RESEARCH NEEDS IDENTIFIED BY THE NORTH CAROLINA COASTAL HABITAT PROTECTION PLAN

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2010 Update

INTRODUCTION

With passage of the Fisheries Reform Act of 1997, the North Carolina General Assembly established the Coastal Habitat Protection Plan (CHPP) program within the North Carolina Department of Environment and Natural Resources (DENR). The Act (General Statute 143B-279.8) requires preparation of a Coastal Habitat Protection Plan, the goal of which is "long-term enhancement of coastal fisheries associated with each coastal habitat." The divisions of Marine Fisheries (DMF), Water Quality (DWQ), and Coastal Management (DCM) were designated as the lead agencies for the development of the CHPP document. Specifically, the CHPP is to:

- Describe fisheries habitats and their biological systems;
- Evaluate the functions, fisheries' values, status, and trends in the habitats;
- Identify existing and potential threats to the habitats and impacts on coastal fishing; and
- Recommend actions to protect and restore the habitats.

To fully attain the CHPP goal, numerous research and monitoring needs were identified by the CHPP Development Team and suggested in the 2010 update of the CHPP (Deaton et al. 2010). The management needs noted by italics in the 2005 CHPP (Street et al. 2005) were addressed to some degree during 2005-2010. Some needs are considered accomplished (omitted in this report), whereas others are considered ongoing with or without progress. Emerging management needs are new or significantly modified from their 2005 versions and may or may not be refined and adopted as actions in the 2009-2011 CHPP implementation plans. Discontinued needs included those recommendations from Street et al. (2005) that were omitted from the chapter update for various reasons (i.e., included in another chapter as part of primary discussion, need discontinued, considered minor, redundant, or too general). The needs are organized by the following topic areas, with page number references.

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DESCRIPTION AND DISTRIBUTION

1. *There should be a cooperative effort to update existing NC estuarine bathymetric maps.* **See Section 6.1.3. "Description and distribution" for more information.**

ECOLOGICAL ROLE AND FUNCTIONS

Corridor and connectivity

1. *Research is needed on the relationship between juvenile Sciaenid abundance and connectivity among nursery habitats and spawning areas.* **See Section 4.2.4.5. "Corridor and connectivity" for more information.**

Ecosystem enhancement

2. *Research on the critical amount and quality of living and dead shell bottom in a water body below which significant changes in biotic community structure occur.* **No specific progress. However, there has been more research on the cumulative effect of oyster filtering capacity on large water bodies (see Section 3.2.1. "Ecosystem enhancement").**

3. *An economic analysis is needed that compares the cost saving of oyster restoration and sanctuary development with that of wastewater treatment capacity, along with the added fishery production of associated finfish species and oyster harvest in the remaining open shellfish harvesting waters*. The results of one such analysis are pending (J. Grabowski/GMRI, pers. com., January 2009). **See Section 3.2.1. "Ecosystem enhancement" for context.**

Habitat requirements

4. *Evaluate whether current sampling locations and methods are sufficient in estuarine waters to monitor the suitability of water quality conditions for SAV survival and growth. If additional monitoring is needed, establishment of continuous monitoring stations should be considered. In either case, priority should be given to those areas already classified Nutrient Sensitive Waters (Street et al. 2005).* **The DMF Habitat Section assembled an inventory of water quality monitoring stations to help determine if conditions could be modeled throughout the estuary – part of mapping potential habitat for SAV. The results show that water quality data are few and far between, especially in estuarine waters (see Section 4.1.3. "Habitat requirements"). Relating land-use characteristics to downstream water quality in a hydrodynamic model could be the most cost effective means of locating potential SAV habitat – existing WQ monitoring stations could be used to calibrate the model.**

5. *A simple model to predict potential SAV habitat in North Carolina would be helpful for identification and protection of this important habitat where it has not been mapped or otherwise documented recently (within the past 10 years).* **See Section 4.1.3. "Habitat requirements" for more information.**

6. *Determine the relationship between changing SAV coverage and water quality conditions (Street et*

al. 2005). **There has been some research in North Carolina, Virginia and Florida relating SAV habitat characteristics to water quality measurements (see Section 4.1.3. "Habitat requirements" and Section 4.2.2. "Ecosystem enhancement").**

Fish utilization of man-made structures

7. *Conduct further research to determine if and to what extent artificial reefs in North Carolina simply concentrate available fish or effectively increase fish biomass (Street et al. 2005).* **No specific progress. See Section 7.2.5. "Fish utilization of man-made structures" for more information.**

