# Distribution and Abundance of Fishes Associated with *Sargassum* Mats in the NW Gulf of Mexico

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## ABSTRACT

Distribution and abundance of fishes associated with *Sargassum* mats in the NW Gulf of Mexico were examined off northern (Galveston) and southern (Port Aransas) Texas from May - August, 2000. A total of 37 species (17 families) was identified from larval purse seine collections. Individuals from seven species composed over 97% of the catch: planehead filefish (*Monacanthus hispidus*), blue runner (*Caranx crysos*), gray triggerfish (*Balistes capriscus*), chain pipefish (*Syngnathus louisianae*), sergeant major (*Abudefduf saxatilis*), sargassum fish (*Histrio histrio*), and greater amberjack (*Seriola dumerili*). Temporal patterns were observed for several taxa; *M. hispidus*, *S. louisianae*, and *H. histrio* were more abundant in early summer (May - June), while *C. crysos* and *A. saxatilis* were more prominent late in the season (July - August). Abundance of dominant taxa was higher in northern waters and both abundance and diversity increased as a function of distance from shore.

KEY WORDS: Gulf of Mexico, habitat use, *Sargassum*

## RESUMEN

La distribución y la abundancia de pescados asociados a las esteras de *Sargassum* en el Golfo de NW de Méjico fueron examinadas de Tejas norteño (Galveston) y meridional (Port Aransas) de Mayo - Agosto, 2000. Un total de 36 especies (17 familias) fue identificado de colecciones larval de la jábega del monedero. Los individuos a partir de siete especies compusieron 97% del retén: filefish del planehead (*Monacanthus hispidus*), corredor azul (*Caranx crysos*), triggerfish gris (*Balistes capriscus*), pipefish de cadena (*Syngnathus louisianae*), comandante del sargento (*Abudefduf saxatilis*), pescados del sargassum (*Histrio histrio*), y mayor amberjack (*Seriola dumerili*). Los modelos temporales fueron observados para varios taxa; *M. hispidus*, *S. louisianae*, y *H. histrio* estaban considerablemente más abundante en el comienzo del verano (Mayo - Junio), mientras que *C. crysos* y *A. saxatilis* estaban considerablemente más abundante tarde en la estación (Julio - Agosto). La abundancia de taxa dominantes era más alta en aguas norteñas y abundancia y diversidad creciente en función de distancia de la orilla.

PALABRAS CLAVES: *Sargassum*, distribución y la abundancia de pescados

## INTRODUCTION

Due to the complexity this habitat affords, *Sargassum* is of particular interest to scientists and fishery managers. Studies in the western Atlantic (Dooley 1972, Settle 1993), Japan (Edgar and Aoki, 1993), Australia (Kingsford and Choat 1985), central Pacific (Gooding and Magnuson 1967), and eastern Gulf of Mexico (Bortone et al. 1977) indicate that many fishes utilize *Sargassum*. These mats appear to enhance early life survival of pelagic fishes by reducing predation-mediated mortality (Kingsford 1995). In addition, the structural complexity acts to enhance growth by providing ample prey resources for juveniles (Hunter and Mitchell 1967, Gorelova and Fedoryako 1986, Edgar and Aoki 1993). As a result, survivorship of individuals associated with these mats may increase and therefore recruitment success may be linked to *Sargassum* (Kingsford and Choat 1985). In response, National Marine Fisheries Service (NMFS) has recently designated *Sargassum* as Essential Fish Habitat (EFH) for several coastal migratory species (NOAA 1996). Nevertheless, studies assessing the value of *Sargassum* as habitat are limited, particularly in the NW Gulf of Mexico where large floating mats are predominant surface features on the continental shelf.

The aim of this study was to evaluate the role of *Sargassum* as essential nursery habitat of fishes in the NW Gulf of Mexico. Patterns of habitat use were examined to determine the function and dynamics of the *Sargassum* complex. Specifically, patterns of abundance and assemblage diversity were assessed at two levels. Inshore versus offshore comparisons were analyzed for small-scale spatial patterns, while upper and lower regions of the northwestern Gulf were investigated for large-scale differences. In addition, seasonal changes in abundance were examined to evaluate temporal stability, and to identify important periods of recruitment to the *Sargassum* complex.

