CHAPTER 6: SPOTTED SEATROUT

Populated with text from the Omnibus Amendment to the ISFMP for Spanish Mackerel, Spot, and Spotted Seatrout (ASFMC 2012)

Section I. General Description of Habitat

Overall, one issue with spotted seatrout is that the species is comprised of unique spatial populations, generally associated with an estuary. Little mixing goes on outside of adjacent estuaries. This means that it is not always safe to project the findings of one subpopulation onto the whole species, and this concern is amplified by the number of studies in the Gulf of Mexico or areas not comparable to the U.S. southeast Atlantic. For example, Powell (2003) presents good information on inferred spawning habitat and egg and larval distribution of spotted seatrout in Florida Bay (Powell et al. 2004). Florida Bay is a shallow, subtropical, oligohaline estuary without lunar tides, and considering that the spotted seatrout inhabiting this area are a unique subpopulation, it makes sense to limit the inference from a population like this onto both a distinct genetic and morphological stock in the Carolinas that inhabits a very different type of estuary (reiterated by Smith et al. 2008, which found growth differences among subpopulations). Research suggests salinity tolerances are genetic and that caution should be used when applying research to other populations.

Part A. Spawning Habitat

Geographic and Temporal Patterns of Migration

Many age-1 spotted seatrout are mature (L_{50}=292 for females; Ihde 2000) and all are mature by age-2. Consistent with the other life stages, spotted seatrout are generally restricted to their natal estuary (Kucera et al. 2002) and for spawning adults this means that spawning takes place often in the lower reaches of the estuary or nearshore just outside inlets.

Spawning seasons vary throughout the species range, and tend to lengthen as a function of warmer water. For example, spawning in Florida Bay has been reported to run from March to October (Powell 2003), while spawning in South Carolina is restricted from late April to early September (Roumillat and Brouwer 2004), and may not begin until May in North Carolina (Luczkovich et al. 2008) and the Chesapeake Bay (Smith et al. 2008). Adult spotted seatrout begin to spawn in March or April in southwest and west-central Florida estuaries (e.g., Tampa Bay and Charlotte Harbor; McMichael and Peters 1989) and in April or May in the more northerly Florida estuaries (e.g., northern IRL) (Tabb 1961; Crabtree and Adams 1998). Specific estuarine spawning locations are not well documented, especially in Atlantic estuaries, although Luczkovich et al. (2008) recorded more spawning-associated calls near Bay River (western Pamlico Sound) than near Ocracoke Inlet (eastern Pamlico Sound). It is also worth mentioning that many of the environmental variables reported by Luczkovich et al. (2008) are in contrast with spawning habitat descriptions reported by Holt and others working in the Gulf of Mexico.

Salinity
Based on work in the Gulf of Mexico, Kucera et al. (2002) found differing egg characteristics from different Texas bays. Decreasing salinity resulted in increasing size and wet weight of eggs with the opposite true for increasing salinity. Eggs from spawners native to high salinity estuaries spawned at 20 ppt were not positively buoyant and died. Although it is difficult to generalize anything broadly applicable from this study, it does suggest that spawning salinity may be a locally-adapted trait.

Less work has reported on spawning salinities in the Atlantic, though Luczkovich et al. (2008) report spotted seatrout spawning-related drumming to take place in bottom salinities averaging 11.8 ppt (range 7.1–26.9 ppt), which is considerably less saline than reports from the Gulf of Mexico, but may also reflect the habitats investigated and not a uniform distribution of available salinities.

Substrate
It is unclear if spawning habitats are shared with adult habitats, and if so, what substrate preferences are. However, as eggs are pelagic, it is likely that substrate is less important than other environmental variables (such as temperature, salinity, tide, etc.).

Temperature
Spawning temperatures appear to be consistently high among all reports. For example, Louisiana spawning aggregations were highly associated with temperature 29.7 ± 0.31°C (2 standard errors; Saucier and Baltz 1993), with Brown-Peterson et al. (1988) proposing a critical minimum spawning temperature of 23°C. Others have suggested minima of 25.6°C (Tabb 1966) and 26.3°C (Rutherford et al. 1989). Similarly in the Atlantic, spotted seatrout did not drum below 23°C (but one outlier), with most drumming occurring between 25–30°C (Luczkovich et al. 2008). Hatch dates in the Chesapeake Bay have been dated to early May, yet it remains unclear if this northern distributional population has a lower spawning temperature tolerance.