Foraging habitat

8. *Due to the increasing numbers of rays in NC, the impact of ray foraging pits in NC waters should be examined.* **See section 6.2.5.1. "Foraging".**

pH

9. *A similar assessment of acidification risk should be conducted in Anadromous Fish Spawning Areas in North Carolina.* **See Section 2.1.6.2. "pH" for context.**

Spawning

10. *Research is needed on how much SAV proximity affects juvenile production from spawning areas.* **See Section 4.2.4.2. "Spawning" for more information.**

Specific biological functions

11. *More research is needed on the functional value of oyster reefs as spawning habitat for estuary-spawning transient species in North Carolina.* **See Section 3.2.4. "Specific biological functions" for context.**

12. *Further research is needed on the corridor function of intertidal oyster reefs and the importance of connectivity to submerged aquatic vegetation (SAV) and salt marsh for fisheries production.* **See 3.2.4. "Specific biological functions" for context.**

ECOSYSTEM MANAGEMENT AND STRATEGIC HABITAT AREAS

1. *Additional research is needed to verify the relative impact and distribution of cumulative alterations affecting the selection of Strategic Habitat Areas (SHAs).*

2. *A basic need of SHA assessment continues to be the development of accurate and contemporary distribution maps for habitats (see "Distribution" sections of habitat chapters for specific recommendations) and threats (see "Threats and management needs" sections of habitat chapters for specific recommendations).*

STATUS AND TRENDS

Evaluating mitigation/restoration efforts

1. *Given a limited time to monitor for restoration success, criteria should focus on identifying trajectories of functional development that include wetland soil development. In other words, are the functions developing to fully replace that of lost wetlands within a reasonable timeframe?* **See Section 5.3.3.3. "Evaluating mitigation/restoration efforts".**

Status of associated fishery stocks

2. *Research is needed to determine the habitat preferences of other fisheries species and life stages in North Carolina in order to estimate population sizes and determine habitat protection priorities.* **See Section 4.3.2. "Status of associated fishery stocks" for more information.**

3. *More fishery-independent information and habitat change analysis are needed to evaluate the effect of SAV-coverage on the abundance of fish and invertebrates.* **See Section 4.3.2. "Status of associated fishery stocks" for more information.**

4. *More fishery-independent information and habitat change analysis are needed to determine the effect of wetland-coverage on the abundance of fish and invertebrates.* **See Section 5.3.2. "Status of associated fishery stocks" for context.**

Submerged aquatic vegetation restoration and enhancement

5. *Verify if a recovery of SAV has occurred and determine if there is a spatial pattern of that recovery. If there is a pattern, special monitoring and protection should be afforded those core areas from which SAV begins its recolonization (Street et al. 2005). In the mean time, Back Bay/Currituck Sound should serve as a test case for re-establishing SAV in a recovering/recoverable ecosystem.* **No specific progress. See Section 4.3.3. "Submerged aquatic vegetation restoration and enhancement" for more information.**

6. *Research is needed on the feasibility of hard clam augmentation for the purpose of water quality based restoration of SAV.* **See Section 4.3.3. "Submerged aquatic vegetation restoration and enhancement" for more information.**

THREATS AND MANAGEMENT NEEDS

Coastal stormwater program

1. *The effectiveness of new coastal stormwater regulations in maintaining water quality and preventing further shellfish closures should be evaluated by North Carolina Division of Water Quality and Division of Environmental Health-Shellfish Sanitation. Areas where data is lacking, including water quality in stormwater ponds and mining effluent, may require new studies to determine what DWQ monitoring requirements should include.* **See "Coastal stormwater program" subsection of Section 2.4.2.3. "Land use and non-point sources" for context.**

Dams/impoundments

2. *Further research is encouraged to assess impacts of dam removal on downstream fisheries and habitats.* **See "Dams/impoundments" subsection of Section 2.4.1.1. "Flow regulation" for context.**

Diseases and microbial stressors

3. *Research is needed to determine effects of gall infections on SAV beds and related fish communities in North Carolina.* **See Section 4.4.4. "Diseases and microbial stressors" for more information.**

Dredging (navigation channels and boat basins)

4. *Research is needed to estimate the loss of SAV habitat from apparent dredging using the 2007-08 SAV imagery and Geographic Information System (GIS) data for marinas, boat ramps, small boat basins, and navigation channels. The results of such research could be used to set restoration goals addressing historic losses of SAV habitat to dredging.* **See "Dredging (navigation channels and boat**

basins)" subsection of Section 4.4.1.1. "Water-dependent development" for more information.