## MATERIALS AND METHODS

### Sampling Design

The present study was conducted in coastal and offshore waters of the NW Gulf of Mexico. All samples were obtained within the following boundaries: north (29° 0.782' N, 94° 43.32' W), south (27° 37.55' N, 96° 35.84' W), east (28° 58.52' N, 93° 55.19' W), and west (27° 46.81' N, 96° 45.05' W). Offshore waters (15 - 70 nautical miles) in Galveston, Texas and Port Aransas, Texas were designated as the offshore north and offshore south regions, respectively. Regions are separated by approximately 200 miles, and oceanographic differences between the two include currents, winds, bottom topography and nutrient concentrations (Smith 1980a, Sahl et al. 1993). In addition, an inshore north zone (< 15 nm) off Galveston, TX was sampled and compared to the offshore north zone (> 15 nm) (which is the offshore north region). This inshore north zone is heavily influenced by physical and biological processes occurring within the Galveston Bay estuary, such as advection of riverine and bay discharges, while the offshore north zone is governed more by continental shelf processes, such as upwelling (Temple et al. 1977, Smith 1980b).

*Sargassum spp.* and associated fauna were sampled from May through August 2000. Replicate samples (3 - 5) were collected monthly from both the offshore north and offshore south regions. In addition, monthly samples were taken within the inshore north zone. All mats were haphazardly chosen and samples were taken from 0800 to 1500 h using a larval purse seine (20 m long, 3.3 m deep, 1000 μm mesh). The purse seine was deployed as the boat encircled the chosen mat and once completely around the mat the net was pursed. Next, *Sargassum* was discarded, and fishes were funneled into the cod end, collected, and frozen upon dry ice. Mat characteristics (e.g. size, density) and GPS locations were recorded at each sample location. Environmental parameters measured included depth, sea surface temperature, salinity, dissolved oxygen, and water clarity. Fishes were sorted and identified to species in the laboratory and standard length measurements were taken to the nearest 0.1 mm.

**Data Analysis**

Relative abundance of fishes was expressed as catch per unit effort (CPUE), representing the number of fishes caught per larval purse seine sample. Seven species comprised most of the overall catch and statistical analyses were limited to these taxa. CPUE data were log (x+1) transformed to minimize heteroscedasticity. Effects of location and date on CPUE estimates of each species were examined using a two-way analysis of variance (ANOVA). Two-way ANOVAs were also used to examine differences for several other dependent variables; these include environmental conditions, sizes, and diversity estimates. Regional August comparisons were not performed due to a lack of samples in the south region (Port Aransas). Tukey's honestly significant difference (HSD) test was used to determine *a posteriori* differences ($\alpha = 0.05$) among means. The assumption of homogeneity of variances was examined using Levene's test and residual examination. Normality was examined using a probability plot of residuals versus expected values. Sizes of all seven species were compared; however, only four species sizes were statistically analyzed between the offshore north and offshore south regions due to a low number of individuals in the south region. Patterns of diversity were investigated using Shannon diversity (H') and evenness (J') indices (Zar, 1984). Diversity measures were estimated using the following equations:

$$H' = \frac{n \log n - \sum fi \log fi}{n}$$

where *n* is the total number of individuals and *fi* is the number of individuals for each species.

$$J' = H' / \log S$$

where S is the total number of species. Data analysis was carried out using SYSTAT 8.0 (SPSS 1998).

