Diet, Feeding Habits, and Predator Size/Prey Size Relationships of Red Drum (*Sciaenops ocellatus*) in Galveston Bay, Texas

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Feeding Habits of Red Drum (*Sciaenops ocellatus*) in Galveston Bay, Texas: Seasonal Diet Variation and Predator-Prey Size Relationships

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Introduction

The effect of predaceous fishes on the composition of aquatic ecosystems can be significant. Mortality induced by predation can reduce prey abundances locally and may limit prey recruitment in some systems. In order to begin to quantify the potential effects of fish predation on community structure and prey populations, detailed information is needed on the feeding habits of important predators.

The red drum (*Sciaenops ocellatus*) is an abundant estuarine-dependent fish that is widely distributed throughout the Gulf of Mexico. Adults spawn in near shore Gulf waters close to the mouths of passes and inlets during late summer and early fall. Larvae are transported through passes into estuaries via tidal currents, where they settle in shallow nursery areas and remain through the juvenile stage. Although older red drum may migrate to offshore waters during fall and winter, fish at least as old as age four commonly occur in Gulf of Mexico estuaries.

Past research on red drum feeding habits along the Gulf coast indicates that red drum diets are fairly heterogeneous with several crustaceans and juvenile fishes being important dietary components. However, there exists only limited and dated information on the diets of red drum in estuaries along the Texas coast.

Here, we determine the diet and feeding habits of age one and older red drum during fall and spring seasons in Galveston Bay, Texas. Seasonal variation in the composition of the diet is examined and related to temporal patterns in prey availability. The relationship between red drum size and prey size is examined for important prey to determine ontogenetic changes in minimum, mean, and maximum prey sizes consumed. Selective feeding patterns by red drum are assessed through comparisons of prey types and sizes consumed with those available in the field. Lastly, we generate a series of predictive regression equations used to estimate carapace width of blue crabs (*Callinectes sapidus*) from distances between orbital and frontal teeth and assess the potential for these equations to increase size-based dietary information for predators feeding on blue crabs.

Methods

Age one and older red drum were captured in monofilament gill nets between 16 September-21 November 1997 (fall) and between 14 April-17 June 1998 (spring). During each season, 45 gill nets were set throughout the bay, each net being set within a one square mile grid containing

shoreline that was chosen randomly from all available grids that contained shoreline. Gill nets measured 183m long x 1.2m deep and consisted of four separate sections (each of 45.7m length) of 7.6, 10.2, 12.7, and 15.2cm stretched mesh. Gill nets were set between one hour prior to sunset and sunset and were retrieved between sunrise and no more than four hours past sunrise the following day. Gill nets were set perpendicular to the shoreline with the section consisting of the smallest mesh (7.6cm) being positioned closest to the beach. Upon retrieval of each gill net, red drum were measured and the stomachs removed and kept on ice until they could be frozen at the laboratory. At the laboratory, stomachs were thawed and the contents identified to the lowest possible taxon, counted, measured to the nearest mm, and weighed wet to the nearest 0.01g.

Diet composition was evaluated using a variety of indices including the numerical index (%N) (the number of prey in a specific prey category as a percentage of the total number of all prey items), the gravimetric index based on prey wet weight (%W) (the weight of all prey in a specific prey category as a percentage of the total weight of all prey), the percent frequency of occurrence (%FO) (the percentage of all stomachs containing food that contained a specific prey category), and the index of relative importance (IRI), which is based on a combination of the previous three indices (%FO x (%N + %W)) and is expressed as a percentage (%IRI).

Seasonal variation in red drum diet composition was assessed using contingency table analysis. χ^2 statistics were calculated for each combination of season and prey type, with a significant grand total χ^2 statistic indicating a significant difference in the proportions of specific prey species consumed between fall and spring seasons. Prey species selection by red drum was evaluated by comparing the proportional contribution of individual prey species to red drum diets with the proportional contribution of the same prey species to the available prey population in the field.

A series of predictive regression equations was generated to estimate original carapace width of blue crabs from partial carapace remains recovered from red drum stomachs. Measurements of the carapace were used to reconstruct original crab size because it was assumed that if carapace fragments were recovered from a given red drum stomach that the entire crab was consumed. This assumption could not be made for chelipeds or walking legs as crab escapement could have occurred if a cheliped or walking leg were the only parts recovered from the stomach. Further, because of the ability of crabs to regenerate lost limbs, predictions of original size based on measurements from regenerated appendages may not be accurate. Three carapace measurements were regressed against total carapace width. These included the distance between the outer and inner orbital teeth, the distance between the inner orbital tooth and the adjacent frontal tooth, and the distance between the two frontal teeth.

Predator size-prey size relationships were examined by plotting red drum total length versus prey total length measurements (carapace width for crabs). For all prey pooled and for several important prey species, ontogenetic changes in minimum, mean, and maximum prey sizes consumed by red drum were estimated using least squares and quantile regression techniques. Size-selective feeding patterns of red drum were examined by comparing length frequencies of important prey species recovered from red drum stomachs with length frequencies of those same prey species occurring in Galveston Bay during the fall and spring seasons.

Results and Discussion

A total of 598 red drum were collected and examined for stomach contents (229 during fall; 369 during spring), with 383 red drum containing food in the stomach (168 (73.4%) during fall; 215 (58.3%) during spring). Red drum were collected from 27 different locations in the fall and 33 different locations in the spring. Red drum size ranged from 291-763mm during fall and from 345-751mm during spring with clear modes in the length frequency plots representing ages 1-3, with some potential age 4 fish in each season. Red drum ages estimated from the length frequency plots in this study show good agreement with predicted size at age estimated using parameters from previously constructed von Bertalanffy growth models.

