Appendix K: Status and trends in flow regulation

The status and trends in regulation of flow for North Carolina's coastal rivers are summarized below (adapted from DMF 2002a).

Chowan River Basin

Dams

- One hydropower dam on the Meherrin River in Emporia, Virginia, has effectively blocked anadromous fish movement for over 90 years. In 1990, a fish elevator or lift was constructed at the Emporia Dam to facilitate migration of American shad and river herring upstream. The lift's effectiveness is unknown due to small sample size of tagged individuals recaptured. For information, please see the following web sites: <http://www.sdafs.org/meetings/98sdafs/clupeids/simmonds.htm> <http://www.dgif.state.va.us/fishing/lakes/emporia_reservoir/index.html> <http://www.sdafs.org/meetings/98sdafs/clupeids/simmonds.htm>.
- The lowermost dam on the Nottoway River is the Baskerville Mill Dam, which restricts the historical migratory range of striped bass in that river.

Surface water withdrawal

- There is one municipal intake for Norfolk, Virginia, from Blackwater River; the remainder are only for agriculture. Because small agricultural withdrawals do not need a permit, they are not accounted for in the total water withdrawals.

Roanoke River Basin

Dams

- There are several large dams upstream of Roanoke Rapids, including the Lake Gaston Dam, John H. Kerr Dam, Hyco Dam, Mayo Dam, Smith Mountain Lake Dam, Leesville Dam, Philpott Lake Dam, Avalon Dam and Pinnacles Dam (DWQ 2001c; Pearsall et al. [no date]; <www.rrba.org/facts.htm>). Completed in 1952 and operated by the U.S. Army Corps of Engineers (COE), the Kerr Dam created the largest reservoir in the system, covering approximately 48,900 ac (19,789 hectares) (<http://epec.saw.usace.army.mil/kerrdesc.txt>). The Roanoke Rapids Dam is the lowermost dam on the main stem of the river, and there are no power plants downstream of its location. Numerous small municipal water supply dams and old mill dams exist on the river's tributary streams.

The Roanoke River Water Flow Committee

- The Committee, including state and federal government representatives, academics, local officials and residents, and corporate interests, was established in 1988 to address flow issues. A new flow regime was developed and implemented during striped bass spawning periods, which, along with state fishery management efforts, has resulted in greatly improved juvenile striped bass recruitment (Manooch and Rulifson 1989). However, outside of the striped bass spawning period (April 1–June 15), flows remain altered by hydropower peaking operations. New FERC license for Gaston and Roanoke Rapids dams will expand the spawning period into March.

Surface water withdrawal

- There are 26 registered water withdrawals in the North Carolina portion of the basin. Of these, 16 are surface water withdrawals (DWQ 2001c).
- Water supply demand is expected to increase greatly within the basin, and other basins are also considering the river as a potential water supply source. Withdrawal for power plant use accounts for the majority of the water volume removed, although most is eventually returned to the system.

Tar-Pamlico River Basin

Dams

- Tar River Dam/ Reservoir controls downstream releases; the reservoir is water supply for the city of Rocky Mount.
- Rocky Mount Mills Dam, a hydropower facility, is the lowermost dam on the Tar River. It is an obstruction to migrating striped bass, American shad, hickory shad, and blueback herring during the spring spawning season (Collier and Odom 1989) (Map 2.11).

Surface water withdrawal

- There are several municipal surface water withdrawals (including Enfield, Greenville, Louisburg, Rocky Mount, Tarboro) and numerous agricultural withdrawals.
- Of the 60 water withdrawals registered in the basin (39 agricultural, 21 non-agricultural), 51 are surface water withdrawals (DWQ 2003).
- Surface water withdrawals are projected to increase because of demand and because the basin is partially located within the Central Coastal Plain Capacity Use Area (CCPCUA). Ground water use within the CCPCUA, so demand for surface water as a replacement source will grow.

Neuse River Basin

Dams

- Removal of Quaker Neck Dam in 1998 opened access to 74 additional miles of upstream river habitat for migrating anadromous fish each spring.
- Milburnie Dam, a small hydropower facility near Raleigh, is now the lowermost dam on the Neuse River (Map 2.11).
- Falls Dam/Reservoir is managed by the COE for flood control, municipal water supply, water quality enhancement downstream, and recreation. Currently, discussions are underway between WRC and COE to stabilize downstream flows to benefit spawning by anadromous species in the Neuse River.

Surface water withdrawal

- There are numerous agricultural and municipal water supply withdrawals from the main stem of the river, as well as from many of its tributaries, including the cities of Durham, Raleigh, Smithfield (in addition to a separate intake for Johnston County), Goldsboro, and Wilson.
- Surface water withdrawals are projected to increase due to demand. The CCPCA rules will also affect portions of this river basin, including Carteret, Craven, Jones, Lenoir,

Pamlico, Pitt, Wayne, and Wilson counties. As of 2003, an application was in process for withdrawal of 60 million gallons per day from the Neuse River in Lenoir County to replace existing ground water supplies.

- Of the 176 registered water withdrawals in the Neuse River basin, excluding 78 public water systems, 51 are surface water withdrawals (DWQ 2002).

Cape Fear River Basin

Dams

- The three COE Lock and Dams, constructed for navigation between 1915 and 1934 (Moser et al. 2000), are the lowermost obstructions to fish passage. However, in 1997, efforts to improve anadromous fish passage were made at Lock #1, including the use of fish-locking cycles or lockage to facilitate fish migration during the spawning period and the construction of a steppass Denil fishway (Moser et al. 2000). Sonic tracking of American shad revealed varying proportions (ranging from 18% in 1997 to 63% in 1998) of successful upstream passage of tagged individuals during Lock # 1 operation (Moser et al. 2000). By way of comparison, passage efficiency of adult shad was relatively lower at the fishway (Moser et al. 2000). In general, efficiency of fish passage was improved by a) increasing the frequency of lockage events per day, b) extending lockage duration to include more of the spawning season, and c) encouraging fish entrance into the lock via attractant flows (Moser et al. 2000). Buckhorn Dam is the lowermost complete barrier to fish migration. Striped bass tagged by DMF in the lower Cape Fear River near Wilmington have been recaptured just below this obstruction. Although the hydropower facility at the Buckhorn Dam no longer operates, the dam continues to provide a pool for cooling water for a nearby coal-fired power plant.
- B. Everett Jordan Dam/Reservoir is located well upstream of the lock and dam system. It provides water for Holly Springs, Apex, Cary, Durham, Morrisville, and Chatham, Orange, and Wake counties. (<www.ncwater.org/ReportsandPublications>).

