0.25	-0.64	0.42	6.32	3.52	2.84
		2009	1039.00	458.62	471.58	3.41	26.39	18.14	895.59	0.23	-0.69	0.39	6.04	3.47	2.91
		2010	1054.71	487.38	480.36	3.49	28.42	20.53	851.14	0.23	-0.70	0.38	5.95	3.45	2.86
		2011	1129.77	502.55	494.03	3.33	27.41	21.88	911.88	0.24	-0.67	0.41	6.37	3.55	2.94
		2012	1121.74	463.98	515.83	3.39	28.38	22.49	988.11	0.22	-0.68	0.39	7.12	3.51	2.82
		2013	1021.16	418.38	481.10	3.62	26.32	17.49	910.50	0.21	-0.73	0.36	6.71	3.47	2.95
		2014	1052.97	440.00	483.42	3.44	27.43	19.32	918.95	0.22	-0.69	0.39	6.57	3.46	2.85
		2015	1159.27	492.83	524.93	3.38	29.07	23.70	990.91	0.23	-0.67	0.39	7.10	3.54	2.84
		2016	1144.12	490.76	504.43	3.22	28.65	23.10	968.87	0.25	-0.64	0.42	6.72	3.54	2.81
		2017	1128.36	458.15	522.45	3.31	28.62	23.02	1008.18	0.23	-0.66	0.39	7.37	3.46	2.76
		2018	1109.79	444.68	517.84	3.47	29.06	22.21	999.69	0.22	-0.69	0.37	7.42	3.44	2.80
		2019	1044.45	474.17	458.53	3.28	27.82	18.93	870.72	0.25	-0.66	0.42	5.79	3.44	2.86
FA	SL	1986	1144.68	610.45	496.26	2.52	25.24	28.28	790.20	0.32	-0.50	0.52	5.53	3.32	2.76
		1987	1210.29	677.85	520.33	2.55	26.10	27.70	846.45	0.31	-0.49	0.51	5.30	3.38	2.73
		1988	1007.14	565.25	424.54	2.23	22.84	21.49	684.68	0.35	-0.45	0.58	4.26	3.12	2.75
		1989	1237.05	641.12	543.15	2.50	27.66	31.06	882.32	0.31	-0.49	0.51	6.18	3.27	2.67
		1990	1133.59	604.88	496.50	2.56	25.26	26.70	783.32	0.32	-0.50	0.51	5.38	3.28	2.72
		1991	1267.74	726.25	498.02	2.34	30.35	34.30	776.40	0.34	-0.47	0.54	4.80	3.31	2.69
		1992	1203.81	650.86	515.30	2.27	27.14	31.30	781.71	0.36	-0.43	0.56	5.36	3.20	2.64
		1993	1052.36	551.50	427.88	2.36	21.80	20.95	710.86	0.31	-0.50	0.53	4.77	3.04	2.89
		1994	1080.03	558.05	446.38	2.29	25.05	25.11	788.72	0.35	-0.46	0.56	5.04	3.15	2.66
		1995	1197.99	576.06	517.00	2.51	27.74	28.46	919.93	0.31	-0.49	0.50	6.36	3.24	2.61
		1996	1117.09	585.78	460.78	2.14	26.17	24.53	818.22	0.36	-0.42	0.57	4.99	3.17	2.65
		1997	1243.35	599.66	533.50	2.39	29.64	29.94	971.41	0.32	-0.46	0.52	6.56	3.34	2.50
		1998	1319.18	713.79	588.39	2.76	27.80	26.27	1057.17	0.29	-0.50	0.45	6.33	3.46	2.67
		1999	1055.82	517.74	454.53	2.33	24.26	23.04	824.22	0.34	-0.47	0.55	5.55	3.20	2.67

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		2000	1139.19	530.31	505.53	2.43	25.94	26.68	913.53	0.32	-0.48	0.52	6.55	3.26	2.59
		2001	991.69	500.71	422.37	2.40	23.00	20.64	761.26	0.29	-0.55	0.52	5.39	3.05	2.92
		2002	1137.07	592.85	472.36	2.48	27.03	24.94	839.11	0.32	-0.50	0.53	5.29	3.35	2.69
		2003	1090.06	547.70	462.16	2.47	25.69	24.51	835.40	0.31	-0.52	0.52	5.70	3.19	2.73
		2004	1114.20	538.24	481.53	2.56	25.06	25.20	881.30	0.31	-0.51	0.52	6.05	3.29	2.65
		2005	1242.85	653.63	536.49	2.63	28.09	29.98	907.39	0.31	-0.50	0.50	6.00	3.40	2.60
		2006	967.00	472.97	430.25	2.56	21.42	21.42	761.11	0.27	-0.59	0.50	5.87	3.02	2.99
		2007	1013.57	533.56	424.36	2.53	23.16	22.26	736.14	0.28	-0.58	0.51	5.21	3.06	3.02
		2008	1372.49	761.09	575.30	2.50	31.87	36.31	895.49	0.31	-0.48	0.49	5.96	3.37	2.67
		2009	1031.73	534.85	436.21	2.47	24.10	22.68	767.09	0.30	-0.54	0.52	5.30	3.15	2.84
		2010	1265.78	627.91	542.43	2.58	30.35	33.42	929.51	0.30	-0.51	0.49	6.68	3.36	2.60
		2011	1292.68	734.91	560.47	2.52	27.72	37.62	733.79	0.31	-0.50	0.52	5.67	3.35	2.72
		2012	969.84	516.89	419.26	2.38	21.08	21.35	676.73	0.31	-0.52	0.55	4.87	3.11	2.85
		2013	1066.56	544.12	468.77	2.61	23.92	24.94	787.30	0.31	-0.53	0.52	5.63	3.30	2.67
		2014	1119.27	589.26	459.73	2.46	26.65	25.71	797.89	0.32	-0.51	0.53	5.24	3.28	2.69
		2015	1089.27	606.26	442.68	2.47	26.10	25.73	768.46	0.32	-0.52	0.54	4.76	3.30	2.70
		2016	1244.75	666.83	536.77	2.67	28.58	33.23	828.66	0.29	-0.54	0.49	6.04	3.41	2.69
		2017	1457.11	864.21	640.31	2.72	30.40	43.50	792.51	0.30	-0.51	0.48	6.00	3.42	2.75
		2018	1334.17	723.16	582.52	2.89	29.14	38.10	915.10	0.28	-0.57	0.47	6.68	3.35	2.71
		2019	1237.88	719.58	533.08	2.70	27.40	30.81	804.09	0.31	-0.53	0.49	5.39	3.34	2.79
FA	GB	1982	869.25	410.19	388.44	2.80	21.45	14.20	717.72	0.29	-0.60	0.49	4.98	3.18	2.87
		1983	778.41	405.00	334.36	2.59	17.59	11.28	590.82	0.29	-0.61	0.52	4.14	2.91	3.15
		1984	880.02	435.37	376.41	2.74	21.54	14.11	681.31	0.29	-0.60	0.49	4.62	3.08	2.98
		1985	868.30	426.26	375.69	2.63	20.70	15.47	693.19	0.29	-0.59	0.51	4.89	3.10	2.93
		1986	867.65	419.66	375.78	2.65	20.32	15.11	696.01	0.28	-0.61	0.51	4.97	3.06	3.00
		1987	756.87	390.65	324.49	2.45	16.21	10.41	588.34	0.29	-0.59	0.54	4.14	2.98	3.06
		1988	857.97	418.76	369.39	2.69	20.49	13.34	685.66	0.29	-0.59	0.51	4.65	3.17	2.94
		1989	1031.58	435.45	467.90	2.64	24.98	21.63	895.90	0.28	-0.55	0.48	6.68	3.18	2.69
		1990	797.48	392.67	351.89	2.67	17.57	11.58	639.20	0.27	-0.62	0.50	4.63	2.99	3.08

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		1991	832.14	410.37	371.33	2.60	18.92	13.42	656.46	0.29	-0.59	0.51	4.78	2.94	3.08
		1992	850.88	432.57	367.89	2.62	19.73	14.26	647.10	0.29	-0.59	0.52	4.57	3.02	3.01
		1993	836.09	405.22	353.19	2.53	17.76	12.61	638.41	0.29	-0.56	0.54	4.44	3.18	2.84
		1994	942.16	442.88	397.37	2.93	20.48	17.88	721.02	0.29	-0.62	0.49	5.07	3.11	2.93
		1995	751.40	373.65	326.60	2.50	15.63	10.09	597.62	0.28	-0.61	0.53	4.43	2.90	3.18
		1996	762.67	386.51	326.40	2.52	15.61	10.30	595.50	0.29	-0.60	0.53	4.20	2.97	3.18
		1997	840.81	432.18	352.98	2.59	18.70	13.37	649.18	0.29	-0.60	0.52	4.49	3.07	3.06
		1998	848.38	417.47	368.22	2.76	18.36	13.90	678.46	0.28	-0.62	0.51	4.81	3.13	3.09
		1999	827.66	409.55	358.67	2.63	17.94	12.58	666.56	0.28	-0.60	0.51	4.69	3.13	3.05
		2000	866.93	436.39	364.12	2.48	19.70	15.48	676.79	0.30	-0.56	0.55	4.52	3.21	2.80
		2001	814.54	400.97	352.27	2.64	18.72	12.76	651.37	0.27	-0.63	0.51	4.85	2.99	3.11
		2002	861.25	448.07	360.87	2.57	19.92	14.45	656.97	0.28	-0.60	0.52	4.61	3.06	3.06
		2003	739.74	383.72	318.28	2.58	15.64	9.76	571.79	0.28	-0.63	0.52	4.28	2.88	3.23
		2004	756.71	387.65	335.52	2.82	15.43	10.84	608.13	0.26	-0.67	0.50	4.66	2.98	3.21
		2005	786.39	411.21	336.72	2.63	16.76	11.71	613.10	0.28	-0.61	0.52	4.36	3.03	3.10
		2006	857.09	447.08	361.85	2.68	19.73	15.15	666.33	0.29	-0.59	0.53	4.45	3.26	2.84
		2007	811.43	428.64	353.93	2.81	18.30	13.50	645.35	0.27	-0.65	0.50	4.65	3.10	3.07
		2008	893.21	478.12	385.98	2.74	19.65	16.98	660.39	0.28	-0.62	0.50	4.85	3.10	3.09
		2009	906.66	448.27	400.34	2.89	20.81	17.04	728.92	0.28	-0.62	0.49	5.22	3.28	2.86
		2010	806.31	433.26	350.49	2.84	18.30	13.37	637.00	0.27	-0.66	0.49	4.57	3.05	3.12
		2011	902.15	464.38	394.93	2.74	20.82	17.37	722.80	0.29	-0.58	0.51	4.92	3.27	2.81
		2012	788.89	429.84	354.63	2.72	15.76	14.45	650.61	0.30	-0.59	0.55	4.33	3.31	2.77
		2013	878.61	451.88	389.33	2.90	19.22	17.45	723.32	0.28	-0.62	0.51	5.03	3.27	2.81
		2014	871.18	465.03	369.50	2.65	18.86	15.87	680.63	0.30	-0.58	0.53	4.48	3.30	2.87
		2015	842.99	446.85	368.01	2.75	18.94	15.52	667.49	0.28	-0.62	0.52	4.70	3.16	2.95
		2016	1043.96	567.29	461.71	2.77	23.35	25.00	734.40	0.30	-0.56	0.51	5.25	3.37	2.73
		2017	1025.38	577.66	453.84	2.74	22.05	24.73	686.06	0.30	-0.58	0.52	4.98	3.23	2.89
		2018	1068.55	579.35	464.60	3.04	22.32	26.71	762.84	0.28	-0.63	0.49	5.42	3.33	2.87
		2019	926.03	523.46	412.87	2.75	19.88	19.68	677.44	0.31	-0.58	0.52	4.77	3.11	2.92

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
FA	MG	1982	1145.63	582.99	478.42	2.56	25.59	27.73	851.85	0.33	-0.50	0.53	5.60	3.24	2.74
		1983	1121.62	566.77	480.23	2.71	24.23	28.80	847.38	0.32	-0.54	0.53	5.78	3.21	2.77
		1984	940.44	509.06	401.18	2.82	19.92	20.93	712.94	0.31	-0.59	0.52	4.72	3.02	2.94
		1985	1150.99	612.27	474.60	3.14	26.18	32.13	892.00	0.30	-0.63	0.49	5.80	3.34	2.76
		1986	1103.73	570.79	461.95	2.73	24.10	26.15	868.75	0.31	-0.56	0.51	5.43	3.28	2.84
		1987	989.36	505.07	408.12	2.65	23.79	18.77	757.04	0.31	-0.54	0.52	4.71	3.26	2.80
		1988	1039.63	521.16	446.49	2.92	24.66	24.50	839.55	0.29	-0.59	0.49	5.63	3.24	2.71
		1989	1042.80	486.93	470.82	3.03	24.27	24.16	888.68	0.27	-0.62	0.45	6.20	3.27	2.72
		1990	938.03	448.15	421.53	2.99	23.19	18.05	787.03	0.26	-0.64	0.45	5.67	3.12	2.93
		1991	994.68	474.75	446.97	3.01	24.46	19.05	819.33	0.28	-0.61	0.46	5.61	3.26	2.85
		1992	998.31	480.71	429.53	2.80	24.73	19.52	788.39	0.30	-0.57	0.49	5.31	3.16	2.83
		1993	1016.86	491.40	430.80	2.72	25.00	19.86	795.04	0.30	-0.56	0.49	5.27	3.18	2.78
		1994	978.17	477.77	417.31	2.62	23.11	18.35	765.47	0.32	-0.53	0.52	5.09	3.12	2.78
		1995	885.54	428.02	395.30	2.72	21.46	14.29	735.34	0.31	-0.56	0.50	4.94	3.07	2.86
		1996	1004.95	476.05	438.26	2.71	24.31	19.90	822.91	0.31	-0.55	0.50	5.61	3.20	2.71
		1997	1043.62	537.44	394.47	2.33	23.49	19.80	734.66	0.35	-0.47	0.56	4.38	3.03	2.77
		1998	994.93	493.21	402.21	2.45	21.97	19.69	752.42	0.35	-0.50	0.55	4.65	3.04	2.77
		1999	1011.61	517.90	439.68	3.04	21.96	24.71	840.71	0.29	-0.62	0.49	5.73	3.20	2.84
		2000	1024.70	475.65	448.10	2.88	24.38	20.96	855.82	0.28	-0.59	0.48	5.89	3.38	2.72
		2001	1079.64	524.63	463.97	3.08	25.35	23.68	879.79	0.27	-0.63	0.45	5.90	3.32	2.79
		2002	1074.44	538.39	441.35	2.70	25.63	22.94	818.15	0.31	-0.55	0.51	5.34	3.27	2.75
		2003	1078.74	551.28	449.68	2.84	25.00	25.42	851.68	0.30	-0.58	0.49	5.49	3.26	2.78
		2004	984.67	519.72	412.63	2.71	22.27	20.59	766.84	0.31	-0.57	0.52	4.91	3.15	2.89
		2005	1053.99	568.90	457.18	2.98	24.14	23.96	862.86	0.29	-0.60	0.47	5.54	3.25	2.78
		2006	965.23	532.32	427.01	2.80	20.88	19.92	776.54	0.31	-0.57	0.51	4.95	3.24	2.80
		2007	1001.85	536.13	442.65	3.08	21.82	22.15	821.39	0.29	-0.63	0.48	5.35	3.26	2.94
		2008	1032.67	503.31	470.94	2.95	24.79	23.02	893.50	0.28	-0.60	0.46	6.33	3.21	2.73
		2009	935.63	482.35	428.69	2.87	21.17	19.76	798.40	0.30	-0.59	0.49	5.64	3.13	2.83
		2010	1058.23	532.72	462.74	3.21	24.42	23.70	858.70	0.26	-0.66	0.44	6.10	3.30	2.89

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		2011	925.13	488.23	414.17	2.73	21.24	17.35	780.73	0.31	-0.56	0.50	4.98	3.22	2.81
		2012	1167.93	634.15	484.43	2.83	27.13	26.76	916.36	0.29	-0.57	0.48	5.24	3.46	2.65
		2013	1097.31	567.87	480.37	3.05	23.65	27.11	918.76	0.28	-0.61	0.46	5.89	3.40	2.66
		2014	1137.74	582.49	501.44	3.31	24.56	29.53	968.52	0.25	-0.67	0.43	6.54	3.41	2.79
		2015	1051.51	564.59	437.43	2.72	23.08	25.13	818.01	0.32	-0.55	0.52	5.01	3.21	2.78
		2016	978.41	526.26	425.61	2.89	22.54	20.92	780.39	0.30	-0.59	0.49	5.02	3.21	2.86
		2017	1149.93	656.64	512.35	2.88	23.26	30.45	752.43	0.30	-0.58	0.50	5.40	3.30	2.87
		2018	1322.01	729.18	573.38	3.12	26.97	37.91	959.16	0.27	-0.61	0.44	6.35	3.41	2.73
		2019	1229.10	686.45	520.21	3.03	26.53	33.80	869.92	0.29	-0.60	0.47	5.56	3.43	2.77
FA	SA	1982	1075.36	501.44	478.79	2.94	24.97	23.97	887.03	0.28	-0.59	0.47	6.36	3.27	2.75
		1983	1003.92	487.23	425.90	2.87	22.67	21.24	792.24	0.29	-0.59	0.50	5.38	3.34	2.77
		1984	1020.27	524.02	433.08	3.10	24.44	22.06	784.43	0.26	-0.65	0.45	5.37	3.24	2.85
		1985	1173.30	617.03	458.56	2.79	29.75	27.35	834.34	0.30	-0.56	0.48	4.95	3.35	2.66
		1986	1111.10	558.55	446.74	2.93	27.66	23.20	833.67	0.28	-0.59	0.47	5.05	3.41	2.71
		1987	1202.18	610.39	463.16	3.04	27.71	27.92	823.92	0.28	-0.60	0.45	5.11	3.27	2.81
		1988	1135.32	586.13	479.96	2.92	27.83	26.76	877.92	0.29	-0.59	0.48	6.06	3.31	2.77
		1989	1169.20	547.84	498.98	3.00	29.51	27.75	909.85	0.28	-0.59	0.45	6.23	3.40	2.64
		1990	1168.48	559.62	490.03	3.04	29.44	26.67	924.71	0.27	-0.60	0.44	6.16	3.30	2.67
		1991	1190.73	550.49	500.43	2.95	30.12	27.13	931.92	0.27	-0.59	0.44	6.28	3.36	2.64
		1992	1146.62	597.43	475.88	3.03	28.78	27.52	829.88	0.29	-0.61	0.47	5.52	3.33	2.73
		1993	1163.16	573.19	482.98	3.14	28.90	28.86	887.54	0.28	-0.63	0.45	6.00	3.32	2.65
		1994	1073.70	502.46	463.00	3.12	26.45	23.81	858.46	0.27	-0.63	0.45	5.92	3.31	2.74
		1995	939.91	432.00	418.58	3.13	23.96	16.73	785.93	0.26	-0.65	0.45	5.52	3.32	2.83
		1996	1077.90	483.64	472.29	3.18	25.61	23.01	900.05	0.26	-0.64	0.45	6.34	3.37	2.69
		1997	1067.45	489.49	448.54	3.15	27.20	21.56	847.18	0.26	-0.64	0.44	5.80	3.40	2.76
		1998	1152.62	535.34	482.43	3.09	27.92	27.65	919.27	0.28	-0.62	0.46	6.36	3.36	2.64
		1999	1158.16	561.40	495.51	3.31	27.01	28.65	948.04	0.28	-0.66	0.45	6.77	3.31	2.67
		2000	1141.78	499.49	492.38	2.73	27.89	26.10	950.16	0.29	-0.54	0.48	6.63	3.37	2.53
		2001	1213.69	532.74	523.12	3.11	29.59	29.76	1014.25	0.25	-0.62	0.43	7.29	3.43	2.61

