INJURIES TO FISHERY RESOURCES DUE TO CONTAMINANTS IN THE ALBEMARLE BAY COMPLEX: CONSUMPTION ADVISORIES

Kate Clark
National Oceanic and Atmospheric Administration
Office of Response and Restoration
Silver Spring, MD

July 2004

TABLE OF CONTENTS

Injuries to Fishery Resources Due to Contaminants in the Albemarle Sound Complex: Consumption Advisories for Recreational Fishing

1. Introduction

This report examines the injury to recreational fishing resources in the lower Roanoke River, Welch Creek and the western Albemarle Sound due to fish consumption advisories placed on recreational fishing. The report also presents information on the presence of contamination in fish that is the basis of the advisories, and which led North Carolina state officials to limit use of the resource in order to protect public health.

Beginning in 1988, several contaminant studies have documented high levels of dioxin, and the existence of other contaminants (metals and organics) in sediments, surface water, and biota in Albemarle Sound, the Roanoke River, and some of its tributaries. Studies conducted in 1988 in relation to the Weyerhaeuser Company Paper Mill (Weyerhaeuser) National Pollution Discharge Elimination System (NPDES) permit revealed elevated levels of metals and organics in fish tissue of local fish species. These studies prompted the North Carolina Department of Health and Human Services (NCDHHS) to issue fish consumption advisories for all species of fish for the Lower Roanoke River and Welch Creek in 1990 and for western portions of Albermarle Sound in 1991 (Williams, pers. comm. 2004). These advisories restrict consumption of fish taken by recreational anglers due to high levels of dioxin contamination in fishery resources. This report documents the circumstances leading to restrictions on recreational fishing in the Roanoke River and Albemarle Sound and describes the changing scope of the restrictions up to the present time.

This report is the result of broader investigations of the impacts of contamination in the Lower Roanoke River carried out by government agencies, including the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Water Quality, NCDHHS, the U.S. Department of the Interior (DOI), and the U.S. Environmental Protection Agency (EPA). Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the EPA has designated the site a Superfund Alternative Site. This designation was made, as opposed to being put on the National Priorities List (NPL), with the agreement that Weyerhaeuser would cooperatively follow all of the investigative and remedial procedures involved with the NPL, and in return, avoid the stigma of being labeled as such (EPA 2002).

In light of these previous investigative findings, NOAA is interested in determining if a Natural Resource Damage Assessment (NRDA) should be conducted to assess if natural resources have been injured as a result of contamination in the Lower Roanoke River and Albemarle Sound. The NRDA process will determine the effects of toxic contamination in the Lower Roanoke River and Albemarle Sound and the appropriate type and level of restoration needed to restore resources to baseline and compensate for their lost use.

The information summarized in this report confirms that the public's recreational use of and access to the Lower Roanoke River and Albemarle Sound has been severely curtailed due to toxic contaminants in fish. This area was subject to fish consumption advisories for all species from 1990 to October 2001. In 2001 the advisory was lifted to limit only the consumption of catfish and carp. Based on these facts, NOAA concludes that the recreational fishery of the Lower Roanoke River and Albemarle Sound has been injured.

2. Regulatory Background

The Trustees act under authority granted to them in the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and other applicable laws. Regulations promulgated under CERCLA by DOI define the injury that is the subject of this investigation. The regulations provide that a natural resource injury exists whenever a hazardous substance is present in fish at concentrations sufficient to "exceed action or tolerance levels established by the Food and Drug Administration (FDA) under section 402 of the Food, Drug and Cosmetic Act, 21 U.S.C. Sec. 342, in edible portions of organisms …" or "exceed levels for which an appropriate State health agency has issued directives to limit or ban consumption of such organisms."[1] This report focuses on North Carolina regulations and consumption advisories that restrict fish consumption based on contaminant levels in fish.