Surface water withdrawal

- There are numerous municipal water withdrawals, and they are the largest threat to instream flow in the Cape Fear river basin.
- In 1999, there were 57 registered water withdrawals in the basin (DWQ 2000c).
- Surface water withdrawals are projected to increase 39% by 2010, excluding new permitted withdrawals. Municipalities dependent on water withdrawals include Cary, Apex, Orange County, Wake County – Research Triangle Park, Fayetteville, Fort Bragg, Wilmington, and the lower Cape Fear Water and Sewer Authority.

Appendix L: Effects of environmental pollutants on fish early life stages
[modified from Weis and Weis (1989), Key et al. (2000); "exp" = "exposure"]

Chemicals	Effect on fish			Water quality standards (ug/l) for aquatic life	
	Test organism	Test	Results	Salt-water	Fresh-water
Benzo[a] Pyrene (B[a]P)					
Methylmercury	Mummichog	unspecified exp.	Abnormal cell division of embryos		
Chlorine					
Chlorine, total residual	Striped bass	0.07 mg/l exp.	3.5% of embryos hatched and malformation of surviving hatchlings	na	17 (AL)
		0.01 mg/l exp.	23% of embryos hatched		
		0.15 mg/l exp.	Embryo mortality noted in combination with temperature change of 2^{o}C.		
	Spotted seatrout	unspecified exp.	Greater resistance of embryos than larvae		
	Striped bass, white perch, blueback herring, silversides	0.3 mg/l exp.	Lethal to embryos		
Herbicides					
Atrazine	Channel catfish	0.4 mg/l exp.	Embryo deformities		na
Diquat	Mummichog	0.01-10mg/l exp.	Fry neurologically impaired after embryo exposed		
Trifluraline	Sheepshead minnow	unspecified exp.	Embryo deformities		
PCBs					
Aroclor 1016	Sheepshead minnow	>32 ug/l exp.	Total mortality of embryos and fry		
Aroclor 1242	Fathead minnow	<5.4 ug/l exp.	No effect on embryos		
Aroclor 1254	Sheepshead minnow	10 ug/l exp.	Reduced survival rate of embryos		

Chemicals	Effect on fish			Water quality standards (ug/l) for aquatic life	
	Test organism	Test	Results	Salt-water	Fresh-water
Aroclor 1254	Sheepshead minnow	>0.1 ug/l exp.	Reduced fry survival		
		0.14 ug/l exp.	Adult exposure and reduced survival of embryos and fry		
Pesticides					
Aldicarb (Temik)	Fathead minnow	<320 ug/l exp.	No effect		
	Fathead minnow	156 ug/l exp.	100% larvae mortality in 30-day test		
Carbaryl (Sevin)	Silversides	10 ug/l exp.	Embryo malformations		
	Killifish	10 ug/l exp.	Arrested embryo development, embryos transferred to clear water after continuous exp. had abnormalities		
DDT	Killifish	1mg/l exp.	Hatchlings with tail deformities	0.001	0.001
		0.1 ug/l exp.	Slowed development of embryos		
	Silversides	25 ug/l exp.	Embryo malformations		
	Yellow perch	unspecified exp.	No fin ray asymmetry		
Dieldrin	Winter flounder	>1.74 ng/g eggs	Eggs not fertilized	0.0002	0.002
		39 ug/l exp.	50% mortality		
Endrin	Sheepshead minnow	0.31 ug/l	Embryo stunting, some mortality, and lower fertility of adults	0.002	0.002
Fenoprop (Kuron)	Bluegill	>10 ug/l exp.	100% mortality of hatchlings		
Fenvalerate	Sheepshead minnow	3.9 ug/l exp.	Reduced hatchling survival		
	Fathead minnow	0.43 ug/l exp.	Unspecified negative effect on larvae		
Fonofos	Fathead minnow	<80 ug/l exp.	No effect		
		33 ug/l exp.	100% larvae mortality in 30-day test		
Kelthane (Dicophol)	Fathead minnow	125 ug/l exp.	Delayed and reduced hatching, survivors deformed and died		
		39 ug/l exp.	50% mortality		

Chemicals	Effect on fish			Water quality standards (ug/l) for aquatic life	
	Test organism	Test	Results	Salt-water	Fresh-water
Kepone	Sheepshead minnow	1.9 ug/l exp.	16% arrested development of embryos		
	Fathead minnow	0.31ug/l exp.	Reducing hatching success		
Lindane	Caranx	unspecified exp.	Premature hatching and fry deformities	0.004	0.01
Malathion	Silversides	10 ug/l exp.	Embryo malformations		
Methoxychlor	Winter flounder	>1.74 ng/g eggs	Eggs not fertilized	0.03	0.03
		39 ug/l exp.	50% mortality		
Mirex	Fathead minnow	2,3,7 ug/l exp.	Increased viability of hatchlings	0.001	0.001
		13,34 ug/l exp.	No effect		
Parathion	Mummichog	10 ug/l exp.	Arrested embryonic development, 50% of embryos exposed for 3 days and returned to clean water had malformations	0.178	0.013
Permethrin	Sheepshead minnow	22 ug/l exp.	Reduced hatchling survival		
		2.2 ug/l exp.	Reduced hatchling size		
Permethrin biomist	Gambusia	25,114 mg/l	48 h LC_{50}		
Permethrin-Permanone	Gambusia	0.0027 mg/l	48 h LC_{50}		
Pyrethroids	Sheepshead minnow	0.06 ug/l exp.	Reduced fish weight		
Temephos	Gambusia	0.014-0.039 mg/l	48 h LC_{50}		
Petroleum hydrocarbon					
Toluene	Fathead minnow	30-45 mg/l exp.	Embryonic malformations	na	11
Water soluable fraction of No. 2 fuel oil	Mummichog	unspecified exp.	Malformation of larvae and decreased time to hatching of embryos, increased toxicity noted at suboptimal water conditions		

