Analysis Areas for Strategic Assessment of Estuarine and Coastal Waters

July 1987

Joint EPA/NOAA Team on Estuarine and Coastal Waters

Analysis Areas for Strategic Assessment of Estuarine and Coastal Waters

Strategic Assessment Branch
Ocean Assessments Division
Office of Oceanography and Marine Assessment
National Ocean Service
National Oceanic and Atmospheric Adminstration
U.S. Department of Commerce

Office of Marine and Estuarine Protection
Office of Water
U.S. Environmental Protection Agency

Environmental Results Branch
Management Systems Division
Office of Management Systems and Evaluation
Office of Policy, Planning and Evaluation
U.S. Environmental Protection Agency

Purpose

This volume identifies areal units that are being used to collect and organize information on the estuarine and coastal regions of the contiguous USA. The units or analysis areas identified are those used in NOAA's Strategic Assessment Program, but are also commonly used by EPA and others for organizing information. The volume is intended to serve as a starting point for establishing a consistent set of areal units that may eventually be used in EPA's program on Near Coastal Waters.

The EPA/NOAA Team

A joint EPA/NOAA team has been informally created to develop a set of information and assessment products on the Nation's estuarine and coastal areas. The team's objective is to make maximum use of the data, information, and knowledge that exists nationwide about the important areas addressed by EPA's National Estuarine Program and Near Coastal Waters Program.

The team brings together EPA and NOAA personnel to conduct hands-on data development and synthesis. Its creation signals an increased commitment by EPA and NOAA to address jointly resource-use and environmental quality problems in estuarine and coastal areas. The involvement of NOAA and EPA personnel on the team will vary depending on the project. This volume is the team's first product. Development of a second product, *Synthesis of Estuarine and Coastal Information for EPA Region I,* is now underway and will be completed this fall. Plans are to develop additional information and assessment products in FY 1988.

Background

Defining the areal units for analysis is one of the important first steps in conducting any study or in organizing and presenting a body of information or knowledge. The units chosen must take into account the boundaries of natural systems, "problem sheds" or impact areas, political jurisdictions, and a variety of management regimes, as well as considerations of scale and resolution. It is unlikely that any single unit will satisfy the competing needs for areal specificity, the resolution that existing data will support, and the resources available. Consequently, selecting areal units for analysis will always require compromise, particularly when attempting to characterize complex estuarine and coastal areas. It is important that the areal unit(s) chosen fit into a consistent hierarchy that can be useful for and can incorporate analyses at the local and regional level, and can be meaningfully aggregated for nationwide assessments.

The areal units/analysis areas presented in this volume reflect this compromise between the detailed level required for local decisionmaking, e.g., segmenting a stream or river into short reaches, and the aggregation needs for realistically assessing nationwide priorities and tradeoffs.

Organization of this Volume

This volume is organized into five sections. This first section defines the analysis areas or units used in the Strategic Assessment Program and presents a schematic diagram illustrating each. A few comments are also presented on the problem of defining offshore analysis areas. The remaining four sections are:

Coastal Counties – This section contains a complete list organized by state of coastal counties and those noncoastal counties that intersect an estuarine drainage area. A schematic map of each coastal state showing the location of each county is also included. Volume II of the National Estuarine Inventory (NEI) presents areal estimates of 24 land use categories for each coastal and noncoastal county and indicates the area of each category that lies within and outside the estuarine drainage area.

Estuarine Drainage Areas – This section contains a map of each of the 101 estuaries in the NEI. The maps show: the estuarine drainage area (EDA) boundary for each estuary; the USGS cataloging units that comprise each EDA; and the three zones into which the estuarine surface has been segmented based on salinity. Estuarine drainage areas are not shown for eight estuaries in Oregon and one in California as they have only recently been added to the Inventory.

Rivers and Streams – This section contains a summary of the rivers and streams entering coastal counties, and a schematic map of each state showing the point at which each enters a coastal county.

Offshore Boundaries – This section contains maps from NOAA's Strategic Assessment Data Atlas series showing political, maritime, and jurisdictional boundaries in offshore areas, and a paper describing an early effort to segment offshore areas based on zones of impact of onshore pollution.

Definitions

Coastal Counties (Figure 3) – The list of coastal counties used by the Strategic Assessments Branch is based on a list originally produced by NOAA's Office of Coastal Zone Management. The list includes 328 counties from the 22 coastal states of the contiguous USA, excluding the Great Lakes. In general, each county borders on waters that are either marine, estuarine, or tidal fresh. Human activities in these counties have a direct impact on estuarine and coastal waters. Several NOAA projects use coastal counties as the primary geographic unit for organizing data because much existing information (land use, population, etc.) is only available by county. Counties are a widely used unit of comparison, and reflect the political and institutional boundaries by which many management decisions are made.

A related "county level" analysis unit is the noncoastal counties that intersect EDAs. These inland counties do not have a direct link to marine, estuarine, or tidal fresh waters, but nevertheless can have an indirect impact on these environments due to their proximity to coastal counties.

USGS Cataloging Units (Figure 2) – Cataloging Units are the smallest of four levels of hydrologic units used by the USGS to define the Nation's river drainage system (the other three levels, beginning with the largest, are the Region, Subregion, and Accounting Unit). A cataloging unit typically encompasses either a portion of or the entire watershed of a major river and is used to define EDAs. Cataloging units are usually at least 700 square miles in area.

Hydrologic Unit/County Subareas - HUCOs (Figure 4) – A hydrologic cataloging unit/county subarea, or HUCO, is the unique area of overlap between a USGS hydrologic cataloging unit and a coastal county. It is the basic geographic unit by which data in the National Coastal Pollutant Discharge Inventory (NCPDI) are organized. By aggregating appropriate HUCOs, pollutant loading estimates can be summarized by either county or cataloging unit.

Fluvial Drainage Area - FDA - The FDA is the entire drainage area of a major river . In most cases the FDA is larger than an estuarine drainage area. In a few cases the FDA coincides with the estuarine drainage area. This occurs when the total drainage of the system is small and may consist of only one or two cataloging units. A small map showing the fluvial and estuarine drainage area appears as an inset on the NEI map for each estuarine system.

Estuarine Drainage Areas - EDAs (Figure 1) – An EDA is the land and water component of a fluvial drainage area that most directly affects an estuary. In most cases, the boundaries of an EDA are delineated by the boundaries of the USGS hydrologic cataloging unit(s) or portion of the unit(s) that contains the head of tide of the streams and rivers flowing to the estuary and the seaward estuarine boundary of the estuary. In many cases this means the EDA boundary extends landward beyond the actual head of tide to the drainage divide of the cataloging unit. In cases where complex coastal drainages occur, drainage divides that bisect cataloging units have been determined using topographic maps to more accurately represent areas draining directly to estuaries. The EDA is always equal to or smaller than the FDA. Because it is based on hydrogeological features, an EDA often includes more than one political or jurisdictional unit.

The concept of the EDA was developed by NOAA to establish a useful spatial unit for compiling land use and flow data and other factors such as sources of pollutants that directly affect each estuary.

Rivers and Streams Entering Coastal Areas (Figure 3) – The rivers and streams that originate outside of and flow into coastal areas are termed "upstream sources" in the NCPDI and the NEI. These rivers and streams carry pollutant loads to estuaries and coastal waters that are generated from point and nonpoint sources discharging inland of coastal drainage areas. For many estuaries, upstream sources are a major source of pollutants. Over 320 rivers and streams are identified and located in the section on rivers and streams. From this universe, 163 have been included in the NCPDI based on their volume of discharge and size of watershed. The flow from these 163 rivers and streams accounts for over 90 percent of the total freshwater flow entering coastal counties.

Estuarine Zones (Figure 5) – Each estuary in the NEI is divided into three estuarine zones based on the average annual depth-averaged salinity concentration in the estuary. The salinity ranges (measured in parts per thousand) corresponding to each zone often dictate the distribution of biological communities and contribute to estuarine circulation. The salinity zones are:

- Estuarine Seawater Zone = 25.0 ppt and greater
- Estuarine Mixing Zone = 0.5 to 25.0 ppt
- Estuarine Tidal Fresh Zone = 0.0 to 0.5 ppt

Isohaline Zones (Figure 6) - It is currently planned to identify the location of isohaline zones in each estuary to provide a finer resolution for salinity distribution as an indicator of transport processes, and as a required parameter in delineating the extent of estuarine-dependent resources. Salinities will be averaged over high and low freshwater inflow periods based upon a 3-month moving average. Isohalines will be depicted in 5 part per thousand increments for surface and bottom water. A measure of salinity stability over averaging periods will also be provided.

Problem of Offshore Areas

In onshore areas, units such as counties, cataloging units, and EDAs are used or adapted to define "problem sheds" for analyzing the impact of human activities on nearshore waters. For offshore areas, no comparable spatial unit exists at present defining natural management zones that can be used in evaluating the direct and indirect impact on offshore waters of man's activities. Much additional work is needed to define appropriate units. The information presented here on existing political boundaries (Federal, state, county), maritime zones (e.g., territorial and contiguous zones), and jurisdictional areas (e.g., Fishery Conservation Zones, Minerals Management Service Outer Continental Shelf Central Planning Areas), illustrates the complexity of the institutional considerations for defining these units. The paper describing use of remotely sensed satellite imagery to determine spatial boundaries of nearshore areas that are affected by land based pollutants provides an example of an attempt to address this complex problem.

Figure 1. Estuarine Drainage Area

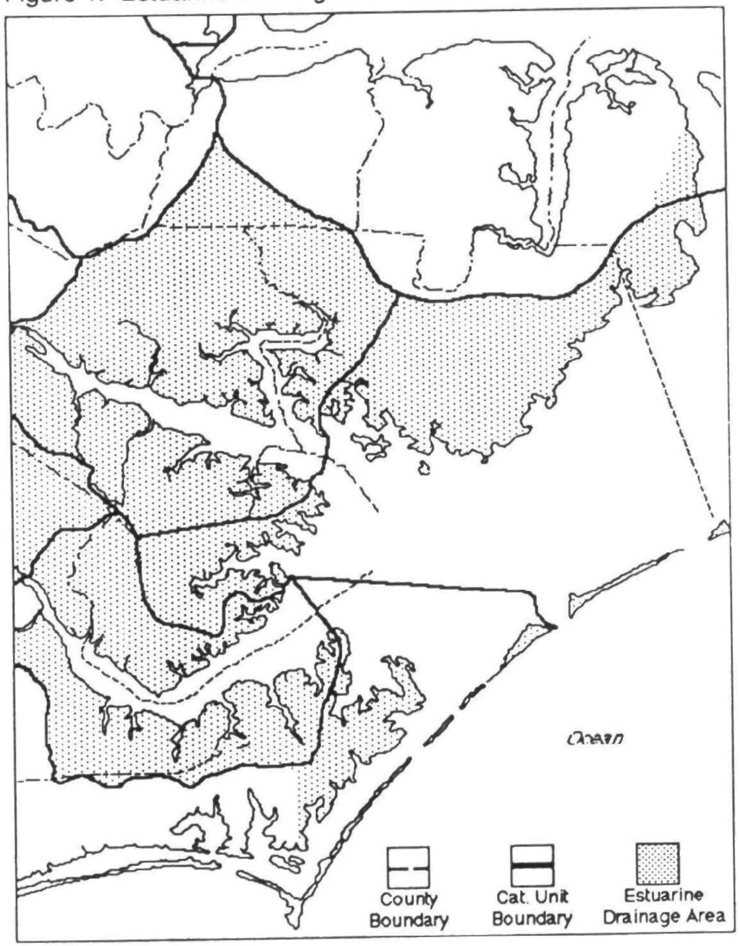


Figure 2. USGS Cataloging Units

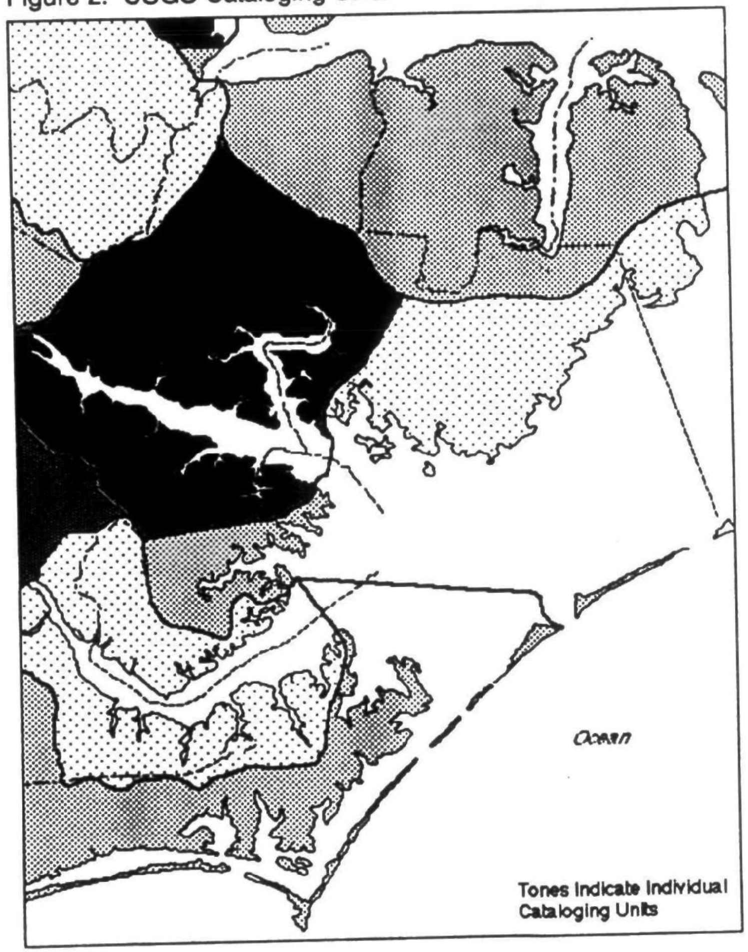


Figure 3. Counties

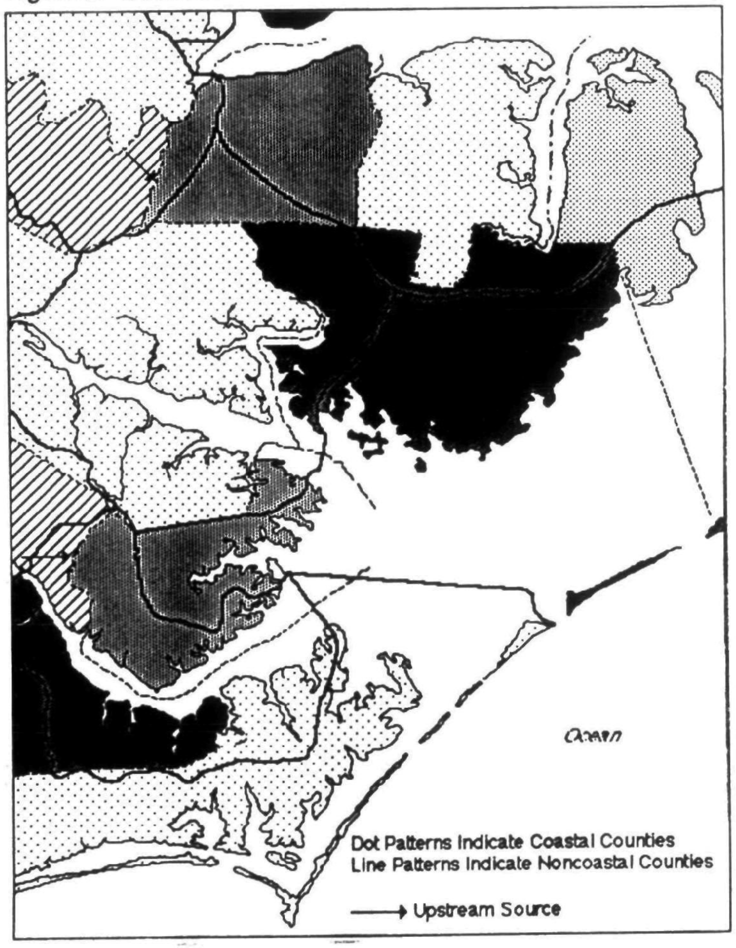


Figure 4. Hydrologic Unit/County Subareas (HUCOs)