Part of the CERCLA process to address environmental injury includes a Natural Resource Damage Assessment, resulting in the calculation of environmental losses due to contamination. The NRDA process leads to the restoration of natural resources and resource services in an amount sufficient to make the public whole. Recreational fishing is an important service provided by aquatic natural resources, and the effects of contamination on recreational fishing in an area like the Lower Roanoke River and Albemarle Sound could potentially be a significant part of an NRDA claim under CERCLA. Other possible portions of the damage assessment, such as investigation of injury to ecological functions in the environment may also be addressed.

3. Site Ecology and History

The Roanoke River originates in the mountains of Virginia and flows 380 miles to the Albemarle Sound in North Carolina. This report focuses on a 14.3 miles of the Lower Roanoke River, including the Middle and Eastmost Rivers. The boundaries, as defined by EPA in their Baseline Ecological Risk Assessment (BERA), extend "from a point upstream of the Weyerhaeuser Plant…", which is just above Plymouth, NC to the upper western reaches of Albemarle Sound (Fig. 1). The hydrodynamics of the Lower Roanoke River are characterized by low velocities and highly regulated due low topography in the basin and dams upstream. (*Note: the tidal reach is unknown, but meeting minutes from the Roanoke River Basin Association documents the Weyerhaeuser facility taking in salt water through their intakes during droughts. Therefore, it is believed that the tidal reach is south of Plymouth, NC when rain fall is normal [2004].)* The Middle River, which

[1] The regulations can be found at 43 CFR Sec. 11.62(f)(1)(ii) and 43 CFR Sec. 11.62(f)(1)(iii).

branches off of the Roanoke River a half of a mile above the Weyerhaeuser facility receives about one third of the Roanoke River main stream flow. Vegetation is dominated by bottomland hardwoods. The area's resource value is underscored by the presence of two endangered species, the bald eagle and the shortnose sturgeon, as well as ten National Wildlife Refuges. The Albemarle Sound is part of the Albemarle-Pimlico Sound National Estuary Program.