Chemicals	Effect on fish			Water quality standards (ug/l) for aquatic life	
	Test organism	Test	Results	Salt-water	Fresh-water
Water soluable fraction of No. 2 fuel oil	Mummichogs, sheepshead minnow	12 ppm	100% mortality of hatchlings		
		6 ppm	50% mortality of hatchlings		
		1,4 ppm	Stimulated hatching		
Wood preservative					
Pentachlorophenol	Fathead minnow	128 ug/l exp.	Reduced larval survival		
		>73 ug/l exp.	Reduced growth of larvae		

Appendix M: Land protection and conservation programs in the North Carolina coastal river basins by eligible land types and conservation techniques (DENR 1999). Eligible land types include agricultural (A), forested (F), wetlands (W), prior converted wetlands (PCW), riparian areas (R), and residential (RES).

Eligible Land Types	Federal and State Programs/Nonprofit/Private Organizations/Land Trusts	Donation	Purchase	Conservation Easement	Lease	Management Agreement	Restoration	Other
A, PCW, R	Conservation Reserve Program (USDA NRCS)				X	X	X	
A, PCW, R	Continuous Conservation Reserve Program (USDA NRCS)				X	X	X	
A, W	Debt Cancellation Conservation Contact Program (USDA FSA)					X		
A,F,PCW,R	Environmental Quality Incentives Program (USDA NRCS)					X		
A, F, W, PCW, R, RES	North American Wetlands Conservation Act (USFWS)	X	X	X		X	X	X
PCW, R	Wetlands Reserve Program (USDA NRCS)			X			X	
A, F, PCW, RES	Wildlife Habitat Incentives Program (USFWS)					X	X	
A, PCW, R	NC Agriculture Cost Chare Program (DENR DSWC)						X	
A, F, W, PCW, R, RES	NC Clean Water Management Trust Fund (DENR)		X	X		X	X	X
A, PCW	Conservation Reserve Enhancement Program (USDA FSA and DENR DSWC)			X	X	X	X	
A, F, W, PCW, R, RES	Conservation Tax Credit Program (DENR)	X	X	X				
A, F, W, PCW, R	NC Forest Development Program (DENR DFR)					X		
F, R	Forest Land Enhancement Program (DENR DFR)					X	X	X
F, R	Forest Legacy (USDS FS)		X	X		X		
A, F, W, PCW, R	Forest Management Technical Assistance (DENR DFR)					X		X
F, W, R	Forest Practice Guidelines/BMP's (DENR DFR)							X
F, W, R	Forest Stewardship Program (USFS, DENR DFR)					X		X
W, R	Public Trust / Submerged Lands Program (DENR DMF)	X						
F, W, R	Registry of Natural Heritage Areas (DENR DPR)			X		X		
R	Rivers Assessment (DENR DWR)							
A, F, W, PCW, R, RES	NC Wetlands Restoration Program (DENR DWQ)	X	X	X			X	
A, F, W, R	Conservation Trust for North Carolina	X	X	X	X	X		X
A, F, W, PCW, R, RES	NC Coastal Federation	X	X	X			X	
A, F, W, R, RES	NC Local and Regional Land Trusts (20)	X	X	X	X	X	X	X
F, W, R	NC Chapter of The Nature Conservancy	X	X	X				

APPENDIX N:

NORTH CAROLINA MARINE FISHERIES COMMISSION

POLICIES FOR THE PROTECTION AND RESTORATION
OF MARINE AND ESTUARINE RESOURCES
FROM BEACH DREDGING AND FILLING
AND LARGE-SCALE COASTAL ENGINEERING

NORTH CAROLINA MARINE FISHERIES COMMISSION HABITAT AND WATER QUALITY
STANDING ADVISORY COMMITTEE: NOVEMBER 6, 2000
NORTH CAROLINA MARINE FISHERIES COMMISSION:
NOVEMBER 16, 2000

Policy Context

This document establishes the policies of the North Carolina Marine Fisheries Commission (Commission) regarding protection and restoration of the state's marine and estuarine resources associated with beach dredge and fill activities, and related large-scale coastal engineering projects. The policies are designed to be consistent with the overall habitat protection policies of the Commission, adopted April 13, 1999, as amended February 17-18, 2000, as follows:

It shall be the policy of the North Carolina Marine Fisheries Commission that the overall goal of its marine and estuarine resource protection and restoration programs is the long-term enhancement of the extent, functioning and understanding of those resources.

Toward that end, in implementing the Commission's permit commenting authority pursuant to N.C.G.S. §143B-289.52(a)(9), the Chairs of the Habitat and Water Quality Standing Advisory Committee, in consultation with the Commission Chair, shall, to the fullest extent possible, ensure that state or federal permits for human activities that potentially threaten North Carolina marine and estuarine resources:

> (1) are conditioned on (a) the permittee's avoidance of adverse impacts to marine and estuarine resources to the maximum extent practicable; (b) the permittee's minimization of adverse impacts to those resources where avoidance is impracticable; and (c) the permittee's provision of compensatory mitigation for all reasonably foreseeable impacts to marine and estuarine resources in the form of both informational mitigation (the gathering of base-line resource data and/or prospective resource monitoring) and resource mitigation (in kind, local replacement, restoration or enhancement of impacted fish stocks or habitats); and

(2) result, at a minimum, in no net loss to coastal fisheries stocks, nor functional loss to marine and estuarine habitats and ecosystems.

The findings presented below assess the marine and estuarine resources of North Carolina which are potentially threatened by activities related to the large-scale movement of sand in the coastal ocean and adjacent habitats, and the processes whereby those resources are placed at risk. The policies established in this document are designed to avoid, minimize and offset damage caused by these activities, in accordance with the laws of the state and the general habitat policies of this Commission.