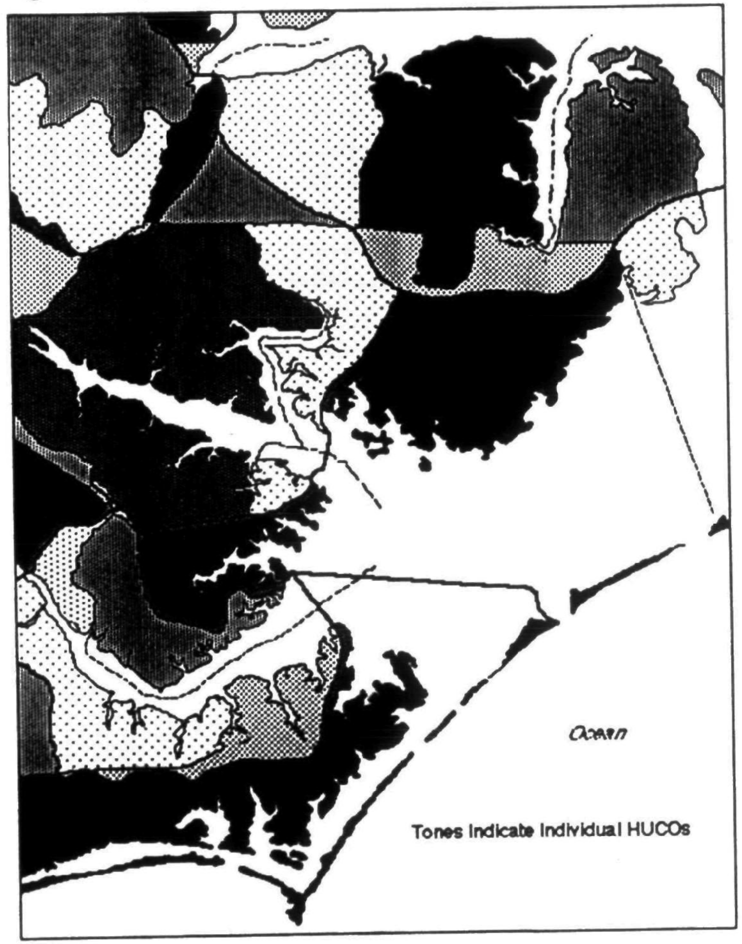


Figure 5. Estuarine Zones

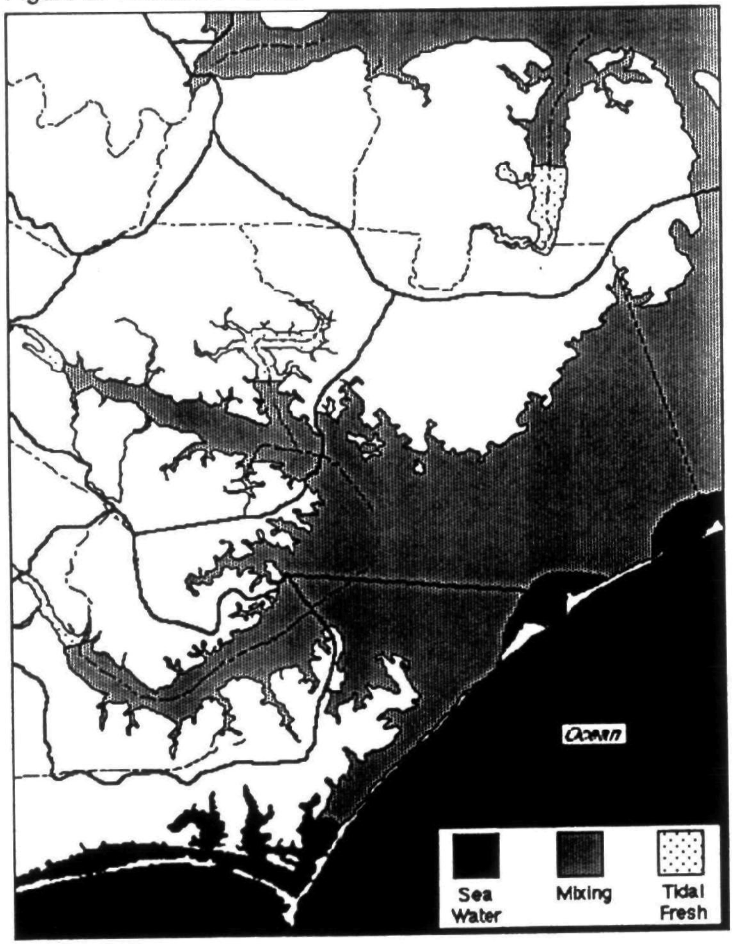
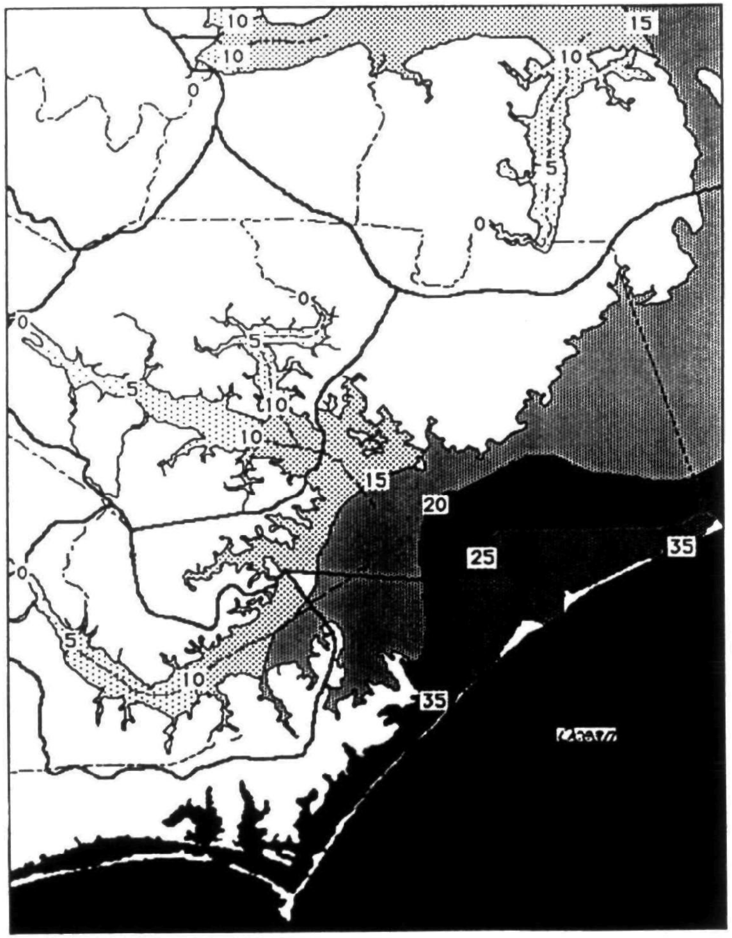


Figure 6. Planned Isohaline Segmentation



COASTAL COUNTIES

Coastal and Non-Coastal Counties

Counties in Estuarine Drainage Areas (EDAs)

ALABAMA

Coastal counties

Baldwin	Mobile

Noncoastal counties in EDAs

Brooks	Choctaw	Clarke	Coffee	Conecuh	Covington
Crenshaw	DecaturEscambia		Geneva	Grady	Houston
Monroe	Thomas	Washington	Wilcox		

CALIFORNIA

Coastal counties

Alameda	Contra Costa	Del Norte	Humbolt	Los Angeles	Marin
Mendocino	Monterey	Napa	Orange	Sacremento	San Diego
San Francisco	San Joaquin	San Luis Obispo	San Mateo	Santa Barbara	Santa Clara
Santa Cruz	Solano	Sonoma	Ventura		

Noncoastal counties in EDAs

Placer	San Benito	San Bernardino	Siskiyo	Sutter	Trinity
Yolo					

CONNECTICUT

Coastal counties

Fairfield	Middlesex	New Haven	New London

Noncoastal counties in EDAs

Hartford	Litchfield	Tolland	Windham

DELAWARE

Coastal counties

Kent	New Castle	Sussex

FLORIDA

Coastal counties

Alachua	Baker	Bay	Bradford	Brevard	Broward
Calhoun	Charlotte	Citrus	Clay	Collier	Columbia
Dade	De Soto	Dixie	Duval	Escambia	Flagler
Franklin	Gadsden	Gilchrist	Glades	Gulf	Hamilton
Hardee	Hendry	Hernando	Highlands	Hillsborough	Holmes
Indian River	Jackson	Jefferson	Lafayette	Lake	Lee
Leon	Levy	Liberty	Madison	Manatee	Marion
Martin	Monroe	Nassau	Okaloosa	Okeechobee	Orange
Osceola	Palm Beach	Pasco	Pinellas	Polk	Putnam
St. Johns	St. Lucie	Santa Rosa	Sarasota	Seminole	Sumter
Suwannee	Taylor	Union	Volusia	Wakulla	Walton
Washington					

GEORGIA

Coastal counties

Bryan	Camden	Chatham	Glynn	Liberty	McIntosh

Noncoastal counties in EDAs

Appling	Atkinson	Bacon	Ben Hill	Brantley	Bullock
Charlton	Clinch	Coffee	Effingham	Emanuel	Evans (city)
Irwin	Jeff Davis	Jenkins	Long	Montgomery	Pierce
Screven	Tattnall	Toombs	Ware	Wayne	

LOUISIANA

Coastal counties

Acadia	Ascension	Assumption	Calcasieu	Cameron	East Baton Rouge
Iberia	Iberville	Jefferson	Jefferson Davis	Lafourche	Livingston
Orleans	Plaquemines	St. Bernard	St. Charles	St. James	St. John the Baptist
St Martin	St. Mary	St. Tammany	Tangipahoa	Terrebonne	Vermilion
West Baton Rouge					

Noncoastal counties in EDAs

Allen	Avoyelles	Beauregard	East Feliciana	Evangeline	Lafayette
Pointe Coupee	Rapides	Sabine	St. Helena	St. Landry	Vernon
Washington					

MAINE

Coastal counties

Cumberland	Hancock	Knox	Lincoln	Sagadahoc	Waldo
Washington	York				

Noncoastal counties in EDAs

Androscoggin	Aroostook	Franklin	Kennebec	Oxford	Penobscot
Piscataquis	Somerset				

MARYLAND

Coastal counties

Anne Arundel	Baltimore	Baltimore City	Calvert	Caroline	Cecil
Charles	Dorchester	Harford	Kent	Prince Georges	Queen Anne's
St. Mary's	Somerset	Talbot	Wicomico	Worcester	

Noncoastal counties in EDAs

Caroline	Howard	Montgomery

MASSACHUSETTS

Coastal counties

Barnstable	Bristol	Dukes	Essex	Middlesex	Nantucket
Norfolk	Plymouth	Suffolk			

Noncoastal counties in EDAs

Berkshire	Hampden	Worcester

MISSISSIPPI

Coastal counties

Hancock	Harrison	Jackson

Noncoastal counties in EDAs

Amite	Franklin	George	Greene	Lamar	Lincoln
Marion	Pearl River	Perry	Pike	Stone	Walthall
Wayne	Wilkinson				

NEW HAMPSHIRE

Coastal counties

Rockingham	Strafford

Noncoastal counties in EDAs

Belknap	Carroll	Coos	Grafton	Hillsborough	Merrimack

NEW JERSEY

Coastal counties

Atlantic	Bergen	Burlington	Camden	Cape May	Cumberland
Essex	Gloucester	Hudson	Mercer	Middlesex	Monmouth
Ocean	Passaic	Salem	Somerset	Union	

Noncoastal counties in EDAs *New Jersey Continued*

Hunterdon	Morris	Sussex

NEW YORK

Coastal counties

Albany	Bronx	Columbia	Dutchess	Greene	Kings
Nassau	New York	Orange	Putnam	Queens	Rensselaer
Richmond	Rockland	Suffolk	Ulster	Westchester	

Noncoastal counties in EDAs

Schenectady	Schohare	Sullivan

NORTH CAROLINA

Coastal counties

Beaufort	Bertie	Brunswick	Camden	Carteret	Chowan
Craven	Currituck	Dare	Gates	Hertford	Hyde
New Hanover	Onslow	Pamlico	Pasquotank	Pender	Perquimans
Tyrrell	Washington				

Noncoastal counties in EDAs

Anson	Bladen	Columbus	Cumberland	Duplin (city)	Edgecombe
Greene	Harnett	Johnson	Jones	Lenoir	Martin
Nash	Pitt	Richmond	Robeson	Scotland	Union
Wake (city)	Wayne	Wilson			

OREGON

Coastal counties

Clatsop	Columbia	Coos	Curry	Douglas	Lane
Lincoln	Multnomah	Tillamook			

Noncoastal counties in EDAs

Clackamas	Josephine	Washington

PENNSLYVANIA

Coastal counties

Bucks	Delaware	Philadelphia

Noncoastal counties in EDAs

Chester	Lancaster	Montgomery

RHODE ISLAND

Coastal counties

Bristol	Kent	Newport	Providence	Washington

SOUTH CAROLINA

Coastal counties

Beaufort	Berkeley	Charleston	Colleton	Dorchester	Georgetown
Horry	Jasper	Williamsburg			

Noncoastal counties in EDAs

Bamberg	Berkeley	Chesterfield	Clarendon	Darlington	Dillon
Florence	Hampton	Kershaw	Lancaster	Lee	Marion
Marlboro	Orangeburg	Sumter			

TEXAS

Coastal counties

Aransas	Brazoria	Calhoun	Cameron	Chambers	Galveston
Harris	Jackson	Jefferson	Kenedy	Kleberg	Matagorda
Nueces	Orange	Refugio	San Patricio	Victoria	Wharton
Willacy					

Noncoastal counties in EDAs

Angelina	Austin	Bee	Brooks	Colorado	De Witt
Duval	Fort Bend	Goliad	Gonzales	Hardin	Hidalgo
Jim Hogg	Jim Wells	Jasper	Karnes	Lavaca	Liberty
Live Oak	McMullen	Newton	San Jacinto	Starr	Tyler
Waller	Washington	Webb			

VIRGINIA

Coastal counties

Accomack	Alexandria	Arlington	Caroline	Charles City	Chesapeake
Chesterfield	Colonial Heights	Essex	Fairfax	Fairfax City	Falls Church
Fredericksburg	Gloucester	Hampton	Hanover	Henrico	Hopewell

Coastal counties of Virginia continued

Isle of Wight	James City	King and Queen	King George	King William	Lancaster
Manassas	Manassas Park	Mathews	Middlesex	New Kent	Newport News
Norfolk	Northhampton	Northumberland	Petersburg	Poquoson	Portsmouth
Prince George	Prince William	Richmond	Richmond (city)	Spotsylvania	Stafford
Suffolk	Surry	Virginia Beach	Westmoreland	Williamsburg	York

Noncoastal counties in EDAs

Albemarle	Amelia	Appomattox	Buckingham	Cumberland	Dinwiddie
Fauquier	Fluvanna	Goochland	Loudon	Louisa	Nottoway
Orange	Powhatan	Prince Edward	Southampton		

WASHINGTON

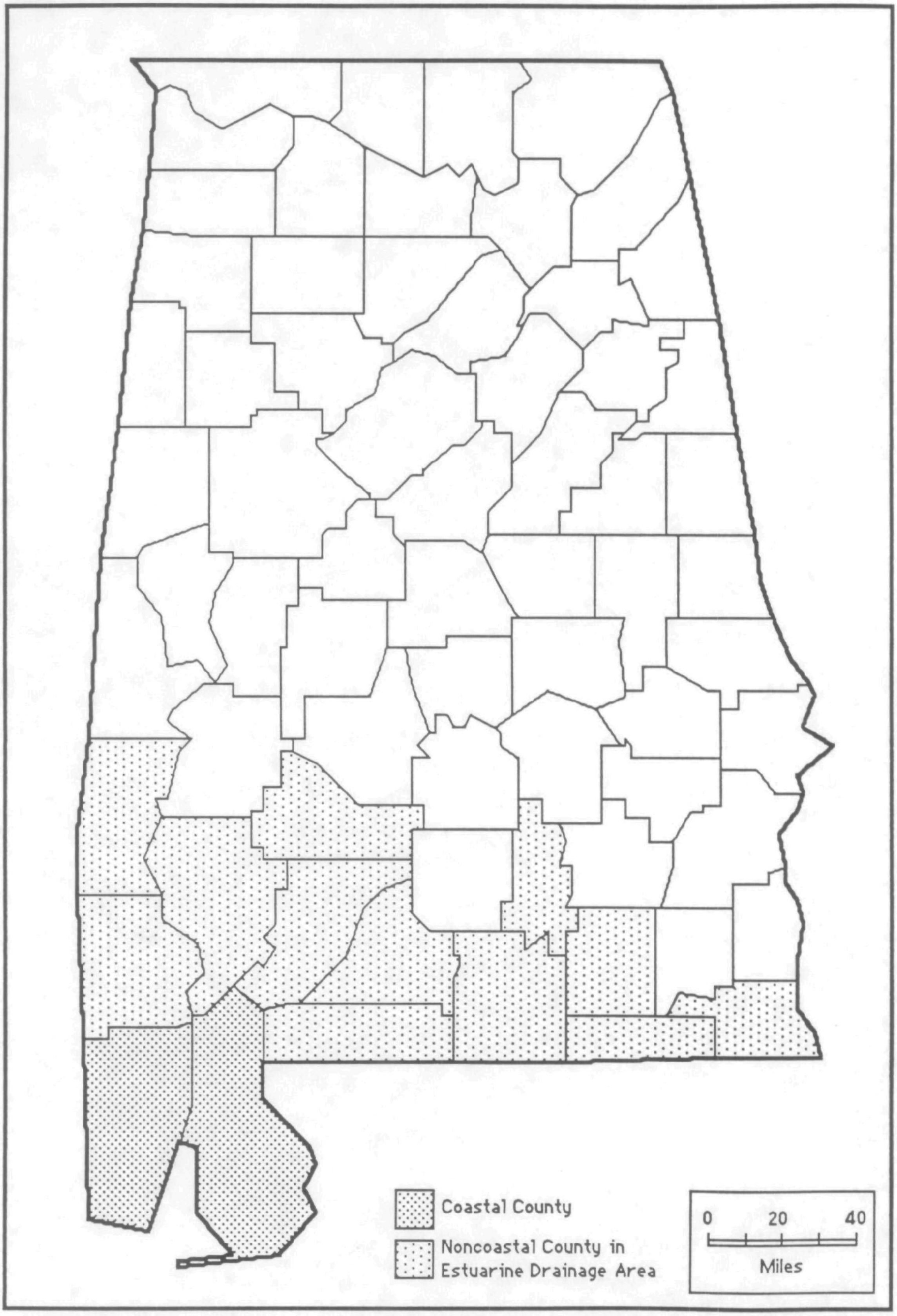
Coastal counties

Clallam	Clark	Cowlitz	Gray's Harbor	Island	Jefferson
King	Kitsap	Mason	Pacific	Pierce	San Juan
Skagit	Snohomish	Thurston	Wahkiakum	Whatcom	