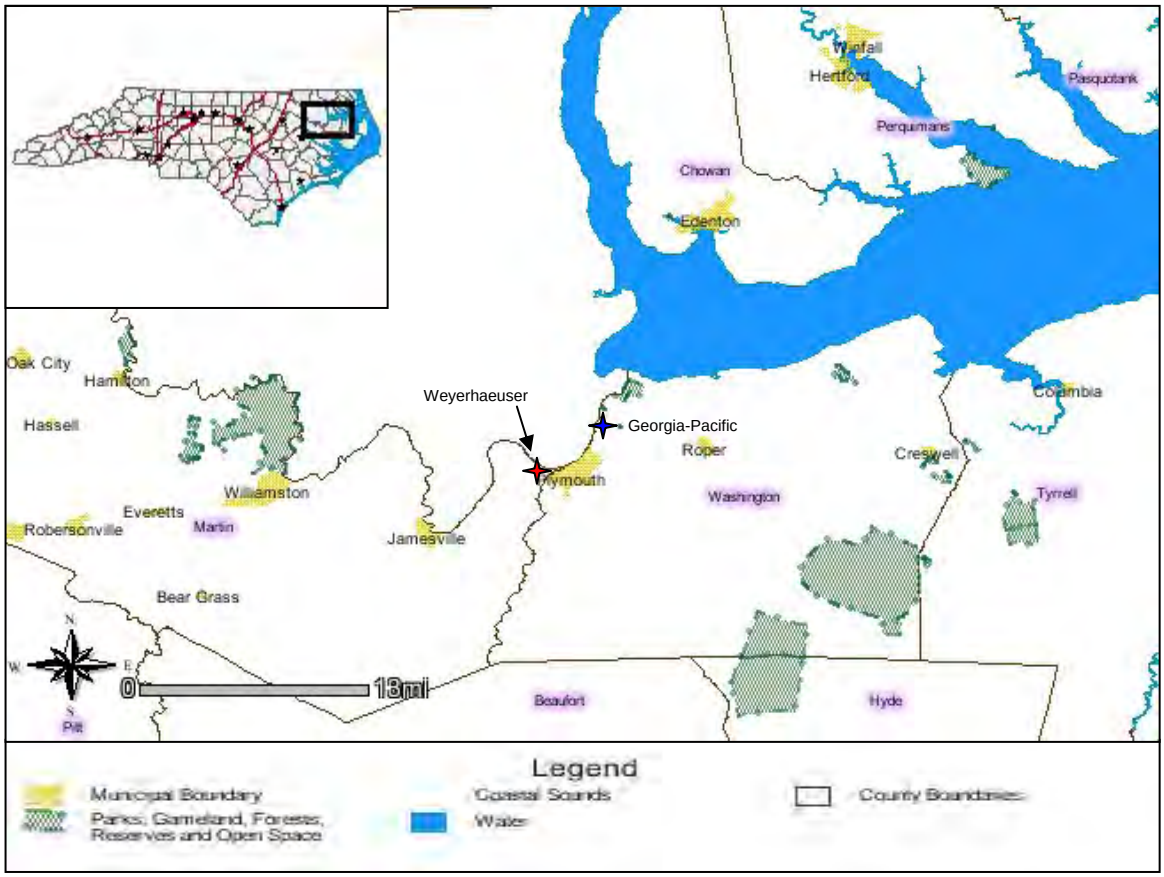


Figure 1: A map of the western portion of Albemarle Sound and the lower Roanoke River. The Weyerhaeuser and Georgia-Pacific Plants are located up and down river of Plymouth, NC, respectively.

Two facilities along the Lower Roanoke River, the Weyerhaeuser Company Paper Mill and the Georgia Pacific Sawmill, are believed be to the source of environmental contamination leading to the fishing restrictions (Fig. 2) (CDM 2002). Table 1 and Table 2 are timelines of historic waste discharge practices at each site.

Figure 2: A map of the Lower Roanoke River study area. Welch Creek is located in between Plymouth, NC and the Weyerhaeuser site. Georgia-Pacific is located closer to the Albemarle Sound. The total river miles covered by the study is 14.3 miles and includes the lower 7 miles of the Roanoke River, the Middle River and the Eastmost River.

Table 1: Weyerhaeuser Company Paper Mill Waste Management Timeline

Dates	Practices/Event
1937 to 1957	Kieckhefer-Eddy Company produced pulp and container board products. Wastewater was discharged directly into the Roanoke.
1952 to 1965	The site operates a mercury cell chlorine production plant. Process fluid drained through the floor and directly into the Roanoke. By-product containing mercury was disposed of on-site in an unlined landfill.
1957	Kiechhefer merges with Weyerhaeuser. Weyerhaeuser owns/operates facility.
1957 to 1968	Wastewater was discharged into Welch Creek, 1.6 miles from its confluence with the Roanoke River.
1968 to 1987	A series of wastewater treatment ponds were constructed on-site. Treated wastewater was discharged into Welch Creek, 2.3 miles from its confluence with the Roanoke River.
1969 to 1975	Discharge was regulated by State permit.
1975 to present	Discharge is regulated by NPDES permit.
1979 to present	Lumber (not treated prior to 1979) is treated with a chromated copper arsenate process which produces 6000 lbs of sludge per year. This waste is shipped to RCRA disposal facility.
1988 to present	Treated wastewater is discharged into the Roanoke River, 0.5 miles downstream of the plant.

Table 2: Georgia Pacific Waste Management Timeline

Dates	Practices/Event
before 1950	Facility is owned/operated by Atlas Plywood Company. Waste management practices and timeline are unknown.
1950 - 1980	Georgia-Pacific owns and operates facility. The company debarked, sawed and planed rough hardwood timber from logs. Conveyor belt and dip vat were used to treat wood.
1983	Mill destroyed by fire. Property sold to Decatur Partnerships and leased to Outerbanks Contractors for use as an asphalt plant.
Ongoing	Surface run-off contaminates Roanoke River
1995	Sediment samples contain lead, arsenic, pentachlorophenol and dioxin. All are linked to the site.