Marine and Estuarine Resources At Risk from Beach Dredge and Fill Activities

The Commission finds:

1. In general, the array of large-scale and long-term beach alteration projects currently being considered for North Carolina together constitute a real and significant threat to the marine and estuarine resources of the United States and North Carolina.

2. The cumulative effects of these projects have not been adequately assessed, including impacts on public trust marine and estuarine resources, use of public trust beaches, public access, state and federally protected species, state critical habitats and federal essential fish habitats.

3. Individual beach dredge-and-fill projects and related large-scale coastal engineering activities rarely provide adequate assessment or consideration of potential damage to fishery resources under state and federal management. Historically, emphasis has been placed on the logistics of sand procurement and movement, and economics, with environmental considerations dominated by compliance with limitations imparted by the Endangered Species Act for sea turtles, piping plovers and other listed organisms.

4. Opportunities to avoid and minimize impacts of beach dredge-and-fill activities on fishery resources, and offsets for unavoidable impacts have rarely been proposed or implemented.

5. Large-scale beach dredge and fill activities have the potential to cause impacts in four types of habitats:

    a. waters and benthic habitats near the dredging sites;
    b. waters between dredging and filling sites;
    c. waters and benthic habitats near the fill sites; and
    d. waters and benthic habitats potentially affected as sediments move subsequent to deposition in fill areas.

6. Certain nearshore habitats are particularly important to the long-term viability of North Carolina's commercial and recreational fisheries and potentially threatened by large-scale, long-term or frequent disturbance of sediments:

    a. inlets;
    b. the swash and surf zones and beach-associated bars; and
    c. underwater soft-sediment topographic features, both onshore and offshore
    d. underwater hard-substrate topographic features.

7. Large sections of North Carolina waters potentially affected by these projects, both individually and collectively, have been identified as Essential Fish Habitats (EFH) by the South Atlantic Fishery Management Council (SAFMC) and the Mid-Atlantic Fishery Management Council (MAFMC). Affected species under federal management include:

    a. summer flounder (various nearshore waters, including the surf zone and inlets; certain offshore waters);
    b. bluefish (various nearshore waters, including the surf zone and inlets);
    c. red drum (ocean high-salinity surf zones and unconsolidated bottoms to a depth of 50 meters);

d. several snapper and grouper species (live hard bottom from shore to 600 feet, and – for estuarine-dependent species [e.g., gag grouper and gray snapper] – unconsolidated bottoms and live hard bottoms to the 100 foot contour);
e. spiny dogfish (various coastal waters from the surf zone to 200 miles);
f. black sea bass (various nearshore waters, including unconsolidated bottom and live hard bottom to 100 feet, and hard bottoms to 600 feet);
g. penaeid shrimps (offshore habitats used for spawning and growth to maturity, and waters connecting to inshore nursery areas, including the surf zone and inlets);
h. coastal migratory pelagics (sandy shoals of capes and bars, barrier island and ocean-side waters from the surf zone to the shelf break inshore of the Gulf Stream; all coastal inlets);
i. corals of various types (hard substrates and muddy, silty bottoms from the subtidal to the shelf break);
j. calico scallops (unconsolidated bottoms northeast and southwest of Cape Lookout in 62-102 feet);
k. sargassum (wherever it occurs out to 200 miles);
l. many large and small coastal sharks, managed by the Secretary of the Department of Commerce (inlets and nearshore waters, including pupping and nursery grounds).

8. Beach dredge and fill projects also potentially threaten important fish habitats for anadromous species under federal, interstate and state management (in particular, inlets and offshore overwintering grounds), as well as essential overwintering grounds and other critical habitats for weakfish and other species managed by the Atlantic States Marine Fisheries Commission and the State of North Carolina. The SAFMC identified for anadromous and catadromous species those habitats that have been EFH if there had been a council plan (inlets and nearshore waters).

9. Many of the habitats potentially affected by these projects have been identified as Habitat Areas of Particular Concern by the SAFMC. The specific fishery management plan is provided in parentheses:

    a. all nearshore hard bottom areas (SAFMC, snapper-grouper);
    b. all coastal inlets (SAFMC, penaeid shrimps, red drum, and snapper-grouper);
    c. near-shore spawning sites (SAFMC, penaeid shrimps, and red drum)
    d. well-known seafloor features, including the Point, Ten Fathom Ledge and Big Rock (SAFMC, snapper-grouper, coastal migratory pelagics, and corals);
    e. pelagic and benthic sargassum (SAFMC, snapper-grouper);
    f. sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras (SAFMC, coastal migratory pelagics) and;
    g. Bogue Sound and New River Estuary (SAFMC, coastal migratory pelagics).

10. Habitats likely to be affected by beach dredge and fill projects include many being recognized in North Carolina Fishery Management Plans as important for state-managed species. Many of these habitats are in the process of being recognized as Critical Habitat Areas by the Commission, in either FMPs or in Coastal Habitat Protection Plans. Examples include:

    a. inlets (Blue Crab FMP, Red Drum FMP, River Herring FMP);
    b. oceanic nearshore waters (Blue Crab FMP, Red Drum FMP); and
    c. many others as FMPs and CHPPs are adopted over the coming years.

11. Recent work by scientists in east Florida has documented exceptionally important habitat

values for nearshore, hard-bottom habitats often buried by beach dredging projects, including use by over 500 species of fishes and invertebrates, and juveniles of many reef fishes. Equivalent scientific work is just beginning off North Carolina, but life histories suggest that similar habitat use patterns will be found.