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		2002	1048.60	516.20	429.63	2.76	25.63	21.52	814.04	0.29	-0.58	0.50	5.36	3.33	2.73
		2003	1116.45	532.48	470.95	2.94	27.03	24.87	888.46	0.27	-0.60	0.46	6.13	3.33	2.71
		2004	1066.94	550.49	437.47	2.91	23.96	22.65	794.06	0.29	-0.60	0.48	5.19	3.23	2.88
		2005	1142.92	568.63	475.49	3.14	26.24	26.82	850.00	0.27	-0.64	0.45	5.83	3.30	2.81
		2006	1124.10	550.58	478.03	3.07	27.36	25.97	900.18	0.27	-0.62	0.45	5.98	3.37	2.68
		2007	1089.03	547.58	458.89	3.21	24.78	24.87	853.70	0.27	-0.65	0.45	5.62	3.31	2.83
		2008	1122.72	495.90	512.08	2.99	27.58	25.43	978.32	0.26	-0.59	0.44	7.08	3.36	2.63
		2009	1279.63	552.59	571.63	3.01	32.20	31.41	1104.42	0.26	-0.58	0.42	8.00	3.39	2.50
		2010	1172.46	552.61	502.28	3.11	27.54	28.24	944.27	0.26	-0.62	0.44	6.59	3.39	2.69
		2011	1213.85	599.33	499.95	2.64	32.05	28.38	959.61	0.30	-0.52	0.49	6.00	3.43	2.53
		2012	1199.41	587.90	513.79	2.97	29.56	28.34	974.71	0.27	-0.59	0.45	6.36	3.44	2.65
		2013	1153.53	559.85	507.63	3.03	26.57	26.42	966.32	0.26	-0.61	0.44	6.46	3.37	2.68
		2014	1132.80	589.85	468.66	2.88	25.27	23.48	895.28	0.29	-0.58	0.48	5.32	3.40	2.75
		2015	1207.23	624.85	505.86	3.40	25.47	31.57	948.00	0.26	-0.67	0.43	6.02	3.46	2.82
		2016	1018.19	552.41	433.60	2.77	21.78	22.58	755.64	0.32	-0.56	0.51	4.85	3.14	2.88
		2017	1225.35	575.79	537.90	3.12	27.72	31.99	967.98	0.27	-0.62	0.44	7.05	3.38	2.69
		2018	1234.02	560.10	542.66	3.37	28.60	31.48	1012.43	0.24	-0.67	0.39	7.36	3.40	2.70
		2019	1204.42	594.81	504.89	3.28	26.56	31.64	889.93	0.26	-0.66	0.43	6.16	3.37	2.77
FA	AB	1982	1172.41	546.70	496.45	2.57	26.07	26.98	873.91	0.30	-0.51	0.50	6.23	3.25	2.64
		1983	1125.35	562.50	478.44	2.77	24.27	26.79	825.02	0.29	-0.56	0.50	5.83	3.25	2.75
		1984	1099.00	611.14	453.51	2.79	23.51	26.99	693.98	0.29	-0.60	0.49	4.92	3.08	2.97
		1985	1193.35	628.85	489.18	2.70	29.80	29.47	825.62	0.30	-0.54	0.50	5.39	3.43	2.61
		1986	1064.84	542.75	437.35	2.60	27.12	22.65	787.64	0.31	-0.53	0.52	5.06	3.31	2.68
		1987	1140.56	552.09	453.84	2.58	27.15	23.45	819.90	0.30	-0.52	0.51	5.34	3.33	2.68
		1988	1105.70	553.04	457.70	2.47	26.91	24.04	812.86	0.33	-0.49	0.53	5.27	3.26	2.63
		1989	1209.94	534.95	530.39	2.74	29.91	28.60	970.95	0.28	-0.54	0.46	7.05	3.32	2.58
		1990	1231.38	595.63	504.83	2.66	29.94	29.02	904.64	0.30	-0.52	0.48	6.11	3.29	2.64
		1991	1082.31	513.81	462.98	2.88	28.54	22.53	841.33	0.28	-0.58	0.46	5.67	3.29	2.68
		1992	1229.51	626.60	511.14	2.73	30.45	29.91	836.42	0.30	-0.53	0.48	5.68	3.36	2.64

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		1993	1360.57	668.22	557.82	2.54	33.82	35.05	967.01	0.31	-0.48	0.48	6.53	3.34	2.51
		1994	1104.65	527.62	464.83	2.74	27.68	23.07	835.27	0.30	-0.55	0.48	5.66	3.25	2.71
		1995	1031.95	481.17	447.03	2.74	25.47	20.53	824.92	0.30	-0.55	0.49	5.66	3.26	2.68
		1996	1104.49	505.08	477.57	2.74	27.71	23.81	884.81	0.30	-0.55	0.48	6.13	3.29	2.66
		1997	1204.68	587.00	480.92	2.62	30.82	26.84	895.20	0.31	-0.52	0.50	5.73	3.37	2.59
		1998	1114.58	534.32	451.38	2.55	27.26	22.66	840.59	0.31	-0.51	0.51	5.40	3.24	2.69
		1999	1287.82	593.34	536.83	2.69	32.23	31.92	1007.17	0.29	-0.52	0.47	6.89	3.36	2.56
		2000	1178.47	508.33	508.97	2.56	29.72	27.27	980.34	0.30	-0.51	0.49	6.90	3.27	2.55
		2001	1072.67	477.52	466.03	2.87	26.15	21.06	886.96	0.27	-0.59	0.46	6.38	3.25	2.79
		2002	1112.35	537.48	462.77	2.62	28.00	23.54	880.50	0.31	-0.53	0.50	5.68	3.33	2.63
		2003	1186.94	587.38	484.03	2.70	29.50	27.20	883.25	0.30	-0.54	0.49	5.76	3.34	2.64
		2004	1175.17	599.40	497.35	2.83	27.94	27.19	853.21	0.29	-0.57	0.47	5.74	3.36	2.76
		2005	1141.33	582.16	483.00	2.85	27.95	26.81	846.24	0.29	-0.57	0.48	5.66	3.34	2.69
		2006	1047.11	545.13	450.30	2.62	24.84	21.25	788.83	0.31	-0.53	0.51	5.00	3.29	2.72
		2007	1162.48	593.08	486.03	2.88	28.56	27.00	871.00	0.29	-0.57	0.47	5.64	3.33	2.71
		2008	1242.57	546.51	565.08	2.81	30.34	31.63	1036.04	0.27	-0.54	0.45	7.79	3.41	2.48
		2009	1163.32	524.97	515.58	2.65	28.87	26.89	959.01	0.30	-0.52	0.48	6.85	3.23	2.58
		2010	1153.45	545.08	497.74	2.77	27.67	25.71	907.44	0.27	-0.57	0.46	6.48	3.24	2.75
		2011	1165.35	546.40	503.99	2.84	29.50	26.76	937.16	0.28	-0.56	0.46	6.47	3.38	2.64
		2012	1213.00	531.00	543.45	2.86	30.32	28.77	1026.42	0.27	-0.56	0.45	7.36	3.39	2.58
		2013	1098.13	484.26	504.75	3.02	27.31	23.46	966.07	0.25	-0.60	0.43	7.03	3.37	2.64
		2014	1232.76	553.37	542.10	3.00	30.54	28.83	1051.94	0.26	-0.59	0.42	7.41	3.39	2.58
		2015	1248.24	649.10	527.12	2.72	29.56	31.52	880.29	0.30	-0.54	0.48	5.98	3.37	2.70
		2016	1208.37	672.58	524.80	2.71	26.11	30.98	762.87	0.31	-0.53	0.50	5.46	3.23	2.82
		2017	1204.55	648.39	537.01	2.90	27.25	30.47	820.10	0.29	-0.57	0.47	6.01	3.31	2.77
		2018	1243.80	635.80	565.93	3.05	28.36	32.89	900.21	0.27	-0.60	0.44	6.82	3.31	2.74
		2019	1134.49	550.99	498.15	2.87	27.82	25.60	898.01	0.28	-0.57	0.46	6.22	3.32	2.67
FA	CC	1982	798.39	393.99	350.43	2.42	15.95	12.62	638.71	0.31	-0.54	0.57	4.49	3.28	2.80
		1983	829.03	406.41	363.77	2.34	17.41	12.98	674.23	0.34	-0.49	0.58	4.43	3.22	2.72

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		1984	878.69	481.88	349.68	2.24	20.09	15.24	641.14	0.34	-0.49	0.58	3.68	3.19	2.75
		1985	890.60	467.07	366.01	2.59	20.82	15.08	673.49	0.30	-0.57	0.54	4.17	3.35	2.79
		1986	779.79	395.88	329.30	2.46	16.07	11.44	606.26	0.30	-0.55	0.57	3.97	3.35	2.75
		1987	770.57	385.40	321.95	2.54	16.21	10.04	587.15	0.31	-0.54	0.58	3.76	3.56	2.65
		1988	913.12	429.08	400.94	2.65	21.01	16.07	756.95	0.30	-0.55	0.53	5.06	3.38	2.59
		1989	1026.77	458.06	454.36	2.53	24.24	21.23	866.14	0.32	-0.51	0.53	6.01	3.26	2.62
		1990	1060.51	525.35	442.00	2.57	24.56	20.99	842.03	0.31	-0.52	0.52	5.07	3.35	2.72
		1991	1061.63	524.19	435.78	2.55	26.61	22.09	827.13	0.32	-0.52	0.53	5.14	3.37	2.65
		1992	989.39	476.60	409.97	2.60	23.51	18.40	773.78	0.30	-0.54	0.53	5.01	3.45	2.62
		1993	1065.58	479.40	465.95	2.78	25.67	22.13	891.05	0.29	-0.56	0.49	6.36	3.43	2.65
		1994	992.35	459.98	430.33	2.75	22.46	19.89	806.65	0.29	-0.56	0.52	5.52	3.49	2.62
		1995	1059.21	461.52	476.57	2.76	25.00	22.18	915.94	0.28	-0.55	0.49	6.44	3.36	2.61
		1996	1060.35	467.10	474.21	2.80	25.00	22.25	912.18	0.28	-0.57	0.48	6.52	3.37	2.60
		1997	1073.76	518.24	438.75	2.61	26.30	22.61	834.53	0.30	-0.54	0.51	5.37	3.38	2.63
		1998	921.38	433.40	398.81	2.54	21.54	17.30	753.25	0.31	-0.52	0.54	5.01	3.34	2.63
		1999	863.49	435.25	373.16	2.58	19.20	14.76	696.50	0.29	-0.57	0.54	4.66	3.26	2.81
		2000	1130.67	526.19	476.83	2.51	28.44	26.15	917.37	0.30	-0.50	0.52	6.04	3.52	2.41
		2001	972.84	477.79	415.03	2.67	22.47	18.60	785.87	0.29	-0.57	0.52	5.22	3.37	2.70
		2002	1034.91	498.11	426.51	2.81	23.45	19.87	805.42	0.28	-0.59	0.49	5.19	3.47	2.74
		2003	915.83	473.18	386.24	2.49	20.21	17.92	702.61	0.32	-0.52	0.56	4.44	3.39	2.60
		2004	994.04	497.64	426.92	2.76	22.34	19.37	764.58	0.28	-0.57	0.50	4.91	3.51	2.72
		2005	1016.79	517.60	433.61	2.75	23.99	20.18	794.12	0.29	-0.57	0.50	5.06	3.35	2.77
		2006	950.47	458.72	421.13	2.75	22.51	17.94	779.21	0.29	-0.56	0.50	5.16	3.38	2.68
		2007	947.38	496.79	402.90	2.76	22.99	17.94	730.04	0.30	-0.57	0.51	4.53	3.42	2.68
		2008	871.97	428.49	394.07	2.73	20.23	14.45	728.34	0.29	-0.56	0.52	4.87	3.45	2.64
		2009	1018.52	459.76	463.71	2.89	25.47	20.86	885.77	0.27	-0.59	0.46	6.27	3.37	2.64
		2010	1023.48	522.22	429.88	2.70	24.29	20.45	797.91	0.29	-0.56	0.51	5.01	3.47	2.61
		2011	1000.40	490.46	436.53	2.84	24.59	19.00	828.77	0.28	-0.58	0.48	5.37	3.40	2.70
		2012	979.61	498.21	421.49	2.71	21.74	17.53	797.95	0.30	-0.55	0.52	4.79	3.50	2.57

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		2013	1067.58	504.69	477.20	3.11	25.74	22.46	916.90	0.25	-0.63	0.44	6.23	3.43	2.69
		2014	996.82	504.43	433.61	2.79	22.36	18.98	826.27	0.29	-0.57	0.50	5.24	3.48	2.70
		2015	1035.39	541.13	427.16	2.49	24.44	21.40	802.07	0.32	-0.50	0.54	4.72	3.44	2.59
		2016	865.20	438.95	385.06	2.73	18.42	13.05	715.73	0.30	-0.57	0.51	4.48	3.31	2.83
		2017	966.62	487.98	437.24	2.94	20.75	17.68	812.11	0.27	-0.61	0.47	5.22	3.45	2.80
		2018	1084.32	598.52	476.00	2.98	21.83	20.70	908.39	0.26	-0.61	0.45	5.26	3.48	2.75
		2019	1067.20	535.45	461.80	2.90	23.95	21.28	877.08	0.27	-0.58	0.47	5.32	3.52	2.67
FA	UL	1982	1016.72	417.21	463.28	2.88	24.09	19.77	882.34	0.27	-0.58	0.47	6.52	3.43	2.66
		1983	959.15	388.81	437.92	3.19	24.38	16.29	832.05	0.24	-0.65	0.43	6.12	3.35	2.80
		1984	1069.96	513.06	431.16	2.75	28.28	20.88	812.17	0.28	-0.57	0.47	5.17	3.24	2.72
		1985	1019.75	434.30	462.34	2.79	24.79	20.96	886.88	0.27	-0.57	0.47	6.45	3.29	2.61
		1986	1127.59	489.98	502.23	3.07	29.03	24.27	967.06	0.25	-0.61	0.43	6.76	3.49	2.63
		1987	1171.03	512.38	506.16	2.95	30.29	25.53	969.33	0.26	-0.59	0.44	6.75	3.43	2.63
		1988	1312.68	488.04	593.70	2.86	32.48	31.83	1167.18	0.25	-0.55	0.41	9.02	3.34	2.46
		1989	1367.89	506.64	624.31	2.85	34.50	34.41	1231.94	0.24	-0.54	0.40	9.48	3.34	2.40
		1990	1326.63	574.15	572.94	2.68	34.53	32.68	1118.82	0.28	-0.51	0.44	7.64	3.41	2.46
		1991	1393.90	520.03	642.12	2.94	35.75	36.25	1269.21	0.24	-0.56	0.39	9.78	3.46	2.41
		1992	1325.27	551.90	577.84	2.78	33.40	32.80	1125.21	0.27	-0.54	0.45	8.12	3.48	2.50
		1993	1436.63	526.92	655.87	2.74	35.74	37.91	1297.30	0.25	-0.52	0.41	10.09	3.35	2.34
		1994	1469.94	493.75	702.60	2.91	36.98	40.04	1400.79	0.23	-0.55	0.37	11.38	3.40	2.30
		1995	1455.42	486.34	692.42	2.93	36.29	39.18	1378.89	0.23	-0.55	0.37	11.25	3.37	2.30
		1996	1417.00	498.51	653.18	2.93	35.11	36.25	1294.47	0.23	-0.56	0.38	10.29	3.36	2.41
		1997	1456.59	531.80	663.10	2.79	37.06	38.85	1315.63	0.25	-0.53	0.40	10.25	3.39	2.31
		1998	1311.81	474.99	613.89	2.77	32.60	33.75	1212.39	0.26	-0.53	0.43	9.56	3.34	2.35
		1999	1280.92	488.89	582.47	2.78	31.76	31.43	1143.80	0.26	-0.54	0.43	8.76	3.35	2.44
		2000	1397.68	513.15	644.87	2.76	35.66	37.34	1277.40	0.25	-0.53	0.41	10.01	3.36	2.34
		2001	1335.99	481.62	619.24	2.88	33.25	33.38	1222.14	0.24	-0.56	0.41	9.62	3.33	2.46
		2002	1380.22	492.70	638.22	2.76	33.83	35.84	1264.22	0.25	-0.53	0.41	10.01	3.34	2.35
		2003	1195.61	467.29	544.39	2.70	28.91	28.35	1063.39	0.26	-0.56	0.45	8.22	3.24	2.63

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		2004	1337.88	503.94	616.01	2.79	33.70	34.42	1215.09	0.25	-0.55	0.42	9.37	3.36	2.43
		2005	1409.31	506.08	659.41	2.84	35.82	37.48	1308.06	0.24	-0.54	0.40	10.27	3.39	2.30
		2006	1299.08	482.91	598.33	2.81	32.20	32.15	1177.77	0.25	-0.54	0.42	9.09	3.37	2.40
		2007	1362.90	512.48	624.04	2.79	33.86	34.80	1231.50	0.25	-0.54	0.42	9.45	3.38	2.40
		2008	1280.35	488.16	595.79	2.79	31.88	31.95	1171.84	0.26	-0.54	0.43	8.89	3.36	2.41
		2009	1426.93	499.04	673.00	2.88	35.92	38.04	1337.43	0.23	-0.54	0.38	10.59	3.35	2.31
		2010	1403.35	562.23	608.68	2.65	33.96	35.45	1166.33	0.27	-0.50	0.43	8.76	3.28	2.43
		2011	1309.46	487.61	611.40	2.84	32.56	32.79	1201.40	0.25	-0.55	0.42	9.29	3.36	2.45
		2012	1327.89	505.91	604.09	2.75	32.82	32.89	1189.07	0.26	-0.52	0.43	8.91	3.39	2.42
		2013	1407.29	497.05	661.09	2.88	34.45	36.23	1311.25	0.23	-0.54	0.39	10.30	3.37	2.38
		2014	1438.53	516.30	669.84	2.86	35.70	38.05	1330.14	0.24	-0.54	0.40	10.40	3.46	2.35
		2015	1473.81	523.14	685.08	2.80	37.14	40.09	1362.87	0.24	-0.52	0.39	10.76	3.41	2.27
		2016	1382.33	492.54	650.41	2.77	34.51	36.47	1286.93	0.25	-0.52	0.41	10.16	3.35	2.32
		2017	1428.90	492.64	679.57	2.86	35.77	38.39	1351.77	0.23	-0.54	0.38	10.77	3.39	2.30
		2018	1389.27	493.60	653.60	2.80	34.90	36.86	1294.95	0.24	-0.54	0.40	10.27	3.34	2.33
		2019	1351.28	521.73	616.73	2.76	34.46	35.27	1211.82	0.25	-0.54	0.42	9.22	3.40	2.40
FA	LL	1982	1152.97	469.79	521.34	2.86	26.94	24.97	1010.72	0.26	-0.56	0.45	7.33	3.38	2.65
		1983	1043.31	476.30	444.41	2.86	24.39	19.82	840.64	0.28	-0.58	0.48	5.67	3.43	2.76
		1984	1062.65	522.15	449.35	2.90	25.33	20.83	798.95	0.27	-0.60	0.47	5.33	3.33	2.89
		1985	1030.92	508.29	433.92	2.84	24.87	19.50	820.14	0.29	-0.58	0.49	5.05	3.46	2.77
		1986	1041.70	495.46	430.38	2.90	24.57	18.30	811.48	0.28	-0.59	0.48	5.12	3.43	2.83
		1987	1170.40	588.83	458.55	2.64	29.52	24.88	872.93	0.31	-0.53	0.51	5.02	3.55	2.66
		1988	1070.26	524.02	436.34	2.76	26.99	20.78	824.70	0.29	-0.56	0.49	5.01	3.44	2.72
		1989	1149.75	519.54	486.30	2.80	29.12	24.26	933.64	0.28	-0.55	0.47	6.17	3.38	2.66
		1990	1188.80	541.04	503.29	2.90	30.45	25.67	968.11	0.27	-0.57	0.44	6.34	3.45	2.63
		1991	1127.06	512.21	473.78	2.70	28.33	24.31	908.38	0.29	-0.54	0.50	6.09	3.56	2.49
		1992	1220.12	526.77	534.09	2.84	30.67	28.36	1013.77	0.27	-0.56	0.45	7.21	3.50	2.54
		1993	1231.19	517.18	542.84	2.81	30.95	29.12	1055.29	0.26	-0.56	0.44	7.52	3.42	2.53
		1994	1263.07	524.43	560.03	2.88	32.44	30.50	1088.79	0.26	-0.56	0.43	7.78	3.46	2.50

Table 47. continued.