Noncoastal counties in EDAs

Lewis	Skamania

Alabama

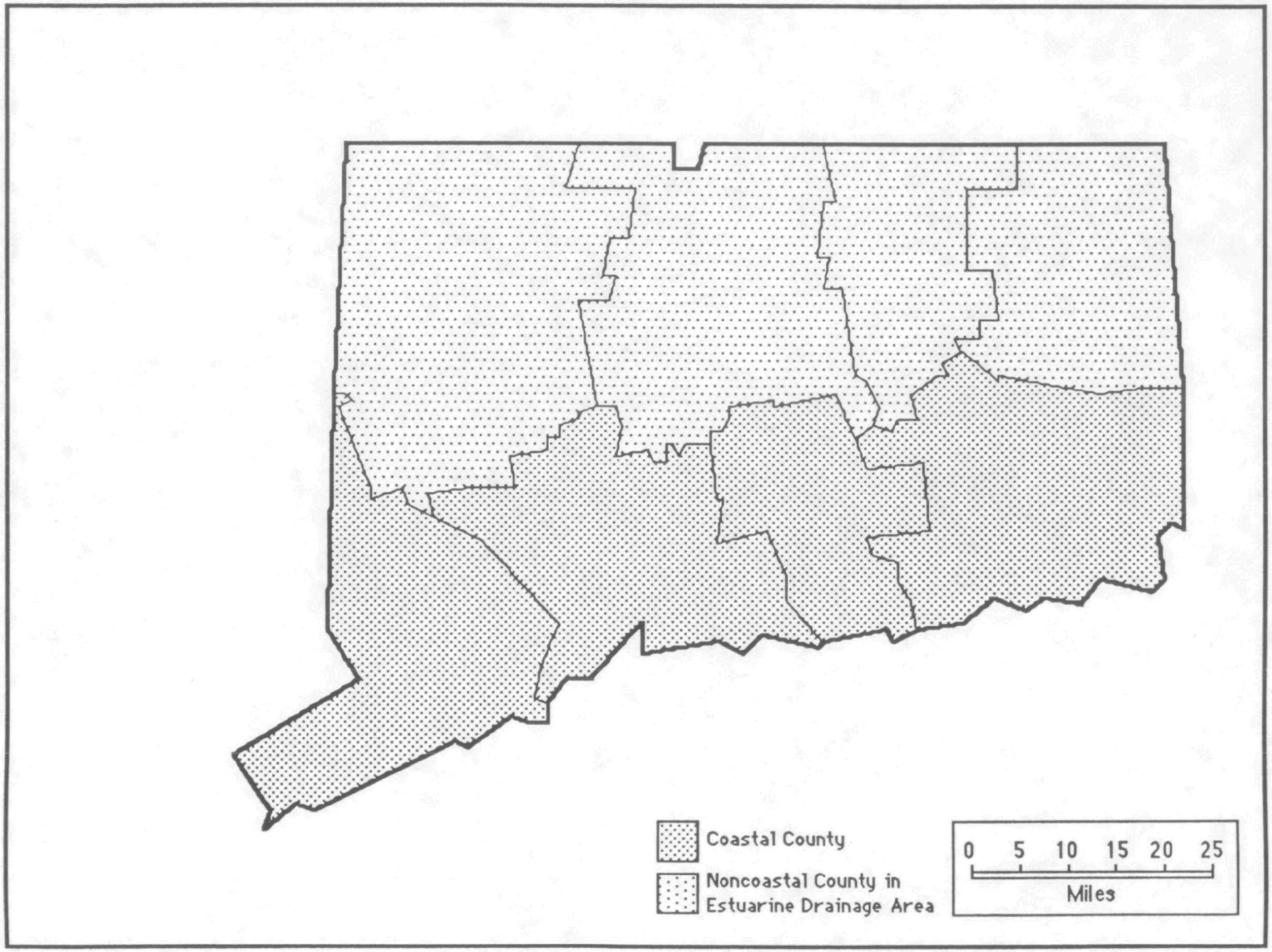


Coastal County
Noncoastal County in
Estuarine Drainage Area
0
20
40
Miles

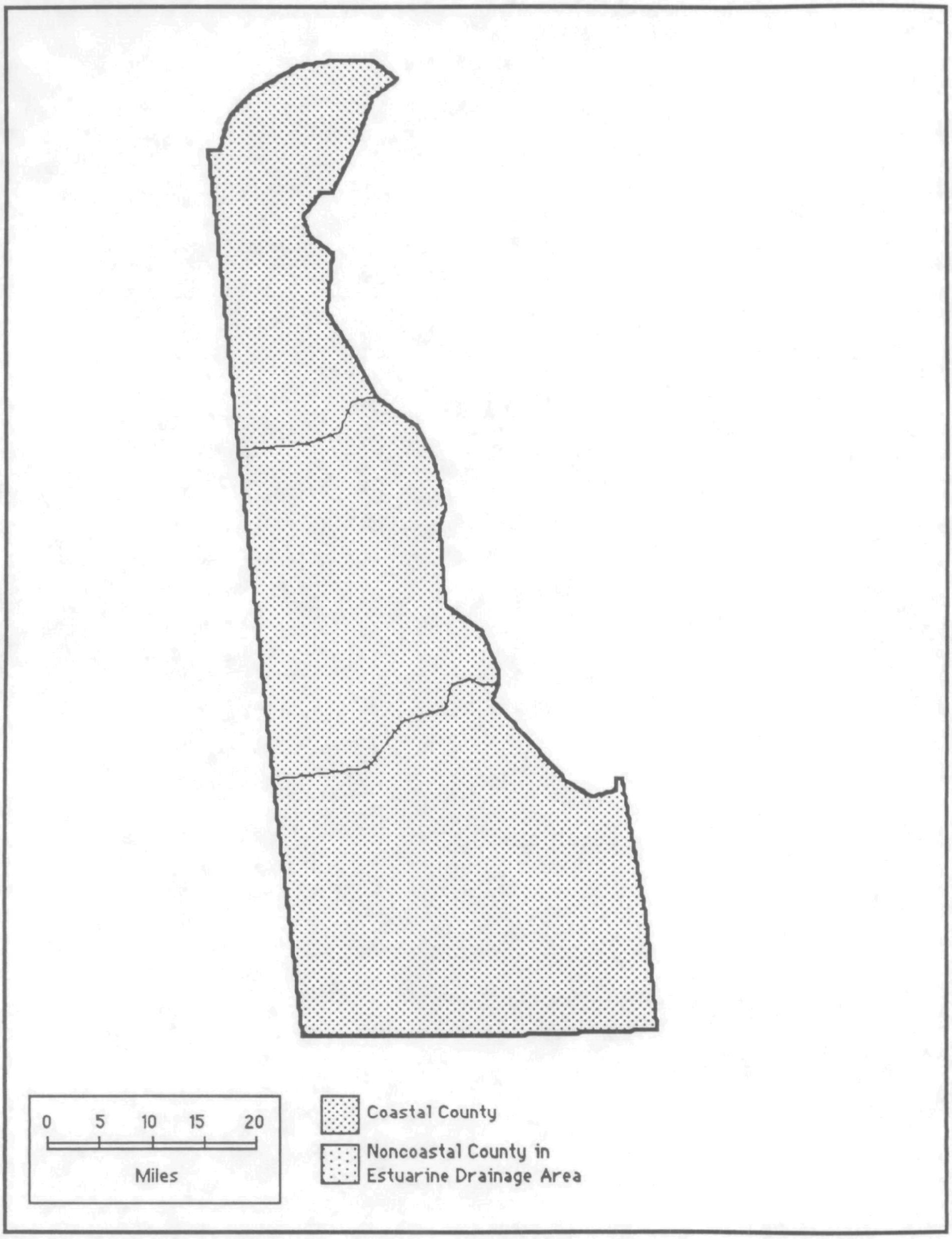
California


Coastal County
Noncoastal County in
Estuarine Drainage Area
0
50
100
150
200
Miles

Connecticut



Delaware



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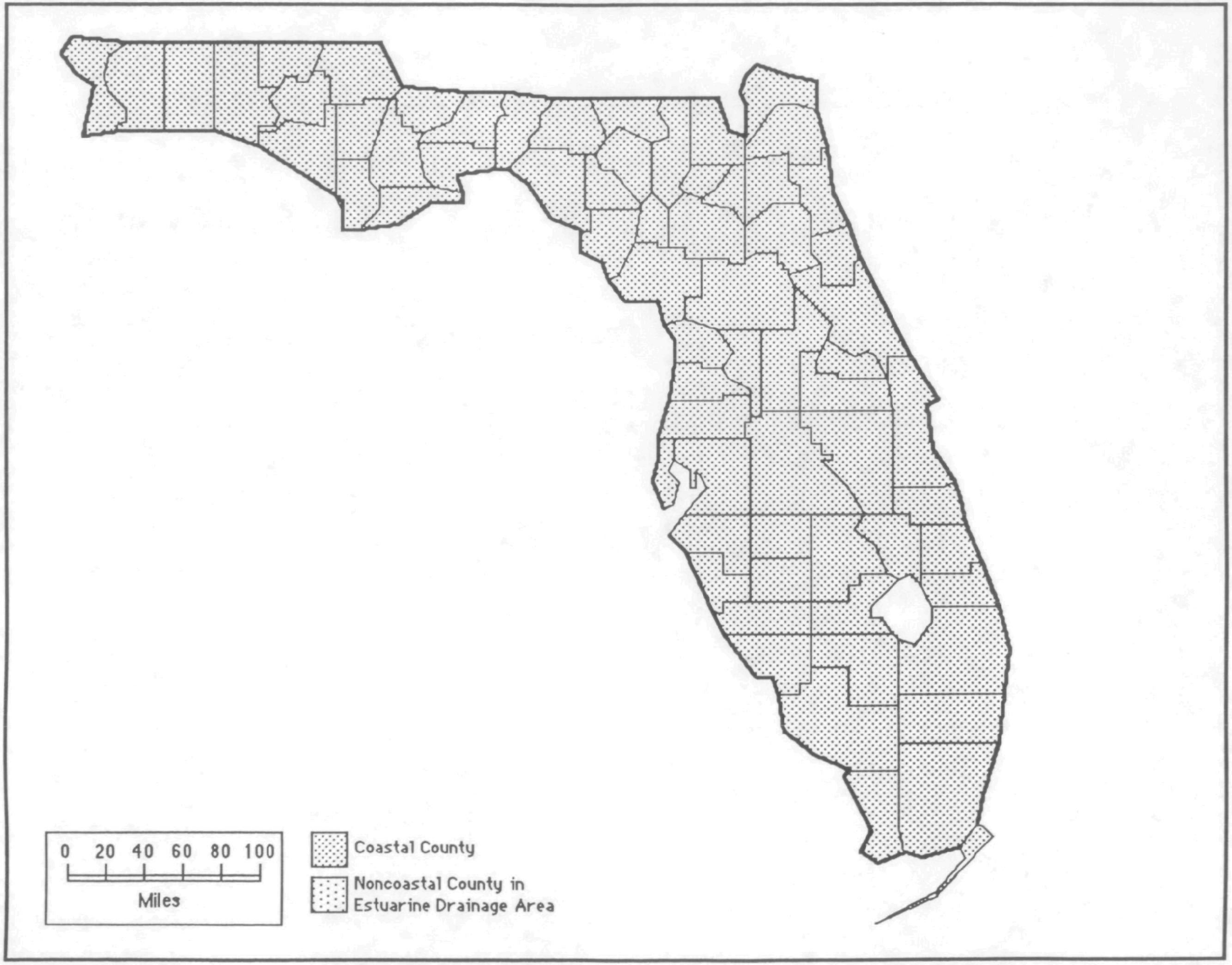
Miles
Coastal County
Noncoastal County in
Estuarine Drainage Area

Florida



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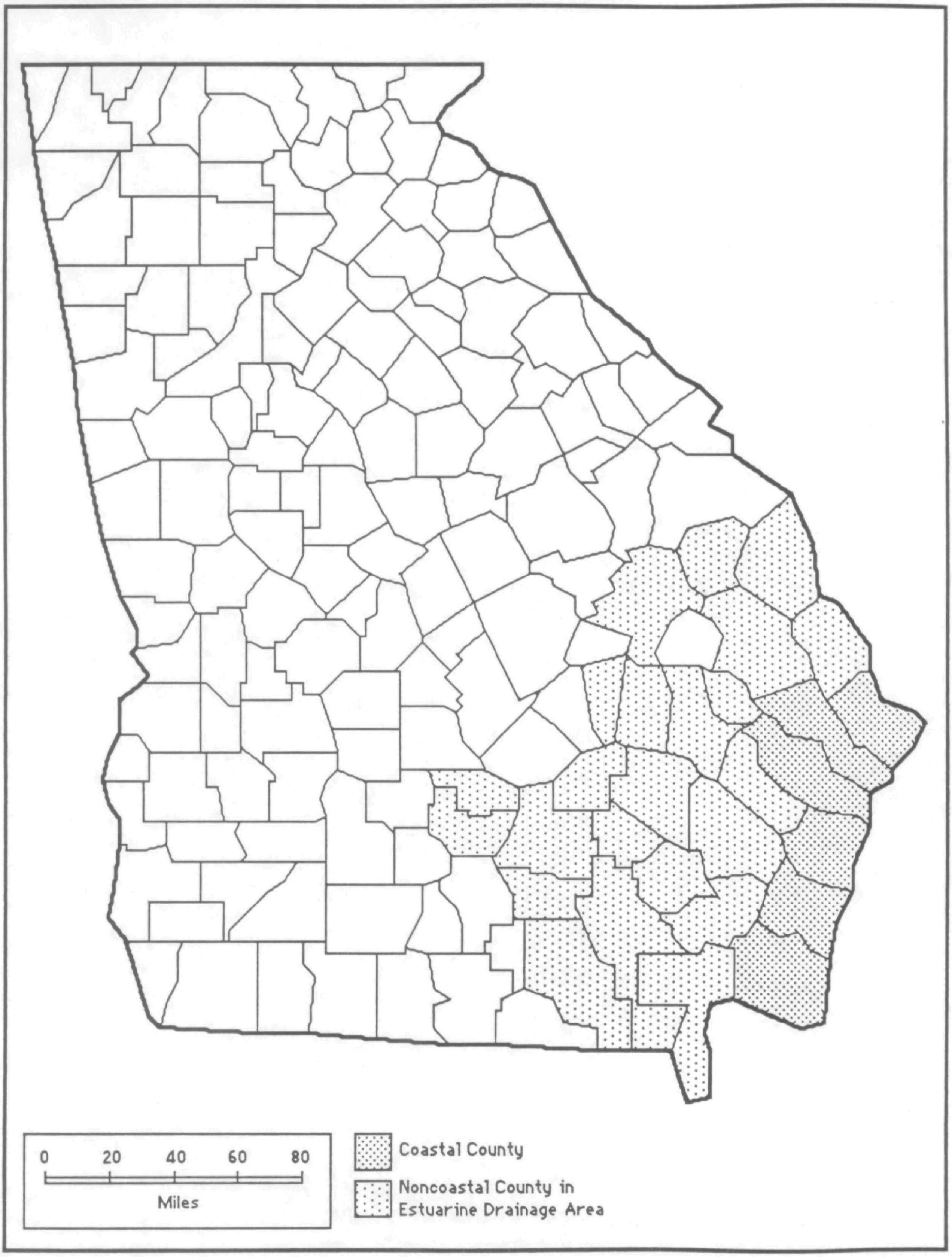
Miles
Coastal County
Noncoastal County in
Estuarine Drainage Area

