7.0 RESEARCH AND INFORMATION NEEDS

Although a substantial amount of research regarding HMS and habitat associations has been conducted since publication of the 1999 FMP, there are still considerable information gaps. In many cases the movements of these animals are still not well understood or have only been defined in broad terms. Furthermore, although the habitats through which these animals transit may be intensely studied, and the physical and biological processes fairly well understood in broad terms, there is little understanding of the particular characteristics that influence the distribution of tuna, swordfish, sharks, and billfish within those systems. Unlike many estuarine or coral reef species that can be easily observed, collected or cultured, the extensive mobility and elusiveness of the species, combined with their rarity, has delayed the generation of much of the basic biological and ecological information needed to analyze their habitat affinities. Based on the present state of information concerning the habitat associations of HMS, the following research and information needs have been identified.

Tuna and swordfish

Ecosystem Structure and Function

- Investigate the influence of habitat characteristics such as temperature (*e.g.*, the relation to thermal fronts) and salinity on tuna and swordfish distributions, spatially as well as seasonally.

- Monitor animal movements using advanced archival and satellite telemetry technology in order to better define tuna and swordfish distributions, seasonality, environmental tolerances and preferred habitats.

- Identify spawning areas and investigate the role of environmental factors which affect distribution and survival of larval and juvenile tuna and swordfish, leading to variations in year class abundance.

- Characterize submarine canyon processes, eddies, gyres, and fronts as they interact with tuna and swordfish and characterize their importance as zones of aggregation.

- Further identify major prey species for tuna and swordfish, including preferred feeding areas and influences of environmental factors.

- Gain a better understanding of the life histories of tuna and swordfish, including the development of culture methods to keep tuna and swordfish alive in captivity for life history studies.

- Improve the capability to identify tuna and swordfish eggs and early life stages of these species.

- Expand investigations of BFT movement and stock structure, and determine the levels of each stock on mixing grounds of the western Atlantic and the central North Atlantic.

- Improve our understanding of BFT movements during the first year(s) of life to help elucidate migration paths of juveniles.

- Characterize BFT natal homing behavior to spawning grounds in the Gulf of Mexico and Mediterranean to provide more information on spawning migrations and behavior.

- Develop a detailed model for the breeding habitat of BFT in the Gulf of Mexico and determine their essential breeding habitat.

Effects of Habitat Alteration

- Identify fisheries that operate in tuna and swordfish EFH and characterize threats to tuna and swordfish EFH, particularly spawning and nursery areas.

- Investigate the effects of contaminants on tuna and swordfish life stages, especially eggs and larvae; this would require the development of better laboratory culture techniques for these species.

- Determine the effects of contaminants (*e.g.*, oil spills) in offshore epipelagic habitats where tuna and swordfish are known to spawn or otherwise aggregate.

- Identify habitat linkages between inshore and offshore habitats to better define the zone of influence for inshore activities that may adversely affect tuna and swordfish habitats.

Synthesis and Information Transfer

- Incorporate/develop spatially consistent databases of environmental conditions throughout the tuna and swordfish ranges (*e.g.*, temperature, salinity, currents).

- Further analyze fishery dependent data to construct a clearer view of relative abundances.

- Contour abundance information to better visualize areas where tuna and swordfish are most commonly encountered.

- Construct spatial databases for early life history stages (*i.e.*, eggs and larvae).

- Derive objective criteria to model areas of likelihood for relative abundances of tuna and swordfish based on environmental parameters.

- Define and model habitat suitability based on seasonal analyses of tolerances of environmental conditions.

Sharks

Ecosystem Structure and Function

- Continue the delineation of shark nurseries using a more quantitative approach beyond simple presence-absence information; establish the geographic boundaries of the summer nurseries of commercially important species.

- Determine the location of the winter residency areas using a more quantitative approach beyond simple presence-absence information

- Expand the use of acoustic telemetry and satellite archival tags in shark species, particularly of juvenile shark in seasonal migrations, to better define locations, distributions, and environmental tolerances.

- Determine if sharks return to their natal nurseries; determine if females exhibit philopatry.

- Determine growth and survival rates of each life stage

- Determine biotic and abiotic relationships such as temperature (*e.g.*, the relation to thermal fronts) and salinity spatially as well as seasonally; determine the significance of areas of aggregation; determine the role of coastal/inshore habitats in supporting neonates and juveniles.

- Expand current models for delineating EFH for shark nursery grounds to include water quality and other anthropogenic variables that potentially influence distribution.