Threats to Marine and Estuarine Resources from Beach Dredge and Fill Activities

The Commission finds that beach dredge-and-fill activities and related large-scale coastal engineering projects (including inlet alteration projects) threaten the marine and estuarine resources of North Carolina through the following mechanisms:

1. Direct mortality and displacement of organisms at and near sediment dredging sites;
2. Alteration of seafloor topography and associated current and waves patterns and magnitudes at dredging areas;
3. Alteration of seafloor sediment size-frequency distributions at dredging sites, with secondary effects on benthos at those sites;
4. Elevated turbidity and deposition of fine sediments down-current from dredging sites;
5. Direct mortality and displacement of organisms at initial sediment fill sites;
6. Elevated turbidity in and near initial fill sites, especially in the surf zone, and deposition of fine sediment down-current from initial fill sites;
7. Alteration of near-shore topography and current and waves patterns and magnitudes associated with fill;
8. Movement of deposited sediment away from initial fill sites, especially onto hard bottoms;
9. Alteration of large-scale sediment budgets, sediment movement patterns and feeding and other ecological relationships, including the potential for cascading disturbance effects;
10. Alteration of large-scale movement patterns of water, with secondary effects on water quality and biota;
11. Alteration of movement patterns and successful inlet passage for larvae, post-larvae, juveniles and adults of marine and estuarine organisms;
12. Alteration of long-term shoreline migration patterns (inducing further ecological cascades with consequences that are difficult to predict); and
13. Exacerbation of transport and/or biological uptake of toxicants and other pollutants released at either dredge or fill sites.

Commission Policies for Beach Dredge and Fill Projects and Related Large Coastal Engineering Projects

The Commission establishes the following general policies related to large-scale beach dredge-and-fill and related projects, to clarify and augment the general policies already adopted on April 13, 1999:

1. Projects should fulfill the Commission's general habitat policy by avoiding, minimizing and offsetting damage to the marine and estuarine resources of North Carolina;

2. Projects should provide detailed analyses of possible impacts to each type of Essential Fish Habitat (EFH), with careful and detailed analyses of possible impacts to Habitat Areas of Particular Concern (HAPC) and Critical Habitat Areas (CHA), including short and long term, and population and ecosystem scale effects;

3. Projects should provide a full range of alternatives, along with assessments of the relative impacts of each on each type of EFH, HAPC and CHA;

4. Projects should avoid impacts on EFH, HAPCs and CHAs that are shown to be avoidable through the alternatives analysis, and minimize impacts that are not;

5. Projects should include assessments of potential unavoidable damage to marine resources, using conservative assumptions;

6. Projects should be conditioned on the avoidance of avoidable impacts, and should include compensatory mitigation for all reasonably predictable impacts to the marine and estuarine resources of North Carolina, taking into account uncertainty about these effects. Mitigation should be local, up-front and in-kind wherever possible;

7. Projects should include baseline and project-related monitoring adequate to document pre-project conditions and impacts of the projects on the marine and estuarine resources of North Carolina;

8. All assessments should be based upon the best available science, and be appropriately conservative so as to be prudent and precautionary; and

9. All assessments should take into account the cumulative impacts associated with other beach dredge-and-fill projects in North Carolina and adjacent states, and other large-scale coastal engineering projects that are ecologically related.

References

Butler IV, M. J., J. H. Hunt, W. F. Herrnkind, M. J. Childress, R. Bertelsen, W. Sharp, T. Matthews, J. M. Field, and H. G. Marshall. 1995. Cascading disturbances in Florida Bay, U.S.A.: cyanobacteria blooms, sponge mortality, and implications for juvenile spiny lobsters Panulirus argus. Mar. Ecol. Prog. Ser. 129:119-125.

Dodge, R. E., R. C. Aller and J. Thomson. 1974. Coral growth related to resuspension of bottom sediments. Nature 247: 574-576.

Gilmore, R. G., Jr. 1977. Fishes of the Indian River Lagoon and adjacent waters, Florida. Bull. Fl. St. Mus. Bio. Sci. 22(3), 147 p.

Gilmore, R. G., Jr. 1992. Striped croaker, Bairdiella sanctaeluciae. pp. 218-222. In C. R. Gilbert, ed. Rare and endangered biota of Florida. II. Fishes. Univ. Press of Florida, Gainesville, FL, 242 p.

Hackney, C.T., M. Posey, S. Ross and A. Norris. 1996. A review and synthesis of data on surf zone fishes and invertebrates in the South Atlantic Bight and the potential impacts from beach renourishment. Report to the U.S. Army Corps of Engineers, Wilmington District.

Kirtley, D. W. and W. F. Tanner. 1968. Sabellariid worms: builders of a major reef type. J. Sed. Petrol. 38(1):73-78.

Lindeman, K. C. 1997. Comparative management of beach systems of Florida and the Antilles: applications using ecological assessment and decision support procedures. pp.134-164. In: G. Cambers, ed. Managing beach resources in the smaller Caribbean islands. UNESCO Coastal Region & Small Island Papers # 1, 269 p.

Lindeman, K.C. and D.B. Snyder. 1999. Nearshore hardbottom fishes of southeast Florida and effects of habitat burial caused by dredging. Fish. Bull. 97(3):508-525.

Nelson, W. G. 1989. Beach nourishment and hard bottom habitats: the case for caution. pp. 109-116. In: S. Tait, ed. Proc. 1989 National Conf. Beach Preserv. Technol. Fl. Shore and Beach Preserv. Assoc., Tallahassee, FL, 236 p.

Nelson, W. G. and L. Demetriades. 1992. Peracariids associated with sabellariid worm rock (Phragmatopoma lapidosa Kinberg) at Sebastian Inlet, Florida, U.S.A. J. Crust. Bio. 12(4):647-654.

Odum, W. E. 1982. Environmental degradation and the tyranny of small decisions. BioScience 32(9):728-29.

Pandolfi, J., D. R. Robertson, and D. R. Kirtley. 1998. Sabellariid worms: builders of a major reef type. Coral Reefs 17:120.

Peterson, C.H., D.H.M. Hickerson and G.G. Johnson. 2000. Short-term consequences of nourishment and bulldozing on the dominant large invertebrates of a sandy beach. J. Coastal Res. 16(2): 368-378.

Sedberry, G. R. and R. F. Van Dolah. 1984. Demersal fish assemblages associated with hard-bottom habitat in the South Atlantic Bight of the U. S. A. Environ. Biol. Fishes 11(4):241-258.