Season	Bay	Year	Lmax	Lcom	Lmat	Amat	Tmax	Wmax	Linf	K	t0	M	GenT	TrLvl	MoPos
		1995	1270.01	503.18	573.74	2.97	32.90	30.60	1121.28	0.25	-0.58	0.41	8.32	3.46	2.50
		1996	1267.93	521.08	561.16	2.86	32.39	30.56	1088.84	0.26	-0.56	0.43	7.89	3.44	2.49
		1997	1225.33	595.59	495.21	2.47	32.07	30.16	949.16	0.32	-0.49	0.52	5.85	3.51	2.42
		1998	1258.70	562.58	525.79	2.69	32.17	29.28	1018.61	0.29	-0.53	0.47	6.77	3.49	2.55
		1999	1160.77	521.11	493.74	2.80	29.04	25.56	950.13	0.27	-0.57	0.46	6.39	3.44	2.68
		2000	1183.76	558.35	493.87	2.70	30.95	27.06	949.46	0.29	-0.54	0.48	6.06	3.47	2.55
		2001	1235.15	558.08	520.35	2.88	29.93	27.72	1006.15	0.27	-0.57	0.45	6.58	3.51	2.67
		2002	1149.24	560.98	464.80	2.58	28.67	24.64	882.01	0.31	-0.52	0.51	5.37	3.43	2.63
		2003	1167.40	587.31	449.02	2.44	29.26	25.10	852.88	0.32	-0.49	0.53	4.84	3.41	2.61
		2004	1050.44	557.72	412.40	2.58	27.53	21.61	775.10	0.32	-0.52	0.53	4.17	3.50	2.58
		2005	1114.96	562.58	449.84	2.68	29.55	24.08	854.16	0.30	-0.53	0.50	4.85	3.50	2.59
		2006	1130.12	562.15	452.67	2.56	28.55	23.21	860.36	0.31	-0.51	0.50	4.97	3.35	2.64
		2007	1187.91	561.61	499.63	2.81	30.10	26.49	958.06	0.29	-0.55	0.47	6.01	3.51	2.58
		2008	1133.08	530.73	483.08	2.80	27.45	24.02	914.69	0.28	-0.56	0.48	5.88	3.51	2.69
		2009	1066.46	505.19	454.20	2.70	25.29	21.43	865.36	0.29	-0.55	0.49	5.40	3.40	2.69
		2010	1269.73	652.00	515.12	2.74	28.86	30.01	828.98	0.29	-0.54	0.48	5.43	3.37	2.78
		2011	1084.41	476.38	484.54	2.93	26.71	22.26	920.64	0.27	-0.59	0.45	6.38	3.39	2.68
		2012	1049.30	475.08	462.72	3.04	27.04	20.47	880.47	0.26	-0.61	0.45	5.78	3.45	2.69
		2013	1103.39	471.71	498.69	3.04	28.12	23.22	949.23	0.25	-0.60	0.43	6.65	3.41	2.64
		2014	1112.95	484.10	500.78	3.12	27.64	22.31	951.96	0.25	-0.62	0.42	6.59	3.44	2.73
		2015	1178.42	513.18	517.15	2.82	29.02	26.49	989.09	0.27	-0.56	0.46	6.87	3.49	2.53
		2016	1145.34	525.45	491.39	2.86	28.07	24.55	944.70	0.28	-0.56	0.47	6.19	3.48	2.55
		2017	1162.07	501.09	515.08	2.87	29.41	25.61	995.86	0.27	-0.56	0.45	6.82	3.45	2.55
		2018	1142.62	527.09	489.23	2.80	28.93	24.73	934.73	0.27	-0.57	0.46	6.15	3.41	2.66
		2019	1125.94	547.43	466.99	2.83	29.79	23.63	890.08	0.29	-0.56	0.47	5.37	3.48	2.63

Table 48. Community weighted means for functional traits, part two. Community weighted trait means for caudal fin shape (CF), body shape (BSh), body cross section shape (CrSec), piscivory (Pisc), invertivory (Invert), herbivory (Herb), detritivory (Detr), water column position (Pos), preferred temperature in degrees Celsius (Tp), minimum observed temperature in degrees Celsius (MinTp), maximum observed temperature in degrees Celsius (MaxTp), observed temperature range (TpRng), and salinity preference (Sal). Note that some variable abbreviations here differ from those listed in Table 4 to save space. Season abbreviations are SP: spring, FA: fall. Bay abbreviations are as follows, SL: Sabine Lake, GB: Galveston Bay, MG: Matagorda Bay, SA: San Antonio Bay, AB: Aransas Bay, CC: Corpus Christi Bay, UL: Upper Laguna Madre, LL: Lower Laguna Madre.

Season	**Bay**	**Year**	**CF**	**BSh**	**CrSec**	**Pisc**	**Invert**	**Herb**	**Detr**	**Pos**	**RepG**	**Tp**	**MinTp**	**MaxTp**	**TpRng**	**Sal**
SP	SL	1986	2.47	2.53	2.47	0.87	0.89	0.13	0.18	4.00	0.76	20.15	16.98	27.34	10.36	1.85
		1987	2.08	2.58	2.53	0.88	0.89	0.12	0.07	4.41	0.27	19.50	15.03	27.08	12.05	1.73
		1988	2.72	2.81	2.73	0.77	0.80	0.22	0.13	3.95	0.56	21.30	15.47	27.20	11.73	1.92
		1989	2.75	2.98	2.86	0.74	0.77	0.25	0.11	3.94	0.38	21.64	14.84	27.19	12.35	1.98
		1990	2.40	2.74	2.68	0.81	0.85	0.18	0.09	4.25	0.31	20.50	15.11	27.20	12.09	1.87
		1991	2.30	2.73	2.60	0.84	0.87	0.14	0.08	4.27	0.29	19.61	15.02	27.25	12.23	1.74
		1992	2.94	2.93	2.83	0.80	0.82	0.19	0.15	3.88	0.65	22.37	15.80	27.26	11.46	2.22
		1993	2.48	2.95	2.79	0.84	0.88	0.14	0.09	4.32	0.28	21.25	14.28	27.17	12.88	2.11
		1994	3.02	3.03	2.89	0.74	0.79	0.25	0.17	3.77	0.55	22.21	14.94	27.23	12.29	2.13
		1995	2.63	2.91	2.82	0.76	0.82	0.21	0.09	4.13	0.25	20.95	15.04	27.18	12.14	1.95
		1996	2.33	2.89	2.80	0.77	0.81	0.22	0.05	4.30	0.07	20.63	14.03	27.17	13.14	1.84
		1997	2.56	3.01	2.86	0.77	0.83	0.21	0.09	4.20	0.23	21.46	14.33	27.18	12.85	2.06
		1998	2.55	2.94	2.83	0.78	0.83	0.21	0.08	4.20	0.29	21.54	14.52	27.15	12.63	2.09
		1999	2.81	2.98	2.86	0.75	0.80	0.24	0.11	3.99	0.48	21.83	15.23	27.18	11.95	2.09
		2000	3.18	3.17	3.05	0.60	0.73	0.40	0.19	3.58	0.36	21.96	15.52	27.14	11.62	2.04
		2001	2.81	3.04	2.89	0.80	0.84	0.19	0.09	4.15	0.51	22.46	15.09	27.17	12.08	2.29
		2002	3.18	3.11	2.93	0.75	0.83	0.24	0.24	3.62	0.78	23.41	15.98	27.27	11.30	2.47
		2003	3.04	2.97	2.81	0.76	0.81	0.22	0.14	3.84	0.80	22.36	15.95	27.29	11.34	2.16
		2004	2.99	3.12	2.93	0.76	0.83	0.22	0.11	4.01	0.62	22.97	15.45	27.27	11.82	2.37
		2005	2.65	3.11	2.90	0.77	0.81	0.22	0.09	4.14	0.31	22.01	13.99	27.22	13.22	2.15
		2006	3.23	3.12	2.95	0.69	0.75	0.30	0.16	3.68	0.71	22.84	15.45	27.23	11.79	2.20
		2007	2.96	3.00	2.85	0.83	0.88	0.16	0.15	4.08	0.78	23.27	16.01	27.31	11.30	2.54

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		2008	3.22	3.16	2.97	0.73	0.78	0.26	0.14	3.83	0.74	23.34	15.59	27.27	11.68	2.39
		2009	2.73	3.05	2.87	0.79	0.88	0.20	0.14	4.16	0.50	22.51	15.61	27.31	11.70	2.41
		2010	2.56	3.02	2.88	0.87	0.91	0.12	0.09	4.41	0.44	23.17	15.41	27.30	11.90	2.59
		2011	2.89	3.05	2.90	0.78	0.82	0.21	0.09	4.16	0.60	23.02	15.45	27.27	11.82	2.37
		2012	2.76	3.00	2.88	0.81	0.87	0.18	0.14	4.10	0.53	22.78	15.94	27.25	11.31	2.43
		2013	2.76	2.99	2.81	0.85	0.89	0.14	0.11	4.25	0.73	23.11	15.41	27.30	11.89	2.50
		2014	2.51	2.83	2.72	0.87	0.90	0.12	0.11	4.29	0.57	22.11	15.64	27.32	11.67	2.29
		2015	2.31	2.88	2.74	0.88	0.92	0.10	0.08	4.46	0.39	21.80	15.08	27.23	12.16	2.31
		2016	2.14	2.66	2.54	0.94	0.96	0.05	0.06	4.62	0.52	20.75	15.34	27.30	11.97	2.14
		2017	2.46	2.87	2.67	0.85	0.89	0.14	0.10	4.30	0.54	21.20	15.12	27.31	12.19	2.11
		2018	2.54	2.86	2.69	0.87	0.92	0.12	0.13	4.28	0.63	21.94	15.59	27.36	11.77	2.32
		2019	2.21	2.77	2.59	0.92	0.94	0.07	0.05	4.63	0.46	20.95	14.95	27.36	12.42	2.15
SP	GB	1982	4.05	2.71	2.63	0.79	0.88	0.19	0.53	2.59	2.10	25.00	19.12	27.48	8.36	2.75
		1983	3.98	2.80	2.68	0.77	0.91	0.20	0.57	2.60	1.97	24.97	19.08	27.47	8.39	2.85
		1984	3.85	2.85	2.75	0.77	0.92	0.20	0.49	2.80	1.75	24.94	18.69	27.45	8.76	2.87
		1985	4.09	2.75	2.69	0.77	0.91	0.23	0.59	2.54	2.02	25.01	19.37	27.45	8.07	2.87
		1986	3.98	2.91	2.82	0.73	0.90	0.26	0.52	2.78	1.71	24.89	18.93	27.38	8.46	2.89
		1987	4.28	2.71	2.64	0.77	0.93	0.22	0.65	2.36	2.26	25.24	20.07	27.47	7.40	2.96
		1988	4.07	2.57	2.50	0.87	0.92	0.12	0.58	2.46	2.37	25.31	19.36	27.51	8.15	2.82
		1989	4.29	2.71	2.66	0.76	0.96	0.23	0.69	2.31	2.21	25.23	20.39	27.47	7.07	3.05
		1990	4.43	2.63	2.59	0.77	0.96	0.22	0.70	2.26	2.45	25.29	20.92	27.51	6.59	3.04
		1991	4.17	2.63	2.53	0.82	0.90	0.16	0.59	2.41	2.32	24.80	19.56	27.50	7.94	2.72
		1992	3.91	2.72	2.64	0.82	0.94	0.18	0.55	2.68	1.94	24.78	19.26	27.45	8.19	2.85
		1993	4.20	2.72	2.66	0.77	0.95	0.23	0.63	2.50	2.12	24.92	20.35	27.45	7.10	2.98
		1994	4.09	2.64	2.55	0.82	0.94	0.16	0.60	2.50	2.21	24.72	19.69	27.48	7.79	2.80
		1995	4.15	2.55	2.51	0.84	0.92	0.15	0.58	2.51	2.38	24.89	19.47	27.53	8.06	2.73
		1996	3.74	2.87	2.78	0.77	0.87	0.21	0.42	3.02	1.63	24.84	17.82	27.41	9.59	2.73
		1997	3.37	2.82	2.73	0.84	0.94	0.14	0.34	3.54	1.39	24.38	17.32	27.38	10.06	2.79
		1998	3.71	2.91	2.79	0.77	0.93	0.22	0.42	3.26	1.51	24.42	18.21	27.36	9.16	2.83

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		1999	3.70	2.89	2.79	0.77	0.87	0.22	0.36	3.30	1.51	24.40	17.49	27.38	9.89	2.68
		2000	3.78	2.89	2.73	0.80	0.89	0.18	0.40	3.17	1.80	24.87	17.87	27.42	9.56	2.82
		2001	3.53	2.78	2.64	0.87	0.95	0.11	0.41	3.27	1.71	24.48	17.75	27.45	9.70	2.78
		2002	3.79	2.76	2.68	0.82	0.92	0.17	0.47	3.00	1.84	24.83	18.40	27.43	9.04	2.84
		2003	3.88	2.78	2.69	0.81	0.95	0.19	0.47	3.08	1.87	24.74	19.09	27.45	8.36	2.93
		2004	3.99	2.58	2.51	0.86	0.93	0.12	0.51	2.81	2.33	24.97	19.28	27.53	8.25	2.80
		2005	4.08	2.95	2.88	0.67	0.92	0.31	0.54	2.84	1.64	24.84	19.35	27.33	7.98	3.00
		2006	4.26	2.70	2.63	0.78	0.90	0.21	0.57	2.53	2.29	25.19	19.72	27.48	7.76	2.86
		2007	3.54	2.81	2.75	0.83	0.92	0.15	0.37	3.39	1.53	24.65	17.74	27.37	9.64	2.82
		2008	3.81	2.70	2.65	0.84	0.92	0.15	0.38	3.32	1.91	24.55	18.62	27.45	8.84	2.79
		2009	3.68	2.73	2.65	0.88	0.95	0.11	0.39	3.25	1.85	24.79	18.56	27.54	8.97	2.85
		2010	3.67	2.66	2.56	0.89	0.94	0.09	0.40	3.22	1.92	24.37	18.76	27.51	8.75	2.74
		2011	3.74	2.77	2.71	0.84	0.96	0.15	0.39	3.37	1.82	24.85	18.95	27.46	8.51	2.96
		2012	3.79	2.65	2.56	0.89	0.97	0.09	0.49	2.94	2.12	25.04	19.31	27.52	8.21	2.94
		2013	3.91	2.58	2.51	0.90	0.95	0.08	0.45	3.04	2.29	24.84	19.53	27.58	8.05	2.83
		2014	3.69	2.69	2.64	0.87	0.95	0.11	0.36	3.42	1.89	24.87	18.66	27.50	8.85	2.87
		2015	3.58	2.72	2.66	0.89	0.96	0.08	0.30	3.53	1.73	24.47	18.35	27.51	9.16	2.81
		2016	3.56	2.72	2.67	0.86	0.94	0.12	0.28	3.65	1.65	24.20	18.39	27.46	9.07	2.74
		2017	3.55	2.75	2.67	0.83	0.89	0.15	0.28	3.52	1.62	23.83	18.19	27.45	9.26	2.58
		2018	3.43	2.79	2.70	0.84	0.91	0.15	0.22	3.75	1.45	23.77	17.56	27.42	9.87	2.62
		2019	3.59	2.84	2.74	0.80	0.87	0.18	0.23	3.73	1.51	24.07	17.67	27.44	9.77	2.62
SP	MG	1982	3.36	2.82	2.72	0.78	0.83	0.21	0.21	3.56	1.24	22.99	16.73	27.42	10.69	2.24
		1983	3.26	3.10	2.96	0.69	0.81	0.26	0.20	3.68	0.85	23.92	15.82	27.26	11.44	2.51
		1984	4.27	2.67	2.62	0.74	0.84	0.24	0.33	3.14	2.26	24.60	18.96	27.55	8.59	2.53
		1985	3.77	2.70	2.69	0.71	0.86	0.28	0.39	3.15	1.52	23.17	18.46	27.44	8.98	2.37
		1986	3.73	2.82	2.76	0.77	0.83	0.22	0.34	3.08	1.57	24.58	17.48	27.40	9.92	2.56
		1987	3.27	2.77	2.70	0.84	0.90	0.15	0.30	3.52	1.32	23.98	17.04	27.41	10.37	2.59
		1988	3.68	2.89	2.81	0.76	0.89	0.22	0.28	3.47	1.52	24.70	17.60	27.42	9.82	2.77
		1989	3.91	2.78	2.72	0.76	0.83	0.22	0.34	3.05	1.83	24.85	17.86	27.48	9.62	2.59

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		1990	3.95	2.71	2.61	0.77	0.85	0.22	0.41	2.94	1.99	24.41	18.24	27.55	9.32	2.50
		1991	3.98	2.63	2.54	0.84	0.90	0.15	0.47	2.75	2.18	24.68	18.88	27.60	8.72	2.65
		1992	3.51	2.72	2.71	0.79	0.86	0.19	0.34	3.24	1.42	23.91	17.46	27.44	9.98	2.46
		1993	3.82	2.62	2.59	0.82	0.89	0.16	0.42	2.99	1.90	24.15	18.53	27.50	8.97	2.55
		1994	3.90	2.83	2.77	0.72	0.79	0.27	0.29	3.23	1.58	23.89	17.11	27.41	10.30	2.36
		1995	3.78	2.91	2.87	0.67	0.81	0.32	0.35	3.21	1.18	23.39	16.94	27.38	10.44	2.36
		1996	3.99	2.83	2.77	0.74	0.81	0.23	0.41	2.80	1.79	24.99	18.00	27.44	9.44	2.61
		1997	3.43	2.96	2.86	0.73	0.86	0.24	0.29	3.57	1.00	23.49	15.99	27.34	11.35	2.48
		1998	3.69	2.85	2.77	0.76	0.84	0.21	0.26	3.46	1.44	23.99	17.06	27.38	10.32	2.51
		1999	3.99	2.90	2.82	0.72	0.79	0.26	0.32	3.03	1.69	24.77	17.34	27.41	10.07	2.52
		2000	3.78	2.91	2.76	0.75	0.84	0.19	0.23	3.30	1.66	24.28	17.45	27.48	10.03	2.52
		2001	3.92	2.76	2.70	0.78	0.85	0.21	0.37	3.11	1.85	24.80	17.77	27.50	9.73	2.63
		2002	3.93	2.73	2.62	0.82	0.89	0.15	0.39	3.04	2.05	24.84	18.39	27.55	9.16	2.71
		2003	3.55	2.79	2.69	0.83	0.94	0.13	0.33	3.43	1.66	24.72	17.77	27.53	9.75	2.81
		2004	3.47	2.77	2.74	0.82	0.90	0.17	0.28	3.58	1.35	23.92	16.81	27.46	10.65	2.59
		2005	3.79	2.69	2.67	0.82	0.92	0.17	0.37	3.28	1.81	24.63	17.96	27.54	9.57	2.76
		2006	3.79	2.85	2.80	0.76	0.84	0.22	0.25	3.46	1.51	24.03	17.50	27.43	9.93	2.51
		2007	3.67	2.85	2.79	0.76	0.84	0.23	0.22	3.67	1.38	23.72	16.96	27.42	10.46	2.47
		2008	3.67	2.82	2.77	0.83	0.90	0.13	0.24	3.45	1.61	24.71	17.96	27.59	9.63	2.71
		2009	4.13	2.89	2.79	0.70	0.81	0.24	0.23	3.41	1.91	24.71	18.41	27.49	9.07	2.63
		2010	3.85	2.65	2.54	0.89	0.95	0.09	0.30	3.45	2.18	24.81	18.64	27.61	8.97	2.84
		2011	4.01	2.64	2.57	0.85	0.90	0.14	0.23	3.66	2.23	24.91	18.64	27.54	8.89	2.78
		2012	3.73	2.67	2.57	0.88	0.95	0.09	0.29	3.61	2.03	24.72	18.49	27.61	9.11	2.85
		2013	3.87	2.71	2.56	0.89	0.94	0.08	0.24	3.68	2.18	24.83	18.61	27.63	9.02	2.84
		2014	4.01	2.59	2.52	0.92	0.96	0.06	0.21	3.70	2.35	25.00	19.16	27.69	8.53	2.90
		2015	3.44	2.83	2.76	0.82	0.94	0.10	0.21	3.59	1.47	24.37	18.39	27.59	9.19	2.77
		2016	3.91	2.83	2.75	0.77	0.82	0.21	0.21	3.52	1.73	24.28	17.73	27.47	9.74	2.52
		2017	3.60	2.79	2.74	0.82	0.87	0.16	0.16	3.74	1.54	24.08	17.51	27.53	10.02	2.58
		2018	3.60	2.68	2.59	0.87	0.92	0.11	0.18	3.83	1.84	24.20	17.93	27.57	9.64	2.65