Dissolved Oxygen
As with other life stages, DO has not been widely investigated or reported for spawning adults. Despite this paucity of data, the hydroacoustic results suggests that hypoxia did not limit spotted seatrout sound production; drumming has been recorded at DO levels as low as 0.05 mg L^{-1} (mean 6.1 mg L^{-1}, range 0.05–9.73 mg L^{-1}; Luczkovich et al. 2008).

Feeding Behavior
The protracted spawning season of spotted seatrout suggests that they do feed during the spawning season, and feeding patterns likely reflect the same as adult spotted seatrout.

Competition and Predation
No studies of competition or predation of spotted seatrout were found. Spotted seatrout are top predators in estuarine systems and are consumed by larger predatory fishes, ospreys, and other predatory birds.

Part B. Egg Habitat

Spotted Seatrout larvae use tidal flows to migrate into and within estuaries (Perret et al. 1980) where they settle in seagrass beds, shallow bays, and backwater creeks (McMichael and Peters 1989).

Geographic and Temporal Patterns of Migration

Along the Atlantic coast, spotted seatrout likely spawn in a variety of estuarine habitats. Spawning habitats are often located by identifying regions where spotted seatrout are drumming, a behavior characteristic of spawning. In a review of spotted seatrout, Johnson and Seaman (1986) report spawning habitat (and thus egg habitats) to range from non-tidal portions of estuarine tributaries, to outside of estuaries. Because eggs hatch 16–22 h after fertilization between (25–27°C; Holt et al. 1985), the egg phase is relatively short in duration.

Salinity

Preferred salinities of spotted seatrout eggs are unknown but likely varies by spawning habitat. For example, Taniguchi (1981) reported from lab work an optimum salinity for hatching at 28.1 ppt. Gray et al. (1991) reported hatching success in treatments of 30–50 ppt but the highest hatching success was observed at 30 ppt and no hatching observed after 50 ppt.

Substrate

Due to the relatively short duration of the spotted seatrout egg phase and the neutral buoyancy needed to move eggs and provide oxygen, substrate is likely not an important habitat characteristic for this species at this stage.

Temperature

Preferred temperatures of spotted seatrout eggs vary. Using eggs from Texas fish, Fable et al. (1976) reared eggs at 25°C that hatched 16–20 h after fertilization Taniguchi (1981) reported optimum temperature for hatching to be 28°C. While general trends may be applied to Atlantic stocks of spotted seatrout, these results should be used cautiously as they are based not only on artificial conditions (controlled laboratories), but using genetically different stocks that have adapted to different temperature and salinity regimes that exists in the Gulf of Mexico.

Dissolved Oxygen

No work has been conducted or reported having to do with DO and spotted seatrout eggs. Because eggs spawned in low salinities become demersal and die, it is thought that minimally normoxic conditions are required for adequate egg development.

Feeding Behavior

Spotted Seatrout eggs subsist entirely off the yolk sac prior to hatch.

Competition and Predation

Spotted Seatrout eggs likely do not enter into any meaningful ecological competition, as their habitat demands are basic (and largely met by the oceanic or estuarine conditions). Predation of eggs undoubtedly occurs by a variety of oceanic and estuarine consumers, particularly gelatinous zooplankton (Purcell 1985; Olney and Boehlert 1988; Cowan et al. 1992).

Part C. Larval Habitat

Geographic and Temporal Patterns of Migration

In the Gulf of Mexico, Holt and Holt (2000) found the most fish along the bottom during the day and similar numbers on bottom and surface at night, suggesting vertical migration. However, Lyczkowski-Schultz and Steen (1991) observed a reverse vertical behavior. Likely both studies are an accurate reflection of what the authors sampled, but that patterns of vertical distribution may be influenced by spatial or temporal effects not included in the studies. In the Chesapeake Bay, post-settlement, late larvae are obligate seagrass residents in meso- and polyhaline areas (Dorval et al. 2007; Jones 2013).