Endocrine disruptors

5. *The Endocrine Disrupting Chemicals workgroup recommended that a site-specific, compound specific monitoring program is needed to assess potential impact of endocrine disruptors in North Carolina's estuaries. The program should include the following research components:*
   1) *estuarine monitoring of the concentration and prevalence of priority chemicals of concern with possible focus on the Neuse River system,*
   2) *specific research on the effects of chemicals on fishery species, particularly blue crab, oysters, and fish*

   See "Endocrine disruptors" subsection of Section 2.4.3.3. "Toxic chemicals" for context.

6. *Funding from Fisheries Resource Grants and other programs is needed to provide support for further research on oysters and their response to endocrine disrupting chemicals at critical life stages.* **See Section 3.4.2.4. "Toxic chemicals" for context.**

Eutrophication and oxygen depletion

7. *Coastal research and monitoring needs to continue to improve our understanding all of processes of eutrophication and the effects on fish populations.* **Partial progress with latest research (see Section 2.4.3.1. "Eutrophication and oxygen depletion" for more information.**

8. *More information is needed to understand the consequences on the estuarine food web and to what extent anoxia is impacting the soft bottom community.* **Some research has been done by NCSU, Jim Rice on effect of hypoxia on fish displacement and growth. See "Eutrophication and oxygen depletion" section for context.**

Jetties and Groins

9. *Research is needed to determine when and where recruitment to adult fish stocks is limited by larval ingress to estuarine nursery habitats. Without conclusive research, changes to North Carolina's policy on prohibition of shoreline hardening structures on the oceanfront should be considered very carefully.* **See Section 2.4.1.6. "Jetties and groins" for context.**

10. *The long-term consequences of hardened structures on larval transport and recruitment should be thoroughly assessed.* **See Section 2.4.1.6. "Jetties and groins" for context.**

11. *The long-term consequences of hardened structures on larval transport and recruitment should also be thoroughly assessed prior to approval of such structures (groins or jetties).* **See the "Oceanfront shoreline hardening" subsection of section 6.4.1.1. "Water-dependent development" for context.**

Marinas and multi-slip docking facilities

12. *There is a need to study development patterns around marinas in high and low salinity waters and the cumulative impact of docking facilities and associated development on toxic chemical and other contaminant concentrations in the water column.* **Partial progress with study results (see Section 2.4.2.2. "Marinas and multi-slip docking facilities" for more information).**

13. *Studies are needed to compare use of both upland and open water basins by young anadromous fish. To protect designated Anadromous Fish Spawning Areas and Inland Primary Nursery Areas from marina impacts, dredging for new marina construction and other marina-related activities should be managed to minimize alteration of these important functional areas.* **No specific progress; see Section**

2.4.2.2. "Marinas and multi-slip docking facilities" for context.

14. A Sea Grant study assessing impacts of multi-slip docking facilities recommended the following research:
    1) *Cumulative impacts of these small docking facilities and associated development on pollutant concentrations in the water column,*
    2) *Review and development of cumulative impact assessment techniques*

    See Section 2.4.2.2. "Marinas and multi-slip docking facilities" for context.

15. *A threshold contamination level is needed to cap multi-slip docking facilities in open shellfish harvesting waters.* **See Section 3.4.1.1. "Water-dependent development" for more context.**

16. *Determine if adequate light is available beneath North Carolina docks, given the North Carolina Coastal Resources Commission's current siting criteria. The criteria should be evaluated to determine if changes would be needed to allow the minimum amount of light for SAV growth (Street et al. 2005).* **A study by the North Carolina Division of Marine Fisheries (DMF) in 2002-2003 (Connell and Murphey 2004) found reduced shoot density and coverage of SAV under docks compared to pre-construction conditions (see "Marinas and docks" subsection of Section 4.4.1.1. "Water-dependent development").**

17. *Assess the cumulative impacts of dock placement (i.e., shading, boating activity, associated development) on SAV habitat in selected water bodies (Street et al. 2005).* **No progress, but anticipated completion of shoreline mapping and structures inventory will help the North Carolina Division of Coastal Management (DCM) and other permit review authorities evaluate cumulative impacts (see "Marinas and docks" subsection of Section 4.4.1.1. "Water-dependent development" for more information).**

18. *The overall significance of dock shading on SAV should be assessed by comparing concurrent maps of shoreline structures and SAV habitat.* **See "Marinas and docks" subsection of Section 4.4.1.1. "Water-dependent development" for more information.**