Georgia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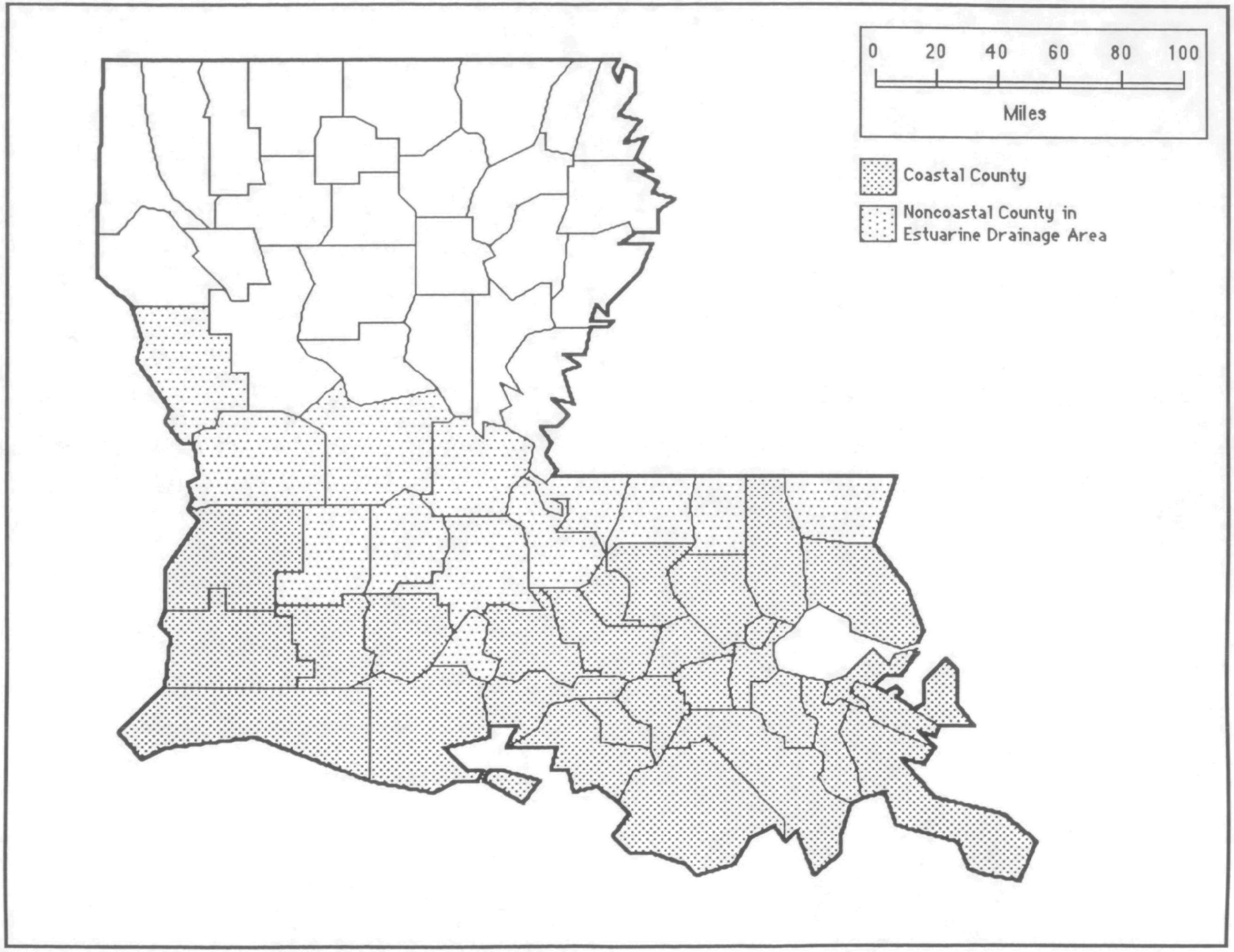
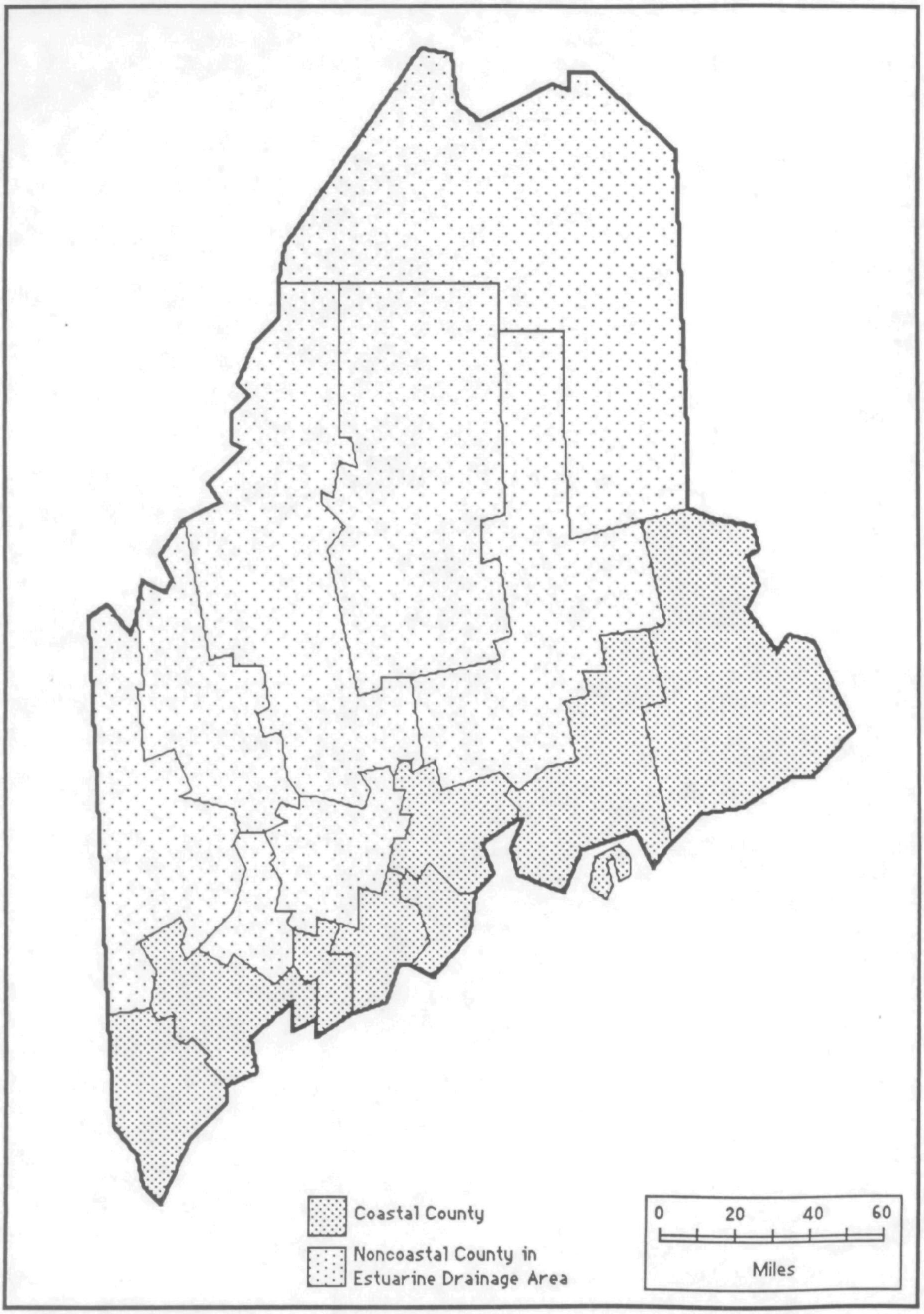
Miles
Coastal County
Noncoastal County in Estuarine Drainage Area

Louisiana



0 20 40 60 80 100
Miles
Coastal County
Noncoastal County in
Estuarine Drainage Area

Maine



Coastal County
Noncoastal County in
Estuarine Drainage Area
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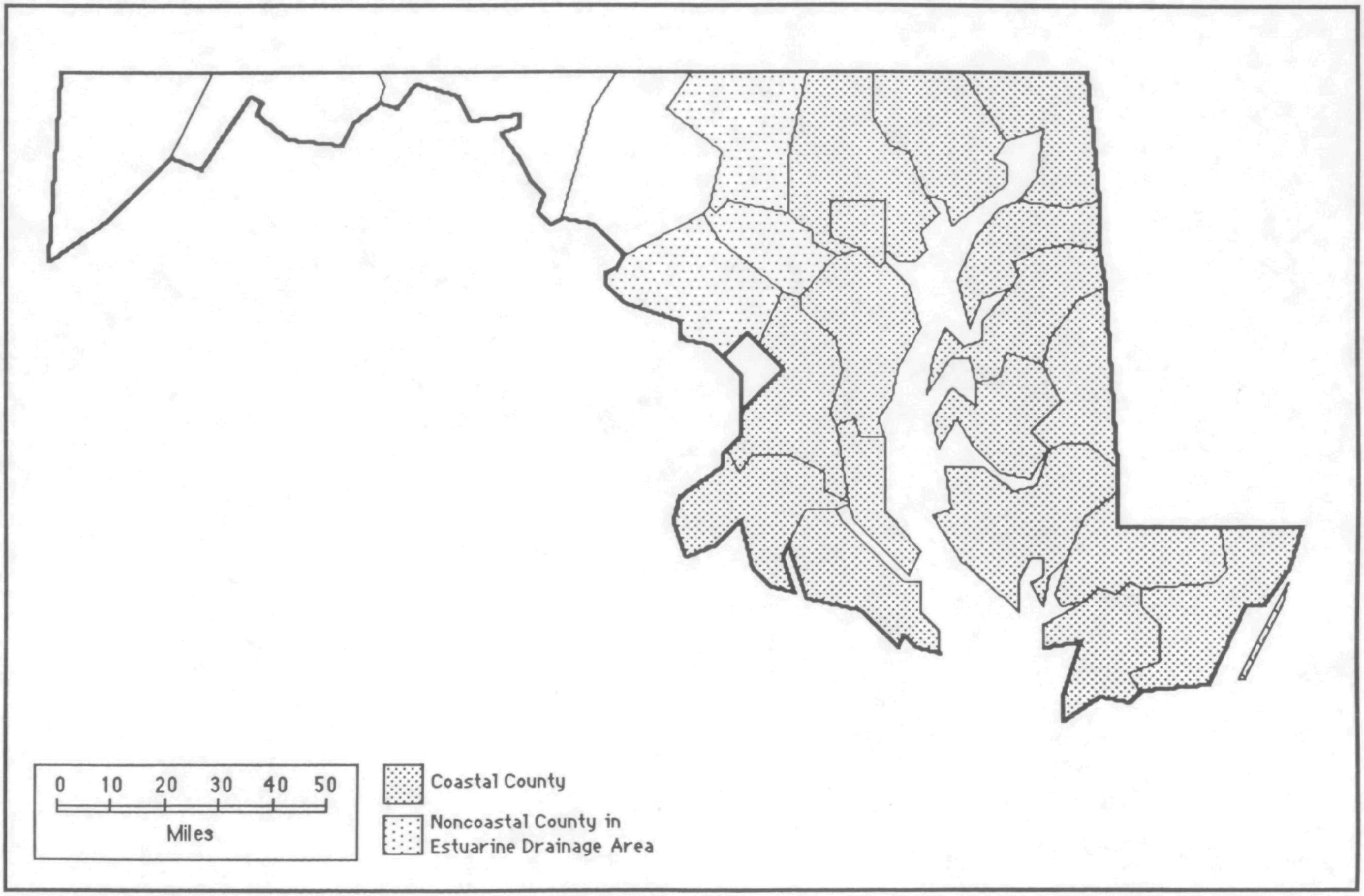
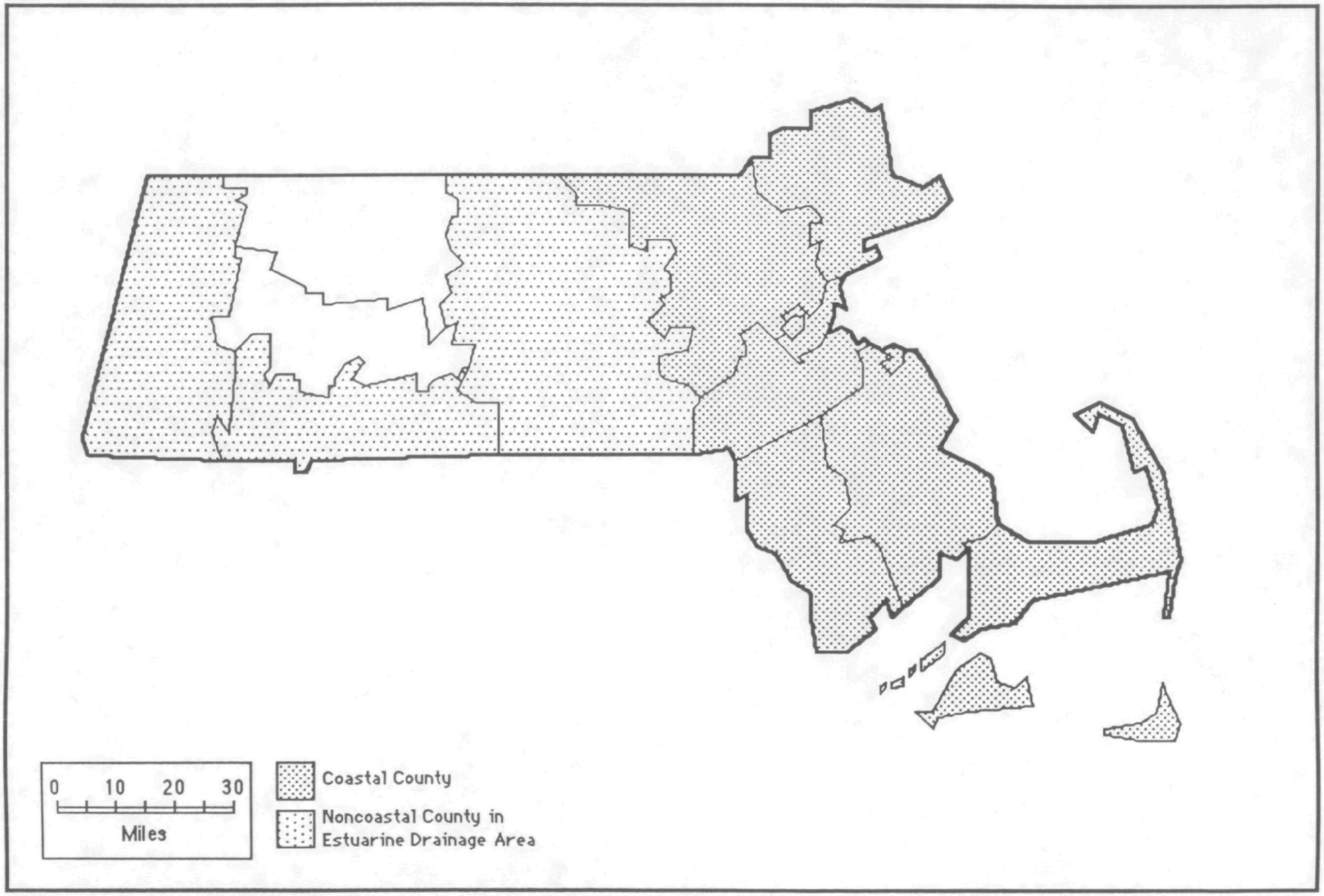
60
Miles

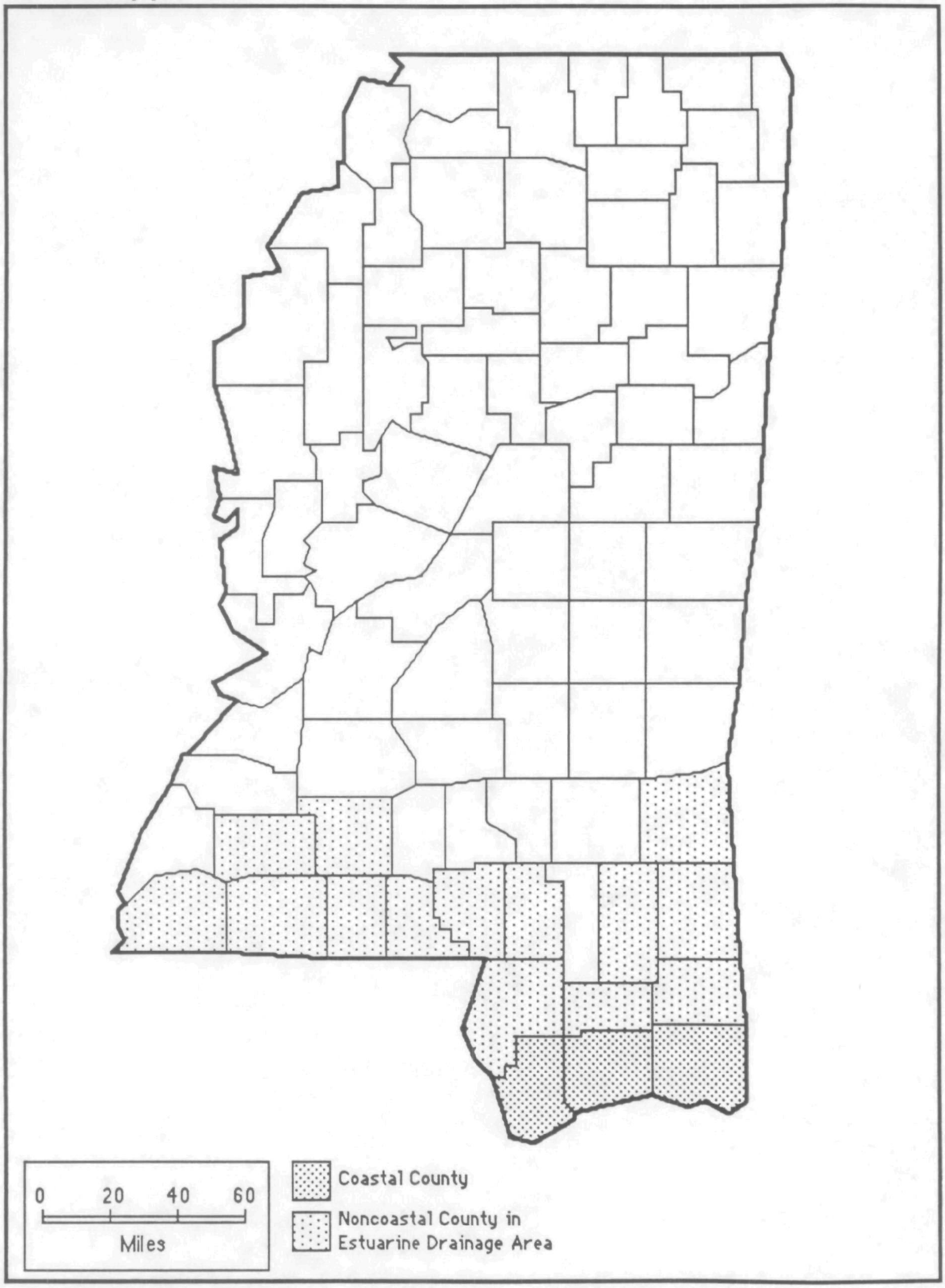
Maryland


0 10 20 30 40 50
Miles
Coastal County
Noncoastal County in Estuarine Drainage Area