Salinity

Spotted Seatrout are among the more euryhaline of larval sciaenid, as Rutherford et al. (1989) could only collect spotted seatrout from 8–40 ppt (mean 33.2 ± 1.7 ppt), which, along with other work (Banks et al. 1991) establishes high tolerances of salinity and high mortality at lower salinities. Tabb (1966) particularly notes that while the overall tolerance range may be wide but abrupt changes in salinity, such are from freshwater inflow resulting from precipitation, renders fish vulnerable. In the Gulf of Mexico, larvae have been collected in salinities ranging from 15–50 ppt, but most are collected at salinities >24 ppt. Low salinities reduce survival of larval spotted seatrout (Holt and Holt 2003).

Substrate

Spotted Seatrout larvae settle on a variety of substrates, though they prefer seagrass habitats when available (Dorval et al. 2005; Dorval et al. 2007; Jones 2013). In estuaries and areas lacking SAV such as much of South Carolina, Georgia, and parts of North Carolina, larval spotted seatrout have been collected in shallow marsh habitats (Wenner et al. 1990).

Temperature

Larval spotted seatrout likely tolerate a wide range of temperatures but optimum temperatures from South Florida are 23–33°C (Taniguchi 1981). In Florida Bay, most larvae were found in temperatures between temperatures 26–33°C (Powell 2003).

Dissolved Oxygen

To date, no studies of DO requirements for larval spotted seatrout have been reported.

Feeding Behavior

The overall pattern of feeding is likely an effect of prey availability in specific estuaries, but larval diet is dominated by plankton, specifically copepods. From wild spotted seatrout larvae in Texas waters, calanoid copepods and bivalve larvae were the most important food items (Holt and Holt 2000).

Competition and Predation

Explicit studies of competitors and predators is lacking; however, larvae of other sciaenids and estuarine species likely compete for similar planktonic prey items. And consistent with other predators of larval sciaenids, gelatinous predators and larger fish are likely the dominant predators of larval spotted seatrout (Purcell 1985; Olney and Boehlert 1988; Cowan et al. 1992).

Part D. Juvenile Habitat

Geographic and Temporal Patterns of Migration

Throughout their range, juvenile spotted seatrout are most often associated with seagrass habitats or SAV. This is certainly true in the Gulf of Mexico (Rooker et al. 1998) and in Florida Bay, where spotted seatrout abundance and distribution has been linked to seagrass communities (Chester and Thayer 1990). In the Florida Bay study, temperature and salinity were relatively constant among sampled areas and spotted seatrout are captured in basins more than channels. In Mississippi waters, spotted seatrout have high site fidelity (Comyns et al. 2008).

In the Atlantic, seagrass beds are likely important (Jones 2013), but surprisingly few studies report on this habitat type, and many are of short duration, limited temporally, or of only a single species. In the Chesapeake Bay, juvenile spotted seatrout are obligate seagrass residents in meso- and polyhaline areas (Dorval et al. 2005; Dorval et al. 2007; Jones 2013). Seagrass beds of Chesapeake Bay provide different growth conditions depending on precipitation and freshwater flow into the bay with higher salinities support faster growth (Smith et al. 2008).

Salinity

The majority of studies involving juvenile spotted seatrout provide varying ranges of tolerated salinities, typically with mean values between 15–25 ppt. Spotted seatrout were the only one of five common coastal fish that grew slower during high river discharge years in Florida (Purtlebaugh and Allen 2010). In the Chesapeake Bay, drought years have been linked to increases in growth (Smith et al. 2008).

Substrate

Juvenile spotted seatrout prefer seagrass (SAV) but use shallow tidal salt marsh habitats when SAV is unavailable. In Florida Bay, juvenile spotted seatrout were most often captured where seagrass density and species diversity was highest (Chester and Thayer 1990).

Temperature

Temperature requirements, particularly minimum temperatures in the northern distributional limits of the species, are similar throughout their range. Based on work in South Carolina, temperatures <5°C are cause for concern as mortality begins to become a serious threat (Anweiler et al. 2014). In North Carolina, spotted seatrout experience approximately 86% mortality after being exposed to 5°C after 10 days (Ellis 2014). In North Carolina, 3.0°C was determined to be a lethal threshold whereas 5°C represents a lethal limit if the exposure persists (Ellis 2014).

Dissolved Oxygen

To date, no studies of DO requirements for larval spotted seatrout have been reported.