## RESULTS

### Environmental Conditions

Seasonal variation in temperature, salinity, and dissolved oxygen was pronounced (Table 1). Temperature and salinity values were low early in the season (May and June), ranging from 26.8°C to 30.5°C and 29‰ to 38‰, respectively. Both parameters increased in July and August, ranging from 28.9°C to 30.9°C and 36‰ to 38.5‰, respectively. In contrast, dissolved oxygen content was higher early in the season, ranging from 6.7 mg/L to 8.2 mg/L, then decreasing from 4.8 mg/L to 7.2 mg/L late in the season. Environmental differences also existed between the inshore and offshore zones of Galveston (Table 1). Significantly higher temperature, salinity, and depth were observed in the offshore zone, while the inshore zone exhibited significantly higher dissolved oxygen content. Visibility was also greater in the offshore zone, but no statistical comparison was performed due to several missing values. A significant zone x season interaction occurred for salinity, indicating the magnitude of differences was variable over time between the inshore and offshore zones. Regional environmental comparisons exhibited similar trends (Table 1). Offshore south (Port Aransas) had significantly higher dissolved oxygen content, in addition to significantly lower temperatures than offshore north (Galveston). A significant region x season interaction occurred for dissolved oxygen. Additionally, both depth and visibility were greater in the offshore south region, but several missing values precluded statistical testing.

### Catch Composition

A total of 10,518 individuals representing 36 species from 17 families was collected over the sampling season (Table 2). Dominant taxa included carangids (jacks), monacanthids (filefishes), balistids (triggerfishes), and syngnathids (pipefishes). Individuals from seven species comprised 97.2% of the total catch: *Monacanthus hispidus* (planehead filefish) 44.0%, *Caranx crysos* (blue runner) 17.4%, *Balistes capriscus* (gray triggerfish) 15.3%, *Syngnathus louisianae* (chain pipefish) 10.4%, *Abudefduf saxatilis* (sergeant major) 5.3%, *Histrio histrio* (sargassum fish) 3.5%, and *Seriola dumerili* (greater amberjack) 1.5%.

Overall catch efficiency was highly variable ranging from 1 to 3,201 individuals per seine, with an average CPUE of 276.6(± 100.8). Relative abundance of all seven abundant species varied among months, and CPUE values peaked early in the season. CPUE values ranged from 47 to 3,191 fishes per purse seine in May, while averaging 632.0(± 374.1). Average CPUE values greatly decreased in June to 130.4(± 55.1), increased in July to 217.5(±158.3), and decreased to the lowest average CPUE values in August at 118.3(± 34.6).

**Table 1.** Environmental conditions from May-August of 2000. Average (± 1 SE) temperature (°C), salinity (‰), dissolved oxygen (mg/L), depth (m), and visibility (m). * indicates $P \leq 0.05$ and $^{ns}$ indicates $P > 0.05$.

| | Temperature | Salinity | Dissolved oxygen | Depth | Visibility |
|---|---|---|---|---|---|
| **Season** | | | | | |
| May | 27.8(0.29) * | 32.1(1.02) * | 7.6(0.14) * | | |
| June | 28.6(0.24) | 35.2(0.70) | 7.2(0.10) | | |
| July | 29.9(0.18) | 37.4(0.21) | 5.8(0.24) | | |
| August | 30.2(0.10) | 37.0(1.00) | 5.5(0.07) | | |
| **Zone** | | | | | |
| Inshore | 28.8(0.19) * | 33.6(0.89) * | 6.9(0.31) * | 17.1(0.19) * | 5.3(0.37) |
| Offshore | 29.9(0.24) | 36.1(0.51) | 6.0(0.27) | 24.9(2.64) | 12.6(1.41) |
| **Region** | | | | | |
| North | 29.9(0.24) * | 36.1(0.51) $^{ns}$ | 6.0(0.27) * | 24.9(2.64) | 12.6(1.41) |
| South | 28.5(0.27) | 37.4(0.32) | 6.9(0.13) | 36.7(3.15) | 19.8(0.61) |

### Size Distribution

Large variability in size distributions existed within *Sargassum* mats and most species present were in the larval or juvenile stage (Table 3). The majority of *M. hispidus*, *A. saxatilis*, and *C. crysos* were less than 25 mm; 75%, 95%, and 62%, respectively. *Histrio histrio* and *B. capriscus* were abundant at larger sizes, as 75% of *H. histrio* ranged between 20 - 50 mm and 95% of *B. capriscus* ranged between 35 - 65 mm. *Syngnathus louisianae* and *S. dumerili* were prominent over a wide size spectrum, ranging from 52 - 209 mm and 32 - 210 mm, respectively.