South Atlantic Fishery Management Council. 1998. Final habitat plan for the South Atlantic region: Essential Fish Habitat requirements for fishery management plans of the South Atlantic Fishery Management Council. 457 pp plus appendices.

Telesnicki, G.J. and W.M. Goldberg. 1995. Effects of turbidity on the photosynthesis and respiration of two South Florida reef coral species. Bull. Mar. Sci. 57(2):527-539.

Wilber, P. and M. Stern. 1992. A re-examination of infaunal studies that accompany beach nourishment projects. Proc. 1992 Natl. Conf. Beach Preserv. Tech. pp: 242-256.

Appendix O: Impacts to fish habitat from commercial and recreational fishing gears used in coastal North Carolina (adapted from Moratorium Steering Committee (1996)).

Fishing method	Habitat Impacts and Recommendations
Bay Scallop Dredge: A fairly lightweight (not>50 lbs.) steel frame, without teeth, used in estuarine waters, and that has an attached, nylon webbing bag to accumulate the catch.	The use of patent tongs is thought to have a major effect on shellfish beds and the bottom generally. Recommend collection of information on this gear, e.g., the habitat impact experiences of other states which have or are presently allowing use of patent tongs.
Beach Seine: Net generally used to corral mullets. A beach seine can also be used on such fish as striped bass and spot. Sometimes a beach seine is used in conjunction with a "stop" net. Net usually spread round fish with a boat and then pulled to the shore. Pulling power can be by hand or by vehicle. This is one of the most historic methods of fishing.	No known habitat impacts. No recommendations at this time.
Bull Rake: A large, heavy clam rake, usually having eighteen (18) to twenty-eight (28) teeth. Handles range from ten (10) feet to forty (40) feet long.	Bull rakes have severe habitat impacts when used on oyster rocks, and can damage SAV beds. Recommend that bull rake clamming on marked oyster grounds and SAV beds be prohibited.
Butterfly Trawl: In this gear, a solid frame holds a modified trawl in the top of the water column, acting like a channel net. Its use generally requires a good tidal flow and it is normally used only at night.	Little known habitat impact. Skimmer trawls are generally okay to use in SAV beds, but should not be used in oyster grounds. Recommend that trawls be prohibited in marked oyster grounds and that the more widespread use of this gear be promoted in estuarine waters.
Cast Net: Small net thrown by hand and used to catch "schooled fish", such as mullet, and used by bait-fish dealers and individual fishermen to net bait-fish and shrimp.	No known habitat impacts. No recommendations at this time.
Channel Net: A passive gear built like a shrimp trawl that is anchored in a specific area. Channel nets are used to catch shrimp in areas with strong tidal flow, which is required to hold the net open.	No known habitat impacts. No recommendations at this time.
Clam Kickers: Generally refers to the use of the propeller of a boat to blow the mud/silt off the clams and into a trawl having a heavy steel cage or bag made of rings. The gear is chained so that it plows up the clams as it is towed behind the vessel. Often the stern of the vessel is loaded so that the propeller "wash" is directed at a downward angle.	The use of this gear has severe impacts upon SAV beds and oyster grounds. Recommend that areas that may be used by these dredges not be expanded in public trust areas. However, employment in mariculture operations to recover shellfish crops should be considered a viable use of the gear if leases are located in an area where the gear is already allowed, if adjacent leases would not be affected. Permits should be issued by the division of Marine Fisheries on a case-by-case basis. During the oyster season, legal size oysters caught incidental to clamming should be allowed to be retained.
Clam Tongs: Hand held steel "forceps", used to recover clams from any and all types of bottom. Clam tong teeth tend to be longer and more closely spaced than the teeth on oyster tongs.	Habitat impacts of oyster dredges can be significant. Historically, such dredges have been used only on bottoms that were oyster beds. Dredges can plow down any mounds of shellfish and should not be allowed for use in SAV beds. Recommend maintaining present limits on usage and that steps be taken to ensure that the gear is used with adequate consideration of its habitat impacts.
Crab Dredges: A crab dredge is much like an oyster dredge, except perhaps with longer teeth, and is used to dredge crabs from the bottom sediments during the winter months. Crab dredges are used in northern North Carolina waters from Long Shoal north.	Habitat impacts from the use of crab dredges can be significant, and the gear causes severe damage on oyster grounds or in SAV beds. Recommend that the current restrictions on the use of this gear be maintained, and that steps be taken to ensure that crab dredges are used with adequate regard to their effects on coastal fishery habitats.