Feeding Behavior

Juvenile spotted seatrout eat mysids and caridean shrimp whereas larger juveniles eat penaeid shrimp and fishes (Johnson and Seaman 1986; Able and Fahay 2010).

Competition and Predation

Studies of competitors and predators are lacking; however, juvenile spotted seatrout and other juvenile sciaenids compete for space in upper-estuary habitats, and food in years of limited prey production. However, these are generalities and not based on specific studies of spotted seatrout. Juvenile spotted seatrout are preyed upon by larger fishes, such as striped bass (*Morone saxatilis*), Atlantic croaker (*Micropogonias undulatus*), Atlantic tarpon (*Megalops atlanticus*), and barracuda (*Sphyraena barracuda*) (Mercer 1984; Able and Fahay 2010).

Part E. Adult Habitat

Adult and juvenile spotted seatrout occupy similar habitats (i.e., seagrass beds) but they do partition their foraging habitats through ontogenetic diet shifts (Deary 2015). As adult spotted seatrout increase in size, pelagic fishes and penaeid shrimp become increasingly important in their diet (Lorio and Schafer

1966; ASMFC 1984; Mercer 1984; Daniel 1988). Diet analysis of spotted seatrout in the lower Cape Fear River, North Carolina, revealed that spotted seatrout are mainly piscivorous after reaching age 1 (Tayloe and Scharf 2006).

Geographic and Temporal Patterns of Migration

Most individuals of adult spotted seatrout have high site fidelity and display limited movement. In Florida's Gulf of Mexico waters 9–72 cm TL fish were tagged and 95% of recaptures were found within 48.3 km of the original tagging site (Iversen and Tabb 1962). More recently, Hendon et al. (2002) reported similar findings in that 92% of recaptured spotted seatrout moved <10 km, 82% moved <3 km.

In the Atlantic, Music (1981) observed the vast majority of recaptures within the estuary of capture with a mean distance traveled of 8.9 km. In addition, genetic studies corroborate the findings of tagging studies with significant genetic differentiation among estuaries along the Atlantic coast (O'Donnell et al. 2014). There was some evidence of movement in and out of open sounds from creeks and rivers in fall and winter, and to beach habitat in spring and summer (Music 1981). While movement in and out of an estuary is reported range-wide in association with feeding, spawning, and avoidance of specific temperature or salinity conditions (Lorio and Perrett 1980; Johnson and Seaman 1986), seasonal movements out of Chesapeake Bay may be the only example of a true migration by any subpopulations of spotted seatrout (Mercer 1984; Wiley and Chapman 2003).

Salinity

Adult spotted seatrout are likely tolerant of seawater but less tolerant of freshwater.

Substrate

Adult spotted seatrout likely use a range of habitats including lower-estuary and nearshore beaches. However, adult substrate preferences have not been reported and throughout their range estuarine habitats likely vary (e.g., presence or absence of SAV) making a universal substrate designation unlikely. As with juveniles, SAV is likely preferred, but limiting in many estuaries.

Temperature

Experimental work on minimum temperatures in juvenile spotted seatrout are similar for adults (Anweiler et al. 2014), and as with other environmental parameters, estuarine or region specific preferences and tolerances should not be assumed to apply throughout the range.

Dissolved Oxygen

To date, no studies of DO requirements for adult spotted seatrout have been reported.

Feeding Behavior

Tabb (1961) reported Indian River, Florida spotted seatrout switching prey throughout the year based on prey availability, and consumed fishes include many common estuarine species (anchovies, pinfish, silverside, mullet, croaker, and others) (Johnson and Seaman 1986).

Competition and Predation

No studies of competition or predation of spotted seatrout were found.

Section II. Essential Fish Habitats and Habitat Areas of Particular Concern

Essential Fish Habitat

Spotted seatrout are an estuarine fish, which relies heavily on SAV throughout all life stages. They also utilize shallow, soft bottom estuarine habitats as nurseries and as foraging and refuge habitats. Spotted seatrout are also known to use marine soft bottom habitat during summer and winter estuarine temperature extremes (ASMFC 2012).

Identification of Habitat Areas of Particular Concern

The ASMFC lists SAV as a HAPC for spotted seatrout (ASMFC 1984). Spotted seatrout are commonly found in SAV, but it is yet to be determined whether it is an EFH.