- Study the physiological responses of juvenile sharks to organochlorine contaminant exposure in order to understand how these pollutants may impact reproduction and subsequently population growth.

- Information on shark populations and their dynamics within nursery areas, including short- and long-term movement patterns.

- Evaluate tidal marshes and other coastal habitats for their importance in sustaining shark populations.

- Examine the role of sharks in regulating ecosystem structure.

- Expand the knowledge of barrier island/shark interactions in the Gulf of Mexico, including diel movements and prey species.

- Studies on shark community dynamics, including how inter- and intra-specific interactions between shark species and size classes influence their distributions.

- Research as to the cues that trigger movement to and from EFH, including nurseries.

- Further understand how shark species utilize coastal habitats on a diel basis.

- Determine factors that determine the carrying capacity of nursery areas; determine factors that regulate shark population dynamics in a location, nursery area selection, habitat use within nurseries, effects of human disturbance.

Effects of Habitat Alteration

- Document the effects of anthropogenic disturbance on the distribution, abundance and survival of neonates and juveniles in inshore and estuarine areas.

- Identify fisheries that operate in shark EFH and characterize threats from fishery practices to shark EFH, particularly nursery areas.

- Identify the types of habitats shark bottom longline gear is set on and its potential impact to the benthic environment.

Synthesis and Information Transfer

- Incorporate/develop spatially consistent databases of environmental conditions throughout the sharks' ranges (*e.g*., temperature, salinity, currents).

- Further analyze historic and current fishery independent data to construct a clearer view of relative abundances.

- Contour abundance information to better visualize areas where sharks are most commonly encountered.

- Construct spatial databases for early life history stages (neonates and early juveniles), incorporating seasonal changes.

- Derive objective criteria to model areas of likelihood for relative abundances of sharks based on environmental parameters.

- Define and model habitat suitability based on seasonal analyses of species tolerances of environmental conditions.

Billfish

Ecosystem Structure and Function

- Investigate the influence of habitat characteristics such as temperature (*e.g*., the relation to thermal fronts) and salinity on billfish distributions, spatially as well as seasonally.

- Monitor animal movements using advanced archival and satellite telemetry technology in order to better define billfish distributions, seasonality, environmental tolerances and preferred habitats; have longer monitoring times to capture seasonality in the tag deployments.

- Monitor long-term, large scale movements of billfish populations, critical for defining, assessing, and managing their stocks.

- Identify spawning, nursery and feeding habitats.

- Investigate the role of environmental factors which affect distribution and survival of larvae and juveniles, leading to variations in year class abundance.

- Characterize submarine canyon processes, eddies, gyres, and fronts as they interact with billfish and characterize their importance as zones of aggregation.

- Further identify major prey species for billfish, including preferred feeding areas and influences of environmental factors.

- Gain a better understanding of the life history of billfish, including age and growth; develop culture methods to keep billfish alive in captivity for life history studies.

- Develop new methods for identifying billfish eggs, larvae and juveniles, gender, and state of maturity; in particular, develop techniques to better distinguish roundscale spearfish from white marlin to more accurately determine abundances of each and conduct spatial and temporal comparisons.

- Develop alternative innovative stock assessment models to better estimate the level of bycatch of billfish in different fisheries.

- Develop fishery independent indices of abundance for billfish.

- Obtain more detailed spatio-temporal information on the distribution of marlin reproduction and the identification of nursery areas for management decisions.

- Expand reproductive studies on a regional scale to further define essential fish habitat for billfish – may require major research vessel time to accomplish this.

- Conduct post-release survival studies for recreational and commercial fisheries.

Effects of Habitat Alteration

- Investigate the effects of contaminants on billfish life stages, especially eggs and larvae; this would require the development of better laboratory culture techniques for these species.

- Determine the effects of contaminants (*e.g.*, oil spills) in offshore epipelagic habitats where billfish are known to spawn or otherwise aggregate.

- Identify habitat linkages between inshore and offshore habitats to better define the zone of influence for inshore activities that may adversely affect billfish habitats.

Synthesis and Information Transfer

- Incorporate/develop spatially consistent databases of environmental conditions throughout the billfish ranges (*e.g.*, temperature, salinity, currents).

- Further analyze fishery dependent data to construct a clearer view of relative abundances.

- Contour abundance information to better visualize areas where billfish are most commonly encountered.

- Construct spatial databases for early life history stages (*i.e.*, eggs and larvae).

- Derive objective criteria to model areas of likelihood for relative abundances of billfish based on environmental parameters.

- Define and model habitat suitability based on seasonal analyses of tolerances of environmental conditions.

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