Fishing method	Habitat Impacts and Recommendations
Crab Pot: A wire trap similar to a fish pot. This is the usual method for catching crabs in North Carolina.	Very little habitat impact. Main habitat impact is from discarded bait cartons. It is generally okay to use crab pots in SAV beds, PNAs , or oyster grounds. Anecdotal reports indicate the use of anti-fouling solution or "cleansing" solutions aboard boats or near the waters edge to treat crab pots. Also anecdotal evidence exists to indicate that zinc used in crab pots to minimize rusting may contribute to heavy metal pollution in estuarine systems. Recommend: (1) a requirement that bait boxes be returned to shore; (2) a requirement that biodegradable escape panels be used in crab pots [Note: There is work being done that indicates that "tagged" crabs left in a crab pot with no food subsequently appear in other baited pots]; (3) prohibition of the use of any anti-fouling solution aboard a vessel or within seventy-five (75) feet of the shoreline; and (4) a study of the effects of zinc used to coat crab pots in terms of estuarine pollution.
Crab Trawl: A trawl consisting of larger mesh nets made like a shrimp trawl. The basic equipment is the same as a shrimp trawl except that the bottom leading edge of the trawl is laced with several loops of heavy chain so that the crabs are "plowed" out of the bottom where they have embedded themselves.	For all bottoms, the severity of habitat impacts from the use of shrimp trawls is related to the size of the doors. Damage to oyster grounds is generally moderate to high. Studies are inconclusive on the question of whether trawling in other areas has significant habitat impacts. Recommend continuation of prohibition of trawling in marked oyster grounds. A study of the impact of trawling on different types of habitat should also be conducted.
Dip Nets/Pier Net: Hand nets that are not usually used to catch fish by themselves, but rather, are used as tools in conjunction with other fishing gears. For example, a flounder fisherman may use a dip net to scoop up a flounder that is in his net but appears ready to fall out, or a fisherman may use a pier net to bring up catches of mullet too large to lift without danger of splitting his cast net, or to lift other species to keep from breaking the line of his fishing rod. However, large dip nets are used to catch river herring and shad in coastal streams.	No known habitat impacts. No recommendations at this time.
Eel Pot: A wire trap that looks like a crab pot, but has smaller wire mesh.	No known habitat impacts. If escape panels are used, the lost pots become habitat. Okay to use in SAV beds or oyster grounds. Recommend that biodegradable escape panels be required for eel pots.
Electric Shocking: Refers to the use of mechanical devices that generate an electric current into coastal fishing waters, which stun the fish and cause them to rise to the surface. The practice of electric shocking is currently allowed only in a portion of the Cape Fear River, where it is used to catch catfish.	Habitat effects on this practice are unknown, but would seem to potentially be significant. Recommend that this practice continue to be prohibited in North Carolina.
Estuarine Gill Net: A major gear used in North Carolina's internal coastal waters that captures fish by entangling them when they swim into the net. The next is often anchored to the bottom or attached to stakes. In some fisheries, gill nets are fished by drifting with the current. A variety of mesh sizes are used to take spot, flounder, American shad, river herring, mullet, striped bass and many other species. This gear is often used by recreational fishermen.	Estuarine gill nets have negligible habitat impacts. Such gear can be safely used in PNAs, SNAs and SAV beds. Proper identification of gear owners should be emphasized, along with regular tending of the fear to avoid wastage of fish. No recommendations at this time.
Explosives: Pyrotechnic devices, such as dynamite, used to create a concussion, which causes the stunned or dead fish to rise to the surface where they are gathered. The use of explosives to fish is not legal in North Carolina	No known habitat impacts. No recommendations at this time.
Fish Pot: A wire trap having directed (one-way) openings whereby fish may enter to get to bait. Fish pots are generally used in the ocean harvesting of black sea bass. Fish pots are also used to harvest catfish in the Albemarle Sound area.	Very little habitat impact. Impact can increase in coral formations. "Lost" pots become habitat when used correctly with biodegradable panels. Pots in estuarine waters do not adversely affect oyster grounds or SAV beds. Recommend that biodegradable escape panels be required for all fish pots.
Fish Trawls/Flynets: Usually large trawl nets, generally fished in ocean waters. Fish trawls may drag on the bottom, but also may utilize "mid-water technology." Fish trawling is not allowed in inside waters in North Carolina.	No known habitat impacts, but complaints have been received of float nets being used in a manner that blocks navigation channels, and of failure to yield to boat traffic. Recommend that float netters be required to yield to boat traffic.
Float Netting: This is done when a shrimp trawler "floats" its doors so that it can act as a butterfly or channel net, usually occurring in ebb tidal flow and at night.	No known habitat impacts, but there have been complaints that these netters have failed to yield to boat traffic when working the Atlantic Intracoastal Waterway and marked channels. Recommend that the use of butterfly trawls be promoted, with a requirement that netters must yield to all boat traffic when utilizing navigation channels

Fishing method	Habitat Impacts and Recommendations
Fyke Net: A usually round net having a series of throats. Tyke nets are primarily used in the upper reaches of estuaries.	No known habitat impacts. No recommendations at this time.
Gig: A spear with or without barbed points at its tip, used mostly to spear flounder at night, using underwater lights.	No known habitat impacts. No recommendations at this time.
Hand Clam Rake: A tool that usually has nine (9) teeth or less, and looks a lot like a garden rake. Most rakes have a handle, but they can consist merely of "metal fingers" that rest at the wrist and extend over the fingers. Clam rakes can be utilized to "scratch" for clams under water or for "signing" on tidal flats at low tide.	Very little habitat impact in most areas, but slight impacts occur in SAV beds. Clam rakes are difficult to use on most oyster rocks, but impact can be great when used to pull oysters into piles in order to get at the clams beneath. Recommend that: (1) no rakes be allowed in marked oyster rocks/beds {these oyster areas would be designated "clam seed management areas"}; and (2) during the normal oyster season, clams should be allowed as an unlimited, approved, incidental catch when harvesting oyster.
Hand Clamming: Refers to the clamming method wherein clammers are in the water on their hands and knees feeling for clams. Clammers typically use latex gloves as protection for their hands, but can use the "metal hands" noted under "Clam Rake", above.	Very little known habitat impact. Hand clamming in generally okay in SAV beds. Recommend that hand clamming on marked oyster grounds be prohibited except as part of the normal oyster season.
Hand Seine: Small mesh net used to catch bait. Usually pulled by hand, but sometimes a boat is used to spread the seine.	No known habitat impacts. Recommend increasing allowable hand seine sizes to thirty (30) feet.
Hook and Line: The customary “rod and reel” method of fishing, used as the “up and down” bottom rig in the reef fish fishery. “Electro-mate” reels are customarily used for rapid line retrieval.	Virtually no habitat impacts, but see comments at right on monofilament fishing line and other relevant equipment. No recommendations at present.
Hydraulic Clam Dredge: Gear generally used to harvest clams, that employs a conveyer system that can be lowered to the bottom where jets of water uncover the clams. These dredges are allowed only in "mechanical clamming" areas. The gear is also used by mariculturists to harvest shellfish crops from their public bottom leases.	The use of purse seines has no habitat impacts as the net is fished entirely within the water column. No recommendations at this time.
Long haul seine: Usually a long seine, heavily leaded (weighted) and dragged by boats in estuarine waters to catch fish.	Some damage to SAV beds may occur from the heavily leaded bottom line being dragged through the grass beds. Damage to SAV beds by the boat motor propellers may be significant in shallow waters. There is concern over the use of this gear in PNAs (where use is currently prohibited) and near oyster rocks. Recommend: (1) a study be implemented to determine the actual bottom damage and whether the damage is short-term or long-lasting; (2) all oyster grounds, PNAs, and SAV beds be permanently marked: and (3) a study be conducted into the effects of long haul seine activities in these areas.
Long-line System: Fishing lines used for top-water, underwater or bottom fishing.	Virtually no habitat impacts when used as a top-water gear. Impact of bottom gear can range from minor on sand bottoms to significant when used in live rock (coral) formations. Recommend that bottom gear should be prohibited in coral formations.
Ocean Drift Net: Usually a monofilament gill net constructed so as to be tended from the top down. Ocean drift nets generally utilize a larger mesh size than bottom fishing nets. There is very little, if any, use of this gear in the ocean off North Carolina.	No known habitat impacts. No recommendations at this time.
Ocean Sink Gill Net: These are offshore gill nets that may be heavily anchored or not, as is appropriate to the area and fishery.	Sink nets have very little habitat impact unless gear becomes entangled with live rock formations. Lost or discarded webbing can become a danger for continued fishing until webbing becomes encrusted. Recommend better, more positive identification of net owners.
Otter Trawl: A cone-shaped net fashioned in one of the many patterns of "Otter Trawls", used primarily in North Carolina to catch shrimp. The gear is pulled from behind or alongside a vessel using "doors" or "gates" to keep the trawl open. The doors are sized (18" x 36" to 40" x 120") and weighted (50 lb. to 500 lb.) in direct ratio to the size of the trawl. Trawls skim the bottom, and shrimp are made to "pop" up into the net by a "tickler" chain pulled just ahead of the bottom line. Trawl doors ride along the bottom.	
Oyster Dredge: Usually heavy, large-toothed cages towed by a vessel to recover oysters from deeper waters. Oyster dredges are currently allowed only in Pamlico Sound, with a one hundred-(100) pound weight limit.	These dredges have severe habitat impacts. Recommend that dredges continue to be prohibited in estuaries and on live bottom formations offshore [Note: This fishery is regulated under a federal FMP, and its impacts are not presently an issue in NC].