Despite contamination in the affected areas, the North Carolina Division of Marine Fisheries (NCDMF) reports that Albemarle Sound is North Carolina's largest spawning population of striped bass with a statewide landing of $718,000 in 2003. Catfish landing values for 2003 are reported at about $100,000 with 95% of the catch coming from Albemarle Sound. The NCDMF estimates statewide commercial finfish landings for 2003 at approximately $33.7 million. The Sound supports economically vital recreational and commercial fisheries and the entire area provides important habitat for a wide array of wildlife and migratory birds.

4. Contamination and Monitoring in the Lower Roanoke River and Albemarle Sound

Several contaminant studies have documented high levels of dioxin, along with the existence of other contaminants (metals and organics) in sediments, surface water, and biota in Albemarle Sound, the Roanoke River, and some its tributaries. One of the first studies, conducted in 1988 in relation to the Weyerhaeuser Company Paper Mill (Weyerhaeuser) National Pollution Discharge Elimination System (NPDES) permit, revealed elevated levels of metals and organics in fish tissue of local fish species (CDM Federal 2002b). These findings prompted the North Carolina Division of Environmental Management (NCDEM) to issue fish consumption advisories for all finfish in the Roanoke River and Welch Creek in 1990 and for Albermarle Sound in 1991. Monitoring of contamination of fish has continued in the area, and in 2001 the consumption advisory was changed to regulate only the consumption of catfish and carp (NCDHHS 2004).

Additional studies have been conducted focusing on contaminated benthic sediments and birds. Riggs et al. (1989) and Riggs (1996) discuss the ability for estuarine organic-rich muds in the area, which provide important habitat for microorganisms and filter-feeders, to sequester contaminants. Studies on the effects of dioxin and furans on wood ducks and fish-eating birds (Beeman and Augspurger 1996, Augspurger et al. 1996) concluded that while both species had elevated levels of dioxin in eggs, there was no significant difference in hatching success or survivorship between the research area (within 1.5 km of the Weyerhaeuser site) and the reference area.

The EPA's BERA report also identifies measured levels of PCBs, Pesticides, VOCs, SVOCs, and metals around the Weyerhaeuser and Georgia-Pacific sites found in soils, sediments, surface water, and various biota samples (CDM Federal 2002). The follow contaminant information is taken from the BERA (CDM Federal 2002) and EPA's Remedial Investigation (CDM Federal 2002b).

4.1 Dioxins

Dioxin is an extremely toxic chemical that has no industrial or commercial uses. It is an unwanted byproduct in the manufacture of other chlorinated chemicals supplied for industrial and agricultural uses, for example, as pesticides. All of North Carolina's dioxin advisories are related to contamination from paper mills (NCDHHS 2004).

Human health effects from acute exposure to dioxin include potentially disfiguring and persistent skin lesions and other toxic effects. Lower levels of exposure have been associated with immune system and reproductive disorders. The Environmental Protection Agency has designated dioxin as a probable carcinogen (EPA 2003).

Fish

Tests on four species of fish taken in August 1999 and June 2000 in the Lower Roanoke River found levels of dioxin ranged from 0.03 to 6.5 ppt (parts per trillion) in largemouth bass, 0.13 to 26 ppt in catfish, 0.27 to 1.7 ppt in redear sunfish, and 0.76 to 4.5 in bluegill

(CDM 2002b). It should be noted that the levels reported are for fish in which dioxin was detected, several of the fish sampled showed no trace of dioxin. The FDA has issued guidance, not a formal action, suggesting that limiting consumption is appropriate when concentrations exceed 25 ppt. The state of North Carolina, however, limits consumption when concentrations exceed 3 ppt (NCDENR 1996). The data from the 1990 Fish Tissue Dioxin Levels in North Carolina report which lead to the limited consumption of all finfish in the area shows that dioxin contamination was widespread throughout the Lower Roanoke River and two of the areas sampled along the Roanoke River had dioxin contamination averages of 25 ppt when sampled in 1987 through 1989 (NCDEM 1990). Additional samples taken in 1990 showed reduced levels of dioxin and cite better discharge practices by Weyerhaeuser, different laboratory analyses, seasonal differences, species variation, and other factors as possible reasons for the decrease (NCDEM 1990). These decreases were also seen in laboratory samples taken from the Neuse River, the site of another Weyerhaeuser facility and the same explanations are given.