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		2019	3.56	2.77	2.71	0.79	0.82	0.20	0.17	3.68	1.47	23.51	17.30	27.45	10.16	2.36
SP	SA	1982	3.86	2.62	2.53	0.85	0.96	0.12	0.37	3.36	2.16	24.63	19.07	27.55	8.48	2.82
		1983	3.87	2.65	2.56	0.84	0.94	0.12	0.29	3.64	2.11	24.56	18.83	27.53	8.70	2.80
		1984	4.21	2.49	2.47	0.80	0.92	0.15	0.45	2.83	2.53	24.69	20.43	27.62	7.20	2.68
		1985	3.99	2.34	2.32	0.88	1.00	0.10	0.50	3.01	2.55	24.18	21.01	27.61	6.60	2.76
		1986	3.72	2.50	2.47	0.90	0.99	0.07	0.42	3.29	2.11	24.69	19.30	27.49	8.19	2.87
		1987	3.25	2.64	2.62	0.85	0.95	0.13	0.38	3.51	1.40	24.39	17.19	27.40	10.21	2.72
		1988	3.23	2.63	2.58	0.88	0.97	0.10	0.33	3.59	1.45	23.76	17.78	27.48	9.71	2.65
		1989	3.79	2.47	2.44	0.90	0.94	0.09	0.49	2.83	2.18	24.44	19.35	27.54	8.20	2.67
		1990	4.09	2.41	2.37	0.89	0.94	0.09	0.55	2.63	2.58	24.81	19.93	27.62	7.68	2.72
		1991	3.91	2.49	2.41	0.90	0.96	0.09	0.47	2.94	2.31	24.52	19.22	27.57	8.35	2.73
		1992	3.30	2.68	2.55	0.91	0.97	0.08	0.32	3.63	1.62	23.93	17.81	27.55	9.75	2.69
		1993	3.30	2.80	2.60	0.90	0.97	0.09	0.31	3.69	1.54	24.08	17.08	27.54	10.47	2.74
		1994	3.70	2.78	2.65	0.83	0.88	0.16	0.32	3.40	1.77	24.50	17.64	27.48	9.85	2.65
		1995	3.83	2.73	2.65	0.79	0.92	0.18	0.39	3.14	1.78	24.19	18.43	27.49	9.06	2.60
		1996	3.48	2.84	2.74	0.81	0.90	0.13	0.33	3.23	1.50	24.51	17.47	27.45	9.98	2.68
		1997	3.56	2.73	2.55	0.90	0.98	0.06	0.36	3.42	1.96	24.76	17.97	27.59	9.62	2.88
		1998	3.36	2.85	2.69	0.88	0.97	0.08	0.31	3.57	1.55	24.68	17.22	27.45	10.22	2.90
		1999	3.50	3.00	2.85	0.70	0.85	0.28	0.24	3.68	0.95	22.91	15.55	27.38	11.83	2.26
		2000	3.61	3.00	2.82	0.76	0.86	0.19	0.23	3.45	1.38	24.18	16.84	27.41	10.57	2.55
		2001	3.16	3.14	2.81	0.80	0.95	0.15	0.23	3.86	0.96	23.34	15.55	27.50	11.95	2.61
		2002	3.46	2.87	2.66	0.87	0.95	0.10	0.31	3.50	1.60	24.39	17.36	27.50	10.15	2.76
		2003	3.42	2.82	2.69	0.86	0.97	0.11	0.36	3.45	1.52	24.58	17.44	27.49	10.06	2.85
		2004	3.41	2.90	2.71	0.88	0.94	0.10	0.28	3.61	1.49	24.41	17.03	27.52	10.49	2.79
		2005	3.46	2.81	2.69	0.85	0.93	0.12	0.34	3.38	1.52	24.41	17.27	27.49	10.22	2.73
		2006	3.72	2.83	2.82	0.75	0.84	0.22	0.27	3.25	1.30	23.64	17.69	27.46	9.77	2.43
		2007	3.67	2.73	2.63	0.86	0.93	0.10	0.29	3.48	1.78	24.31	18.35	27.57	9.22	2.71
		2008	3.77	2.64	2.57	0.91	0.96	0.06	0.34	3.28	2.01	24.75	18.81	27.62	8.81	2.84
		2009	3.58	2.82	2.74	0.88	0.94	0.09	0.23	3.56	1.47	24.16	17.75	27.61	9.86	2.73

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		2010	3.48	2.75	2.61	0.91	0.97	0.05	0.24	3.72	1.71	24.25	17.88	27.61	9.72	2.80
		2011	3.64	2.72	2.64	0.87	0.94	0.08	0.25	3.50	1.80	24.59	18.31	27.58	9.27	2.79
		2012	3.44	2.79	2.70	0.89	0.94	0.08	0.23	3.67	1.51	24.43	17.50	27.51	10.01	2.79
		2013	3.47	2.64	2.57	0.91	0.96	0.06	0.21	3.82	1.71	23.86	18.16	27.54	9.38	2.70
		2014	3.50	2.82	2.72	0.86	0.94	0.10	0.18	3.77	1.49	24.14	17.76	27.53	9.77	2.75
		2015	3.74	2.57	2.53	0.92	0.97	0.05	0.23	3.79	2.08	24.54	19.05	27.59	8.54	2.85
		2016	3.79	2.52	2.49	0.93	0.97	0.05	0.26	3.59	2.18	24.55	19.05	27.55	8.50	2.83
		2017	3.56	2.76	2.67	0.84	0.89	0.14	0.17	3.84	1.45	23.16	17.18	27.47	10.29	2.47
		2018	3.73	2.60	2.49	0.93	0.97	0.04	0.29	3.59	1.98	23.55	18.61	27.63	9.02	2.68
		2019	3.58	2.72	2.62	0.91	0.95	0.08	0.26	3.53	1.75	24.39	18.06	27.59	9.53	2.78
SP	AB	1982	3.42	2.85	2.68	0.83	0.91	0.16	0.25	3.77	1.46	23.95	17.01	27.44	10.42	2.64
		1983	3.45	2.96	2.77	0.80	0.89	0.17	0.23	3.80	1.38	24.30	16.61	27.46	10.85	2.70
		1984	3.93	2.57	2.65	0.73	0.91	0.26	0.47	3.07	1.85	24.31	18.91	27.51	8.60	2.63
		1985	3.38	2.71	2.74	0.73	0.95	0.26	0.46	3.31	1.19	23.48	18.21	27.36	9.14	2.64
		1986	3.35	2.81	2.74	0.81	0.92	0.18	0.30	3.73	1.27	24.14	17.24	27.36	10.11	2.75
		1987	3.09	2.93	2.86	0.79	0.88	0.20	0.25	3.79	0.89	24.06	15.49	27.35	11.86	2.59
		1988	3.19	2.83	2.75	0.84	0.92	0.13	0.26	3.69	1.20	24.17	16.81	27.37	10.56	2.70
		1989	3.43	2.91	2.82	0.80	0.85	0.19	0.32	3.28	1.25	24.52	16.52	27.37	10.85	2.60
		1990	3.73	2.64	2.56	0.86	0.93	0.12	0.46	3.05	1.96	24.71	18.21	27.53	9.32	2.74
		1991	3.54	2.78	2.66	0.85	0.91	0.15	0.39	3.32	1.62	24.67	16.92	27.45	10.53	2.73
		1992	3.34	2.69	2.64	0.86	0.94	0.13	0.42	3.29	1.48	24.25	17.43	27.48	10.05	2.68
		1993	3.07	2.96	2.79	0.82	0.88	0.18	0.26	3.74	0.99	23.74	15.55	27.43	11.88	2.54
		1994	3.31	2.96	2.85	0.78	0.82	0.21	0.26	3.47	1.07	23.94	15.99	27.34	11.35	2.47
		1995	3.63	3.08	2.95	0.68	0.75	0.30	0.29	3.16	1.11	24.28	16.02	27.33	11.31	2.40
		1996	3.32	2.97	2.86	0.81	0.85	0.18	0.27	3.47	1.12	24.55	16.33	27.34	11.02	2.64
		1997	3.18	2.93	2.75	0.86	0.94	0.12	0.33	3.57	1.23	24.36	16.55	27.46	10.91	2.80
		1998	3.22	2.87	2.71	0.90	0.96	0.07	0.35	3.46	1.37	24.68	16.89	27.45	10.56	2.87
		1999	3.07	3.12	2.94	0.78	0.86	0.19	0.22	3.71	0.78	24.11	15.12	27.33	12.20	2.60
		2000	3.29	3.14	2.99	0.75	0.83	0.22	0.23	3.51	0.86	24.40	15.54	27.33	11.79	2.60

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		2001	2.96	3.18	2.92	0.83	0.91	0.14	0.23	3.85	0.79	24.33	14.96	27.38	12.43	2.79
		2002	3.38	3.01	2.87	0.81	0.88	0.17	0.30	3.41	1.20	24.67	16.38	27.38	11.00	2.73
		2003	3.25	3.03	2.87	0.82	0.91	0.14	0.29	3.44	1.11	24.60	16.51	27.42	10.91	2.79
		2004	3.00	2.96	2.81	0.87	0.93	0.11	0.23	3.79	0.97	24.03	16.01	27.44	11.43	2.70
		2005	3.14	3.00	2.86	0.81	0.88	0.16	0.23	3.61	0.94	23.98	15.86	27.47	11.61	2.58
		2006	3.48	2.98	2.91	0.76	0.84	0.22	0.27	3.28	1.10	24.18	16.83	27.45	10.62	2.54
		2007	3.34	2.77	2.74	0.89	0.93	0.09	0.32	3.36	1.36	24.49	17.50	27.50	10.00	2.75
		2008	3.56	2.95	2.85	0.81	0.86	0.17	0.27	3.33	1.31	24.45	17.08	27.49	10.41	2.64
		2009	3.42	2.97	2.78	0.87	0.91	0.11	0.29	3.43	1.37	24.71	16.85	27.54	10.69	2.78
		2010	2.88	3.10	2.75	0.91	0.95	0.07	0.19	4.03	0.99	23.68	15.35	27.54	12.19	2.72
		2011	3.47	2.83	2.77	0.86	0.91	0.12	0.24	3.57	1.39	24.56	17.35	27.50	10.15	2.75
		2012	3.48	2.84	2.74	0.85	0.92	0.11	0.27	3.49	1.49	24.59	17.57	27.52	9.95	2.76
		2013	3.83	2.70	2.62	0.90	0.93	0.08	0.34	3.23	1.99	25.04	18.54	27.62	9.07	2.84
		2014	3.67	2.74	2.67	0.91	0.97	0.07	0.22	3.79	1.79	24.78	18.21	27.62	9.40	2.92
		2015	3.67	2.74	2.64	0.89	0.96	0.10	0.27	3.70	1.79	24.61	18.29	27.59	9.30	2.88
		2016	3.68	2.87	2.85	0.74	0.80	0.23	0.21	3.42	1.36	24.09	17.29	27.40	10.11	2.43
		2017	3.34	2.94	2.83	0.78	0.86	0.19	0.17	3.72	1.10	23.60	16.84	27.46	10.62	2.49
		2018	3.30	2.79	2.73	0.88	0.91	0.10	0.17	3.83	1.30	23.91	17.17	27.53	10.35	2.61
		2019	3.35	2.92	2.77	0.83	0.87	0.15	0.17	3.82	1.28	23.97	16.48	27.44	10.95	2.58
SP	CC	1982	3.20	2.87	2.79	0.80	0.95	0.11	0.31	3.57	1.23	24.53	17.28	27.40	10.12	2.79
		1983	3.45	3.09	2.90	0.72	0.85	0.18	0.31	3.15	1.22	24.67	16.86	27.38	10.52	2.66
		1984	3.75	2.89	2.89	0.73	0.83	0.22	0.34	2.90	1.34	24.98	17.91	27.45	9.53	2.66
		1985	4.04	2.72	2.70	0.75	0.94	0.21	0.60	2.45	1.93	25.20	19.89	27.43	7.54	2.97
		1986	3.53	2.99	2.88	0.78	0.90	0.19	0.35	3.38	1.31	24.77	17.21	27.34	10.12	2.85
		1987	3.18	2.82	2.73	0.90	0.97	0.08	0.31	3.71	1.30	24.79	16.74	27.37	10.62	2.94
		1988	3.79	2.81	2.71	0.82	0.88	0.15	0.45	2.81	1.78	25.10	17.90	27.46	9.56	2.76
		1989	3.65	2.88	2.85	0.79	0.88	0.15	0.38	2.91	1.47	25.09	17.65	27.43	9.78	2.76
		1990	3.61	2.85	2.79	0.80	0.87	0.15	0.35	3.14	1.53	24.94	17.38	27.40	10.02	2.72
		1991	3.67	2.87	2.84	0.79	0.83	0.20	0.30	3.22	1.40	24.86	17.14	27.34	10.20	2.65

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		1992	3.07	2.99	2.80	0.89	0.96	0.08	0.28	3.72	1.10	24.59	16.07	27.41	11.34	2.89
		1993	3.18	3.13	2.84	0.88	0.91	0.10	0.27	3.58	1.10	24.58	15.67	27.47	11.80	2.81
		1994	3.37	3.04	2.79	0.86	0.92	0.12	0.34	3.37	1.35	24.74	16.37	27.47	11.11	2.81
		1995	3.60	3.10	2.98	0.70	0.80	0.22	0.32	2.96	1.18	24.85	16.62	27.37	10.75	2.58
		1996	3.30	3.06	2.88	0.82	0.88	0.14	0.28	3.44	1.15	24.70	16.30	27.40	11.10	2.73
		1997	3.29	2.85	2.72	0.91	0.97	0.07	0.34	3.54	1.44	24.86	17.22	27.43	10.20	2.95
		1998	3.21	2.85	2.68	0.92	0.99	0.05	0.38	3.39	1.51	24.97	17.37	27.50	10.13	2.95
		1999	3.10	2.95	2.84	0.87	0.96	0.07	0.24	3.69	1.14	24.81	16.67	27.41	10.74	2.89
		2000	3.01	3.02	2.83	0.91	0.97	0.04	0.23	3.75	1.05	24.74	16.41	27.45	11.05	2.92
		2001	3.15	2.91	2.84	0.91	0.99	0.05	0.27	3.61	1.14	24.89	17.27	27.52	10.25	2.98
		2002	2.95	3.12	2.85	0.93	1.00	0.04	0.23	3.90	0.98	24.61	16.02	27.45	11.43	2.96
		2003	3.17	2.98	2.97	0.85	0.97	0.07	0.22	3.54	0.95	24.90	17.37	27.48	10.11	2.90
		2004	3.36	2.76	2.86	0.89	0.96	0.08	0.28	3.48	1.15	24.74	17.83	27.51	9.68	2.84
		2005	3.49	2.82	2.90	0.84	0.90	0.14	0.25	3.37	1.11	24.51	17.57	27.46	9.89	2.69
		2006	3.50	2.98	3.03	0.80	0.89	0.15	0.23	3.27	1.00	24.88	17.36	27.49	10.13	2.75
		2007	3.62	2.88	2.84	0.84	0.89	0.13	0.33	3.12	1.45	25.00	17.56	27.48	9.92	2.76
		2008	3.61	2.97	2.90	0.83	0.92	0.14	0.33	3.25	1.32	24.95	17.79	27.49	9.70	2.87
		2009	3.58	2.96	2.94	0.81	0.89	0.14	0.26	3.27	1.21	24.96	17.58	27.52	9.94	2.76
		2010	3.51	3.10	2.98	0.77	0.91	0.21	0.29	3.44	1.07	24.66	17.26	27.42	10.16	2.90
		2011	3.55	2.87	2.85	0.88	0.96	0.08	0.28	3.25	1.38	25.06	18.09	27.58	9.49	2.93
		2012	3.47	2.76	2.81	0.93	0.98	0.03	0.27	3.34	1.40	25.15	18.11	27.65	9.54	2.95
		2013	3.74	2.80	2.82	0.87	0.95	0.09	0.28	3.27	1.57	25.13	18.34	27.62	9.28	2.90
		2014	3.56	2.85	2.82	0.87	0.98	0.08	0.28	3.36	1.48	25.05	18.25	27.61	9.36	3.00
		2015	3.66	2.85	2.85	0.85	0.91	0.13	0.27	3.32	1.41	24.94	17.74	27.53	9.78	2.82
		2016	3.75	2.73	2.67	0.87	0.94	0.09	0.33	3.24	1.86	25.08	18.23	27.49	9.25	2.88
		2017	3.88	2.77	2.76	0.81	0.91	0.14	0.36	3.06	1.80	25.13	18.80	27.54	8.74	2.85
		2018	3.63	2.75	2.80	0.89	0.96	0.08	0.27	3.38	1.54	25.06	18.27	27.54	9.27	2.92
		2019	3.32	2.77	2.78	0.95	0.99	0.03	0.23	3.60	1.36	24.95	17.60	27.54	9.94	2.96
SP	UL	1982	3.10	3.20	2.95	0.68	0.97	0.15	0.44	3.62	0.85	24.62	16.56	27.25	10.70	2.98