Five of the seven abundant species (*C. crysos*, *B. capriscus*, *S. louisianae*, *H. histrio*, and *S. dumerili*) were small early in the season, significantly increasing in size from May to June (Tukey HSD, $P < 0.05$). Smallest sizes of *M. hispidus*, *C. crysos*, and *A. saxatilis* were present in July, while sizes of *B. capriscus*, *S. louisianae*, and *H. histrio* were smallest in August. Three of the seven abundant species were significantly larger in the inshore zone: *M. hispidus* ($F_{1,4420} = 89.78$, $P < 0.001$), *C. crysos* ($F_{1,1553} = 372.65$, $P < 0.001$), and *A. saxatilis* ($F_{1,430} = 20.38$, $P < 0.001$) (Table 3). Significant zone x season interactions occurred for all species, indicating the magnitude of differences in size between zones was variable over time. Of the four species statistically analyzed for regional differences, *M. hispidus* ($F_{1,1340} = 79.82$, $P < 0.001$), *C. crysos* ($F_{1,1604} = 52.81$, $P < 0.001$), and *A. saxatilis* ($F_{1,366} = 17.09$, $P < 0.001$) were significantly larger in the offshore south region. In contrast, *B. capriscus* ($F_{1,1438} = 13.81$, $P < 0.001$) was significantly larger in the offshore north region (Table 3). *Monacanthus hispidus* and *A. saxatilis* had a significant region x season effect with a trend of both species having a pronounced size difference in July and a minimal difference in June.

**Table 2.** Number of fishes collected within *Sargassum* mats by family and species from May-August, 2000.

| Family | Species | Total numbers |
|---|---|---|
| **Antennariidae** | *Histrio histrio* | 368 |
| **Balistidae** | *Balistes capriscus* | 1604 |
| | *Canthidermis maculata* | 3 |
| **Carangidae** | *Caranx crysos* | 1827 |
| | *Seriola dumerili* | 154 |
| | *Decapterus punctatus* | 24 |
| | *Seriola rivoliana* | 17 |
| | *Caranx bartholomaei* | 11 |
| | *Seriola fasciata* | 5 |
| | *Elagatis bipinnulata* | 5 |
| | *Caranx hippos* | 1 |
| **Clupeidae** | *Harengula jaguana* | 23 |
| | *Sardinella aurita* | 1 |
| **Coryphaenidae** | *Coryphaena hippurus* | 1 |
| **Diodontidae** | *Diodon holocanthus* | 1 |
| **Engraulidae** | *Anchoa hepsetus* | 24 |
| **Haemulidae** | *Conodon nobilis* | 2 |
| **Kyphosidae** | *Kyphosus sectatrix* | 7 |
| | *Kyphosus incisor* | 7 |
| **Lobotidae** | *Lobotes surinamensis* | 16 |
| **Monacanthidae** | *Monacanthus hispidus* | 4621 |
| | *Aluterus scriptus* | 35 |
| | *Aluterus heudeloti* | 21 |
| | *Cantherhines pullus* | 19 |
| | *Monacanthus setifer* | 16 |
| | *Aluterus monoceros* | 2 |
| **Mugilidae** | *Mugil curema* | 2 |
| **Nomeidae** | *Psenes cyanophrys* | 14 |
| | *Psenes pellucidus* | 1 |
| **Pomacentridae** | *Abudefduf saxatilis* | 555 |
| **Priacanthidae** | *Pristigenys alta* | 1 |
| **Syngnathidae** | *Syngnathus louisianae* | 1096 |
| | *Syngnathus pelagicus* | 25 |
| | *Hippocampus erectus* | 1 |
| | *Syngnathus scovelli* | 1 |
| **Tetraodontidae** | *Sphoeroides parvus* | 7 |
| TOTAL | | 10,518 |