Clam Tissue
Clam (*Corbicula* and *Rangia*) tissue sampled at 9 location near the bottom of the Roanoke River were tested for dioxin in June 2000. Dioxin TEQ levels in clams ranged from 0 to 0.36 ppt (CDM 2002b).

Surface Water
Surface water was tested for dioxin using high volume surface water sampling techniques. The dissolved dioxin TEQ in the water ranged from 0.31 to 41 fg/L (ppb [parts per billion]), with the latter value occurring in Welch Creek near its confluence with the Roanoke River (CDM 2002b).

Suspended Sediment
Suspended sediment was tested for dioxin using high volume surface water sampling techniques. The dioxin TEQ in the suspended sediment ranged from 5.07 fg/L to 896 fg/L, with the latter value occurring, again, in Welch Creek near its confluence with the Roanoke River (CDM 2002b).

Sediment
Benthic sediment samples taken in August 1999 and June 2000 in the Lower Roanoke River found levels of dioxin ranged from 16 to 430 ppt for shallow sediments (0-6 in), 16 to 360 ppt for intermediate sediments (18-36 in), and 17 to 180 ppt for deep sediments (60-72 in) (CDM 2002b). The highest level detected in shallow sediments, 430 ppt, was taken from the confluence of Welch Creek and the Roanoke River (CDM 2002b). The highest intermediate depth dioxin level, 360 ppt, was found in sediments downstream of both facilities and close to the Albemarle Sound (CDM 2002b). The highest deep sediment dioxin sample, 180 ppt, was found in the Albemarle Sound (CDM 2002b). The increase or decrease in dioxin with depth at each sample site correlates inversely with sediment grain size (CDM 2002b).

4.2 Other Contaminants

PCBs, pesticides, VOCs, SVOCs, PAHs and metals were also analyzed in sediments and biota of the Lower Roanoke River and Albemarle Sound as part of the RI (CDM 2002b). In addition to dioxin, surface waters and suspended sediments were tested for VOCs and metals. While a statewide fish consumption advisory exists for mercury in North Carolina, it is not a contaminant of potential concern (COPC) for fish in the Lower Roanoke. However, levels exceeding the reference value of 0.54 mg/kg were present in all three sediment depths sampled in the area (CDM 2002b). No other contaminants were found at levels high enough to warrant fish advisories in the Lower Roanoke River and Albemarle Sound.

The Lower Roanoke River Final Remedial Investigation Report (CDM 2002b) determined ecological risk caused by the COPCs. Ecological risk means that the EPA has determined that the presence of COPCs is likely to directly and/or indirectly have an adverse effect on certain resources in the ecosystem. The results of resources at risk are summarized in Table 3.

Table 3: Summary of Pollutants Posing an Ecological Risk to Resources in the Lower Roanoke River

Resource at Risk	Pollutant
Wetland Soil Invertebrates	Chromium, copper, dioxin
Worm Eating Birds	Mercury, dioxin
Benthic Macroinvertebrates	Mercury, copper, dioxin
Fish Tissue	Mercury, dioxin, furans
Omnivorous Birds	Mercury, dioxin
Carnivorous Birds	Mercury, dioxin
Omnivorous Mammals	Mercury, dioxin

5. North Carolina Directives Regarding the Harvest or Consumption of Fish

The North Carolina Department of Health and Human Services issues fish consumption advisories to protect recreational anglers from excessive exposure to contaminants. For several species, statewide advisories exist due to mercury contamination. Other species are addressed only through site-specific advisories.

5.1 Development of Fish Consumption Advisories

Fish consumption advisories are developed through a scientific process that includes collecting samples of fish from waters throughout the state and analyzing them for the presence of chemical contaminants. The contamination levels are compared to thresholds developed by the federal government or the state for the protection of human health.