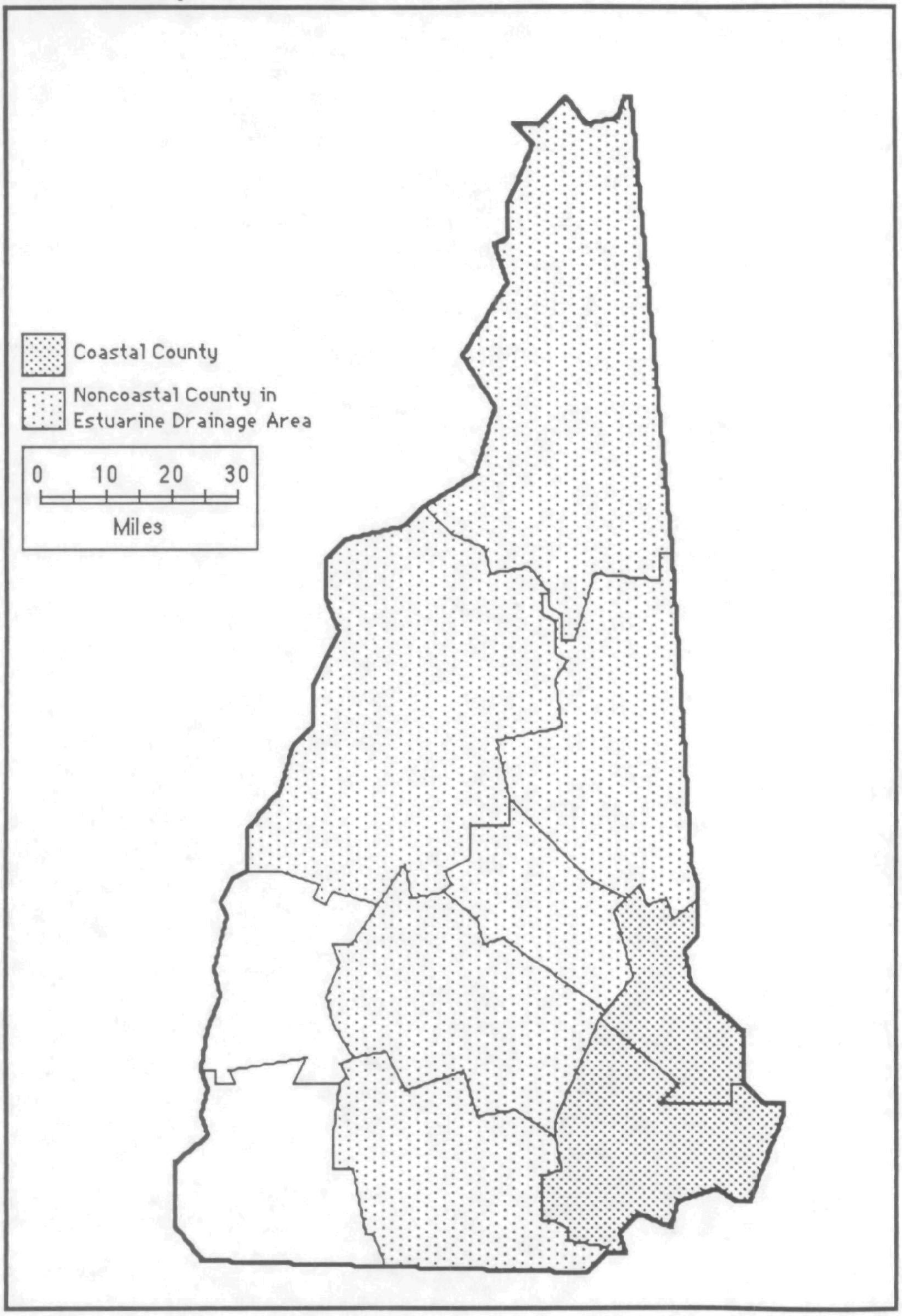
Massachusetts



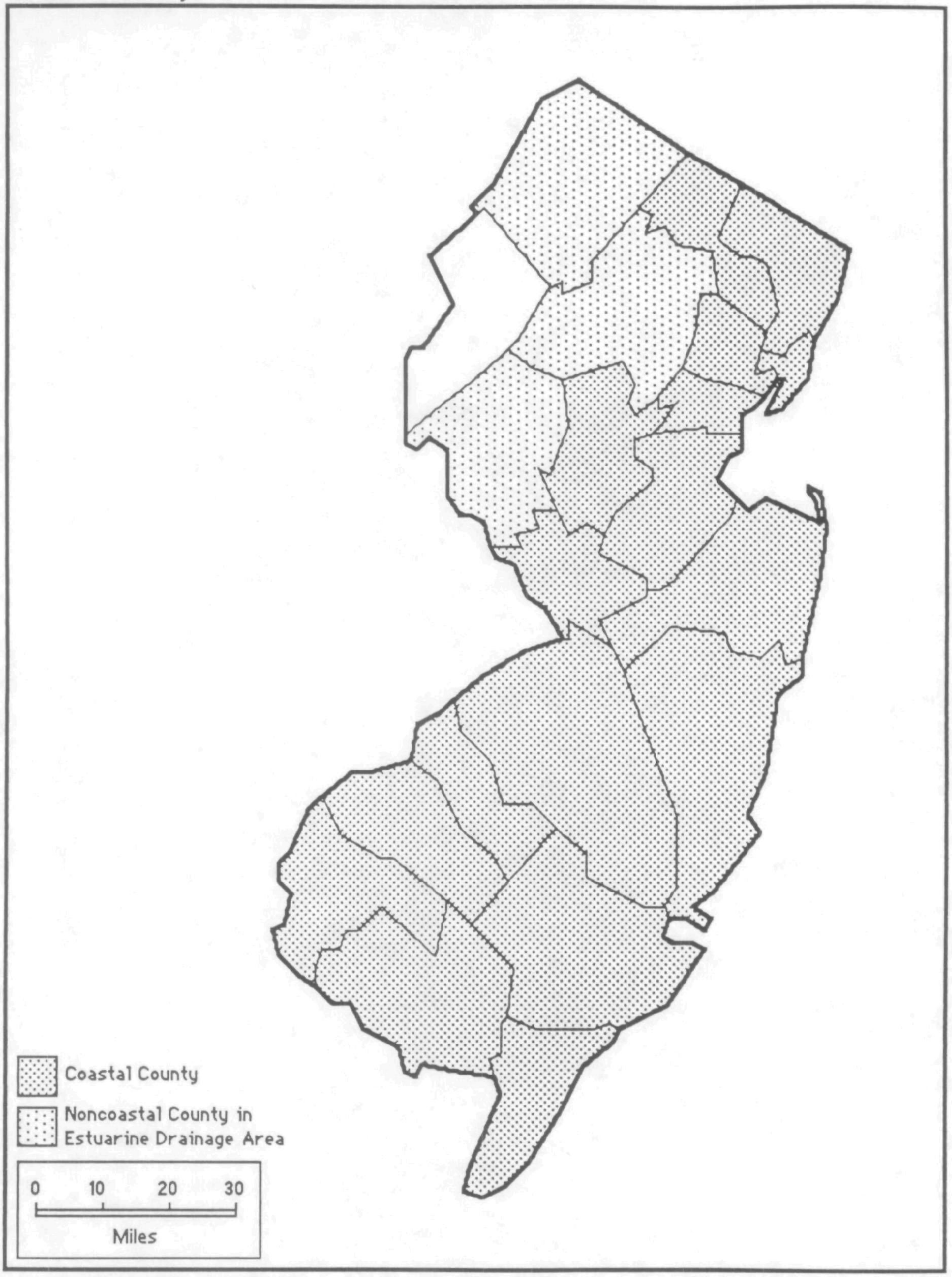
Mississippi



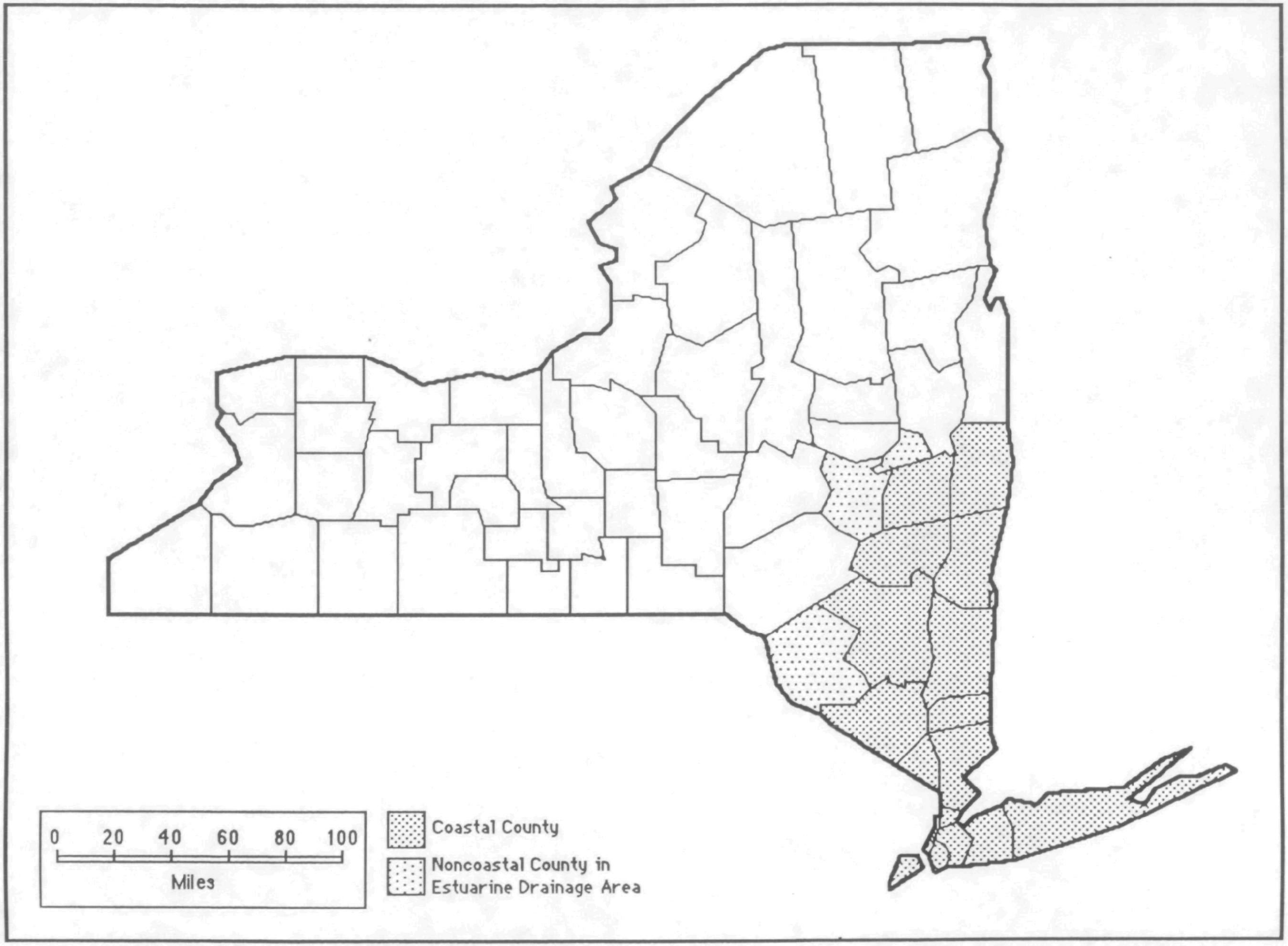
New Hampshire



New Jersey

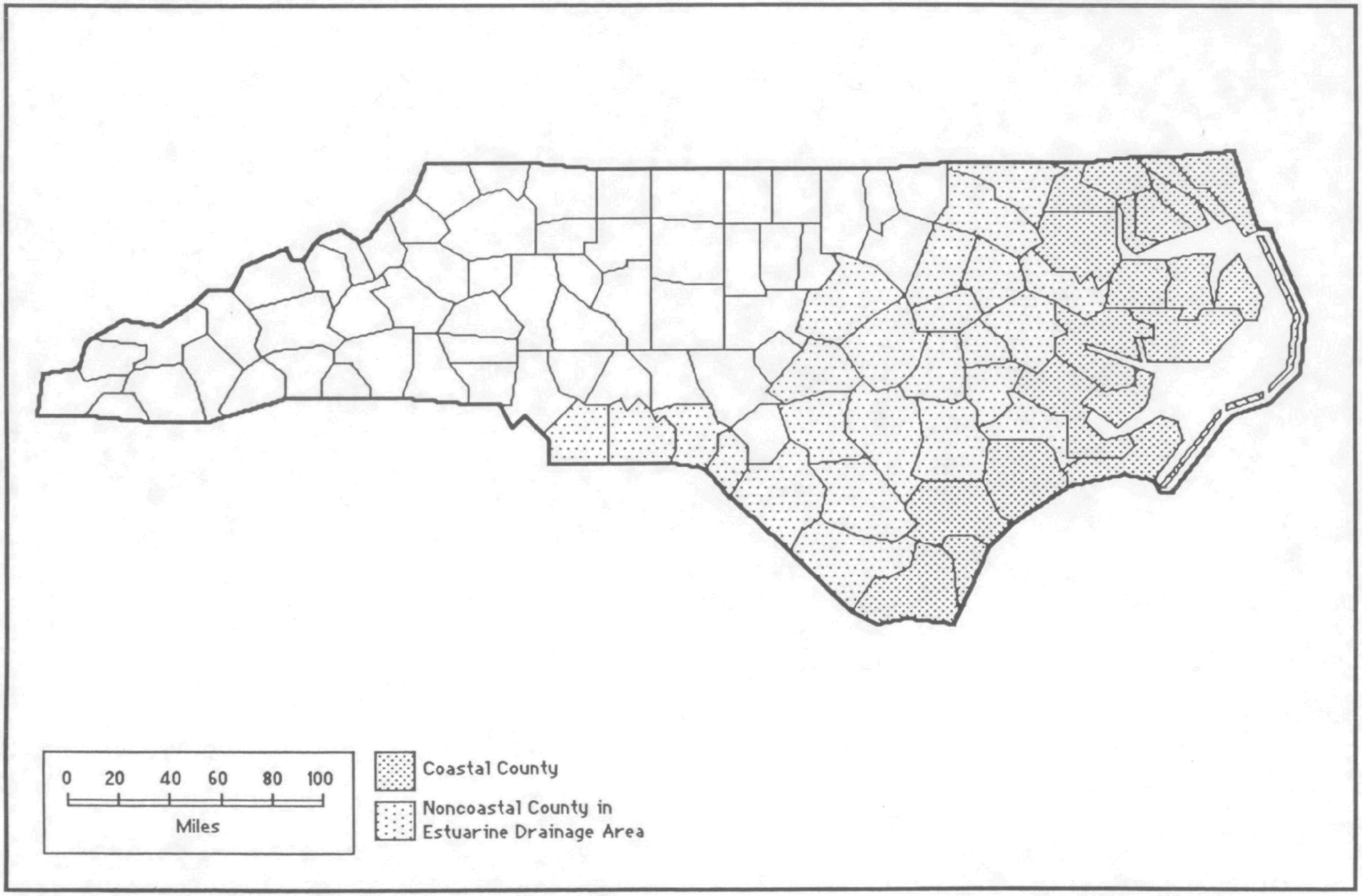

Coastal County
Noncoastal County in
Estuarine Drainage Area
0
10
20
30
Miles

New York

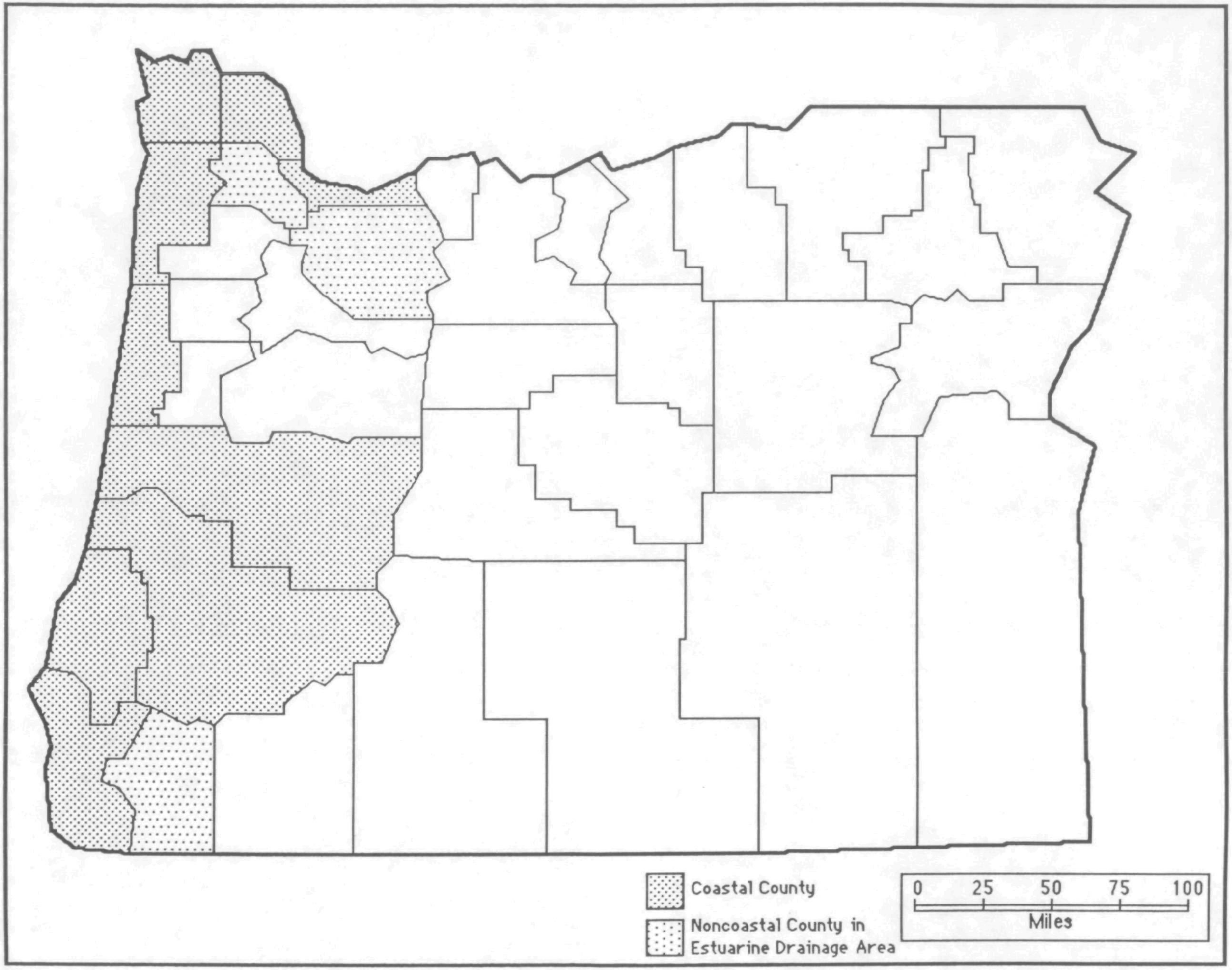


0 20 40 60 80 100
Miles
Coastal County
Noncoastal County in
Estuarine Drainage Area