19. *Research that quantifies the cumulative impact of dock and marina policies on soft bottom and other fish habitats.* **Research conducted regarding the cumulative impact of microbial contamination from multiple docks in an area (see the "Marinas and docks" subsection of section 6.4.1.1. "Water-dependent development" for context). See section 2.4.2.2. "Marinas and multi-slip docking facilities" in the "Water column" chapter for more information.**

Mobile Bottom Disturbing Fishing Gear

20. *Further analysis is needed to spatially quantify where, how often, and when trawling occurs in specific areas of soft bottom habitat. It is also important to quantify the episodic and chronic effects of trawling on nursery functions in different estuarine settings.* **Some new research presented in the "Bottom trawling" subsection of section 6.4.3.1. "Mobile bottom disturbing gear".**

21. *The impacts of active gillnets on soft bottom should continue to be investigated.* **NC Sea Grant has funded a Fisheries Resource Grant to investigate the impacts of active gillnets on PNAs, report pending (see section 6.4.3.1. "Mobile bottom disturbing gear" for context).**

22. *Conduct research to determine if and to what extent hard bottom is being damaged by trawling activity in North Carolina, particularly shrimp trawls in the southern portion of the coast. The specific locations of trawl trips should be mapped. To assess potential effects of trawling, experimental trawls of predetermined duration, magnitude, and frequency should be conducted in a previously untrawled hard bottom location (Street et al. 2005).* **No specific progress. See Section**

7.4.3.1. "Mobile bottom disturbing gear" for more information.

Non-native, invasive, or nuisance species

23. *Conduct research to determine the relative fishery value of Eurasian watermilfoil compared to native vegetation (Street et al. 2005).* **No specific progress. See Section 4.4.3. "Non-native, invasive, or nuisance species" for more information.**

24. *The Weed Team observed native species resilience to 2-4-D treatments of milfoil and would like to test the observation further (Rob Emens/DWR., pers. observation, May 2009).* **See Section 4.4.3. "Non-native, invasive, or nuisance species" for more information.**

25. *Research is needed to determine the ecological role and effects of animal grass on SAV beds and related fish communities in North Carolina.* **See Section 4.4.3. "Non-native, invasive, or nuisance species" for more information.**

26. *More research is needed on the long-term impact of Phragmites invasions on estuarine fish use.* **See Section 5.4.3. "Non-native, invasive, or nuisance species".**

27. *Further information on Indo-Pacific lionfish biology and competitive/predatory interactions with native fish species is needed. Although complete eradication of lionfish in the marine waters off the North Carolina coast is unlikely, focused lionfish control efforts in strategic locations are needed to reduce the likelihood of potentially detrimental ecological effects.* **See Section 7.4.5. "Non-native, invasive, or nuisance species" for more information.**

Nutrients and Sediment

28. *North Carolina Department of Environment and Natural Resource should work with National Marine Fisheries Service to determine what levels of Total Suspended Solids, chlorophyll a and other parameters are needed to achieve desired water clarity (Street et al. 2005).* **The latest research is presented in Section 4.4.2.1. "Nutrients and sediment".**

29. *Epiphytic and macroalgal cover should be considered as a monitoring parameter for SAV condition in North Carolina.* **See Section 4.4.2.1. "Nutrients and sediment" for more information.**

Other toxins

30. *Since the use of this new technology is increasing, more research is needed to assess the impacts of polymers on aquatic estuarine life.* **See "Other toxins" subsection of Section 2.4.3.3. "Toxic chemicals" for context.**

Pesticides

31. *Research is needed to identify those pesticides safe for spraying over open waters and, for those pesticides whose toxicity is impacted by salinity, appropriate application rates for controlling mosquitoes.* **No specific progress; see "Pesticides" subsection of Section 2.4.3.3. "Toxic chemicals" for context.**

Sea level rise and climate change

32. *Analysis and monitoring of long-term trends in estuarine salinity and temperature is needed to evaluate the impact of sea level rise and climate change on fishery resources in North Carolina.* **See Section 2.4.5. "Sea level rise and climate change" for context.**

33. *The effect of temperature-induced early season reproduction on subsequent spatfall should be evaluated*. **See Section 3.4.5. "Sea level rise and climate change" for context.**

34. *It is essential to gain a better understanding of forecasted changes in estuarine salinities in North Carolina to more accurately predict the effects on shell bottom distribution and health*. **See Section 3.4.5. "Sea level rise and climate change" for context.**

35. *More research is needed to examine the potential ecological effects of declining ocean pH on shell bottom in North Carolina under environmentally realistic scenarios*. **See Section 3.4.5. "Sea level rise and climate change" for context.**