Environmental conditions in spawning areas may affect growth and mortality of egg and larvae, as sudden salinity reductions cause spotted seatrout eggs to sink, thus reducing dispersal and survival (Holt and Holt 2003).

Winter water temperature dynamics are of particular importance to habitat quality for spotted seatrout. Generally, spotted seatrout overwinter in estuaries, only moving to deeper channels or to nearshore ocean habitats in response to water temperatures below 10°C (Tabb 1966; ASMFC 1984). Sudden cold snaps have been found to stun and kill large numbers of spotted seatrout in estuarine habitats during winter (Tabb 1966; Perret et al. 1980; ASMFC 1984; Mercer 1984). These large mortality events are often associated with rapid declines (less than 12 h) in temperature, which numb fish before they can escape to warmer waters (Tabb 1958, 1966). It should be noted that cold stun events appear to have a large influence on spotted seatrout population dynamics and that cumulative degree day, which characterizes temperatures across time, are potentially more appropriate predictor of cold stress over large spatial scales (Ellis 2014). Periodic increases in mortality associated with cold stuns should be considered when implementing management measures as they are likely to continue to occur on a periodic basis and are largely unpredictable (NCDMF 2010).

Present Condition of Habitat Areas of Particular Concern

By nature, the extent of SAV coverage tends to fluctuate on a scale of days to decades, depending on species, physical conditions, and location (Fonseca et al. 1998). Globally, SAV habitat is declining. Rapid, large-scale SAV losses have been observed in the European Mediterranean, Japan, Chesapeake Bay, Florida Bay, and Australia (Orth et al. 2006). While threats to the stability of SAV health and distribution are many, water quality degradation, including nutrient enrichment and sediment loading, is the greatest threat (Orth et al. 2006). The impacts of nutrient enrichment and sediment loading, such as increased turbidity, increased epiphytic loads, and sedimentation, and increased concentrations of toxic hydrogen sulfide directly reduce SAV growth, survival, and production (Dennison et al. 1993; Fonseca et al. 1998; SAFMC 1998). The effects of eutrophication are most severe in sheltered, low flow areas with concentrated nutrient loads and large temperature fluctuations (Burkholder et al. 1994).

Once SAV habitat is lost, the associated sediments are destabilized, which can result in accelerated shoreline erosion and turbidity. These are conditions that are not favorable to vegetation recolonization and expansion in the affected area. SAV in adjacent areas may also be impacted by the resulting increase of turbidity in surrounding habitats, increasing the total area affected (Durako 1994; Fonseca 1996). Losses of SAV on much larger scales are particularly problematic because the rate of recovery though propagation, recolonization, etc. is often much slower than the rate of loss (Fonseca et al. 1998).

Excerpted from Atlantic Sciaenid Habitats: A Review of Utilization, Threats, and Recommendations for Conservation, Management, and Research

Nevertheless, recovery of SAV habitat may be possible with improvements to water quality as evidenced by the net gain of SAV acreage in Tampa Bay, Florida and Hervey Bay, Australia following strict water quality standards (Orth et al. 2006).

Dredging for navigational purposes, marinas, or infrastructure can directly impact SAV through large-scale removal or destruction of existing grass beds. Docks constructed over SAV and the associated shading can lead to the gradual loss of seagrass both beneath and adjacent to the structure (Loflin 1995; Shafer 1999; Florida Department of Environmental Protection, unpublished data). In addition to the impacts of shoreline development and dredging on SAV, the associated increase in boating activity can lead to increased prop scarring through vegetated areas. The propeller cuts leaves, shoots, and roots structures and makes a trench through the sediment. Recovery of SAV from prop scarring can take in upwards of 10 years, depending on species and local conditions (Zieman 1976). Wakes associated with increased in boating can lead to the destabilization of sediments, which, in turn, can increase turbidity and impact growth potential.

Use of bottom disturbing fishing gears also have the potential to damage or destroy vegetation. Although the damage from each gear varies in severity, shearing of leaves and stems, and uprooting whole plants are the most common impacts of bottom disturbing gears (ASMFC 2000). Shearing of leaves and stems does not necessarily result in mortality of seagrass, but in general, productivity is reduced (ASMFC 2000). Gears that result in below-ground disturbance may cause total loss of SAV and require months to years for the affected area to recover.