North Carolina

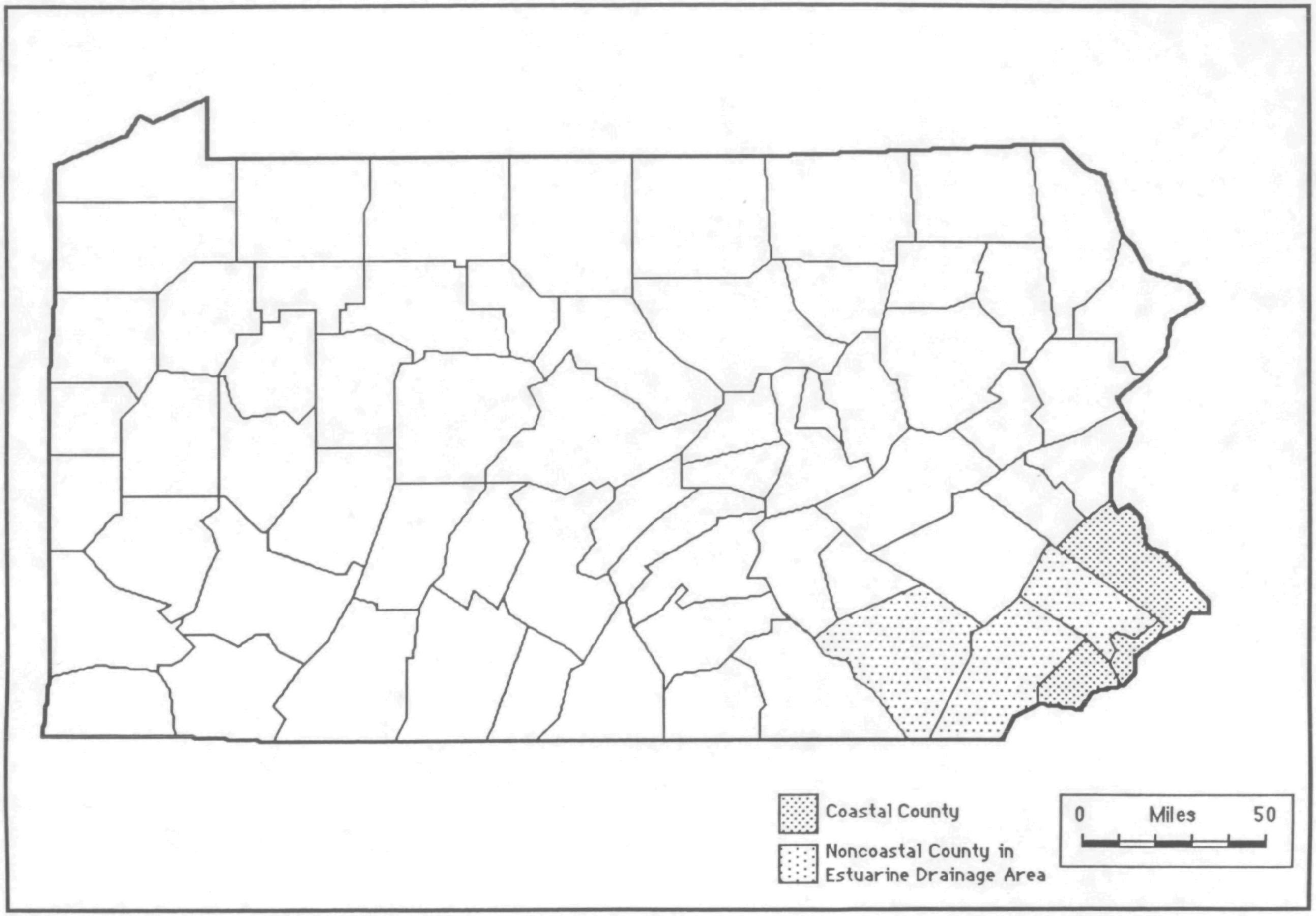


Oregon

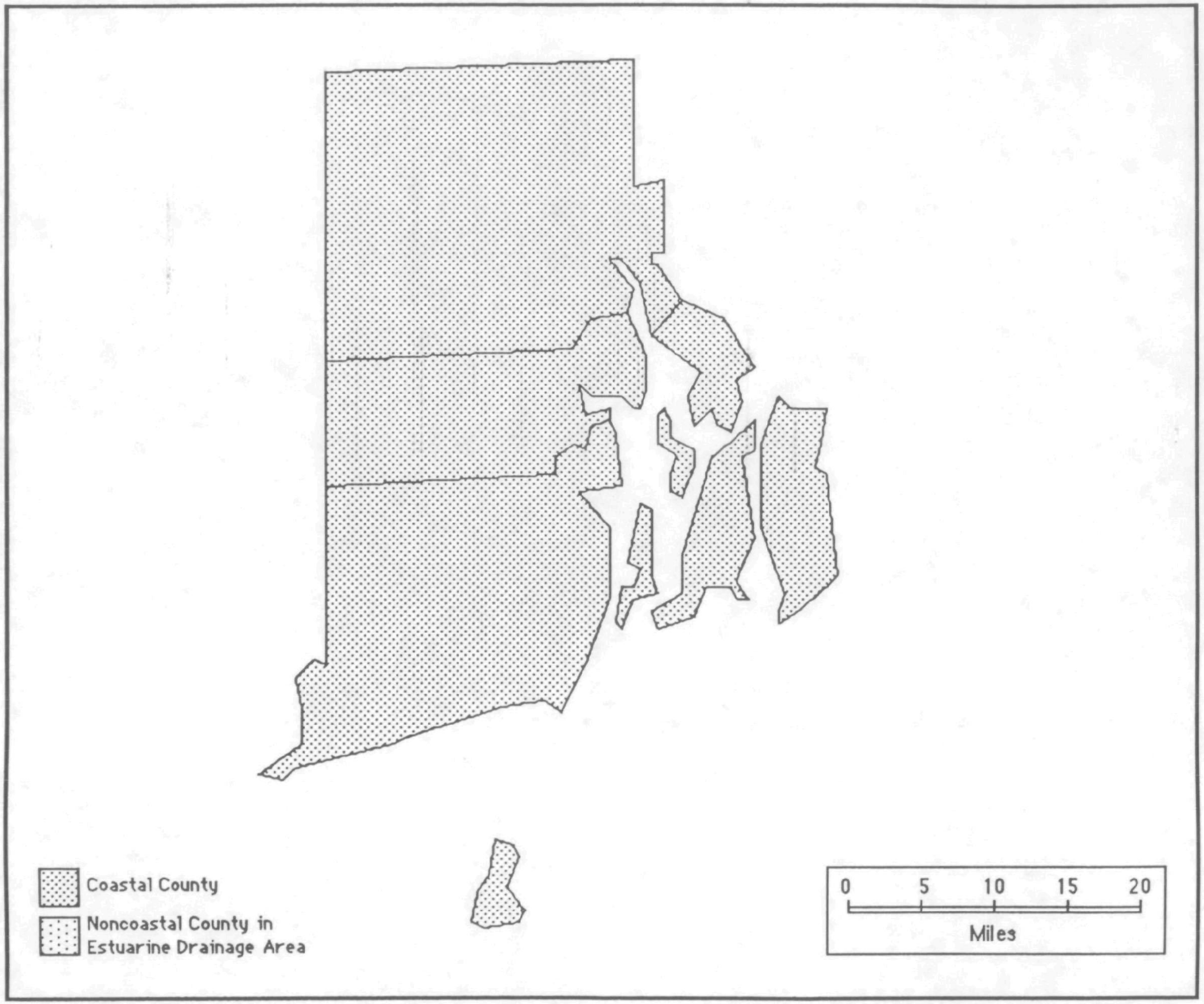


Coastal County
Noncoastal County in Estuarine Drainage Area
0
25
50
75
100
Miles

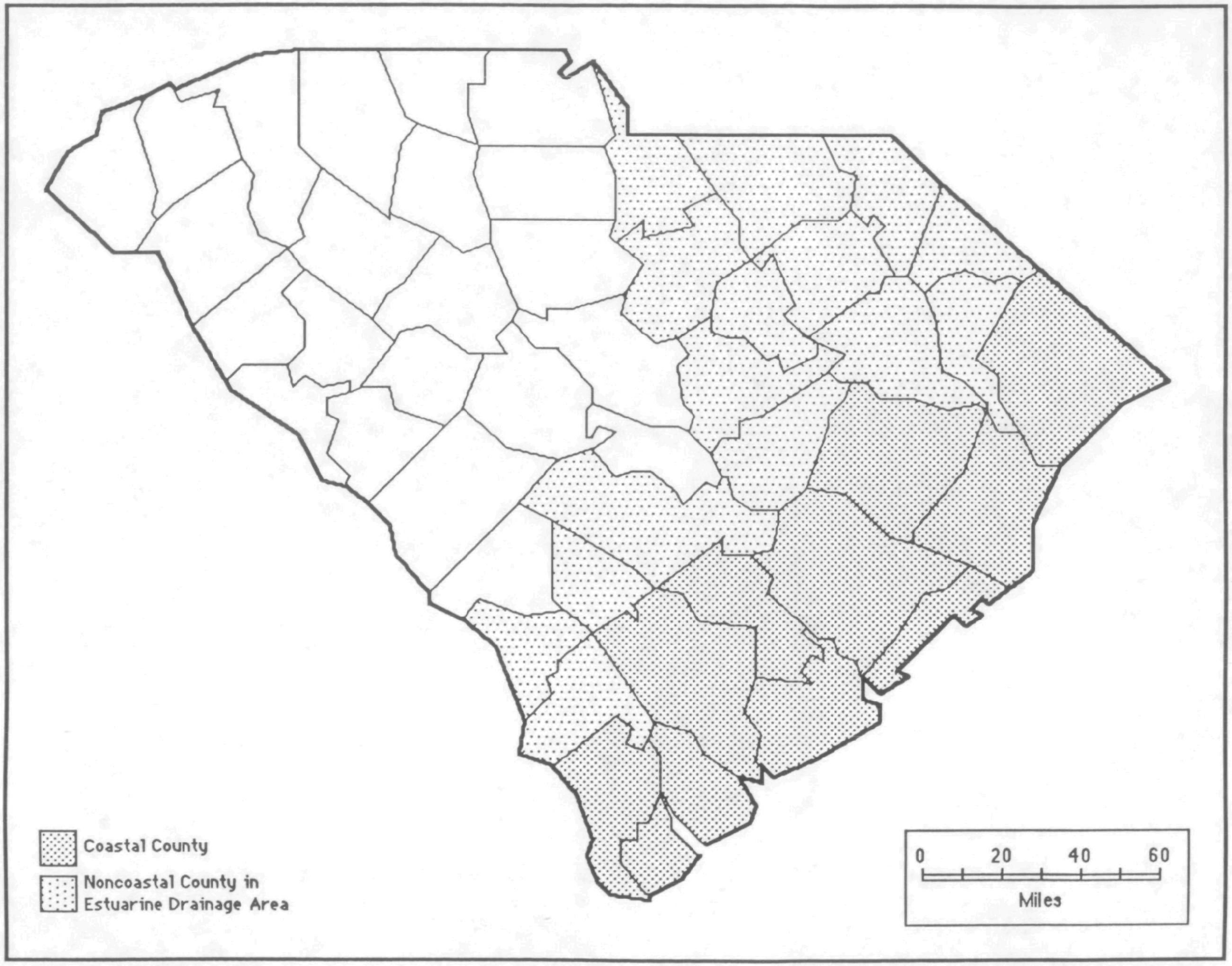
Pennsylvania



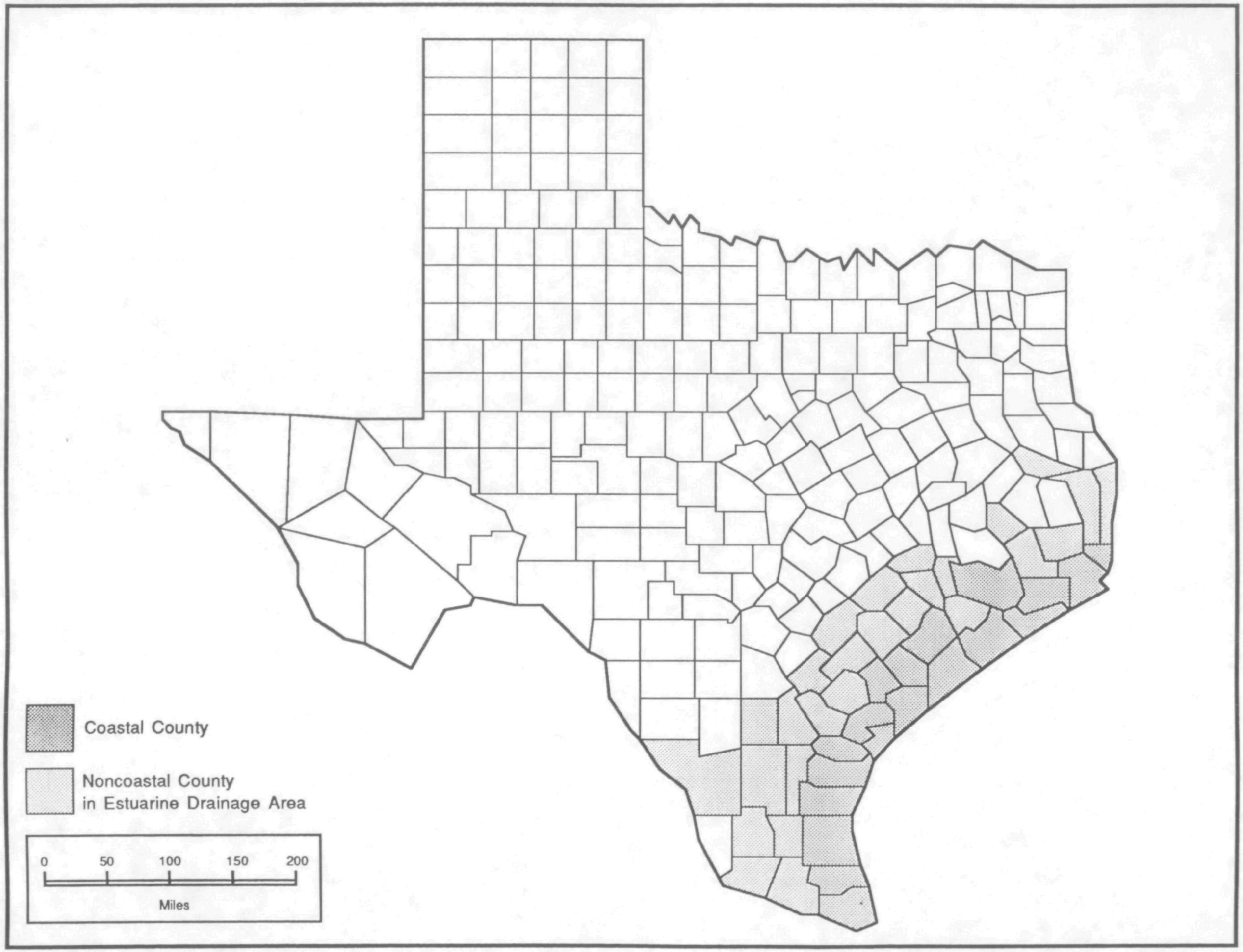
Rhode Island



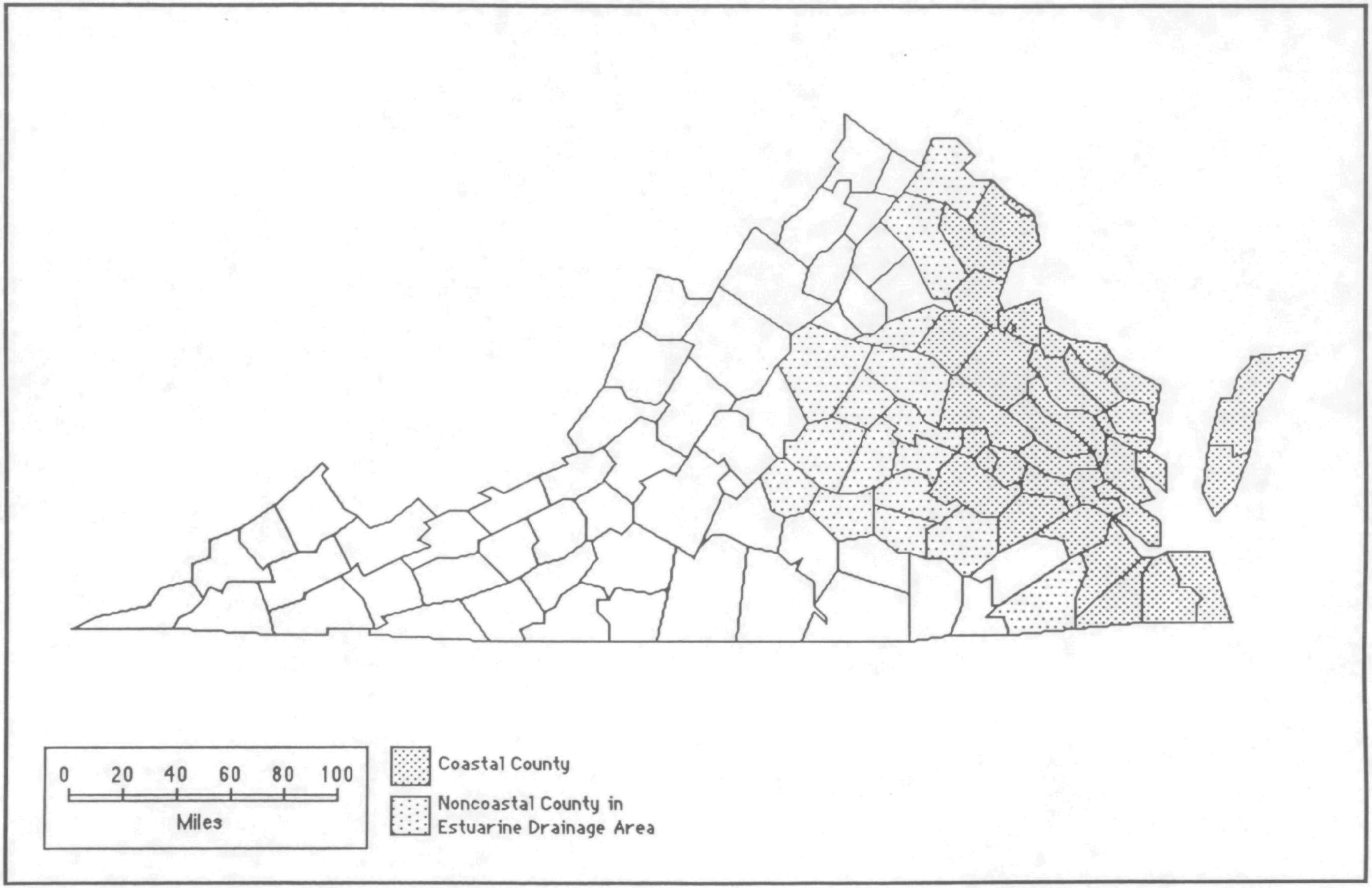
South Carolina



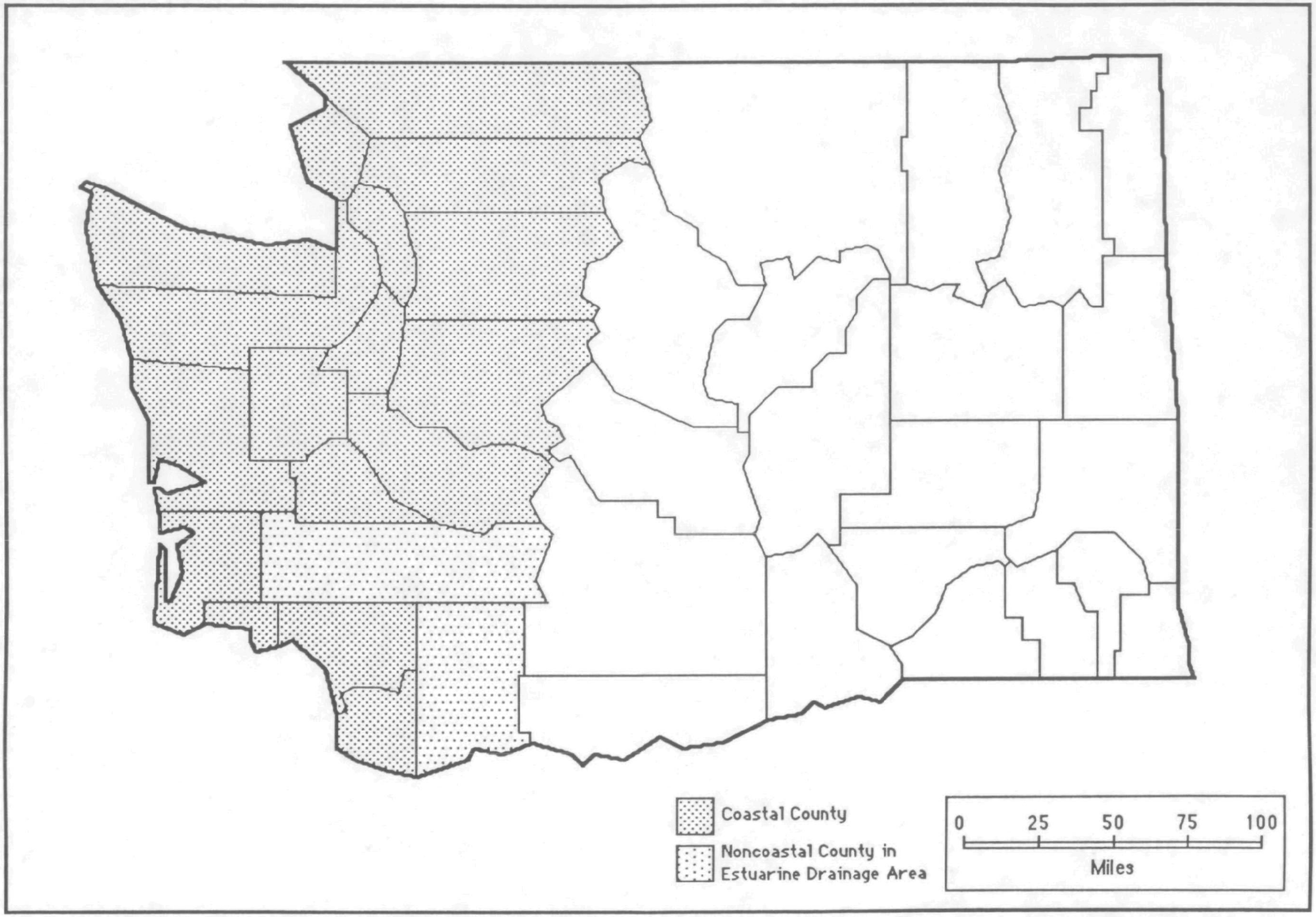
Texas


Coastal County
Noncoastal County
in Estuarine Drainage Area
0
50
100
150
200
Miles

Virginia


0 20 40 60 80 100
Miles
Coastal County
Noncoastal County in
Estuarine Drainage Area

Washington


Coastal County
Noncoastal County in
Estuarine Drainage Area
0 25 50 75 100
Miles

ESTUARINE DRAINAGE AREAS

Estuarine Drainage Areas

Passamaquoddy Bay

01050001 St. Croix , MN
01050002 Maine Coastal, MN

Englishman Bay

01050002 Maine Coastal, MN

Narragaugus Bay

01050002 Maine Coastal, MN

Blue Hill Bay

01050002 Maine Coastal, MN

Penobscot Bay

01050002 Maine Coastal, MN
01020005 Lower Penobscot, MN

Muscongus Bay

01050003 St. George-Sheepscot, MN
01050002 Maine Coastal, MN

Sheepscot Bay

01050003 St. George-Sheepscot, MN
01030003 St. George-Sheepscot, MN
01040002 Lower Androscoggin, MN/NH

Casco Bay

01060001 Presumpscot, MN

Saco Bay

01060001 Presumpscot, MN
01060002 Saco, MN/NH

Great Bay

01060003 Piscataqua-Salmon Falls,MN, NH, MA

Merrimack River

01070002 Merrimack, MA/NH

Boston Bay

01090001 Charles, MA

Cape Cod

01090002 Cape Cod, MA/RI

Buzzards Bay

01090002 Cape Cod, MA/RI

Narragansett Bay

01090004 Narragansett, MA/RI

Gardiners Bay

02030202 Southern Long Island, NY

Long Island Sound

02030201 Northern Long Island, NY
02030202 Southern Long Island, NY
02030102 Southern Long Island, NY
01100007 Long Island Sound, CT
01100006 Saugatuck, CT/NY
01100005 Housatonic, CT/MA/NY
01100004 Quinnipiac, CT
01080205 Lower Connecticut, CT/MA
01100002 Shetucket, CT/MA
01100003 Thames, CT

Connecticut River

01080205 Lower Connecticut, CT/MA

Great South Bay

02030202 Southern Long Island, NY

Hudson/Raritan

02030202 Southern Long Island, NY
02030201 Northern Long Island, NY
02030101 Northern Long Island, NY
02020008 Hudson-Wappinger, NY
02020006 Middle Hudson, MA/NY
02020007 Rondout, NJ/NY
02030103 Hackensack-Passai, NY/NJ
02030105 Raritan, NJ
02030104 Sandy Hook-Staten Island, NY/NJ

Barnegat Bay

02040301 Mullica-Toms, NJ

Delaware Bay

02040204 Delaware Bay, DL/NJ
02040207 Broadkill-Smyrna, DL
02040205 Brandywine-Christina, DL/MD/PA
02040202 Lower Delaware NJ/PA
02040201 Crosswicks-Nesahaminy, NJ/PA
02040202 Lower Delaware, NJ/PA
02040206 Cohansey-Maurice, NJ

Chincoteague

02060010	Chincoteague, MD/DI/VA

Chesapeake Bay

02070010	Middle Potomac-Anacostia-Occoquan, DC/MD/VA
02070011	Lower Potomac, MD/VA
02080104	Lower Rappahannock, VA
02080102	Great Wicomico-Piankatank, VA
02080101	Lower Chesapeake Bay, VA
02080109	Western Lower Delmarva, VA
02080105	Mattaponi, VA
02080106	Pamunkey, VA
02080107	York, VA
02080205	Middle James-Willis, VA
02080206	Lower James, VA
02080207	Appotamox, VA
02080208	Hampton Roads, VA
02080108	Lynnhaven-Poquoson, VA
02080101	Lower Chesapeake Bay, VA
02060006	Patuxent, MD
02060001	Upper Chesapeake Bay, MD
02060004	Severn, MD
02060005	Choptank, DL/MD
02060003	Gunpowder-Patapsco, MD/PA
02060002	Chester-Sassafras, DL/MD/PA
02060007	Blackwater-Wicomico, DL/MD
02060008	Nanticoke, DL/MD
02060009	Pocomoke, DL/MD/VA

Potomac River

02070010	Middle Potomac-Anacostia-Occoquan, DC/MD/VA
02070011	Lower Potomac, MD/VA

Rappahannock River

02080104	Lower Rappahannock, VA

York River

02080107	York,VA
02080106	Pamunkey,VA
02080105	Mattaponi, VA

James River

02080202	Maury, VA
02080206	Lower James, VA
02080207	Appotamox, VA
02080205	Middle James-Willis, VA

Albemarle Sound

03010203	Ghowan, NC/VA
03010107	Lower Roanoke, NC
03010205	Albemarle, NC/VA

Pamlico Sound

03020105	Pamlico Sound, NC
03020106	Bogue-Core Sounds, NC
03020104	Pamlico, NC
03020103	Lower Tar, NC