The fall diet of red drum was dominated primarily by decapod crustaceans with teleost fishes being of secondary importance. Decapods occurred in nearly 83% of red drum stomachs examined that contained food with crabs and shrimp occurring in approximately 40% and 60% of stomachs, respectively. Of the crabs consumed, the blue crab (*Callinectes sapidus*) was most commonly eaten, occurring in 25% of red drum stomachs and accounting for nearly 20% of the diet by weight. White shrimp (*Penaeus setiferus*) were the single most important dietary item of red drum in the fall, occurring in nearly 23% of stomachs examined and accounting for nearly 40% of the diet by number. In addition, the majority of unidentified shrimp were likely white shrimp based on the relative proportions of the three shrimp species recovered in red drum diets in the fall. Based on a combination of the numbers provided in table 1 for white shrimp and unidentified shrimp, white shrimp likely represented nearly 60% of the diet of red drum by number and occurred in over 60% of red drum stomachs analyzed during fall months. Other decapods that occurred in fall red drum diets in relatively small proportions included lesser blue crab (*Callinectes similis*), brown shrimp (*Penaeus aztecus*), several Xanthid crabs, grass shrimp (Palaemonetes spp.), green porcellain crabs (*Petrolisthes armatus*), and estuarine snapping shrimp (*Alpheus estuariensis*).

Teleost fishes occurred in slightly over 40% of the stomachs examined in the fall and represented about 40% of the diet by weight, with a large proportion of fish being unidentified. The most prevalent species were black cheeked tonguefish (*Symphurus plagiusa*), shrimp eels (*Ophichthus gomesi*), and Gulf menhaden (*Brevoortia patronus*). Other fish species eaten in the fall included bay anchovy (*Anchoa mitchilli*), hardhead catfish (*Arius felis*), mullet (Mugil spp.), least puffer (*Sphoeroides parvus*), midshipman (*Porichthys plectrodon*), and sea robin (Prionotus spp.). Sea anemones, isopods, and oyster shell were also recovered in trace amounts.

The spring diet of red drum was dominated by teleost fishes, which represented over 97% of the diet by number and over 80% by weight. Gulf menhaden represented the largest proportion of fishes consumed, with 95% of red drum food items and nearly 70% of the weight of food consumed being Gulf menhaden. The frequency of occurrence of Gulf menhaden was only 35%, which was low when compared to the percent of red drum diets by number and weight represented by this prey. However, large quantities of Gulf menhaden were often recovered from individual red drum stomachs, often as high as 100-200 per stomach, accounting for the large diet proportions by number and weight for this species. Other fish species that occurred in relatively low quantities included mullet, black cheeked tonguefish, shrimp eels, southern

flounder (*Paralichthys lethostigma*), pinfish (*Lagodon rhomboides*), Gulf toadfish (*Opsanus beta*), and rough silverside (*Membras martinica*).

Decapod crustaceans were of lesser importance in the diets of red drum in spring months, but still occurred in nearly 45% of red drum stomachs that contained food. Although shrimp prey declined sharply from the fall, blue crabs remained an important dietary item of red drum in the spring. Blue crabs occurred in nearly 20% of red drum stomachs that contained food and represented nearly 10% of the diet by weight. White shrimp were absent from the spring diets of red drum as this species is rarely found in the bay during spring months. Other decapod crustaceans recovered from the stomachs of red drum in the spring included lesser blue crab, brown shrimp, Xanthid crabs, grass shrimp, estuarine snapping shrimp, and ohio or river shrimp (*Machrobrachium ohione*).

Overall, the diet of red drum showed strong seasonal patterns, and was dominated by white shrimp (*Penaeus setiferus*) during fall and Gulf menhaden (*Brevoortia patronus*) during spring. Blue crabs (*Callinectes sapidus*) were an important component of red drum diets during both seasons. Significant differences existed between prey types consumed by red drum during fall and spring seasons, which were likely a result of seasonal variation in prey availability.

Predictive regression equations were generated to estimate original carapace width of blue crabs from several measurements taken from carapace fragments recovered from red drum stomachs. Regressions were highly significant with r^2 values exceeding 0.97 and increased the number of blue crabs with size information nearly three fold. Significant predator size/prey size relationships were detected for all prey combined, as well as separately for white shrimp, Gulf menhaden, and blue crab. Although slopes were statistically significant, prey sizes changed only slightly with increasing red drum size. Comparisons of prey sizes consumed by red drum with sizes occurring in the field indicate that red drum feed predominantly in near shore shallow water habitats, which serve as nursery areas for many juvenile fish and crustaceans.

The prey species consumed most frequently by red drum in Galveston Bay support important commercial fisheries not only in this bay, but in many Gulf of Mexico estuaries. Food habits studies completed throughout the Gulf of Mexico have demonstrated the importance of blue crabs and Penaeid shrimp to the diets of red drum. Further, our results indicate that Gulf menhaden can potentially dominate red drum diets seasonally. Multispecies approaches to managing fisheries have recently gained attention and attempts are being made to incorporate biological interactions into the modelling of fish stock dynamics. The interactions between red drum and their principal prey species will likely have important ramifications if ecosystem level management practices become a reality in Gulf coast estuaries.

We have presented evidence that adult red drum in Galveston Bay feed on seasonally important prey species and that foraging takes place primarily in shallow water nursery habitats. The observed feeding habits suggest that predation pressure will be highest on juvenile stages of fish and crustaceans. Predation during juvenile life stages of fishes can have significant effects on recruitment variation. Therefore, in years of high abundance, red drum may have the potential to effect prey population levels and recruitment to the adult stage for specific prey species. The feeding habits of red drum make it an important contributor to the structure of prey assemblages in near shore estuarine habitats.