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		1983	3.38	2.89	2.69	0.83	0.98	0.09	0.47	3.14	1.57	24.93	17.38	27.47	10.09	2.91
		1984	3.66	2.63	2.65	0.73	0.96	0.22	0.62	2.83	1.72	24.92	17.61	27.66	10.05	2.76
		1985	3.48	2.83	2.67	0.86	0.97	0.09	0.47	3.12	1.63	24.96	17.64	27.56	9.92	2.89
		1986	2.96	3.01	2.73	0.88	0.98	0.05	0.34	3.70	1.18	24.71	16.23	27.40	11.17	2.95
		1987	2.77	3.11	2.79	0.91	0.99	0.06	0.28	3.96	0.86	24.44	15.12	27.44	12.32	2.94
		1988	3.14	2.84	2.67	0.90	0.99	0.05	0.41	3.46	1.36	24.84	16.85	27.47	10.62	2.94
		1989	2.86	3.05	2.77	0.92	1.00	0.05	0.30	3.82	1.05	24.60	15.40	27.52	12.12	2.95
		1990	3.04	3.01	2.78	0.84	1.00	0.13	0.40	3.62	1.05	24.53	15.34	27.66	12.31	2.87
		1991	2.58	3.38	2.89	0.93	0.98	0.05	0.16	4.24	0.49	24.19	13.87	27.47	13.61	2.94
		1992	2.46	3.37	2.91	0.90	0.99	0.05	0.17	4.35	0.50	24.16	13.63	27.50	13.87	2.93
		1993	2.62	3.36	2.94	0.91	0.96	0.08	0.18	4.20	0.52	24.20	13.81	27.51	13.70	2.88
		1994	2.58	3.44	2.95	0.92	0.96	0.07	0.16	4.27	0.47	24.14	13.45	27.49	14.04	2.89
		1995	2.76	3.41	2.88	0.91	0.95	0.08	0.22	4.04	0.73	24.21	13.81	27.51	13.70	2.87
		1996	2.63	3.36	2.87	0.93	0.98	0.06	0.20	4.16	0.66	24.23	13.89	27.55	13.66	2.93
		1997	2.60	3.28	2.85	0.88	1.00	0.10	0.26	4.21	0.63	24.12	13.53	27.53	14.00	2.90
		1998	2.51	3.44	2.92	0.92	0.97	0.06	0.16	4.33	0.50	24.09	13.40	27.50	14.10	2.91
		1999	2.58	3.47	2.94	0.90	0.95	0.08	0.16	4.29	0.50	24.09	13.28	27.47	14.19	2.87
		2000	2.80	3.34	2.96	0.82	0.91	0.16	0.22	4.02	0.58	24.19	13.74	27.45	13.71	2.75
		2001	2.58	3.41	2.92	0.93	0.98	0.06	0.18	4.26	0.53	24.16	13.66	27.49	13.83	2.93
		2002	2.49	3.42	2.90	0.93	0.99	0.04	0.16	4.33	0.52	24.16	13.62	27.52	13.89	2.97
		2003	2.57	3.50	2.96	0.87	0.95	0.11	0.17	4.30	0.44	24.03	13.11	27.49	14.38	2.87
		2004	2.60	3.45	2.92	0.91	0.97	0.05	0.19	4.24	0.56	24.18	13.68	27.50	13.82	2.92
		2005	2.65	3.38	2.91	0.94	0.98	0.04	0.18	4.14	0.62	24.29	14.08	27.54	13.46	2.94
		2006	2.73	3.19	2.89	0.90	1.00	0.09	0.25	4.06	0.66	24.34	14.38	27.57	13.19	2.91
		2007	2.59	3.36	2.91	0.90	0.99	0.08	0.21	4.23	0.56	24.17	13.58	27.55	13.97	2.91
		2008	2.89	3.26	2.92	0.88	0.97	0.07	0.27	3.88	0.73	24.49	14.98	27.52	12.54	2.93
		2009	2.93	3.31	2.95	0.89	0.94	0.09	0.21	3.82	0.72	24.45	14.68	27.57	12.89	2.85
		2010	2.60	3.38	2.91	0.93	1.00	0.06	0.19	4.22	0.56	24.20	13.72	27.61	13.89	2.94
		2011	2.78	3.41	3.00	0.84	0.92	0.12	0.19	4.04	0.52	24.22	13.88	27.43	13.55	2.82

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		2012	2.79	3.29	2.97	0.87	0.96	0.09	0.20	3.94	0.60	24.42	14.52	27.55	13.03	2.87
		2013	2.67	3.37	2.93	0.94	0.99	0.03	0.16	4.10	0.60	24.34	14.32	27.58	13.27	2.96
		2014	2.56	3.39	3.01	0.94	1.00	0.04	0.12	4.28	0.34	24.27	13.72	27.60	13.88	2.96
		2015	2.36	3.49	2.99	0.93	1.00	0.04	0.09	4.49	0.26	24.07	13.10	27.51	14.41	2.96
		2016	2.56	3.42	3.01	0.90	0.98	0.07	0.12	4.28	0.35	24.21	13.65	27.54	13.89	2.92
		2017	2.52	3.62	2.99	0.92	0.95	0.07	0.11	4.38	0.37	23.97	12.82	27.54	14.72	2.88
		2018	2.46	3.54	2.94	0.95	0.99	0.03	0.13	4.39	0.43	24.06	13.22	27.55	14.34	2.96
		2019	2.53	3.54	3.04	0.87	0.99	0.10	0.16	4.32	0.26	24.05	13.49	27.56	14.07	2.97
SP	LL	1982	2.96	3.03	2.90	0.83	0.95	0.09	0.25	3.62	0.89	24.73	15.97	27.33	11.36	2.86
		1983	3.08	3.01	2.82	0.85	0.97	0.07	0.31	3.46	1.13	24.79	16.62	27.45	10.83	2.91
		1984	3.39	2.68	2.73	0.82	0.98	0.14	0.46	3.12	1.43	24.99	17.31	27.56	10.25	2.85
		1985	3.28	2.98	2.97	0.77	0.99	0.20	0.40	3.41	0.87	24.71	17.53	27.23	9.70	3.09
		1986	3.14	2.76	2.76	0.91	0.96	0.07	0.32	3.49	1.16	24.91	16.80	27.29	10.49	2.89
		1987	3.07	2.80	2.80	0.89	0.98	0.07	0.33	3.53	1.12	24.89	16.65	27.32	10.66	2.94
		1988	3.13	2.76	2.77	0.91	0.97	0.07	0.33	3.49	1.19	24.95	16.82	27.33	10.51	2.91
		1989	3.22	2.74	2.73	0.92	0.99	0.03	0.37	3.29	1.35	25.09	17.46	27.44	9.98	2.95
		1990	3.06	2.76	2.83	0.88	1.00	0.09	0.33	3.55	1.03	24.90	16.48	27.48	11.00	2.92
		1991	3.06	2.81	2.70	0.95	1.00	0.02	0.34	3.57	1.28	24.89	16.63	27.37	10.74	2.98
		1992	2.79	3.03	2.79	0.94	1.00	0.03	0.26	3.90	0.94	24.56	15.47	27.40	11.93	2.96
		1993	2.89	3.01	2.77	0.95	0.99	0.03	0.27	3.81	1.04	24.63	15.57	27.41	11.83	2.95
		1994	2.77	3.11	2.82	0.95	0.99	0.03	0.24	3.97	0.87	24.51	15.10	27.43	12.34	2.95
		1995	3.13	2.96	2.70	0.94	1.00	0.02	0.37	3.46	1.35	24.84	16.57	27.49	10.92	2.99
		1996	2.88	3.10	2.75	0.96	1.00	0.02	0.29	3.79	1.09	24.61	15.38	27.47	12.09	2.97
		1997	2.85	2.95	2.81	0.94	1.00	0.02	0.26	3.82	0.95	24.74	16.06	27.38	11.32	2.99
		1998	3.02	2.88	2.79	0.90	0.97	0.05	0.29	3.61	1.10	24.83	16.55	27.39	10.84	2.92
		1999	2.80	2.99	2.83	0.92	0.98	0.03	0.25	3.87	0.89	24.68	15.73	27.30	11.57	2.95
		2000	2.91	2.93	2.77	0.93	0.99	0.03	0.29	3.74	1.08	24.77	16.18	27.36	11.17	2.97
		2001	2.90	3.03	2.82	0.95	0.99	0.03	0.25	3.83	0.96	24.69	15.65	27.39	11.75	2.97
		2002	3.15	2.83	2.81	0.90	1.00	0.04	0.33	3.41	1.17	25.04	17.39	27.43	10.04	3.01

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		2003	2.90	2.84	2.85	0.91	1.00	0.03	0.27	3.76	0.87	24.87	16.58	27.40	10.82	2.96
		2004	2.86	2.94	2.96	0.86	1.00	0.06	0.25	3.83	0.66	24.73	16.57	27.45	10.88	2.91
		2005	3.29	2.83	2.94	0.83	0.95	0.07	0.28	3.22	1.03	25.16	17.74	27.47	9.73	2.88
		2006	3.44	2.86	2.85	0.84	1.00	0.14	0.43	3.17	1.22	25.12	18.11	27.63	9.52	2.86
		2007	3.25	2.76	2.82	0.91	1.00	0.05	0.35	3.35	1.23	25.10	17.74	27.51	9.77	2.95
		2008	3.05	2.91	2.84	0.92	0.97	0.05	0.26	3.62	1.00	24.86	16.45	27.42	10.97	2.92
		2009	3.49	2.71	2.73	0.93	0.97	0.05	0.39	3.03	1.53	25.24	17.93	27.55	9.62	2.91
		2010	3.59	2.57	2.57	0.95	1.00	0.01	0.49	2.83	1.90	25.15	18.96	27.59	8.63	2.93
		2011	2.93	2.89	2.83	0.89	1.00	0.06	0.27	3.73	0.93	24.65	16.32	27.41	11.09	2.92
		2012	3.14	2.90	2.77	0.93	1.00	0.01	0.32	3.49	1.24	24.93	16.88	27.50	10.62	2.98
		2013	3.44	2.75	2.68	0.93	0.99	0.02	0.40	3.10	1.65	25.16	17.85	27.52	9.68	2.95
		2014	3.47	2.81	2.71	0.90	0.99	0.02	0.38	2.99	1.66	25.20	18.25	27.60	9.35	2.96
		2015	2.97	2.92	2.80	0.94	0.99	0.02	0.26	3.69	1.06	24.77	16.36	27.46	11.10	2.95
		2016	2.92	3.03	2.88	0.89	0.99	0.03	0.25	3.72	0.91	24.78	16.11	27.43	11.32	2.96
		2017	3.16	2.98	2.80	0.91	0.97	0.05	0.30	3.53	1.20	24.84	16.45	27.50	11.06	2.92
		2018	3.36	2.86	2.69	0.93	0.99	0.04	0.38	3.23	1.56	25.03	17.30	27.56	10.26	2.95
		2019	3.38	2.79	2.76	0.88	0.94	0.08	0.36	3.18	1.43	25.07	17.50	27.46	9.96	2.86
FA	SL	1986	2.99	3.26	3.02	0.69	0.81	0.27	0.16	3.96	0.36	23.37	15.48	27.12	11.64	2.48
		1987	2.71	3.12	2.92	0.71	0.83	0.24	0.17	4.05	0.25	22.61	15.36	27.10	11.75	2.36
		1988	3.40	3.35	3.20	0.55	0.69	0.41	0.22	3.47	0.39	23.56	15.34	27.14	11.79	2.26
		1989	2.92	3.32	3.05	0.69	0.80	0.29	0.16	3.88	0.27	22.94	14.92	27.21	12.29	2.39
		1990	3.21	3.16	2.95	0.69	0.78	0.28	0.23	3.57	0.65	23.22	15.85	27.24	11.39	2.35
		1991	3.04	3.16	3.08	0.72	0.86	0.27	0.19	3.91	0.25	22.74	16.17	27.17	11.00	2.46
		1992	3.18	3.41	3.19	0.62	0.64	0.37	0.08	3.70	0.21	22.99	13.86	27.16	13.29	2.04
		1993	3.25	3.15	3.15	0.48	0.86	0.49	0.42	3.65	0.22	23.20	15.35	27.28	11.93	2.50
		1994	3.32	3.42	3.21	0.57	0.70	0.37	0.16	3.69	0.24	23.35	14.53	27.15	12.62	2.26
		1995	2.99	3.32	3.05	0.67	0.81	0.28	0.20	3.88	0.33	23.12	14.39	27.28	12.89	2.39
		1996	3.14	3.45	3.27	0.58	0.67	0.39	0.10	3.78	0.07	23.42	13.79	27.14	13.35	2.19
		1997	2.65	3.45	3.10	0.72	0.81	0.24	0.10	4.30	0.09	23.28	13.34	27.26	13.92	2.45

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		1998	2.45	3.07	2.87	0.77	0.82	0.21	0.07	4.26	0.15	21.49	13.75	27.20	13.45	2.06
		1999	3.11	3.48	3.20	0.61	0.73	0.34	0.16	3.81	0.22	23.74	14.29	27.15	12.86	2.40
		2000	2.84	3.54	3.15	0.65	0.79	0.28	0.16	4.07	0.14	23.43	13.77	27.22	13.44	2.47
		2001	3.36	3.56	3.31	0.54	0.89	0.41	0.39	3.57	0.22	23.78	16.95	27.13	10.18	2.98
		2002	2.88	3.31	3.09	0.72	0.83	0.25	0.17	3.97	0.31	23.45	15.03	27.23	12.20	2.54
		2003	3.19	3.36	3.14	0.63	0.83	0.34	0.24	3.85	0.39	23.52	15.34	27.24	11.90	2.57
		2004	2.98	3.37	3.08	0.68	0.80	0.29	0.17	3.96	0.36	23.65	14.31	27.27	12.96	2.48
		2005	2.68	3.18	2.92	0.74	0.86	0.20	0.16	4.24	0.37	22.77	14.49	27.28	12.79	2.38
		2006	3.53	3.57	3.30	0.53	0.91	0.43	0.42	3.48	0.35	23.85	17.52	27.16	9.63	3.03
		2007	3.43	3.44	3.28	0.56	0.91	0.42	0.40	3.53	0.32	23.84	17.50	27.15	9.65	3.02
		2008	2.62	3.14	2.96	0.75	0.90	0.23	0.18	4.24	0.20	22.54	15.36	27.23	11.87	2.53
		2009	3.23	3.41	3.18	0.59	0.88	0.35	0.33	3.78	0.36	23.80	16.32	27.17	10.86	2.83
		2010	2.80	3.35	3.03	0.76	0.88	0.22	0.15	4.22	0.36	23.56	14.79	27.30	12.51	2.68
		2011	2.81	3.23	2.98	0.68	0.86	0.25	0.21	4.06	0.32	22.75	15.74	27.20	11.46	2.49
		2012	3.40	3.48	3.24	0.55	0.81	0.41	0.31	3.52	0.37	23.75	16.44	27.17	10.73	2.68
		2013	3.03	3.32	3.02	0.66	0.84	0.25	0.24	3.93	0.57	23.73	15.23	27.27	12.04	2.58
		2014	2.99	3.24	3.05	0.68	0.88	0.28	0.25	4.04	0.43	23.74	15.49	27.28	11.79	2.69
		2015	3.04	3.27	3.06	0.68	0.87	0.27	0.25	3.95	0.48	23.77	16.11	27.22	11.10	2.71
		2016	2.85	3.20	2.93	0.78	0.92	0.20	0.20	4.09	0.55	23.26	16.14	27.31	11.17	2.70
		2017	2.62	3.00	2.83	0.74	0.90	0.21	0.21	4.13	0.36	21.64	16.22	27.23	11.01	2.29
		2018	2.96	3.09	2.90	0.73	0.88	0.25	0.20	4.02	0.64	22.92	15.76	27.39	11.62	2.46
		2019	3.10	3.06	2.94	0.71	0.80	0.27	0.12	4.03	0.57	22.42	16.06	27.25	11.19	2.25
FA	GB	1982	3.65	3.08	2.91	0.67	0.85	0.27	0.45	3.06	1.28	24.71	17.58	27.30	9.72	2.75
		1983	4.04	3.31	3.24	0.47	0.82	0.50	0.53	2.78	0.82	24.34	18.44	27.14	8.70	2.85
		1984	3.77	3.08	3.02	0.60	0.84	0.37	0.49	2.96	1.09	24.54	17.60	27.28	9.68	2.75
		1985	3.62	3.35	3.13	0.59	0.88	0.36	0.46	3.20	0.84	24.46	17.64	27.24	9.59	2.95
		1986	3.68	3.36	3.17	0.58	0.90	0.38	0.48	3.15	0.77	24.43	17.85	27.21	9.36	3.01
		1987	3.80	3.45	3.28	0.48	0.86	0.48	0.50	3.08	0.64	24.39	18.02	27.16	9.14	2.99
		1988	3.58	3.22	3.06	0.64	0.84	0.33	0.40	3.23	0.94	24.53	17.08	27.23	10.15	2.79

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		1989	3.28	3.46	3.09	0.68	0.86	0.28	0.31	3.55	0.66	24.25	15.64	27.32	11.68	2.80
		1990	3.92	3.24	3.13	0.53	0.87	0.45	0.53	2.93	0.98	24.46	18.27	27.24	8.97	2.93
		1991	4.03	3.31	3.21	0.50	0.80	0.48	0.50	2.75	0.85	24.39	18.04	27.19	9.15	2.80
		1992	3.79	3.27	3.14	0.54	0.83	0.43	0.47	3.06	0.86	24.32	17.60	27.20	9.60	2.79
		1993	3.40	3.28	3.08	0.59	0.91	0.37	0.44	3.48	0.76	24.18	16.49	27.37	10.88	2.83
		1994	3.78	3.10	3.02	0.58	0.79	0.39	0.35	3.24	0.88	23.51	16.45	27.30	10.84	2.38
		1995	3.89	3.52	3.38	0.40	0.87	0.53	0.55	3.00	0.47	24.33	18.13	27.12	8.99	3.06
		1996	3.84	3.47	3.34	0.45	0.86	0.50	0.50	3.06	0.54	24.38	17.94	27.12	9.18	2.98
		1997	3.59	3.37	3.23	0.52	0.89	0.42	0.44	3.40	0.57	24.32	17.40	27.18	9.78	2.99
		1998	3.55	3.40	3.22	0.53	0.87	0.38	0.41	3.41	0.52	24.18	17.03	27.10	10.07	2.89
		1999	3.60	3.36	3.18	0.56	0.91	0.39	0.44	3.40	0.63	24.33	17.46	27.20	9.74	3.03
		2000	3.18	3.44	3.14	0.59	0.94	0.30	0.42	3.72	0.53	24.33	16.76	27.21	10.44	3.04
		2001	3.78	3.41	3.25	0.53	0.94	0.44	0.54	3.13	0.69	24.37	18.62	27.20	8.58	3.19
		2002	3.67	3.38	3.25	0.56	0.91	0.43	0.43	3.40	0.60	24.24	17.95	27.20	9.25	3.06
		2003	4.06	3.43	3.34	0.43	0.87	0.55	0.53	2.99	0.67	24.26	18.70	27.15	8.45	3.04
		2004	3.97	3.37	3.25	0.48	0.90	0.48	0.50	3.15	0.81	24.24	18.62	27.20	8.58	3.02
		2005	3.71	3.31	3.22	0.49	0.92	0.44	0.53	3.26	0.69	24.39	18.08	27.21	9.13	3.04
		2006	3.42	3.30	3.07	0.66	0.91	0.29	0.38	3.54	0.91	24.42	17.26	27.32	10.06	2.93
		2007	3.87	3.27	3.14	0.58	0.90	0.38	0.44	3.28	0.99	24.34	18.63	27.26	8.62	3.00
		2008	3.63	3.30	3.19	0.56	0.90	0.40	0.43	3.40	0.69	24.13	18.02	27.21	9.19	2.96
		2009	3.45	3.22	2.99	0.68	0.89	0.26	0.33	3.64	1.03	24.25	17.08	27.31	10.23	2.81
		2010	3.97	3.23	3.13	0.55	0.91	0.41	0.48	3.16	1.07	24.45	19.12	27.25	8.13	3.04
		2011	3.47	3.21	3.00	0.68	0.87	0.26	0.31	3.53	1.05	24.48	17.30	27.32	10.02	2.79
		2012	3.32	3.31	3.00	0.57	0.96	0.20	0.48	3.69	1.01	24.56	17.46	27.28	9.82	3.02
		2013	3.57	3.21	2.98	0.67	0.87	0.27	0.34	3.50	1.26	24.54	17.12	27.40	10.28	2.77
		2014	3.41	3.28	3.09	0.66	0.90	0.29	0.31	3.67	0.86	24.41	17.27	27.32	10.05	2.90
		2015	3.64	3.30	3.11	0.58	0.91	0.33	0.42	3.43	0.94	24.37	18.07	27.27	9.20	2.97
		2016	3.33	3.13	2.93	0.73	0.85	0.22	0.23	3.71	1.07	23.94	16.80	27.40	10.61	2.57
		2017	3.64	3.18	3.07	0.64	0.80	0.33	0.26	3.41	0.91	23.82	17.37	27.34	9.97	2.51

