Associations of Elasmobranchs with Seagrass Habitats in Northwest Florida

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SEFSC Contribution SFD-2024-02

https://doi.org/10.25923/ta7h-wx64

Introduction

Assessment of juvenile elasmobranch nursery habitats and the environmental conditions these sharks are often captured in can offer insight into their preferred habitats. Beck et al. (2001) theorized the role of a nursery habitat is that the area must contribute greater than average production of individuals than other areas, and as a result must support a greater density of individuals, growth, survival, and capacity to move to adult habitats. Heupel et al. (2007) pointed out the application of this theory would be difficult and would result in few areas to be assessed as a nursery due to the differences in life history for each elasmobranch species. To find a more suitable definition, Heupel et al. (2007) proposed a paradigm based on the following criteria: (1) juveniles are more common in those places than in other areas, (2) juveniles tend to remain in or return to such areas for extended periods, (3) the areas of habitat are repeatedly used across years. These criteria have been widely adopted as the proposed standard for elasmobranch nursery designations.

In northwest Florida, distribution patterns of juvenile coastal sharks vary by species. For example, bull shark, *Carcharhinus leucas*, and spinner shark, *C. brevipinna* were consistently captured at higher rates in single areas or over a select group of bays (Mobile Bay, AL to Apalachicola Bay, FL), (Bethea et al., 2014). Further, species diversity varied potentially as a result of environmental conditions such as fluctuating salinity (Bethea et al., 2014). Similar results were found when describing elasmobranch spatial variations and community composition along environmental gradients in the Florida Big Bend (an expansive system that is about 300 km in length and bordered by one of North America's largest seagrass beds (Peterson & Grubbs, 2020). Elasmobranch distributions were found to be influenced by factors such as salinity,

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temperature, dissolved oxygen, depth, and distance to tidal inlets within this expansive seagrass system, which has been decreasing over the past 25-50 years due to decreased water quality (Peterson & Grubbs., 2020). Understanding environmental conditions preferred by elasmobranchs, including factors such as vegetation cover, can offer valuable insight into their habitat requirements. This knowledge becomes crucial in predicting how these species might respond to the increasing threats of climate change and the potential impacts on nursery habitats.

Seagrass meadows are not only credited for being nursery grounds for many juvenile species, but they also provide ecological services by contributing to global carbon storage (Lizcano et al., 2022). The most dominant seagrass species found off northwest Florida include shoal grass, *Halodule wrightii,* manatee grass, *Syringodium filiforme,* and turtle grass, *Thalassia testudinum* (Lizcano et al., 2022). Threats to these habitats such as climate change and other anthropogenic effects can cause these critical habitats to have a decrease in resilience and cause large-scale die-offs. For example, a significant heat wave referred to as *Ningaloo Niño* caused the water temperatures in Shark Bay Australia to increase by 4ºC for 2 months e (Kendrick et al., 2019). The resiliency of the seagrass meadows compared with previous seagrass data from the temperate and tropical species across local and regional ecosystem-wide spatial scales over an 8-year time span showed that the thermal effects on the dominant temperate species *Amphibolis antarctica* were severe and led to foliation followed by rhizome death (Kendrick et al., 2019). This result occurred in 60-80% of the meadows in the bays, which equivalates to an estimated loss of 1,000 km^2 of meadows, impacting multiple consumer populations, thus showing that stressors can result in severe ecological responses and push ecosystems beyond their tolerance (Kendrick et al., 2019).

The loss of these meadows can have severe effects on the predators within these communities as they are reliant on the prey residing in the seagrass ecosystems. For example, White and Potters (2004) discovered that elasmobranch species had the highest species diversity and catch rates in seagrass areas compared to unvegetated sites (White & Potter, 2004). Thus, it is crucial to determine the species' reliance on seagrass meadows. The purpose of this study is to evaluate juvenile elasmobranch populations in northwest Florida and their association with seagrass. As seagrass distribution and density will likely be impacted by climate change, this assessment can aid with understanding how elasmobranch distributional patterns may be affected by changing environmental conditions.

Methods

Field surveys were conducted using a monofilament gill net with varying stretch mesh panels ranging from 7.6 cm-14.0 cm (3.0”-5.5”), each panel was 3.0m (10ft) deep and 30.5m (100ft) long, the panels were unified and set in the water as a single gear (Carlson and Brusher, 1999). All sets which were made during daylight hours were randomized, the gear was fished perpendicular to shore or with the wind, the set soak time was recorded from the time the gear entered the water to the time the gear was removed from the water, with each removal haul starting 0.5-1.0 after the gear first entered the water, upon completion of the return haul, the gear was then moved to a new location. During each set, the mid-water temperature (ºC), salinity, dissolved oxygen ($mg1^{-1}$) average depth (m) (calculated using gear start and end points recorded from the vessel’s depth finder) and water clarity (measured by secchi disc) were recorded

(Bethea et al., 2014). Bottom type was qualitatively assessed visually or based on the identification of sediment and associated flora from the anchor.