Fishing method	Habitat Impacts and Recommendations
Oyster Tongs: Hand held steel "forceps", typically used while standing in a boat to recover oysters from water ranging in depth from that barely deep enough to float a boat to then 910) to twelve (12) feet.	Some habitat impact in SAV beds. Impacts on oyster beds may be negated if clam and oyster seasons are combined at some future point. Recommend that clam tongs be prohibited on marked oyster rocks except during oyster harvest season.
Patent Tongs: Very large steel "forceps" typically used to recover oysters from deep water.	The use of clam kicking has severe habitat impact on all bottoms. The gear causes severe damage to SAV beds and to oyster rocks. Recommend that gear continue to be prohibited in SAV beds and over marked oyster grounds.
Pound Net: A passive gear using netting "leads", which the fish travel along to a net "pound", where they are captured. Captured fish can be culled alive. Mesh size in the pound can be fish size selective. This gear known also as "weirs", and is one of the oldest methods of fishing. Some states have specific laws protecting weirs.	No known habitat impacts. The poles used to support the pound net leads and pound are permanent structures that can themselves become habitat, but abandoned or broken-off poles can become a hazard to navigation. No recommendations at this time.
Purse Seine: Large net used to catch menhaden. A menhaden school is surrounded by the purse et and a large weight is then dropped to close, or "purse", the bottom of the net.	
Sea Scallop Dredge: An extremely heavy steel cage similar to an oyster dredge that drags the bottom and is used in the ocean. These dredges are intended for use only on beds of scallops at sea.	Very little habitat impact. It is generally okay to use these dredges in SAV beds over a short scallop season. No recommendations at this time.
Shrimp Pot: A wire trap used as a special type of underwater trap or pot to catch shrimp.	No known habitat impacts. Okay to use in SAV beds, PNAs, or oyster grounds. No recommendations at this time.
Skimmer Trawl: A trawl net that utilizes a solid frame and a flat offshore "foot" in order to push a trawl through the water without using doors. Use of this gear is limited to areas where the depth of the water is no more than the size of the metal frame. Its use is highly successful in the "white shrimp" fishery.	The use of crab trawls has severe impacts on all bottoms, causing great damage to oyster grounds and moderate to severe damage in SAV beds. Crab trawling results in substantial sedimentation in the trawled area. Recommend that crab trawls be prohibited in marked oyster grounds. Because of heavy chain at the mouth of these trawls, there was much concern over potential damage to SAV beds. For that reason, also recommend a study of the effects of crab trawling on SAV beds.
Spear: Similar to a gig, but usually single pronged, used by underwater divers using scuba gear.	No known habitat impacts. No recommendations at this time.
Stop Net: [See "Beach Seine", above] A term used for large mesh nets that are set out of "run" perpendicular to the beach. Stop nets are not intended to catch anything themselves, given that the mesh size in these nets is from six (6) to ten (10) inches. During the night, migrating mullet (or other fishes) gather against the stop net, which they perceive as an obstruction to travel. Other species may either swim through the stop net or go around it. A beach seine is used to gather the fish "encamped" at the stop net site. A recent DMF study showed that ninety-five percent (95%) of the fish "encamped" at the stop net are mullet.	Use of this gear can seriously damage live rock formations. Recommend the continued prohibition of use in inside (internal) coastal waters. Federal rules should address the use of flynets in the EEZ.
Trammel Net: A multi-walled net usually made with two outer walls of large mesh (6" to 12" stretch or more" made of heavy gauge monofilament, and an inner wall of small mesh monofilament. A fish "pockets" itself between the walls.	Only impact is from lost or discarded nets. Recommend that better, more positive identification of net owner be required.
Trolling Gear: Fishing lines attached to a reel or directly to a boat and "trolled" through the water. Used when fishing for king mackerel, tuna, etc.	No known habitat impacts. No recommendations at this time.
Trot Line: Lines used in estuarine waters to catch crabs and fish, consisting of a long multi- or monofilament line baited at intervals, with or without hooks, used much like an ocean long-line.	No known habitat impacts. No recommendations at this time.