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		2018	3.56	3.10	2.98	0.71	0.84	0.27	0.20	3.62	1.01	23.64	17.12	27.40	10.28	2.52
		2019	3.93	3.22	3.12	0.55	0.69	0.42	0.20	3.36	1.01	23.93	16.67	27.27	10.60	2.30
FA	MG	1982	3.14	3.20	3.10	0.64	0.78	0.32	0.19	3.72	0.42	23.97	14.87	27.30	12.43	2.39
		1983	3.35	3.29	3.11	0.62	0.72	0.34	0.17	3.43	0.58	23.98	15.09	27.25	12.16	2.28
		1984	3.98	3.12	3.10	0.52	0.72	0.46	0.38	2.86	1.07	24.24	17.06	27.30	10.24	2.36
		1985	3.28	2.98	2.87	0.73	0.88	0.23	0.31	3.49	1.07	24.54	16.70	27.36	10.66	2.67
		1986	3.46	3.19	3.06	0.67	0.85	0.30	0.29	3.38	0.83	24.41	16.45	27.33	10.88	2.70
		1987	3.29	3.09	3.00	0.67	0.83	0.28	0.30	3.52	0.80	24.41	15.99	27.29	11.30	2.60
		1988	3.48	3.06	2.90	0.69	0.86	0.25	0.36	3.35	1.19	24.58	16.78	27.42	10.64	2.67
		1989	3.61	3.04	2.80	0.75	0.88	0.21	0.38	3.22	1.48	24.69	17.08	27.46	10.38	2.73
		1990	3.85	3.00	2.91	0.68	0.90	0.30	0.49	2.96	1.40	24.76	18.42	27.41	8.99	2.88
		1991	3.59	2.99	2.87	0.75	0.80	0.24	0.33	3.09	1.29	24.45	16.80	27.35	10.55	2.51
		1992	3.63	3.05	2.98	0.65	0.78	0.31	0.33	3.09	1.06	24.43	16.41	27.33	10.92	2.46
		1993	3.53	3.04	2.96	0.66	0.81	0.31	0.35	3.24	1.04	24.32	16.34	27.39	11.05	2.52
		1994	3.53	3.09	3.02	0.58	0.77	0.36	0.33	3.31	0.90	24.28	15.67	27.35	11.69	2.39
		1995	3.87	3.09	3.02	0.58	0.72	0.37	0.36	2.92	1.15	24.48	16.48	27.31	10.84	2.36
		1996	3.46	3.16	2.99	0.66	0.79	0.30	0.30	3.40	0.97	24.31	15.69	27.37	11.69	2.48
		1997	3.31	3.05	3.16	0.46	0.78	0.50	0.33	3.65	0.32	23.66	14.23	27.39	13.17	2.24
		1998	3.64	3.28	3.22	0.50	0.63	0.47	0.19	3.40	0.42	23.48	14.18	27.24	13.06	2.04
		1999	3.67	3.11	2.98	0.63	0.80	0.32	0.29	3.25	1.13	24.54	16.81	27.37	10.55	2.53
		2000	3.15	3.18	2.93	0.76	0.91	0.18	0.28	3.73	0.99	24.53	16.06	27.42	11.35	2.77
		2001	3.47	2.95	2.85	0.76	0.92	0.20	0.34	3.47	1.23	24.31	17.08	27.49	10.41	2.73
		2002	3.25	3.15	3.04	0.66	0.83	0.28	0.20	3.72	0.68	23.96	15.70	27.37	11.67	2.50
		2003	3.46	3.13	3.01	0.69	0.85	0.28	0.26	3.61	0.94	24.20	16.35	27.37	11.02	2.65
		2004	3.63	3.10	3.09	0.61	0.81	0.37	0.31	3.33	0.82	24.30	16.68	27.33	10.65	2.56
		2005	3.69	2.98	2.94	0.69	0.81	0.28	0.23	3.47	1.25	24.42	17.04	27.48	10.44	2.53
		2006	3.77	3.13	3.02	0.64	0.74	0.32	0.19	3.31	1.16	24.29	16.72	27.41	10.69	2.37
		2007	3.89	2.94	3.02	0.71	0.82	0.28	0.26	3.12	1.17	24.52	17.88	27.48	9.60	2.55
		2008	3.68	3.13	2.93	0.69	0.80	0.27	0.24	3.47	1.28	24.48	16.65	27.44	10.79	2.56

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		2009	3.87	3.19	3.07	0.59	0.76	0.35	0.27	3.30	1.15	24.48	16.94	27.38	10.44	2.49
		2010	3.58	2.95	2.87	0.75	0.91	0.22	0.28	3.67	1.21	23.87	17.51	27.43	9.92	2.71
		2011	3.84	3.16	3.05	0.64	0.75	0.30	0.20	3.32	1.18	24.67	17.16	27.38	10.22	2.52
		2012	3.44	2.91	2.85	0.83	0.92	0.14	0.21	3.52	1.33	24.80	17.48	27.58	10.10	2.80
		2013	3.68	3.04	2.84	0.78	0.88	0.19	0.23	3.45	1.61	24.78	17.33	27.63	10.30	2.69
		2014	3.60	2.94	2.83	0.79	0.96	0.16	0.27	3.61	1.48	24.77	17.84	27.59	9.75	2.89
		2015	3.67	3.20	3.10	0.63	0.74	0.34	0.18	3.36	0.88	23.97	16.54	27.34	10.80	2.37
		2016	3.84	3.00	2.99	0.66	0.77	0.31	0.24	3.21	1.25	24.58	17.41	27.41	10.00	2.46
		2017	3.53	3.06	2.97	0.67	0.75	0.30	0.14	3.60	0.99	23.44	16.70	27.35	10.65	2.27
		2018	3.39	2.91	2.81	0.76	0.87	0.21	0.17	3.74	1.22	23.63	16.91	27.55	10.63	2.47
		2019	3.41	2.90	2.88	0.78	0.88	0.19	0.18	3.58	1.18	24.22	17.26	27.52	10.26	2.58
FA	SA	1982	3.37	3.08	2.89	0.72	0.85	0.24	0.27	3.62	1.04	24.33	16.07	27.38	11.31	2.62
		1983	3.23	3.12	2.92	0.70	0.88	0.22	0.27	3.78	0.88	24.06	16.19	27.33	11.14	2.64
		1984	3.54	2.75	2.73	0.72	0.99	0.24	0.51	3.38	1.46	24.58	18.10	27.48	9.38	2.90
		1985	3.10	2.72	2.73	0.78	0.97	0.18	0.39	3.72	1.03	24.06	16.93	27.44	10.51	2.73
		1986	3.25	2.77	2.71	0.81	0.96	0.14	0.34	3.73	1.25	24.18	17.12	27.41	10.29	2.79
		1987	3.18	2.58	2.69	0.67	0.97	0.31	0.41	3.76	0.85	22.79	16.07	27.51	11.44	2.33
		1988	3.30	2.91	2.86	0.75	0.95	0.23	0.36	3.57	1.01	24.20	17.06	27.43	10.37	2.76
		1989	3.15	2.91	2.73	0.83	0.94	0.11	0.32	3.60	1.19	24.23	16.74	27.46	10.72	2.74
		1990	3.32	2.72	2.69	0.79	0.96	0.19	0.41	3.49	1.34	24.46	16.77	27.56	10.79	2.74
		1991	3.09	2.84	2.72	0.82	0.97	0.15	0.39	3.64	1.15	24.29	16.20	27.52	11.32	2.77
		1992	3.31	2.83	2.77	0.76	0.93	0.21	0.37	3.51	1.18	24.08	17.15	27.44	10.29	2.64
		1993	3.36	2.84	2.73	0.77	0.91	0.20	0.33	3.57	1.28	23.95	16.60	27.50	10.90	2.57
		1994	3.48	2.94	2.79	0.76	0.87	0.19	0.32	3.32	1.29	24.12	16.81	27.42	10.61	2.55
		1995	3.54	2.93	2.78	0.75	0.93	0.16	0.43	3.14	1.54	24.83	17.94	27.44	9.50	2.85
		1996	3.27	3.11	2.84	0.75	0.92	0.17	0.31	3.60	1.10	24.04	16.24	27.46	11.22	2.63
		1997	3.21	2.88	2.76	0.80	0.97	0.13	0.36	3.61	1.23	24.22	16.79	27.47	10.68	2.77
		1998	3.23	3.14	2.90	0.76	0.91	0.20	0.23	3.86	0.82	23.45	15.79	27.43	11.65	2.55
		1999	3.31	3.21	2.95	0.68	0.89	0.27	0.18	3.90	0.73	23.42	15.84	27.42	11.58	2.41

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		2000	2.93	3.31	2.96	0.76	0.90	0.16	0.22	3.90	0.65	23.97	15.12	27.42	12.31	2.70
		2001	3.06	3.14	2.85	0.84	0.99	0.12	0.23	4.04	0.91	23.88	16.05	27.51	11.46	2.83
		2002	3.19	3.11	2.98	0.72	0.95	0.23	0.30	3.77	0.84	24.27	16.69	27.46	10.77	2.84
		2003	3.20	3.09	2.93	0.73	0.96	0.21	0.27	3.85	0.86	23.99	16.54	27.47	10.93	2.77
		2004	3.49	2.94	2.99	0.65	0.88	0.32	0.28	3.65	0.78	23.76	16.59	27.42	10.83	2.54
		2005	3.51	2.86	2.86	0.72	0.92	0.23	0.27	3.66	0.99	23.43	17.17	27.51	10.34	2.53
		2006	3.49	2.94	2.83	0.80	0.92	0.15	0.25	3.65	1.24	24.02	17.21	27.54	10.33	2.68
		2007	3.79	2.84	2.87	0.75	0.87	0.22	0.21	3.53	1.22	23.58	17.56	27.54	9.98	2.46
		2008	3.36	3.10	2.87	0.81	0.91	0.14	0.22	3.69	1.17	24.45	16.61	27.55	10.94	2.75
		2009	2.98	3.12	2.83	0.85	0.97	0.11	0.22	4.04	0.86	23.99	15.43	27.57	12.13	2.76
		2010	3.25	3.00	2.87	0.80	0.96	0.16	0.24	3.85	0.98	23.86	16.70	27.55	10.85	2.73
		2011	3.00	3.06	2.92	0.84	0.93	0.12	0.19	3.94	0.82	24.51	16.11	27.48	11.37	2.81
		2012	3.26	2.90	2.81	0.84	0.97	0.10	0.21	3.72	1.19	24.61	17.31	27.58	10.27	2.86
		2013	3.62	2.97	2.83	0.82	0.94	0.15	0.25	3.58	1.38	24.45	17.48	27.61	10.12	2.82
		2014	3.53	2.77	2.82	0.78	0.97	0.18	0.28	3.61	1.33	24.70	17.45	27.62	10.17	2.83
		2015	3.53	2.69	2.75	0.83	0.94	0.13	0.21	3.65	1.33	24.01	17.94	27.60	9.66	2.63
		2016	3.93	3.07	3.09	0.60	0.70	0.38	0.18	3.28	0.93	23.78	16.48	27.35	10.87	2.22
		2017	3.24	3.09	2.90	0.78	0.89	0.16	0.16	3.90	0.85	23.47	15.96	27.46	11.50	2.55
		2018	3.41	2.89	2.73	0.86	0.95	0.12	0.23	3.81	1.30	23.66	16.75	27.59	10.84	2.70
		2019	3.56	2.82	2.76	0.81	0.91	0.16	0.25	3.69	1.19	23.08	17.16	27.49	10.33	2.49
FA	AB	1982	2.90	3.15	3.00	0.64	0.88	0.30	0.27	3.91	0.46	23.81	14.48	27.46	12.99	2.52
		1983	3.10	3.13	2.99	0.63	0.87	0.31	0.30	3.69	0.65	23.75	15.46	27.42	11.95	2.52
		1984	3.52	2.85	2.92	0.57	0.92	0.41	0.51	3.29	0.91	23.78	17.66	27.36	9.71	2.66
		1985	2.87	2.94	2.79	0.81	0.97	0.14	0.31	3.96	0.87	24.00	16.40	27.43	11.03	2.79
		1986	3.16	3.12	2.97	0.72	0.88	0.22	0.29	3.67	0.82	24.31	16.14	27.37	11.23	2.70
		1987	2.77	3.00	2.94	0.68	0.95	0.25	0.31	4.03	0.50	23.99	14.88	27.45	12.57	2.65
		1988	3.08	3.14	3.01	0.67	0.82	0.28	0.24	3.78	0.60	24.06	14.99	27.36	12.37	2.49
		1989	2.89	3.17	2.90	0.77	0.90	0.18	0.26	3.90	0.68	24.06	14.80	27.41	12.61	2.67
		1990	2.84	2.94	2.88	0.73	0.95	0.24	0.35	3.98	0.61	23.98	15.01	27.46	12.46	2.69

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		1991	3.30	2.84	2.74	0.79	0.91	0.18	0.42	3.38	1.29	24.53	16.57	27.46	10.89	2.69
		1992	2.94	2.90	2.80	0.77	0.92	0.20	0.33	3.78	0.86	23.77	15.62	27.44	11.82	2.57
		1993	2.63	3.03	2.90	0.76	0.93	0.22	0.24	4.19	0.43	23.54	14.22	27.45	13.22	2.58
		1994	3.20	2.98	2.90	0.70	0.86	0.26	0.34	3.58	0.91	24.23	15.51	27.41	11.90	2.56
		1995	3.27	3.10	2.93	0.70	0.85	0.24	0.33	3.49	0.98	24.37	15.68	27.41	11.74	2.59
		1996	3.13	3.19	2.97	0.74	0.83	0.22	0.26	3.64	0.79	24.28	15.04	27.35	12.31	2.58
		1997	2.73	3.04	2.92	0.75	0.95	0.19	0.29	4.10	0.55	23.98	14.90	27.43	12.54	2.72
		1998	3.06	3.14	3.05	0.64	0.85	0.30	0.27	3.73	0.52	23.98	14.84	27.39	12.55	2.51
		1999	2.72	3.17	2.96	0.77	0.93	0.18	0.22	4.08	0.47	24.01	14.65	27.42	12.77	2.73
		2000	2.99	3.38	3.08	0.70	0.85	0.22	0.21	3.74	0.52	24.25	14.70	27.40	12.70	2.64
		2001	3.16	3.11	2.98	0.70	0.94	0.25	0.34	3.72	0.79	24.32	15.88	27.44	11.55	2.81
		2002	3.04	3.17	2.99	0.73	0.87	0.22	0.23	3.85	0.67	24.15	15.31	27.38	12.07	2.63
		2003	2.99	3.01	2.93	0.74	0.92	0.21	0.28	3.87	0.70	23.98	15.56	27.46	11.90	2.65
		2004	3.07	2.97	2.91	0.76	0.91	0.21	0.27	3.75	0.78	23.97	16.16	27.42	11.26	2.64
		2005	3.26	2.94	2.87	0.76	0.90	0.20	0.30	3.63	1.05	24.25	16.59	27.49	10.90	2.64
		2006	3.36	3.10	3.00	0.72	0.81	0.25	0.24	3.42	0.88	24.10	16.42	27.41	10.99	2.49
		2007	3.27	2.87	2.87	0.76	0.90	0.21	0.31	3.53	1.05	24.29	16.56	27.52	10.96	2.62
		2008	2.91	3.31	2.92	0.83	0.92	0.11	0.17	4.06	0.78	24.07	15.16	27.52	12.37	2.74
		2009	3.25	3.22	3.01	0.70	0.83	0.24	0.23	3.66	0.78	24.19	15.23	27.48	12.24	2.55
		2010	3.18	3.10	2.99	0.70	0.95	0.27	0.32	3.82	0.73	24.00	16.41	27.48	11.07	2.81
		2011	3.16	3.06	2.89	0.78	0.93	0.12	0.21	3.67	1.02	24.50	16.75	27.54	10.78	2.77
		2012	3.07	3.17	2.91	0.82	0.93	0.10	0.20	3.72	0.91	24.45	16.17	27.53	11.36	2.81
		2013	3.44	3.08	2.87	0.81	0.93	0.12	0.24	3.58	1.32	24.67	17.06	27.62	10.56	2.80
		2014	3.14	3.02	2.82	0.84	0.98	0.12	0.24	3.88	1.12	24.51	16.27	27.60	11.33	2.90
		2015	3.02	2.98	2.93	0.77	0.91	0.20	0.21	3.91	0.69	23.91	16.15	27.45	11.30	2.65
		2016	3.35	2.94	2.96	0.65	0.79	0.33	0.24	3.56	0.76	23.38	16.16	27.41	11.25	2.28
		2017	3.33	2.94	2.89	0.72	0.82	0.25	0.20	3.69	0.97	23.58	16.30	27.47	11.17	2.38
		2018	3.40	2.95	2.83	0.77	0.84	0.21	0.22	3.60	1.13	23.67	16.49	27.51	11.03	2.43
		2019	3.35	3.03	2.88	0.76	0.87	0.19	0.23	3.60	1.15	24.36	16.53	27.48	10.95	2.65

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
FA	CC	1982	3.14	3.46	3.13	0.58	0.93	0.30	0.39	3.76	0.47	24.27	16.75	27.29	10.55	2.95
		1983	3.40	3.49	3.21	0.57	0.74	0.36	0.23	3.57	0.52	24.27	15.26	27.25	11.99	2.45
		1984	3.20	3.27	3.10	0.56	0.87	0.33	0.39	3.70	0.47	24.30	16.38	27.22	10.84	2.80
		1985	3.15	3.19	2.99	0.70	0.96	0.23	0.38	3.79	0.79	24.47	16.94	27.31	10.37	2.99
		1986	3.09	3.51	3.13	0.63	0.94	0.26	0.36	3.74	0.58	24.40	16.66	27.30	10.64	3.00
		1987	2.87	3.38	3.02	0.76	0.95	0.16	0.28	4.06	0.71	24.38	15.97	27.37	11.40	2.82
		1988	3.05	3.28	2.95	0.70	0.89	0.18	0.31	3.82	0.94	24.47	15.58	27.39	11.81	2.75
		1989	3.11	3.44	3.13	0.64	0.79	0.25	0.22	3.73	0.50	24.25	14.57	27.30	12.73	2.54
		1990	3.26	3.17	3.03	0.74	0.84	0.23	0.20	3.64	0.73	24.49	15.85	27.33	11.48	2.67
		1991	3.02	3.23	3.01	0.73	0.86	0.21	0.24	3.88	0.61	24.35	15.31	27.28	11.97	2.70
		1992	2.83	3.26	2.98	0.75	0.92	0.18	0.26	3.95	0.64	24.34	15.31	27.37	12.06	2.78
		1993	2.82	3.26	2.97	0.80	0.95	0.16	0.26	4.03	0.61	24.29	15.18	27.41	12.23	2.83
		1994	2.86	3.32	2.95	0.78	0.93	0.15	0.24	3.93	0.78	24.37	15.51	27.40	11.89	2.79
		1995	3.11	3.25	2.98	0.77	0.90	0.18	0.27	3.66	0.82	24.51	15.64	27.47	11.83	2.75
		1996	3.02	3.24	2.92	0.75	0.94	0.16	0.31	3.83	0.87	24.43	15.73	27.45	11.72	2.83
		1997	2.81	3.19	2.97	0.73	0.96	0.19	0.31	4.00	0.57	24.34	15.58	27.37	11.79	2.87
		1998	3.12	3.32	3.05	0.65	0.90	0.23	0.33	3.83	0.65	24.36	15.97	27.35	11.38	2.69
		1999	3.28	3.38	3.11	0.61	0.94	0.27	0.39	3.72	0.69	24.46	17.04	27.28	10.24	3.01
		2000	2.60	3.33	2.95	0.82	0.99	0.07	0.23	4.24	0.52	24.33	15.32	27.42	12.10	2.90
		2001	3.19	3.28	3.02	0.72	0.96	0.20	0.34	3.82	0.84	24.48	16.59	27.40	10.81	2.96
		2002	3.02	3.11	2.90	0.79	0.99	0.15	0.28	4.00	0.82	24.10	16.34	27.39	11.05	2.91
		2003	3.10	3.33	3.02	0.67	0.91	0.19	0.30	3.97	0.73	24.17	16.08	27.37	11.29	2.75
		2004	3.17	3.14	2.93	0.80	0.96	0.13	0.28	3.64	1.01	24.51	17.09	27.45	10.36	2.80
		2005	3.44	3.09	2.96	0.75	0.90	0.21	0.30	3.40	1.07	24.58	17.18	27.43	10.25	2.75
		2006	3.31	3.20	2.97	0.73	0.87	0.18	0.27	3.43	1.05	24.62	16.69	27.42	10.74	2.66
		2007	3.28	3.01	2.87	0.74	0.94	0.14	0.35	3.60	1.18	24.57	17.44	27.46	10.02	2.78
		2008	3.35	3.19	2.93	0.79	0.91	0.14	0.26	3.58	1.27	24.67	17.18	27.52	10.34	2.75
		2009	3.33	3.13	2.87	0.79	0.93	0.13	0.33	3.47	1.21	24.70	17.08	27.51	10.43	2.82
		2010	3.11	3.12	2.92	0.79	0.96	0.14	0.25	3.81	1.08	24.55	16.91	27.50	10.59	2.89