Captured sharks were sexed, assigned life stages, and measured by their pre-caudal (PCL), fork (FL), total (TL), and stretched total (STL) in centimeters (cm) . Neonates were defined by having an open umbilical scar, the young-of-the-year (YOY) by having a closed yet visible umbilical scar, and juveniles/adults were defined based of macro-analysis or published accounts of 50% size at maturity (Bethea et al., 2014). Relative abundance was determined as catch per unit effort (CPUE) defined as the number of a species-life stage caught divided by soak time (Bethea et al., 2014).

Bottom type categorized as seagrass included any bottom type that is listed as seagrass, seagrass/mud, seagrass/mud/sand, seagrass/sand. We used Ivlev's electivity index to determine species association with seagrass, Ivlev's electivity index is defined as

$$E = (r_i - p_i) / (r_i + p_i)$$

where r_i is the species proportion in which the species was captured in the environmental variable i, and p_i is the proportion of the environmental variable i in all samples (Ivlev 1961).

Results and Discussion

Among the major sampling areas, only 3 areas contained seagrass meadows. Of those samples, 8% (n=735) of elasmobranchs were captured within a seagrass bottom association (Figure 1). The top three most abundant species included Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, cownose ray, *Rhinoptera bonasus*, and bonnethead, *Sphyrna tiburo* (Table 1).

Our results show that 7 elasmobranch species were captured within the following seagrass categories: seagrass, seagrass/mud, seagrass/mud/sand, seagrass/sand. Ivlev's electivity index determined that even though there was some preference for our most abundant species (Atlantic Sharpnose) within a seagrass bottom type, the electivity index was <1 therefore not significant (Figure 2). These results are surprising when comparing the distributional patterns of shark population assemblages in the coastal waters of west-central Florida. Mullins (2021) observed the importance of seagrass and barrier island habitats to the shark assemblage, they found species distribution that held the highest marginal effect with a seagrass bottom type was Blacknose *Carcharhinus acronotus*, which held a percent variable of 29.4%, following with temperature 24.1% and DO 18.9%. Other species such as Blacktip *Carcharhinus limbatus*, Nurse *Ginglymostoma cirratum*, Atlantic sharpnose *Rhizoprionodon terraenovae*, and Bonnethead *Sphyrna tiburo* were all affected by the same variables, however, only Blacknose sharks distribution was mostly influenced by seagrass. The results of this study show that nearshore coastal areas consisting of shallow, warm, seagrass environments are critical habitats for some elasmobranch species (Mullins et al., 2021).

Utilizing this information can be beneficial to continue monitoring coastal habitats along the Gulf of Mexico. Determining if environmental conditions will continue to be favorable to support species diversity/abundance is a critical factor in determining how productive the nursery grounds are.

Table 1 The total amount of species captured from each site in the combined seagrass bottom types (seagrass, seagrass/sand, seagrass/mud/sand, seagrass/mud).

Species	**Area**			**Total**
	CIS	SAB	SJB	
Rhizoprionodon terraenovae	338	0	172	510
Rhinoptera bonasus	0	22	57	79
Sphyrna tiburo	0	42	11	53
Carcharhinus brevipinna	0	0	37	37
Carcharhinus limbatus	0	0	28	28
Dasyatis sp	0	15	0	15
Sphyrna lewini	13	0	0	13
Grand total	351	79	305	735