**Table 3.** Size comparison (standard length) of the seven abundant species (±1 SE). * denotes significant difference in size between respective zones or regions.

| Species | Min. | Max. | Mean Size | Inshore zone | Offshore zone | North region | South region |
|---|---|---|---|---|---|---|---|
| *Monacanthus hispidus*<br>(n = 4621) | 7.8 | 71.8 | 21.9 (±0.1) | 32.5 (±0.4)* | 20.5 (±0.1)* | 20.4 (±65.6)* | 29.1 (±0.8)* |
| *Caranx crysos*<br>(n = 1827) | 12.3 | 134.5 | 34.1 (±0.6) | 93.5 (±6.3)* | 32.5 (±0.6)* | 29.7 (±0.6)* | 48.4 (±3.3)* |
| *Balistes capriscus*<br>(n =1604) | 13.2 | 105.8 | 59.8 (±0.4) | 65.2 (±2.2) | 60.1 (±0.5) | 61.5 (±0.5)* | 58.6 (±0.7)* |
| *Syngnathus louisianae*<br>(n = 1096) | 52.2 | 209.0 | 99.7 (±0.8) | 75.9 (±1.7) | 103.2 (±0.9) | 103.3 (±0.9) | 135.0 (±74.0) |
| *Abudefduf saxatilis*<br>(n = 555) | 9.5 | 38.0 | 15.8 (±0.2) | 20.1 (±0.8)* | 14.9 (±0.2)* | 13.8 (±0.2)* | 17.6 (±0.5)* |
| *Histrio histrio*<br>(n = 368) | 12.0 | 91.8 | 36.5 (±0.8) | 41.4 (±1.7) | 34.8 (±0.8) | 35.0 (±0.8) | 30.5 (±4.8) |
| *Seriola dumerili*<br>(n = 154) | 32.4 | 210.3 | 120.2 (±4.0) | 106.3 (±5.3)* | 123.1 (±4.7)* | 123.4 (±4.7) | 115.1 (±50.0) |

### Spatial and Temporal Patterns of Abundance

CPUE of all seven abundant species in the offshore north zone greatly exceeded those of the inshore north zone (Table 4). Average CPUE of the seven species in the offshore zone ranged from 2 - 87 times higher than the inshore zone. Significant zone effects were observed for *M. hispidus*, *C. crysos*, *B. capriscus*, and *S. louisianae* (Table 4). In addition, *M. hispidus*, *S. louisianae*, *H. histrio* and *S. dumerili* showed a significant seasonal effect as abundance was higher early in the season (Tukey HSD, $P < 0.05$) (Figure 1). A significant zone x season interaction was observed for *S. louisianae*, as a large difference in May indicated the magnitude of the differences between zones varied over time.

Similar trends were observed regionally, as CPUE of the seven abundant species was higher in the offshore north region than the offshore south region. Average CPUE were 1.5-300 times higher in the north region (Table 5). Significant regional effects occurred for *M. hispidus*, *S. louisianae*, *H. histrio*, and *S. dumerili* (Table 5). Additionally, a significant seasonal effect was observed for *S. louisianae* and *H. histrio*; both were significantly more abundant early in the season (Tukey HSD, $P<0.05$) (Fig. 1). *Syngnathus louisianae* and *H. histrio* exhibited a significant region x season effect. The large difference in May suggests that CPUE between regions was not consistent over time.