A newly emerging threat to SAV is the potential impacts of global climate change on this sensitive habitat. While climate change has occurred throughout history, the rate at which sea surface temperature, sea-level, and CO_2 concentrations are increasing is much faster than experienced in the last 100 million years (Orth et al. 2006). These changes may be occurring at a rate too fast to allow seagrass species to adapt. This leads to the potential for further large-scale losses of habitat globally. If SAV is indeed able to adapt to the pace of climate change, shoreline stabilization projects in many coastal areas impede the shoreward migration necessitated by rising sea-level (Orth et al. 2006). Additionally, the increased frequency and intensity of coastal storms and hurricanes, and the associated delivery of freshwater, nutrients, and sediments threaten to further degrade water quality in estuaries and coastal rivers, reducing the health and potential extent of SAV (Scavia et al. 2002; Orth et al. 2006).

Section III. Threats and Uncertainties

Significant Environmental, Temporal, and Spatial Factors Affecting Distribution of Spotted Seatrout

Though largely estuarine, spotted seatrout may move into marine environments during summer and winter estuarine temperature extremes (ASMFC 2012). Another concern for the conservation of this species is the loss of seagrasses, which are a primary habitat for spotted seatrout and can affect their distribution within estuaries.

Unknowns and Uncertainties

The physiological tolerances of spotted seatrout to environmental variables (e.g., DO, temperature, salinity) have not been investigated throughout their range or at different life history stages. Without these data, it is difficult to predict the impact of environmental perturbations on spotted seatrout, which are necessary to sustainably manage this species. Unlike other sciaenids that are mobile, spotted seatrout have high site fidelity. In addition, not much data is available regarding inter- and intra-specific competition, which will become an increasingly common problem as the extent of seagrasses declines (Orth et al. 2006). Future habitat loss is associated with anthropogenic factors (i.e., nutrient enrichment, boating, dredging, etc.) as well as climatic drivers (sea level rise, warming, acidification), which will increase environmental stressors on spotted seatrout populations. Pollution, including mercury, may have negative health effects on spotted seatrout (Adams et al. 2010), and an array of contaminants have been detected in this species (Johnson-Restrepo 2005; Adams et al. 2003; Adams and Paperno 2012).

Section IV. Recommendations for Habitat Management and Research

Habitat Management Recommendations

As with spot, management recommendations for spotted seatrout have been highlighted by the Omnibus Amendment to the ISFMP for Spanish Mackerel, Spot, and Spotted Seatrout (ASFMC 2012):

1. To effectively maintain habitat health, HAPCs should be accompanied by minimization of non-point source and storm water runoff, prevention of significant increases in contaminant loadings, and prevention of the introduction of any new categories of contaminants into the area. Water quality should be monitored to ensure that quality standards are being met.

2. States should minimize loss of wetlands to shoreline stabilization, and monitor navigational dredging, bridge construction, dredged material disposal, and other coastal projects to minimize impact on HAPCs.

3. The use of any fishing gear that is determined by management agencies to have a negative impact on spotted seatrout habitat should be prohibited within HAPCs.

4. States should identify dams that threaten freshwater flows to nursery and spawning areas, and target them for appropriate recommendations during FERC re-licensing.

5. States should continue support for habitat restoration projects, including oyster shell recycling and oyster hatchery programs as well as seagrass restoration, to provide areas of enhanced or restored bottom habitat.

Habitat Research Recommendations

The following research needs were recommended by the Omnibus Amendment to the ISFMP for Spanish Mackerel, Spot, and Spotted Seatrout (ASFMC 2012):

1. Identify essential habitat requirements.

2. Identify unique spawning location.

3. Evaluate the role of SAV on the spawning success of spotted seatrout.

4. Develop water quality criteria for spawning and nursery areas.

5. Evaluate the role of shell hash and shell bottom in spotted seatrout recruitment, particularly where SAV is absent.

6. Expand nursery sampling to include critical habitat (SAV) sampling in high and low salinity areas during the months of July through September.

7. Investigate the relationship between temperature and mortality of adults and juveniles.

8. Define overwintering habitat requirements.

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