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		2011	3.27	3.04	2.91	0.76	0.91	0.15	0.25	3.58	1.14	24.74	17.18	27.47	10.28	2.79
		2012	3.13	3.06	2.84	0.75	1.00	0.06	0.34	3.72	1.20	24.77	17.16	27.50	10.34	2.94
		2013	3.43	2.97	2.78	0.82	0.98	0.09	0.33	3.38	1.48	24.89	17.75	27.59	9.85	2.89
		2014	3.24	3.08	2.97	0.76	0.98	0.11	0.26	3.67	1.01	24.78	17.51	27.55	10.04	2.89
		2015	3.02	3.23	3.04	0.72	0.90	0.16	0.24	3.79	0.67	24.53	16.18	27.39	11.21	2.75
		2016	3.69	3.13	3.04	0.66	0.86	0.24	0.33	3.14	1.17	24.80	17.64	27.43	9.79	2.71
		2017	3.40	3.05	2.95	0.78	0.96	0.13	0.30	3.41	1.13	24.85	17.80	27.55	9.75	2.88
		2018	3.72	2.84	2.80	0.81	0.99	0.12	0.29	3.29	1.68	25.06	18.70	27.69	8.99	2.99
		2019	3.32	3.00	2.85	0.82	0.97	0.08	0.27	3.48	1.34	24.90	17.45	27.57	10.12	2.89
FA	UL	1982	2.90	3.26	2.88	0.79	0.94	0.11	0.29	3.80	0.86	24.45	15.72	27.37	11.65	2.85
		1983	3.41	2.83	2.70	0.78	1.00	0.11	0.51	3.14	1.56	24.92	17.84	27.49	9.65	2.87
		1984	3.28	2.74	2.76	0.73	1.00	0.22	0.52	3.36	1.18	24.65	17.30	27.51	10.21	2.88
		1985	2.92	3.12	2.79	0.72	0.99	0.14	0.47	3.86	0.86	24.41	15.93	27.33	11.40	2.95
		1986	2.73	2.95	2.64	0.90	1.00	0.03	0.31	3.97	1.06	24.58	16.16	27.30	11.14	2.98
		1987	2.86	2.99	2.79	0.87	1.00	0.10	0.33	3.90	0.92	24.49	15.71	27.45	11.74	2.92
		1988	2.55	3.28	2.88	0.81	1.00	0.13	0.28	4.28	0.51	24.04	13.64	27.51	13.87	2.86
		1989	2.64	3.28	2.89	0.86	1.00	0.11	0.27	4.20	0.55	24.13	13.87	27.59	13.72	2.88
		1990	2.75	3.05	2.85	0.90	1.00	0.08	0.24	4.01	0.63	24.44	15.48	27.54	12.07	2.92
		1991	2.42	3.39	2.86	0.94	1.00	0.03	0.16	4.44	0.46	24.10	13.79	27.42	13.64	2.97
		1992	2.34	3.37	2.98	0.87	0.97	0.08	0.15	4.59	0.20	24.01	13.36	27.34	13.97	2.89
		1993	2.38	3.52	3.01	0.84	0.95	0.13	0.14	4.57	0.16	23.81	12.39	27.49	15.10	2.81
		1994	2.38	3.69	3.00	0.92	0.95	0.07	0.08	4.56	0.24	23.85	12.30	27.48	15.18	2.88
		1995	2.37	3.60	2.95	0.90	0.99	0.08	0.16	4.56	0.30	23.84	12.47	27.53	15.06	2.92
		1996	2.42	3.41	2.93	0.86	0.99	0.12	0.21	4.49	0.33	23.89	12.62	27.54	14.91	2.87
		1997	2.34	3.49	2.95	0.89	0.99	0.09	0.16	4.59	0.27	23.87	12.72	27.52	14.80	2.90
		1998	2.46	3.58	2.98	0.80	0.95	0.11	0.22	4.44	0.32	23.94	12.95	27.41	14.46	2.87
		1999	2.56	3.45	2.99	0.80	0.96	0.14	0.23	4.35	0.37	24.03	13.48	27.44	13.97	2.84
		2000	2.50	3.56	2.99	0.87	0.98	0.10	0.18	4.40	0.32	23.97	13.45	27.48	14.03	2.96
		2001	2.65	3.45	2.98	0.83	0.96	0.13	0.21	4.20	0.45	24.07	13.59	27.51	13.92	2.86

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		2002	2.37	3.53	2.99	0.81	0.99	0.12	0.22	4.55	0.20	23.85	12.76	27.48	14.72	2.90
		2003	2.85	3.57	3.14	0.72	0.94	0.23	0.27	4.07	0.25	24.05	14.43	27.34	12.92	2.96
		2004	2.63	3.51	3.03	0.85	0.99	0.10	0.21	4.24	0.37	24.14	14.19	27.48	13.29	3.00
		2005	2.52	3.50	2.95	0.90	0.99	0.06	0.19	4.35	0.43	24.07	13.47	27.56	14.09	2.94
		2006	2.61	3.39	2.94	0.84	0.99	0.10	0.26	4.26	0.49	24.12	13.80	27.53	13.73	2.88
		2007	2.48	3.46	3.00	0.86	0.98	0.10	0.19	4.43	0.28	24.03	13.30	27.49	14.19	2.91
		2008	2.75	3.43	2.97	0.84	0.96	0.10	0.23	4.07	0.55	24.26	14.33	27.50	13.18	2.89
		2009	2.59	3.45	2.93	0.89	0.99	0.08	0.21	4.24	0.49	24.09	13.46	27.62	14.16	2.90
		2010	2.44	3.23	2.97	0.76	0.99	0.23	0.27	4.47	0.20	23.72	12.71	27.57	14.86	2.74
		2011	2.70	3.46	3.00	0.84	0.94	0.10	0.19	4.13	0.45	24.18	14.00	27.48	13.48	2.87
		2012	2.66	3.38	3.01	0.84	0.98	0.09	0.19	4.10	0.41	24.26	14.25	27.59	13.33	2.88
		2013	2.59	3.43	2.97	0.88	1.00	0.08	0.19	4.23	0.42	24.14	13.69	27.63	13.93	2.92
		2014	2.38	3.56	3.02	0.91	1.00	0.04	0.10	4.48	0.24	24.05	13.25	27.55	14.31	2.96
		2015	2.33	3.60	2.98	0.90	1.00	0.05	0.11	4.56	0.24	23.92	12.97	27.53	14.56	2.96
		2016	2.56	3.59	3.01	0.85	0.95	0.09	0.16	4.28	0.34	24.03	13.31	27.52	14.22	2.86
		2017	2.52	3.59	2.99	0.90	0.99	0.05	0.15	4.31	0.38	24.09	13.57	27.58	14.01	2.96
		2018	2.59	3.54	2.99	0.85	0.99	0.09	0.21	4.28	0.41	24.06	13.73	27.56	13.83	2.95
		2019	2.59	3.48	3.01	0.86	0.99	0.07	0.19	4.21	0.40	24.19	14.47	27.50	13.03	3.01
FA	LL	1982	2.85	3.14	2.91	0.78	0.97	0.12	0.27	3.79	0.63	24.48	15.56	27.47	11.91	2.84
		1983	2.93	2.98	2.89	0.76	0.99	0.14	0.34	3.67	0.81	24.61	16.47	27.50	11.04	2.88
		1984	3.25	2.81	2.87	0.76	0.98	0.20	0.42	3.38	0.99	24.53	17.44	27.48	10.03	2.84
		1985	3.02	2.91	2.87	0.81	0.99	0.10	0.36	3.65	0.89	24.76	16.88	27.43	10.55	2.94
		1986	2.91	2.88	2.86	0.78	0.97	0.16	0.33	3.85	0.77	24.54	15.72	27.38	11.66	2.81
		1987	2.65	2.98	2.92	0.85	1.00	0.09	0.22	4.08	0.52	24.52	15.84	27.42	11.58	2.91
		1988	2.95	2.95	2.89	0.80	0.96	0.13	0.31	3.73	0.81	24.66	16.33	27.42	11.09	2.85
		1989	2.95	3.01	2.89	0.79	0.96	0.13	0.31	3.72	0.78	24.58	15.84	27.46	11.62	2.83
		1990	2.93	2.90	2.79	0.87	1.00	0.08	0.32	3.76	0.98	24.66	16.19	27.51	11.31	2.91
		1991	2.52	3.21	2.86	0.89	1.00	0.06	0.22	4.29	0.65	24.33	14.99	27.44	12.45	2.94
		1992	2.64	3.20	2.88	0.90	0.98	0.07	0.22	4.14	0.65	24.29	14.95	27.47	12.51	2.92

Table 48. continued.

Season	Bay	Year	CF	BSh	CrSec	Pisc	Invert	Herb	Detr	Pos	RepG	Tp	MinTp	MaxTp	TpRng	Sal
		1993	2.79	3.21	2.91	0.85	1.00	0.10	0.28	3.98	0.66	24.41	15.37	27.49	12.12	2.95
		1994	2.74	3.23	2.87	0.88	1.00	0.06	0.27	4.02	0.73	24.42	15.11	27.49	12.38	2.94
		1995	2.73	3.24	2.85	0.91	1.00	0.04	0.25	4.00	0.77	24.42	15.08	27.50	12.42	2.96
		1996	2.69	3.22	2.89	0.84	1.00	0.07	0.27	3.99	0.67	24.38	15.16	27.52	12.36	2.93
		1997	2.47	3.24	2.92	0.81	1.00	0.06	0.25	4.35	0.42	24.30	15.07	27.36	12.29	2.95
		1998	2.61	3.18	2.95	0.85	0.98	0.09	0.20	4.21	0.43	24.32	14.92	27.43	12.51	2.89
		1999	2.80	3.17	2.94	0.81	0.99	0.11	0.28	3.88	0.60	24.49	15.80	27.39	11.60	2.95
		2000	2.74	3.10	2.90	0.84	0.99	0.07	0.28	3.99	0.70	24.54	15.81	27.41	11.59	2.94
		2001	2.70	3.08	2.91	0.86	0.99	0.08	0.22	4.10	0.60	24.49	15.15	27.44	12.29	2.91
		2002	2.77	3.06	2.98	0.76	0.98	0.14	0.29	3.98	0.49	24.46	15.71	27.43	11.72	2.87
		2003	2.72	3.02	3.01	0.72	1.00	0.16	0.30	3.94	0.41	24.48	15.86	27.49	11.63	2.86
		2004	2.80	3.00	2.91	0.76	1.00	0.05	0.35	3.76	0.76	24.79	16.85	27.41	10.56	2.92
		2005	2.99	2.98	2.89	0.83	1.00	0.04	0.32	3.49	0.92	24.94	17.50	27.52	10.02	2.93
		2006	3.07	2.91	2.95	0.75	0.94	0.18	0.32	3.58	0.75	24.67	16.36	27.52	11.16	2.75
		2007	2.73	3.04	2.89	0.85	0.99	0.05	0.24	3.98	0.72	24.65	15.89	27.46	11.57	2.93
		2008	2.80	3.10	2.97	0.83	0.99	0.07	0.25	3.95	0.55	24.58	15.91	27.41	11.51	2.92
		2009	3.09	3.06	3.00	0.75	0.98	0.13	0.34	3.49	0.73	24.78	16.81	27.53	10.72	2.86
		2010	2.83	2.76	2.90	0.73	0.98	0.22	0.35	3.83	0.54	23.85	15.69	27.55	11.86	2.62
		2011	3.14	3.04	2.89	0.79	0.96	0.11	0.35	3.55	0.98	24.70	16.52	27.50	10.98	2.86
		2012	3.27	2.89	2.78	0.85	0.99	0.04	0.38	3.16	1.35	25.07	17.87	27.56	9.69	2.92
		2013	3.18	2.96	2.80	0.85	0.99	0.06	0.39	3.36	1.21	24.86	16.95	27.57	10.63	2.90
		2014	3.22	2.90	2.80	0.88	0.98	0.07	0.34	3.39	1.20	24.87	16.95	27.57	10.62	2.90
		2015	2.70	3.20	2.91	0.84	0.99	0.06	0.25	4.05	0.68	24.43	15.30	27.49	12.19	2.92
		2016	2.90	3.04	2.83	0.83	0.98	0.07	0.28	3.74	1.03	24.68	16.21	27.51	11.30	2.90
		2017	2.97	3.06	2.85	0.86	1.00	0.05	0.32	3.63	0.95	24.76	16.38	27.58	11.19	2.92
		2018	3.08	3.05	2.91	0.82	1.00	0.11	0.34	3.59	0.88	24.70	16.90	27.51	10.61	2.98
		2019	3.05	2.90	2.84	0.86	0.98	0.05	0.31	3.48	1.06	24.93	17.26	27.53	10.27	2.91

Table 49. Species catch data by time period. Total catch in number of individuals by species for all species included in the functional diversity analyses. Data are shown for two time periods (1982 – 2000, 2001 – 2019). A column for occurrence is included to indicate whether species are temperate, subtropical, or tropical.

Species (latin name)	**Species (common name)**	**Occurrence**	**Total Catch (1982 - 2000)**	**Total Catch (2001 - 2019)**	**Total Catch All Years**
Pogonias cromis	Black drum	Subtropical	182521	246787	429308
Ariopsis felis	Hardhead catfish	Subtropical	214439	207623	422062
Sciaenops ocellatus	Red drum	Subtropical	141312	174659	315971
Cynoscion nebulosus	Spotted seatrout	Subtropical	99881	118421	218302
Dorosoma cepedianum	Gizzard shad	Subtropical	94643	95078	189721
Bagre marinus	Gafftopsail catfish	Subtropical	31699	90997	122696
Brevoortia patronus	Gulf menhaden	Subtropical	41174	52287	93461
Mugil cephalus	Striped mullet	Subtropical	50358	43103	93461
Micropogonias undulatus	Atlantic croaker	Subtropical	35077	32844	67921
Elops saurus	Ladyfish	Subtropical	10179	37250	47429
Leiostomus xanthurus	Spot	Subtropical	21111	25369	46480
Atractosteus spatula	Alligator gar	Subtropical	14046	24347	38393
Archosargus probatocephalus	Sheepshead	Subtropical	15529	20020	35549
Lepisosteus oculatus	Spotted gar	Subtropical	12670	13979	26649
Paralichthys lethostigma	Southern flounder	Subtropical	10738	6647	17385
Ictalurus furcatus	Blue catfish	Subtropical	5203	7801	13004
Carcharhinus leucas	Bull shark	Subtropical	3759	6216	9975
Lagodon rhomboides	Pinfish	Subtropical	2399	4472	6871
Sphyrna tiburo	Bonnethead	Subtropical	1174	4174	5348
Lutjanus griseus	Gray snapper	Subtropical	1052	3943	4995
Brevoortia gunteri	Finescale menhaden	Subtropical	2491	2164	4655
Rhinoptera bonasus	Cownose ray	Tropical	1559	3075	4634
Cynoscion arenarius	Sand seatrout	Subtropical	1768	2778	4546

Table 49. continued.

Ictiobus bubalus	Smallmouth buffalo	Temperate	2450	1848	4298
Carcharhinus limbatus	Blacktip shark	Subtropical	1387	2260	3647
Chaetodipterus faber	Atlantic spadefish	Subtropical	1067	1613	2680
Trachinotus carolinus	Florida pompano	Subtropical	723	1871	2594
Lepisosteus osseus	Longnose gar	Subtropical	1085	1431	2516
Scomberomorus maculatus	Spanish mackerel	Subtropical	1018	1468	2486
Menticirrhus americanus	Southern kingfish	Subtropical	307	1762	2069
Dasyatis sabina	Atlantic stingray	Subtropical	793	784	1577
Orthopristis chrysoptera	Pigfish	Temperate	725	608	1333
Dorosoma petenense	Threadfin shad	Subtropical	515	714	1229
Paralichthys albigutta	Gulf flounder	Subtropical	879	313	1192
Cyprinus carpio	Common carp	Subtropical	868	230	1098
Carcharhinus brevipinna	Spinner shark	Subtropical	113	849	962
Lobotes surinamensis	Atlantic tripletail	Subtropical	488	449	937
Bairdiella chrysoura	Silver perch	Subtropical	378	544	922
Caranx hippos	Crevalle jack	Subtropical	323	591	914
Centropomus undecimalis	Common snook	Tropical	213	667	880
Peprilus paru	Harvestfish	Subtropical	338	388	726
Rhizoprionodon terraenovae	Atlantic sharpnose shark	Subtropical	339	373	712
Sphyrna lewini	Scalloped hammerhead	Tropical	134	409	543
Morone mississippiensis	Yellow bass	Subtropical	257	272	529
Carcharhinus isodon	Finetooth shark	Subtropical	241	280	521
Megalops atlanticus	Tarpon	Subtropical	146	271	417
Pomatomus saltatrix	Bluefish	Subtropical	221	196	417
Lepisosteus platostomus	Shortnose gar	Subtropical	292	32	324
Prionotus tribulus	Bighead searobin	Subtropical	120	194	314
Alosa chrysochloris	Skipjack herring	Subtropical	173	136	309

Table 49. continued.