**Table 4.** Two-factor ANOVA comparison of the average relative abundance (# per purse seine) (±1 SE) of the seven abundant species in the inshore and offshore zones.

| Species | Inshore | Offshore | F ratio | P value |
|---|---|---|---|---|
| *Monacanthus hispidus* | 29.6 (16.5) | 289.0 (164.6) | 11.32 | 0.003 |
| *Caranx crysos* | 1.4 (0.6) | 121.4 (92.8) | 5.70 | 0.027 |
| *Balistes capriscus* | 3.6 (1.1) | 78.3 (25.8) | 19.44 | <0.001 |
| *Syngnathus louisianae* | 10.3 (6.1) | 67.9 (42.3) | 13.46 | 0.002 |
| *Abudefduf saxatilis* | 2.2 (0.8) | 29.1 (15.2) | 4.21 | 0.054 |
| *Histrio histrio* | 7.0 (3.7) | 18.6 (11.1) | 3.41 | 0.080 |
| *Seriola dumerili* | 1.9 (0.7) | 9.0 (5.0) | 3.50 | 0.076 |

### Diversity Measurements

Species richness (S), diversity (H'), and evenness (J') were variable among locations and seasons. S and H' were higher in the offshore north zone, while J' was higher in the inshore north zone (Table 6). A two-way ANOVA indicated S ($F_{1,20} = 33.33$, $P < 0.001$) and J' ($F_{1,20} = 7.06$, $P = 0.015$) were significantly different between zones. Regional comparisons indicated significantly higher S ($F_{1,15} = 5.55$, $P = 0.033$) and H' ($F_{1,15} = 4.95$, $P = 0.042$) in the offshore north region (Table 6). Despite the change in composition, S remained constant throughout the sampling season. In addition, later months (July and August) exhibited significantly higher H' and J' than those of earlier months (May and June) (Tukey HSD, $P < 0.05$).

**Table 5.** Two-factor ANOVA comparison of the average relative abundance (# per purse seine) (±1 SE) of the seven abundant species in the north and south regions.

| Species | North | South | F ratio | P value |
|---|---|---|---|---|
| *Monacanthus hispidus* | 364.6 (205.2) | 16.0 (7.2) | 10.10 | 0.006 |
| *Caranx crysos* | 136.7 (118.8) | 10.8 (4.1) | 0.74 | 0.404 |
| *Balistes capriscus* | 89.6 (32.3) | 45.8 (12.0) | 0.19 | 0.671 |
| *Syngnathus louisianae* | 85.9 (53.0) | 0.2 (0.1) | 44.35 | <0.001 |
| *Abudefduf saxatilis* | 28.7 (19.3) | 11.7 (3.1) | 0.02 | 0.895 |
| *Histrio histrio* | 23.2 (13.9) | 0.9 (0.4) | 13.65 | 0.002 |
| *Seriola dumerili* | 11.4 (6.2) | 0.2 (0.1) | 6.63 | 0.021 |

## DISCUSSION

Abundance of juvenile fishes collected in association with *Sargassum* suggests these mats serve as pelagic nursery habitat. Based upon size-at-collection, over 95% of the fishes were in their early life stage; 72% were under 50 mm (SL) and the average size of all fishes combined was 40 mm. These results are consistent with other studies investigating the fauna associated with pelagic algae (Fine 1970, Kingsford and Choat 1985). Bortone et al. (1977) found the average size of fishes associated with *Sargassum* in the eastern Gulf was less than 25 mm, while Kingsford (1992) observed an average size less than 20 mm in NE New Zealand. The association of these small fishes to pelagic *Sargassum* is likely attributed to the structure and food supply this habitat affords. Druce and Kingsford (1995) found drift objects (i.e. algae and FADs) influenced the distribution of larval and juvenile fishes in surface waters when compared to open water habitats. Additionally, detached macrophytes have been suggested to serve as nursery areas for juvenile fishes as it provides prey resources and protection from predators (Lenanton et al. 1982, Lenanton and Caputi 1989). Again, gear selectivity may influence the size range collected in this study; nevertheless, the abundance of juveniles associated with *Sargassum* suggests this habitat may be important for early life survival.