One source of federal consumption thresholds is the U.S. Food and Drug Administration (FDA). The FDA sets guidelines for the consumption of fish based on action or tolerance levels. The primary purpose of these regulatory thresholds is to ensure the safety of the commercial food supply by triggering legal action to remove contaminated products from

the market. In addition, the FDA action or tolerance levels frequently serve as a benchmark for issuing fish consumption advisories. While there is a formal FDA tolerance level for mercury, the levels put forth for dioxin are merely guidance. Another source of information regarding appropriate fish consumption guidelines is the U.S. Environmental Protection Agency (EPA), which reports findings of studies on human health effects of environmental contamination. The EPA classifies dioxin and PCBs as probable cancer-causing substances in humans. The EPA has also found that elevated levels of mercury can cause damage to the human nervous system, particularly in developing fetuses and children (EPA 2001).

North Carolina advisories are based on the State and Federal action or tolerance levels. The North Carolina Department of Health and Human Services Issues fish advisories for dioxin and mercury when concentrations exceed 3 ppt and 1.0 ppm, respectively (NCDENR 1996). The mercury tolerance level is set by the FDA. While the mercury advisory is set for seven species statewide, it is important to note that mercury levels in the Roanoke Basin and in the biota are non-detectable or present at trace levels (NCDENR 1996).

5.2 Historic Advisory Levels

Figure 3 shows historical levels of fish consumption advisories in the Lower Roanoke River, Welch Creek and Albemarle Sound. Advisories on the Roanoke River refer specifically to portions of the River from the U.S. Highway 17 bridge near Williamston to the mouth of the Albemarle Sound. Advisories on the Albemarle Sound apply to the western portion of the sound, from Bull Bay to Harvey Point and west to mouth of the Roanoke River and the mouth of the Chowan River at the US Highway 17 bridge. In the North Carolina advisories, a meal is defined as one six-ounce serving.