03020202	Middle Neuse, NC
03020204	Lower Neuse, NC
03010205	Albemarle, NC/VA

Pamlico and Pungo Rivers

03020104	Pamlico, NC
03020103	Lower Tar, NC

Neuse River

03020202	Middle Neuse, NC
03020204	Lower Neuse, NC

Bogue Sound

03020106	Bogue-Core Sounds, NC

New River

03030001	New, NC

Cape Fear River

03030006	Black, NC
03030007	Northeast Cape Fear, NC
03030005	Lower Cape Fear, NC

Winyah Bay

03040207	Carolina Coastal-Sampit, NC/SC
03040206	Waccamaw, NC/SC
03040201	Lower Pee Dee, NC/SC
03040205	Black, SC
03040202	Lynches, NC/SC
03040204	Little Pee Dee, NC/SC

Charleston Harbor

03050202	South Carolina Coastal, SC
03050201	Cooper SC

Santee River

03050112	Santee, SC

St. Helena Sound

03050205	Edisto, SC
03050208	Broad-St. Helena, GA

Broad River

03050208	Broad-St.Helena, GA/SC

Savannah Sound
03050208 Broad-St. Helena, GA/SC
03060109 Lower Savannah, GA/SC

Ossabaw Sound

03060204 Ogeechee Coastal, GA
03060202 Lower Ogeechee, GA

St. Catherines/Sapelo Sound

03060204 Ogeechee Coastal, GA

Altamaha River

03070106 Altamaha, GA

St. Andrew/St. Simon Sound

03070203 Cumberland-St. Simons, GA
03070201 Satilla, GA

St. Johns River

03080101 Upper St. Johns, FL
03080103 Lower St. Johns, FL

Indian River

03080203 Vero Beach, FL
03080202 Cape Canaveral, FL

Biscayne Bay

03090202 Everglades, FL

Ten Thousand Islands

03090202 Everglades, FL
03090204 Big Cypress Swamp, FL

Charlotte Harbor

03100103 Charlotte Harbor, FL
03090205 Caloosahatchee, FL
03100101 Peace, FL
03100102 Myakka, FL

Caloosahatchee River

03090205 Caloosahatchee, FL

Tampa Bay

03100206 Tampa Bay, FL
03100205 Hillsborough, FL
03100204 Alafia, FL
03100203 Little Manatee, FL
03100202 Manatee, FL

Suwanee River

03110101 Waccasassa, FL
03110102 Econfina-Steinhatchee, FL
03110205 Lower Suwanee, FL

Apalachee Bay

03110103 Aucilla FL/GA
03120001 Apalachee Bay-St. Marks, FL/GA
03120003 Lower Ochlockonee, FL/GA

Apalachicola Bay

03130013 New ,FL
03130011 Apalachicola, FL/GA
03130014 Apalachicola Bay, FL

St. Andrew Bay

03140101 St. Andrew-St. Joseph Bays, FL

Choctawhatchee Bay

03140102 Choctawhatchee Bay,FL
03140203 Lower Choctawhatchee,AL/FL

Pensacola Bay

03140105 Pensacola Bay, FL
03140103 Yellow, AL/FL
03140104 Blackwater, AL/FL
03140304 Lower Conecuh, AL/FL

Perdido Bay

03140107 Perdido Bay, AL/FL
03140106 Perdido, AL/FL

Mobile Bay

03160205 Mobile Bay, AL
03160204 Mobile-Tensaw, AL
03160203 Lower Tambigee, AL
03150204 Lower Alabama, AL

Miississippi Sound

03170009 Mississippi Coastal, AL/MS
03170008 Escatawpa, AL/MS
03170006 Pascagoula, MS
03180004 Lower Pearl, LA/MS
08090201 Liberty Bayou-Tchefuncta, LA
08070205 Tangipahoa, LA/MS
08090202 Lake Ponchartrain, LA
08090203 Eastern Louisiana Coastal, LA
08070204 Lake Maurepas, LA
08070203 Tickfaw, LA/MS
08070202 Amite, LA/MS

Lake Borgne

08090203 Eastern Louisiana Coastal, LA
03180004 Lower Pearl, LA/MS
08090202 Lake Pontchartrain, LA
08090201 Liberty Bayou-Tchefuncta, LA
08070205 Tangipahoa, LA/MS
08070203 Tickfaw, LA/Ms
08070204 Lake Maurepas, LA
08070202 Amite, LA/MS

Lake Ponchartrain

08090202 Lake Pontchartrain, LA
08090201 Liberty Bayou-Tchefuncta, LA
08070205 Tangipahoa, LA/MS
08070203 Tickfaw, LA/MS
08070202 Amite, LA/MS
08070204 Lake Maurepas, LA

Miississippi Delta Region

08090203 Eastern Louisiana Coastal, LA
08090100 Lower Mississippi-New Orleans, LA
08090301 East Central Louisiana Coastal, LA
08090302 West Central Louisiana Coastal, LA
08070100 Lower Mississippi-Baton Rouge, LA
08070201 Bayou Sara-Thompson, LA/MS

Atchafalaya

08080101 Atchafalaya, LA
08080102 Bayou Teche, LA
08080103 Vermilion, LA

Calcasieu Lake

08080206 Lower Calcasieu, LA

Sabine Lake

12040201 Sabine Lake, LA/TX
12010005 Lower Sabine, LA/TX
12020003 Lower Neches, TX

Galveston Bay

12040202 East Galveston Bay, TX
12040203 North Galveston Bay, TX
12030203 North Galveston Bay, TX
12040104 Buffalo-San Jacinto, TX
12040204 West Galveston Bay, TX
12040201 Sabine Lake, LA/TX