Figures

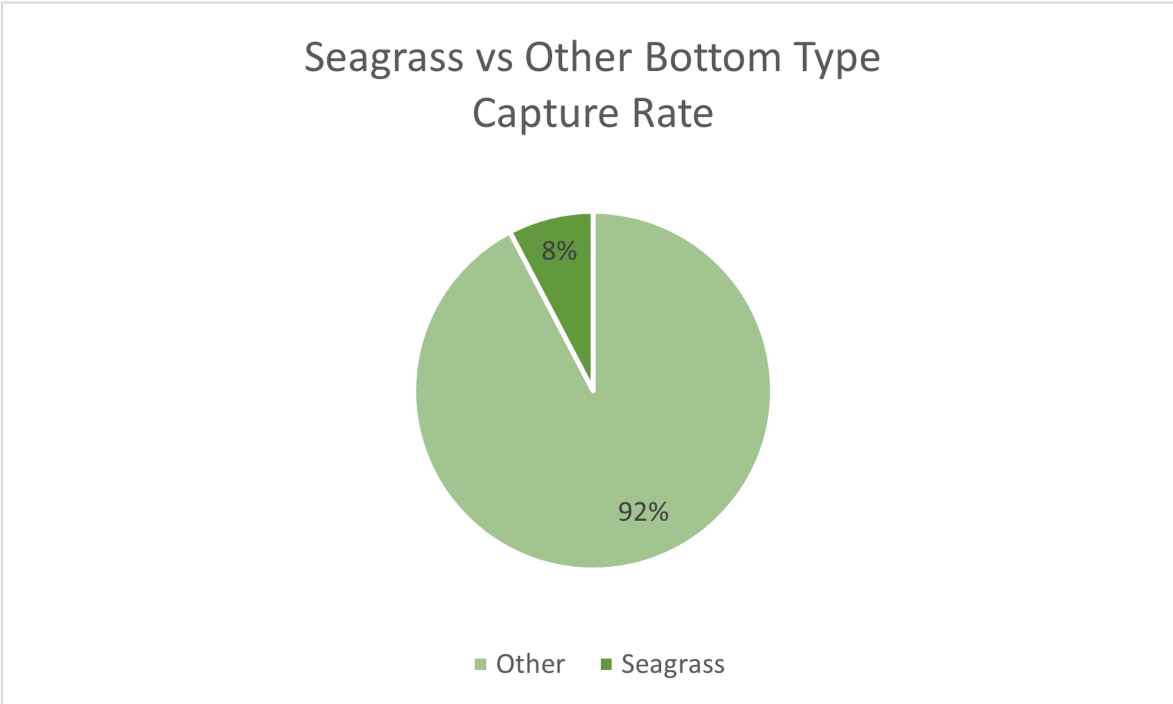

Figure 1 The percentage of the total number of elasmobranchs captured within either a “Seagrass” bottom type (Seagrass, Seagrass/Sand, Seagrass/Mud, Seagrass/Mud/Sand), or “Other” bottom type (Mud, Mud/Sand, Mud/Shell, Oyster, Sand, Sand/Shell)

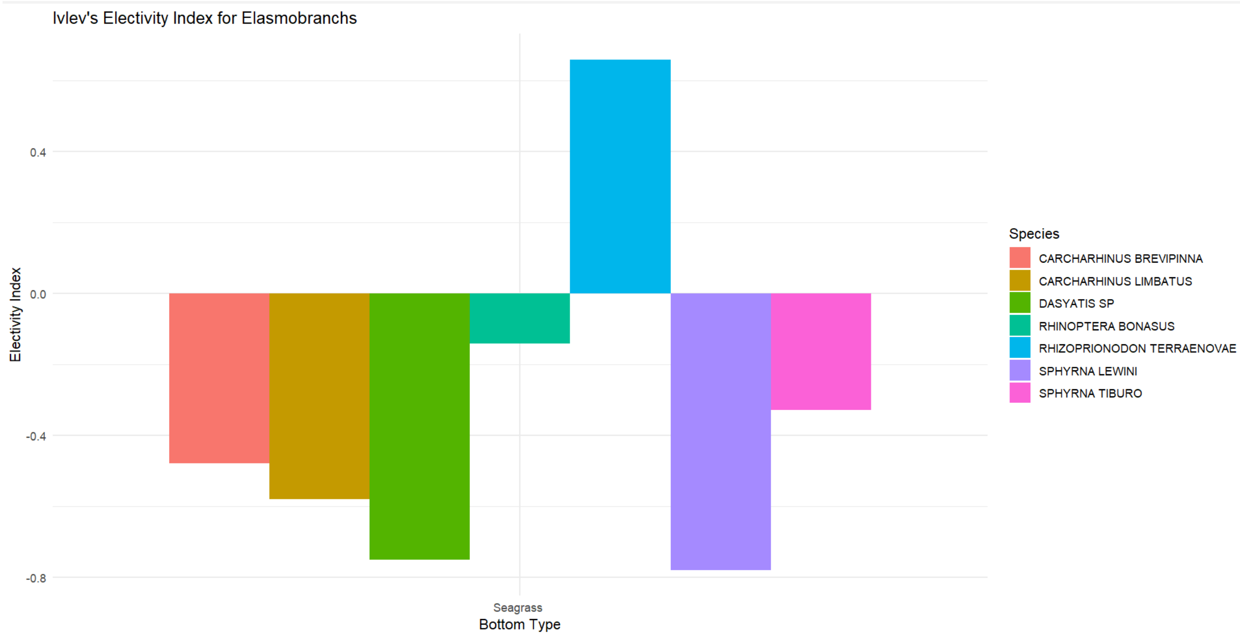

Figure 2 Ivlev's electivity index for each species captured within a seagrass bottom type. Values >1 shows a preference for the bottom type category, <1 shows an avoidance, 0 shows no preference or avoidance.

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