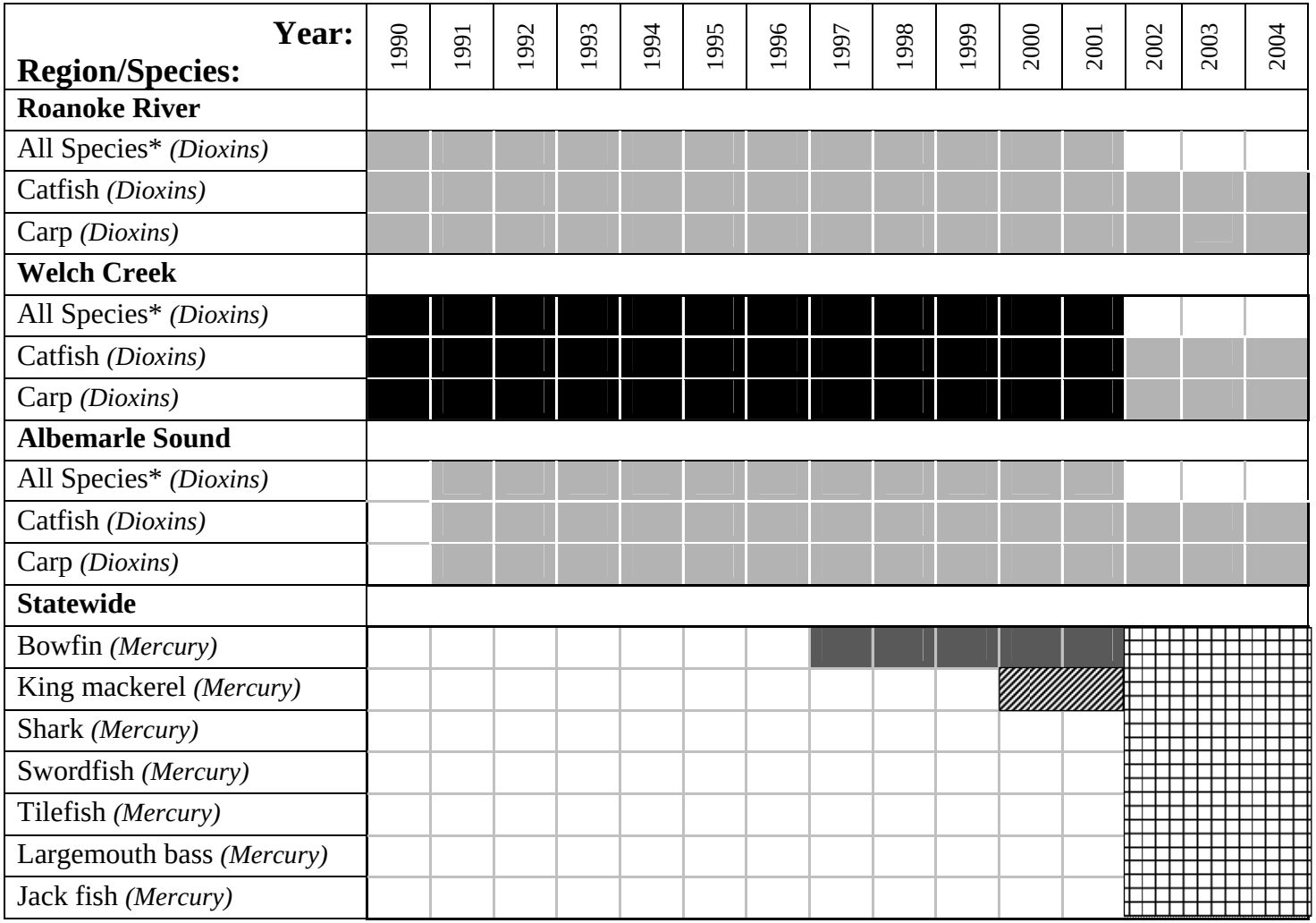
North Carolina first issued fish consumption advisories in the Lower Roanoke River in 1990 and Albemarle Sound in 1991 for all species based on findings of dioxin contamination exceeding the State tolerance level of 3 ppt (NCDENR 1996). Welch Creek had a no consumption advisory for all people (NCDENR 1996). The Roanoke/Albemarle advisory suggested that sensitive populations (women of childbearing age, pregnant women, nursing women, and children under 15) should eat none of the fish from this area, while the general population (other women, men and children over 15) should limit consumption of fish from this area to one meal per month (Williams, pers. comm. 2004). In 2001, the NCDHHS dioxin advisory in the Lower Roanoke River and Albemarle Sound was reduced to limit consumption of only carp and catfish, still at the one-meal-per-month level (NCDHHS 2004). The Welch Creek advisory for dioxin was also reduced in 2001 to allow consumption of one meal per month for non-sensitive populations; for sensitive populations, the advisory for Welch Creek continues to recommend no consumption of fish taken from Welch Creek (NCDHHS 2004).

5.3 Statewide Advisories

The state-wide fish consumption advisory for mercury was first issued for bowfin (or blackfish) on June 12, 1997 (NCDENR 2001). The advisory suggested that sensitive

populations do not eat bowfin caught in State waters and that non-sensitive populations limit consumption to two meals per month. On March 23, 2000, king mackerel was added to the state-wide advisory. The advisory set no consumption limits on king mackerel less than 33 inches. The advisory set for king mackerel between 33 and 39 inches in length suggested that sensitive populations should limit consumption to one meal per month and non-sensitive populations should limit consumption to 4 meals per month. The March 2000 advisory further stated that all people should avoid consumption of king mackerel larger than 39 inches caught in state waters. On April 16, 2002, the statewide mercury advisory was amended to include more stringent consumption limits and more species. Statewide was also defined as water south and east of Interstate 85, which runs northeast to southwest through the approximate center of North Carolina. Sensitive populations are currently advised not to eat any shark, swordfish, tilefish, king mackerel, bowfin, largemouth bass, or jack fish. Non-sensitive populations are advised to limit consumption of these species to four meals per month. Historic fish advisories in the Lower Roanoke River and Albemarle Sound are summarized in Table 4.