36. *The relationship between marsh island extent and quality of surrounding SAV beds should be investigated further*. **See Section 4.4.5. "Sea level rise and climate change" for more information.**

37. *Research site-specific erosion and accretion rates and their relationship to sea level rise and storm events (Street et al. 2005).* **Recent studies have determined site-specific erosion rates in some parts of coastal North Carolina (see Section 5.4.4. "Sea level rise and climate change").**

38. *Examine the cumulative impact of unmitigated wetland losses on overall wetland area in a watershed (Street et al. 2005).* **No specific progress. However, sea level rise and coastal erosion studies suggest a substantial unmitigated loss of wetlands (see Section 5.4.4. "Sea level rise and climate change" and the "Shoreline stabilization" subsection of Section 5.4.1.1. "Water-dependent development").**

39. *Research needs to be conducted to investigate the impacts of climate change on the soft bottom habitat and fauna. This should include effect on productivity.* **NC researchers are investigating the impacts of sea level rise as part of the North Carolina Sea Level Rise Project. The DCM coastal hazards science panel has been discussing the issues of sea level rise on NC coastal areas. Refer to section 6.4.6. "Climate change and sea level rise" for context.**

40. *More research is needed to examine the potential ecological effects of ocean acidification on nearshore hard bottom in North Carolina*. **See Section 7.4.6. "Climate change" for more information.**

Shoreline stabilization

41. *The relationship between SAV habitat characteristics and associated shoreline types should be investigated further*. **See "Shoreline stabilization" subsection of Section 4.4.1.1. "Water-dependent development" for more information.**

42. *Develop better criteria for defining an "erosion" problem in order to prevent unnecessary structures (Street et al. 2005).* **No specific progress (see the "Shoreline stabilization" subsection of Section 5.4.1.1. "Water-dependent development").**

43. *A study should be conducted to quantify the cumulative impact of shoreline hardening on wetland vegetation and habitat-mediated predator-prey interactions in North Carolina estuarine waters. The results of such a study could then be developed into a model to predict a threshold value for the allowable extent of shoreline hardening in a particular water body, after which, changes in community composition and ecosystem services are likely to occur*. **See the "Shoreline stabilization" subsection of Section 5.4.1.1. "Water-dependent development".**

Upland development

44. *Examine the effectiveness of Outstanding Resource Waters (ORW)-related rules for protected wetlands (changing if necessary) (Street et al. 2005).* **No specific progress. However, the new stormwater rules provide some protection for wetlands by decreasing the % impervious surface allowed**

and excluding coastal wetland acreage from the calculation of impervious surface (see Section 5.4.1.2. "Upland development").

Water quality degradation

45. *Evaluate the susceptibility of freshwater wetlands to sulfate pollution (Street et al. 2005).* **No specific progress (see Section 5.4.2. "Water quality degradation").**

46. *Coordinate with University of North Carolina-Wilmington or other ocean water quality monitoring programs to determine the effects of estuarine water quality, particularly nutrient and sediment loading, on hard bottom (Street et al. 2005).* **No specific progress. See Section 7.4.4. "Water quality degradation" for more information.**

47. *Conduct additional water and tissue sampling at hard bottom sites to determine if the benthos of the hard bottom community or the surrounding waters exhibit levels that exceed designated levels of concern (Street et al. 2005).* **No specific progress. See Section 7.4.4. "Water quality degradation" for more information.**

48. *Develop a comprehensive model of pollution sources predicting water quality based on regular mapping/monitoring of pollution sources (including silviculture, agriculture, and impervious surfaces), riparian zone conditions, stormwater control measures, climactic events, flushing rates, and measured pollution levels.* **See Section 2.4.2. "Water quality degradation – sources" for context.**

Water withdrawals

49. *More research is needed to assess the impact of water withdrawals on water column habitat and fish populations in the affected river basins*. **No specific progress; related to monitoring stream flow and water supplies (see "Water withdrawals" subsection of Section 2.4.1.1. "Flow regulation" for more information).**

50. *Research on the potential ecological impact of this type of wastewater system (mine discharge) needs to be assessed further before widespread use.* **See "Water withdrawals" subsection of Section 2.4.1.1. "Flow regulation" for context.**

LITERATURE CITED

Deaton, A.S., W.S. Chappell, K. Hart, J. O'Neal, B. Boutin. 2010. North Carolina Coastal Habitat Protection Plan. North Carolina Department of Environment and Natural Resources. Division of Marine Fisheries, NC. 639 pp.

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