Patterns of habitat use also appeared related to the timing and location of spawning. Variability in size frequencies throughout the sampling period suggests that protracted spring and summer spawning events occurred for several species. Additionally, three of the seven abundant species (*M. hispidus*, *C. crysos*, *A. saxatilis*) were significantly smaller in offshore waters. These results suggest the small sizes collected within the offshore zone are likely related to their proximity to spawning grounds. These findings are consistent with the season and location of reproduction for *M. hispidus* (Berry and Vogele 1961), *C. crysos* (Leak 1981, Shaw and Drullinger 1990), and *A. saxatilis* (Shaw 1955), as extended spring and summer spawning events are common in offshore areas for all three taxa. Conversely, *Syngnathus louisianae* is known to spawn inshore, often in close proximity to seagrass beds (Diaz-Ruiz et al. 2000). Our results are consistent with these findings, as *S. louisianae* was smaller within the inshore zone.

**Table 6.** Average species richness (S), Shannon diversity (H') and evenness (J') indices for all samples. August was removed from regional comparison due to a lack of samples in the south region. * indicates $P \leq 0.05$ and $^{ns}$ indicates $P > 0.05$.

| | | S | H' | J' | Total # of species | Total # of individuals |
|---|---|---|---|---|---|---|
| **Season** | May | 7.5 $^{ns}$ | 0.442 * | 0.520 * | 19 | 5091 |
| | June | 7.6 | 0.447 | 0.551 | 26 | 1529 |
| | July | 7.8 | 0.603 | 0.716 | 35 | 3393 |
| | August | 8.8 | 0.599 | 0.654 | 14 | 505 |
| **Zone** | Inshore | 5.4 * | 0.523 $^{ns}$ | 0.729 * | 20 | 862 |
| | Offshore | 10.5 | 0.574 | 0.586 | 37 | 8756 |
| **Region** | North | 10.7 * | 0.572 * | 0.584 $^{ns}$ | 36 | 8291 |
| | South | 7.2 | 0.457 | 0.515 | 21 | 900 |

Spatial patterns indicated that the abundance of fishes associated with pelagic *Sargassum* varies as a function of distance from shore. The seven abundant species associated with *Sargassum* in the offshore zone was much greater than in the inshore zone. Bortone et al. (1977) found similar trends in fish abundance for several species, including *M. hispidus*, *B. capriscus*, and *S. dumerili*, as distance increased from shore. Since physiochemical conditions differed between zones, physiological tolerances may contribute to the observed patterns. Average salinity values differed between zones by 2.5‰, with a range from 29‰ to 37‰ in the inshore zone and 33‰ to 38.5‰ in the offshore zone. In addition, differences in both temperature and dissolved oxygen content differed between zones by as much as 2.2°C and 2.5 mg/L in certain months, respectively. Boehlert and Mundy (1994) found temperature and salinity were likely factors responsible for onshore-offshore distribution patterns of tuna larvae. Additionally, Raynie and Shaw (1994) found ichthyoplankton assemblages from offshore to estuarine areas were attributed to different life-history strategies and temperature regimes. The combination of environmental conditions and life history patterns are likely to influence the observed spatial differences; however, other factors such as season, life-history strategies, and differential resource exploitation may also be important.

On a larger scale, patterns of habitat use were observed between the offshore north and south regions along the Texas Gulf coast. The seven abundant species in this study were far more abundant in the north region. Qualitative measurements of *Sargassum* biomass indicated less pelagic habitat was available in the north region throughout our sampling. Therefore, species may have been concentrated beneath the limited available habitat in the north region and dispersed in the south region, where much more *Sargassum* was present. Physiochemical factors may also contribute to this pattern as Sahl et al. (1993) found that temperature, salinity, oxygen, and nutrients (nitrate, phosphate, silicate) differed markedly between offshore areas of Galveston and Port Aransas. Results from this study indicated significantly higher temperatures and lower salinity and dissolved oxygen content were associated with the north region. The difference in shelf currents, freshwater discharges, and upwelling at the shelf edge may further contribute to both physical and biological differences between the two regions (Smith 1980b, Cochrane and Kell 1986). Previous studies investigating pelagic fish assemblages have shown their distribution and abundance are influenced by environmental and hydrological conditions (Rey 1996, White 1997). Consequently, the numerical dominance in the north region may result from a combination of biological, physical, and chemical conditions.

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