Opsanus beta	Gulf toadfish	Subtropical	99	100	199
Trachinotus falcatus	Permit	Subtropical	53	145	198
Negaprion brevirostris	Lemon shark	Subtropical	178	14	192
Selene vomer	Lookdown	Subtropical	35	130	165
Menticirrhus littoralis	Gulf kingfish	Subtropical	34	112	146
Peprilus burti	Gulf butterfish	Subtropical	48	83	131
Polydactylus octonemus	Atlantic threadfin	Subtropical	84	31	115
Morone chrysops	White bass	Temperate	68	39	107
Trinectes maculatus	Hogchoker	Subtropical	70	27	97
Mugil curema	White mullet	Subtropical	61	34	95
Dasyatis americana	Southern stingray	Subtropical	25	65	90
Ictalurus punctatus	Channel catfish	Subtropical	25	45	70
Chloroscombrus chrysurus	Atlantic bumper	Subtropical	2	67	69
Morone saxatilis	Striped bass	Temperate	44	24	68
Micropterus salmoides	Largemouth bass	Subtropical	40	25	65
Gymnura micrura	Smooth butterfly ray	N/A*	2	61	63
Ancylopsetta quadrocellata	Ocellated flounder	Subtropical	17	43	60
Centropomus parallelus	Smallscale fat snook	Subtropical	15	45	60
Aplodinotus grunniens	Freshwater drum	Subtropical	20	39	59
Carcharhinus obscurus	Dusky shark	Subtropical	10	48	58
Cynoscion nothus	Silver seatrout	Subtropical	17	38	55
Pylodictis olivaris	Flathead catfish	Subtropical	25	23	48
Synodus foetens	Inshore lizardfish	Tropical	28	16	44
Syngnathus scovelli	Gulf pipefish	Tropical	1	41	42
Echeneis naucrates	Sharksucker	Subtropical	7	29	36
Remora Shark sucker	Remora	Subtropical	3	33	36
Strongylura marina	Atlantic needlefish	Subtropical	19	15	34

Table 49. continued.

Diapterus auratus	Irish pompano	Tropical	3	29	32
Syngnathus louisianae	Chain pipefish	Subtropical	2	30	32
Prionotus rubio	Blackwing searobin	Subtropical	11	19	30
Carcharhinus plumbeus	Sandbar shark	Subtropical	7	20	27
Oreochromis aureus	Blue tilapia	Tropical	1	26	27
Rachycentron canadum	Cobia	Subtropical	12	14	26
Eucinostomus gula	Silver jenny	Subtropical	24	1	25
Gobiosoma bosc	Naked goby	Tropical	2	20	22
Mycteroperca microlepis	Gag	Subtropical	5	16	21
Trichiurus lepturus	Atlantic cutlassfish	Subtropical	10	11	21
Gobiesox strumosus	Skilletfish	Tropical	2	18	20
Anchoa mitchilli	Bay anchovy	Subtropical	1	17	18
Pterygoplichthys anisitsi	Parana sailfin catfish	Tropical	0	18	18
Chilomycterus schoepfi	Striped burrfish	Tropical	3	14	17
Histrio histrion	Sargassumfish	Subtropical	1	15	16
Oligoplites saurus	Leatherjack	Subtropical	6	10	16
Prionotus longispinosus	Bigeye searobin	Tropical	8	7	15
Hemicaranx amblyrhynchus	Bluntnose jack	Subtropical	6	8	14
Syacium gunteri	Shoal flounder	Tropical	0	14	14
Selene setapinnis	Atlantic moonfish	Subtropical	4	9	13
Amia calva	Bowfin	Subtropical	7	5	12
Antennarius striatus	Striated frogfish	Subtropical	0	12	12
Fundulus chrysotus	Golden topminnow	Subtropical	12	0	12
Scorpaena plumieri	Spotted scorpionfish	Subtropical	0	12	12
Dasyatis say	Bluntnose stingray	Subtropical	2	9	11
Lepomis macrochirus	Bluegill	Subtropical	7	3	10
Menidia peninsulae	Tidewater silverside	Tropical	0	10	10

Table 49. continued.

Sphyraena barracuda	Great barracuda	Subtropical	1	9	10
Sphyrna mokarran	Great hammerhead	Subtropical	6	4	10
Syngnathus pelagicus	Sargassum pipefish	Subtropical	0	10	10
Achirus lineatus	Lined sole	Tropical	6	3	9
Lepomis microlophus	Redear sunfish	Subtropical	5	4	9
Ctenopharyngodon idella	Grass carp	Subtropical	5	3	8
Larimus fasciatus	Banded drum	Subtropical	5	3	8
Stellifer lanceolatus	Star drum	Subtropical	1	7	8
Gobiomorus dormitor	Bigmouth sleeper	Tropical	2	5	7
Anchoa hepsetus	Striped anchovy	Subtropical	4	2	6
Kyphosus saltatrix	Bermuda chub	Subtropical	1	5	6
Lutjanus synagris	Lane snapper	Subtropical	3	3	6
Aetobatus narinari	Spotted eagle ray	Subtropical	1	4	5
Caranx latus	Horse-eye jack	Subtropical	1	4	5
Carcharhinus falciformis	Silky shark	Subtropical	2	3	5
Lepomis gulosus	Warmouth	Temperate	1	4	5
Trachinotus goodei	Palometa	Subtropical	5	0	5
Carcharhinus acronotus	Blacknose shark	Subtropical	1	3	4
Citharichthys spilopterus	Bay whiff	Tropical	0	4	4
Echeneis neucratoides	Whitefin sharksucker	Subtropical	0	4	4
Gobiosoma robustum	Code goby	Tropical	0	4	4
Harengula jaguana	Scaled sardine	Tropical	1	3	4
Saurida caribbaea	Smallscale lizardfish	Tropical	1	3	4
Scomberomorus cavalla	King mackerel	Tropical	2	2	4
Ameiurus melas	Black bullhead	Temperate	0	3	3
Ameiurus natalis	Yellow bullhead	Temperate	2	1	3
Carcharhinus porosus	Smalltail shark	Subtropical	2	1	3

Table 49. continued.

Cyclopsetta chittendeni	Mexican flounder	Subtropical	0	3	3
Dasyatis centroura	Roughtail stingray	Subtropical	1	2	3
Gerres cinereus	Yellowfin mojarra	Subtropical	0	3	3
Ophichthus gomesi	Shrimp eel	Tropical	2	1	3
Pomoxis annularis	White crappie	Temperate	2	1	3
Scomberomorus regalis	Cero	Tropical	1	2	3
Sphyrna tudes	Smalleye hammerhead	Subtropical	3	0	3
		Totals	1011608	1246439	2258047

Footnote: *N/A Smooth butterfly ray (*Gymnura micrura*) did not have occurrence data available on FishBase.

Table 50. Proportion of total catch by species. The proportion of the total catch in numbers by species for two time periods (1982 – 2000, 2001 - 2019). A column for occurrence is included to indicate whether species are temperate, subtropical, or tropical.

Species (latin name)	Species (common name)	Occurrence	Catch proportion (1982 - 2000)	Catch proportion (2001 - 2019)
Pogonias cromis	Black drum	Subtropical	0.1804266079	0.1979936443
Ariopsis felis	Hardhead catfish	Subtropical	0.2119783553	0.1665729330
Sciaenops ocellatus	Red drum	Subtropical	0.1396904730	0.1401263921
Cynoscion nebulosus	Spotted seatrout	Subtropical	0.0987348854	0.0950074572
Dorosoma cepedianum	Gizzard shad	Subtropical	0.0935569905	0.0762797056
Bagre marinus	Gafftopsail catfish	Subtropical	0.0313352603	0.0730055783
Brevoortia patronus	Gulf menhaden	Subtropical	0.0407015366	0.0419491046
Mugil cephalus	Striped mullet	Subtropical	0.0497801520	0.0345809141
Micropogonias undulatus	Atlantic croaker	Subtropical	0.0346744984	0.0263502666
Elops saurus	Ladyfish	Subtropical	0.0100621980	0.0298851368
Leiostomus xanthurus	Spot	Subtropical	0.0208687555	0.0203531821
Atractosteus spatula	Alligator gar	Subtropical	0.0138848250	0.0195332463
Archosargus probatocephalus	Sheepshead	Subtropical	0.0153508078	0.0160617567
Lepisosteus oculatus	Spotted gar	Subtropical	0.0125246143	0.0112151497
Paralichthys lethostigma	Southern flounder	Subtropical	0.0106147836	0.0053327921
Ictalurus furcatus	Blue catfish	Subtropical	0.0051432966	0.0062586296
Carcharhinus leucas	Bull shark	Subtropical	0.0037158662	0.0049870070
Lagodon rhomboides	Pinfish	Subtropical	0.0023714720	0.0035878210
Sphyrna tiburo	Bonnethead	Subtropical	0.0011605286	0.0033487399
Lutjanus griseus	Gray snapper	Subtropical	0.0010399285	0.0031634119
Brevoortia gunteri	Finescale menhaden	Subtropical	0.0024624163	0.0017361459
Rhinoptera bonasus	Cownose ray	Tropical	0.0015411108	0.0024670281
Cynoscion arenarius	Sand seatrout	Subtropical	0.0017477126	0.0022287493
Ictiobus bubalus	Smallmouth buffalo	Temperate	0.0024218867	0.0014826237

Table 50. continued.

Carcharhinus limbatus	Blacktip shark	Subtropical	0.0013710845	0.0018131653
Chaetodipterus faber	Atlantic spadefish	Subtropical	0.0010547564	0.0012940866
Trachinotus carolinus	Florida pompano	Subtropical	0.0007147037	0.0015010763
Lepisosteus osseus	Longnose gar	Subtropical	0.0010725498	0.0011480706
Scomberomorus maculatus	Spanish mackerel	Subtropical	0.0010063187	0.0011777552
Menticirrhus americanus	Southern kingfish	Subtropical	0.0003034772	0.0014136271
Dasyatis sabina	Atlantic stingray	Subtropical	0.0007839005	0.0006289919
Orthopristis chrysoptera	Pigfish	Temperate	0.0007166808	0.0004877896
Dorosoma petenense	Threadfin shad	Subtropical	0.0005090905	0.0005728319
Paralichthys albigutta	Gulf flounder	Subtropical	0.0008689137	0.0002511154
Cyprinus carpio	Common carp	Subtropical	0.0008580399	0.0001845257
Carcharhinus brevipinna	Spinner shark	Subtropical	0.0001117033	0.0006811404
Lobotes surinamensis	Atlantic tripletail	Subtropical	0.0004824003	0.0003602262
Bairdiella chrysoura	Silver perch	Subtropical	0.0003736625	0.0004364433
Caranx hippos	Crevalle jack	Subtropical	0.0003192936	0.0004741508
Centropomus undecimalis	Common snook	Tropical	0.0002105559	0.0005351245
Peprilus paru	Harvestfish	Subtropical	0.0003341215	0.0003112868
Rhizoprionodon terraenovae	Atlantic sharpnose shark	Subtropical	0.0003351100	0.0002992525
Sphyrna lewini	Scalloped hammerhead	Tropical	0.0001324624	0.0003281348
Morone mississippiensis	Yellow bass	Subtropical	0.0002540510	0.0002182217
Carcharhinus isodon	Finetooth shark	Subtropical	0.0002382346	0.0002246400
Megalops atlanticus	Tarpon	Subtropical	0.0001443247	0.0002174194
Pomatomus saltatrix	Bluefish	Subtropical	0.0002184641	0.0001572480
Lepisosteus platostomus	Shortnose gar	Subtropical	0.0002886494	0.0000256731
Prionotus tribulus	Bighead searobin	Subtropical	0.0001186230	0.0001556434
Alosa chrysochloris	Skipjack herring	Subtropical	0.0001710149	0.0001091108
Opsanus beta	Gulf toadfish	Subtropical	0.0000978640	0.0000802286

Table 50. continued.

Trachinotus falcatus	Permit	Subtropical	0.0000523918	0.0001163314
Negaprion brevirostris	Lemon shark	Subtropical	0.0001759575	0.0000112320
Selene vomer	Lookdown	Subtropical	0.0000345984	0.0001042971
Menticirrhus littoralis	Gulf kingfish	Subtropical	0.0000336099	0.0000898560
Peprilus burti	Gulf butterfish	Subtropical	0.0000474492	0.0000665897
Polydactylus octonemus	Atlantic threadfin	Subtropical	0.0000830361	0.0000248709
Morone chrysops	White bass	Temperate	0.0000672197	0.0000312891
Trinectes maculatus	Hogchoker	Subtropical	0.0000691968	0.0000216617
Mugil curema	White mullet	Subtropical	0.0000603000	0.0000272777
Dasyatis americana	Southern stingray	Subtropical	0.0000247131	0.0000521486
Ictalurus punctatus	Channel catfish	Subtropical	0.0000247131	0.0000361028
Chloroscombrus chrysurus	Atlantic bumper	Subtropical	0.0000019771	0.0000537531
Morone saxatilis	Striped bass	Temperate	0.0000434951	0.0000192549
Micropterus salmoides	Largemouth bass	Subtropical	0.0000395410	0.0000200571
Gymnura micrura	Smooth butterfly ray	N/A*	0.0000019771	0.0000489394
Ancylopsetta quadrocellata	Ocellated flounder	Subtropical	0.0000168049	0.0000344983
Centropomus parallelus	Smallscale fat snook	Subtropical	0.0000148279	0.0000361028
Aplodinotus grunniens	Freshwater drum	Subtropical	0.0000197705	0.0000312891
Carcharhinus obscurus	Dusky shark	Subtropical	0.0000098853	0.0000385097
Cynoscion nothus	Silver seatrout	Subtropical	0.0000168049	0.0000304869
Pylodictis olivaris	Flathead catfish	Subtropical	0.0000247131	0.0000184526
Synodus foetens	Inshore lizardfish	Tropical	0.0000276787	0.0000128366
Syngnathus scovelli	Gulf pipefish	Tropical	0.0000009885	0.0000328937
Echeneis naucrates	Sharksucker	Subtropical	0.0000069197	0.0000232663
Remora Small eye	Remora	Subtropical	0.0000029656	0.0000264754
Strongylura marina	Atlantic needlefish	Subtropical	0.0000187820	0.0000120343
Diapterus auratus	Irish pompano	Tropical	0.0000029656	0.0000232663

Table 50. continued.

Syngnathus louisianae	Chain pipefish	Subtropical	0.0000019771	0.0000240686
Prionotus rubio	Blackwing searobin	Subtropical	0.0000108738	0.0000152434
Carcharhinus plumbeus	Sandbar shark	Subtropical	0.0000069197	0.0000160457
Oreochromis aureus	Blue tilapia	Tropical	0.0000009885	0.0000208594
Rachycentron canadum	Cobia	Subtropical	0.0000118623	0.0000112320
Eucinostomus gula	Silver jenny	Subtropical	0.0000237246	0.0000008023
Gobiosoma bosc	Naked goby	Tropical	0.0000019771	0.0000160457
Mycteroperca microlepis	Gag	Subtropical	0.0000049426	0.0000128366
Trichiurus lepturus	Atlantic cutlassfish	Subtropical	0.0000098853	0.0000088251
Gobiesox strumosus	Skilletfish	Tropical	0.0000019771	0.0000144411
Anchoa mitchilli	Bay anchovy	Subtropical	0.0000009885	0.0000136389
Pterygoplichthys anisitsi	Parana sailfin catfish	Tropical	0.0000000000	0.0000144411
Chilomycterus schoepfi	Striped burrfish	Tropical	0.0000029656	0.0000112320
Histrio Small eye	Sargassumfish	Subtropical	0.0000009885	0.0000120343
Oligoplites saurus	Leatherjack	Subtropical	0.0000059312	0.0000080229
Prionotus longispinosus	Bigeye searobin	Tropical	0.0000079082	0.0000056160
Hemicaranx amblyrhynchus	Bluntnose jack	Subtropical	0.0000059312	0.0000064183
Syacium gunteri	Shoal flounder	Tropical	0.0000000000	0.0000112320
Selene setapinnis	Atlantic moonfish	Subtropical	0.0000039541	0.0000072206
Amia calva	Bowfin	Subtropical	0.0000069197	0.0000040114
Antennarius striatus	Striated frogfish	Subtropical	0.0000000000	0.0000096274
Fundulus chrysotus	Golden topminnow	Subtropical	0.0000118623	0.0000000000
Scorpaena plumieri	Spotted scorpionfish	Subtropical	0.0000000000	0.0000096274
Dasyatis say	Bluntnose stingray	Subtropical	0.0000019771	0.0000072206
Lepomis macrochirus	Bluegill	Subtropical	0.0000069197	0.0000024069
Menidia peninsulae	Tidewater silverside	Tropical	0.0000000000	0.0000080229
Sphyraena barracuda	Great barracuda	Subtropical	0.0000009885	0.0000072206

Table 50. continued.

Sphyrna mokarran	Great hammerhead	Subtropical	0.0000059312	0.0000032091
Syngnathus pelagicus	Sargassum pipefish	Subtropical	0.0000000000	0.0000080229
Achirus lineatus	Lined sole	Tropical	0.0000059312	0.0000024069
Lepomis microlophus	Redear sunfish	Subtropical	0.0000049426	0.0000032091
Ctenopharyngodon idella	Grass carp	Subtropical	0.0000049426	0.0000024069
Larimus fasciatus	Banded drum	Subtropical	0.0000049426	0.0000024069
Stellifer lanceolatus	Star drum	Subtropical	0.0000009885	0.0000056160
Gobiomorus dormitor	Bigmouth sleeper	Tropical	0.0000019771	0.0000040114
Anchoa hepsetus	Striped anchovy	Subtropical	0.0000039541	0.0000016046
Kyphosus saltatrix	Bermuda chub	Subtropical	0.0000009885	0.0000040114
Lutjanus synagris	Lane snapper	Subtropical	0.0000029656	0.0000024069
Aetobatus narinari	Spotted eagle ray	Subtropical	0.0000009885	0.0000032091
Caranx latus	Horse-eye jack	Subtropical	0.0000009885	0.0000032091
Carcharhinus falciformis	Silky shark	Subtropical	0.0000019771	0.0000024069
Lepomis gulosus	Warmouth	Temperate	0.0000009885	0.0000032091
Trachinotus goodei	Palometa	Subtropical	0.0000049426	0.0000000000
Carcharhinus acronotus	Blacknose shark	Subtropical	0.0000009885	0.0000024069
Citharichthys spilopterus	Bay whiff	Tropical	0.0000000000	0.0000032091
Echeneis neucratoides	Whitefin sharksucker	Subtropical	0.0000000000	0.0000032091
Gobiosoma robustum	Code goby	Tropical	0.0000000000	0.0000032091
Harengula jaguana	Scaled sardine	Tropical	0.0000009885	0.0000024069
Saurida caribbaea	Smallscale lizardfish	Tropical	0.0000009885	0.0000024069
Scomberomorus cavalla	King mackerel	Tropical	0.0000019771	0.0000016046
Ameiurus melas	Black bullhead	Temperate	0.0000000000	0.0000024069
Ameiurus natalis	Yellow bullhead	Temperate	0.0000019771	0.0000008023
Carcharhinus porosus	Smalltail shark	Subtropical	0.0000019771	0.0000008023
Cyclopsetta chittendeni	Mexican flounder	Subtropical	0.0000000000	0.0000024069

Table 50. continued.

Dasyatis centroura	Roughtail stingray	Subtropical	0.0000009885	0.0000016046
Gerres cinereus	Yellowfin mojarra	Subtropical	0.0000000000	0.0000024069
Ophichthus gomesi	Shrimp eel	Tropical	0.0000019771	0.0000008023
Pomoxis annularis	White crappie	Temperate	0.0000019771	0.0000008023
Scomberomorus regalis	Cero	Tropical	0.0000009885	0.0000016046
Sphyrna tudes	Smalleye hammerhead	Subtropical	0.0000029656	0.0000000000

Footnote: *N/A Smooth butterfly ray (*Gymnura micrura*) did not have occurrence data available on FishBase.

Table 51. Proportion of total catch by occurrence. The proportion of the total catch by occurrence category (Temperate, Subtropical, and Tropical) for two time periods (1982 – 2000, 2001 – 2019).

	Proportion of Total Catch	
	1982 - 2000	**2001 - 2019**
Temperate	0.0032542250	0.0020281779
Subtropical	0.9947973919	0.9944000469
Tropical	0.0019464061	0.0035228359