Table 4: Summary of North Carolina Fish Consumption Advisories for the Lower Roanoke River, Welch Creek and Albemarle Sound
1990 - 2004



* Except herring and shad

Advisory: Each person should eat no more than one meal per month. Sensitive persons (children <15 and women of childbearing age) should eat none

Advisory: Eat none.

Advisory: Each person should eat no more than two meals per month. Sensitive persons should eat none.

Advisory: For king mackerel between 33 and 39 inches, each person should eat no more than four meals per month. Sensitive persons should eat no more than one meal per month. For king mackerel over 39 inches, no consumption.

Advisory: Each person should eat no more than four meals per month. Sensitive persons should eat none.

6. References:

Augspurger, T., J. Holland, and M. Canada. 1996. Productivity and Contaminant Assessment of Ospreys from Western Albemarle Sound, North Carolina. Poster Presentation: 7th Annual Meeting of the Society of Environmental Toxicology and Chemistry. Washington, D.C.

CDM Federal. 2002. Final Baseline Ecological Risk Assessment: Lower Roanoke River Study. Prepared for EPA Region 4, Atlanta, Georgia. February 2002.

CDM Federal. 2002b. Final Remedial Investigation Report: Lower Roanoke River: Martin, Washington, and Bertie Counties, North Carolina. Prepared for EPA Region 4, Atlanta, Georgia. June 2002.

EPA 2001. "Fish Advisories, Consumption Advice Fact Sheet." United States Environmental Protection Agency, Office of Water. January 2001. http://www.epa.gov/waterscience/fishadvice/factsheet.html

EPA 2003. Technology Transfer Network Air Toxics Website. "2,3,7,8-Tetrachlorodibenzo-p-Dioxin (2,3,7,8-TCDD)." U.S. Environmental Protection Agency. www.epa.gov/ttnatw01/hlthef/dioxin.html.

Fleming, W.J., and D.K. Beeman. 1993. Productivity Assessment of Two Great Blue Heron Colonies in the Roanoke River Floodplain. (A Report in Partial Fulfillment of Research Work Order No.10 Titled Effect of Dioxin on Non-Game Species at Roanoke River NWR). US Fish and Wildlife Service, Southeast Region, Atlanta, Georgia. http://ecos.fws.gov/dec_reports/160/report.html

North Carolina Department of Environment and Natural Resources (NCDENR). 1996. The Roanoke River Basinwide Water Quality Management Plan. http://dem.ehnr.state.nc.us/basinwide/roanoke/roanoke_wq_management_plan.htm

North Carolina Department of Environment and Natural Resources (NCDENR). 2001. Environmental Management Commission Water Quality Commission Meeting Minutes. February 7, 2001, Archdale Building, 11AM - 2PM. http://dem.ehnr.state.nc.us/admin/emc/committees/wq/2001/2001-02-13.pdf

North Carolina Department of Health and Human Services (NCDHHS). 2004. Fish Consumption Advisories. NCDHHS Epidemiology branch. http://www.epi.state.nc.us/epi/fish/

North Carolina Division of Environmental Management. 1990. 1990 Update: Fish Tissue Dioxin Levels in North Carolina. NCDEM Water Quality Section.

Riggs, S.R., E.R. Powers, J.T. Bray, et al. 1989. Heavy Metal Pollutants in Organic-Rich Muds of the Pamlico River Estuarine System: Their Concentration, Distribution, and Effects Upon Benthic Environments and Water Quality: Albemarle-Pamlico Estuarine Study, US EPA and NCDENR, Report No. 89-06, 108 p.

Riggs, S.R., 1996, Sediment evolution and habitat function of organic-rich muds within the Albemarle estuarine system, North Carolina: Estuaries, v. 19, no. 2A, p. 169-185. 1996

Roanoke River Basin Association. 2004. "Latest Drought News" http://www.rrba.org/drought.html

Williams, L. 2004. Personal Communication. North Carolina Department of Health and Human Services (NCDHHS), Epidemiology. May 12, 2004.