Brazos River

12070104 Lower Brazos, TX

Matagorda Bay

12100402 West Matagorda Bay, TX
12100401 Central Matagorda Bay, TX
12090302 Lower Colorado, TX
12100102 Navidad, TX
12100101 Lavaca, TX

San Antonio Bay

12100403 East San Antonio Bay, TX
12100404 West San Antonio Bay, TX

Aransas Bay

12100405 Aransas Bay, TX
12100406 Mission, TX
12100407 Aransas, TX

Corpus Christi Bay

12110201 North Corpus Christi Bay, TX
12110202 South Corpus Christi Bay, TX
12110111 Lower Nueces, TX

Laguna Madre

12110203 North Laguna Madre, TX
12110205 Baffin Bay, TX
12110204 San Fernando, TX
12110206 Palo Blanco, TX
12110207 Central Laguna Madre, TX
12110208 South Laguna Madre, TX

Baffin Bay

12110205 Baffin Bay, TX
12110204 San Fernando, TX

San Diego Bay

18070304 San Diego, CA

San Pedro Bay

18070104 Santa Monica Bay, CA
18070105 Los Angeles, CA
18070106 San Gabriel, CA
18070201 Seal Beach, CA

Santa Monica Bay

18070104 Santa Monica Bay, CA

Monterey Bay

18060001 San Lorenzo-Soquel, CA
18060011 Alisal-Elkhorn Sloughs, CA
18060012 Carmel, CA

San Francisco Bay

18050002	San Pablo Bay, CA
18050001	Suisun Bay, CA
18020109	Lower Sacremento, CA
18040003	San Joaquin Delta, CA
18050004	San Francisco Bay, CA
18050003	Coyote, CA

Suisun Bay

18050001	Suisun Bay, Ca
18020109	Lower Sacramento, CA

Eel River

18010105	Lower Eel, CA

Humboldt Bay

18010102	Mad-Redwood, CA

Klamath River

18010209	Lower California, CA/OR

Coos Bay

17100304	Coos, OR

Winchester Bay

17100303	Umpqua, Or

Columbia River

17080006	Lower Columbia, OR/WA
17080003	Lower Columbia-Clatskanie, OR/WA
17080005	Lower Cowlitz, WA
17080002	Lewis, WA
17080001	Lower Columbia-Sandy, OR/WA
17090012	Lower Willamette, OR

Willapa Bay

17100106	Willapa Bay, WA

Grays Harbor

17100105	Grays Harbor, WA
17100104	Lower Chehalis, WA

Puget Sound

17110001	Fraser, WA
17110021	Crescent-Hoko, WA
17110020	Dungeness-Elwha, WA
17110018	Hood Canal, WA
17110019	Puget Sound, WA
17110015	Nisqually, WA
17110014	Puyallup, WA
17110013	Duwamish, WA
17110012	Lake Washington, WA
17110011	Snohomish, WA
17110008	Stillaguamish, WA
17110007	Lower Skagit, WA
17110004	Nooksack, WA
17110002	Strait of Georgia, WA
17110003	San Juan Islands, WA

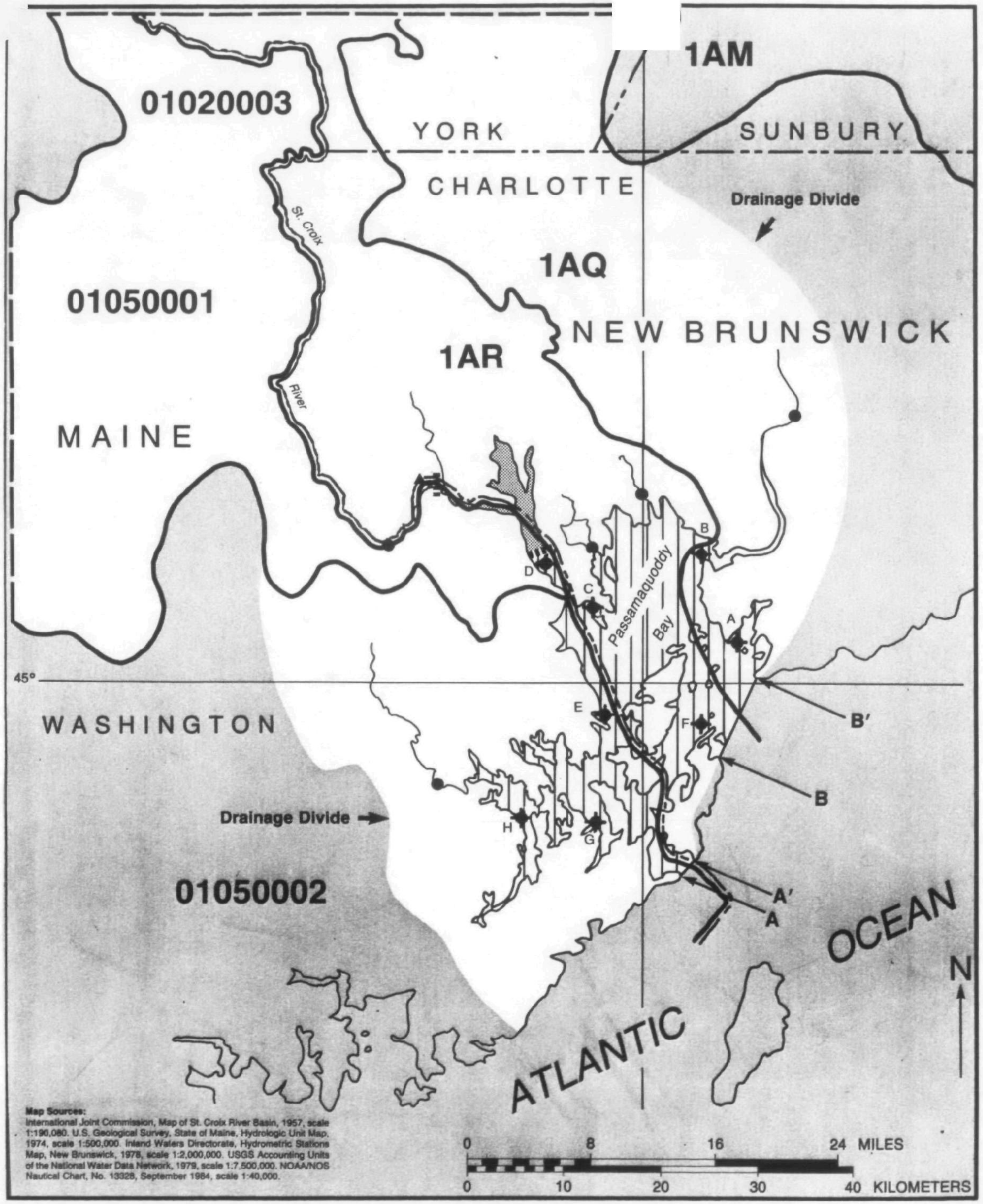
Hood Canal

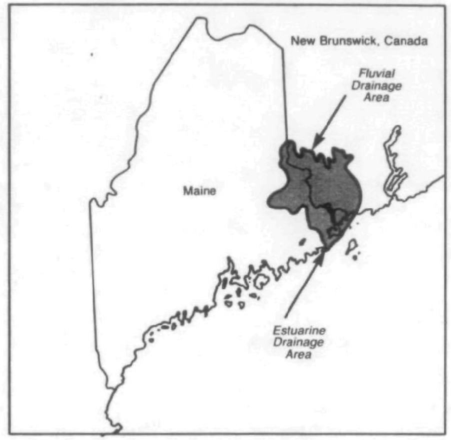
17110018	Hood Canal, WA
17110019	Puget Sound, WA

Skagit Bay

17110019	Puget Sound, WA
17110011	Snohomish, WA
17110008	Stillaguamish, WA
17110007	Lower Skagit, WA

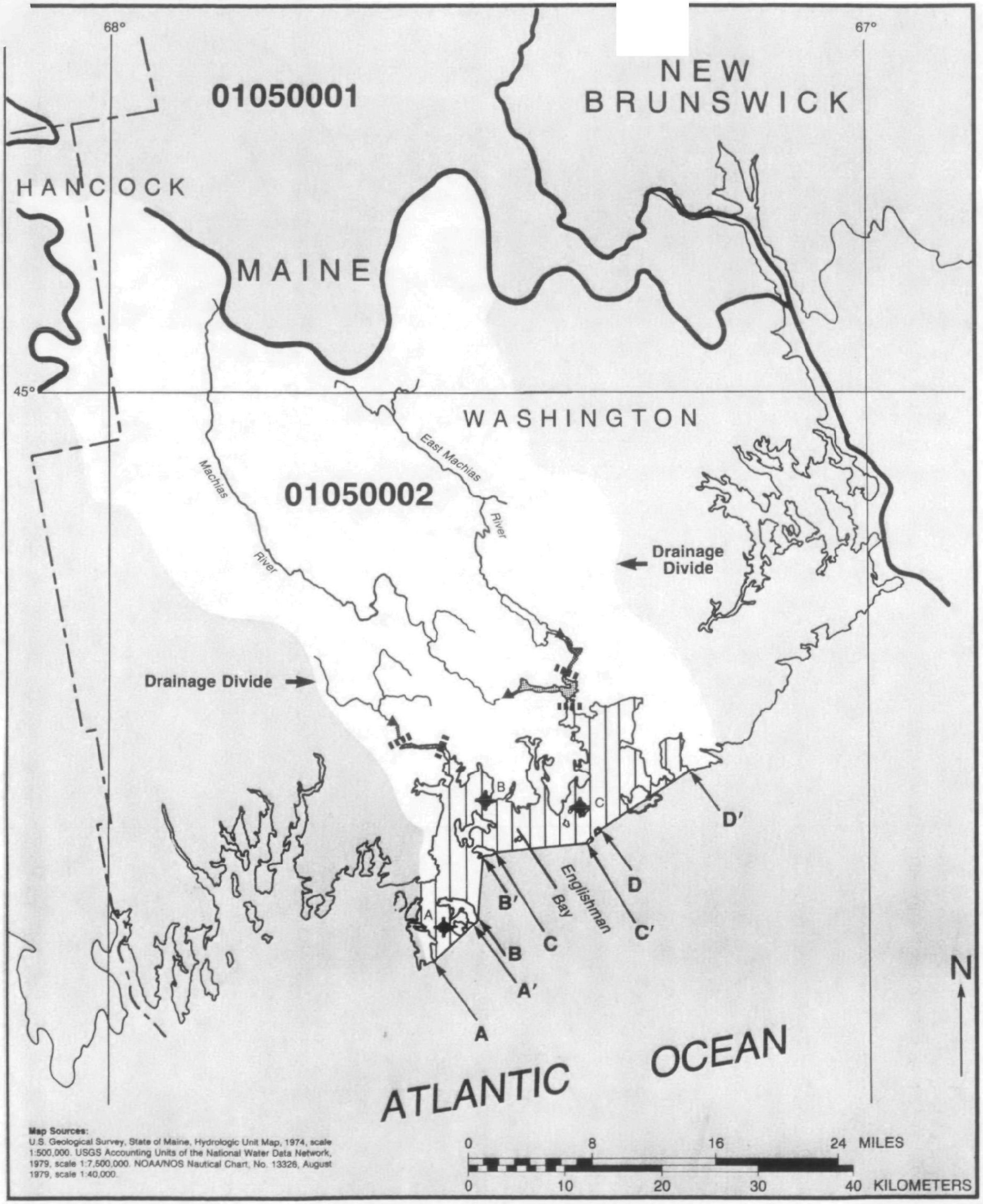
Passamaquoddy Bay ME, NB



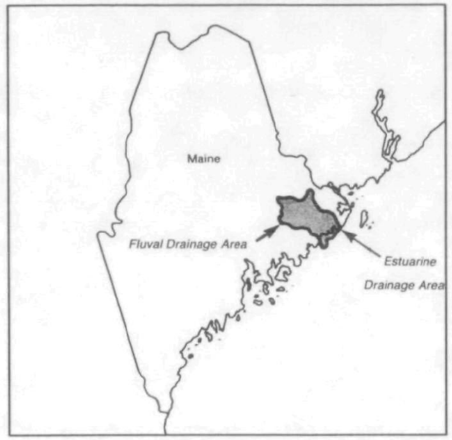


- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Englishman Bay
ME



Map Sources:
U.S. Geological Survey, State of Maine, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 13326, August 1979, scale 1:40,000.



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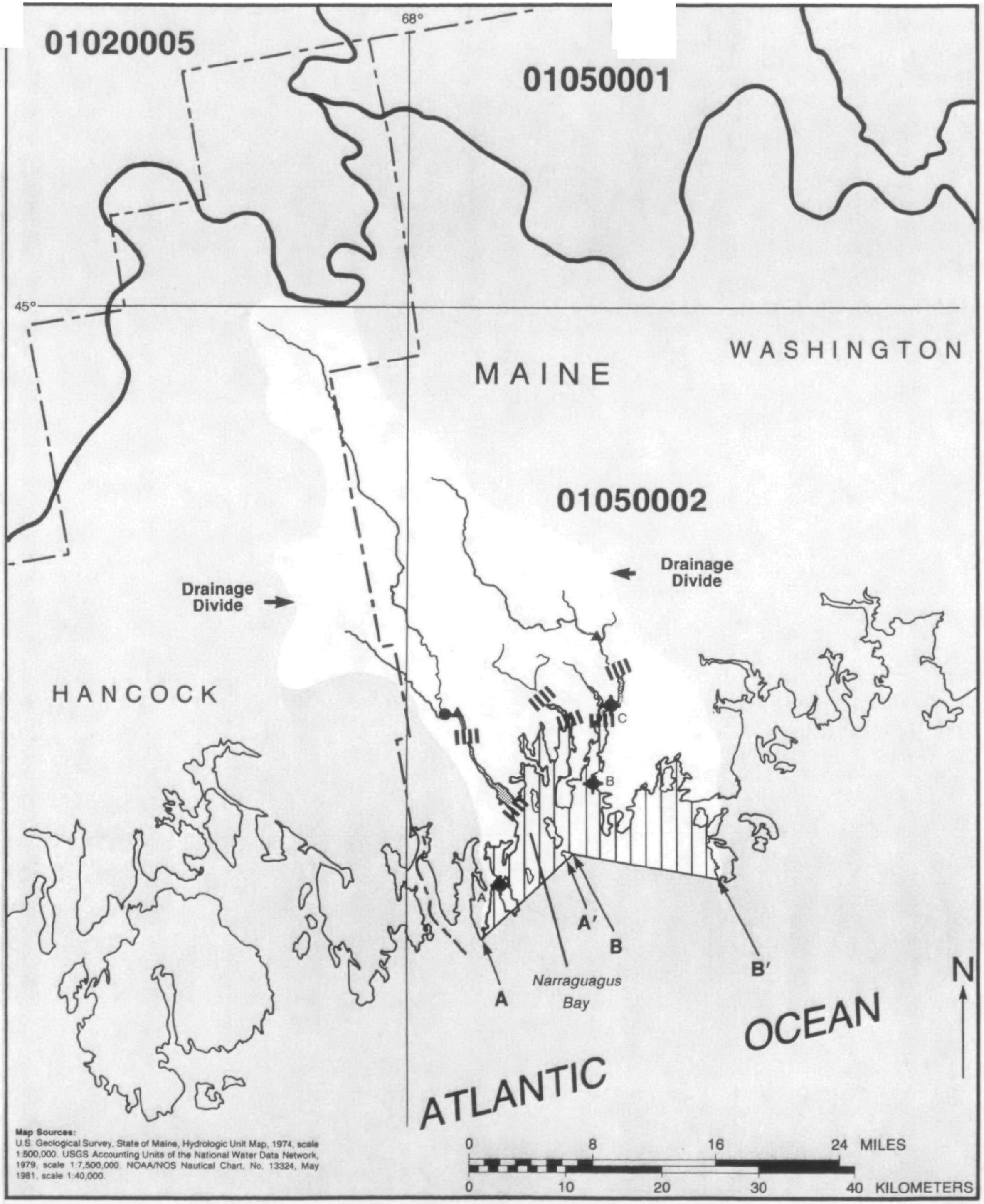
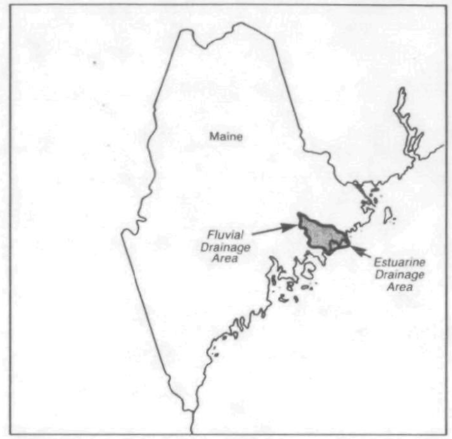
National Ocean Service / NOAA

Narraguagus Bay
ME



Map Sources:
U.S. Geological Survey, State of Maine, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 13324, May 1981, scale 1:40,000.



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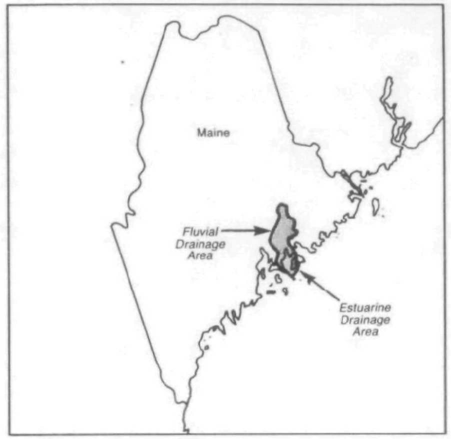
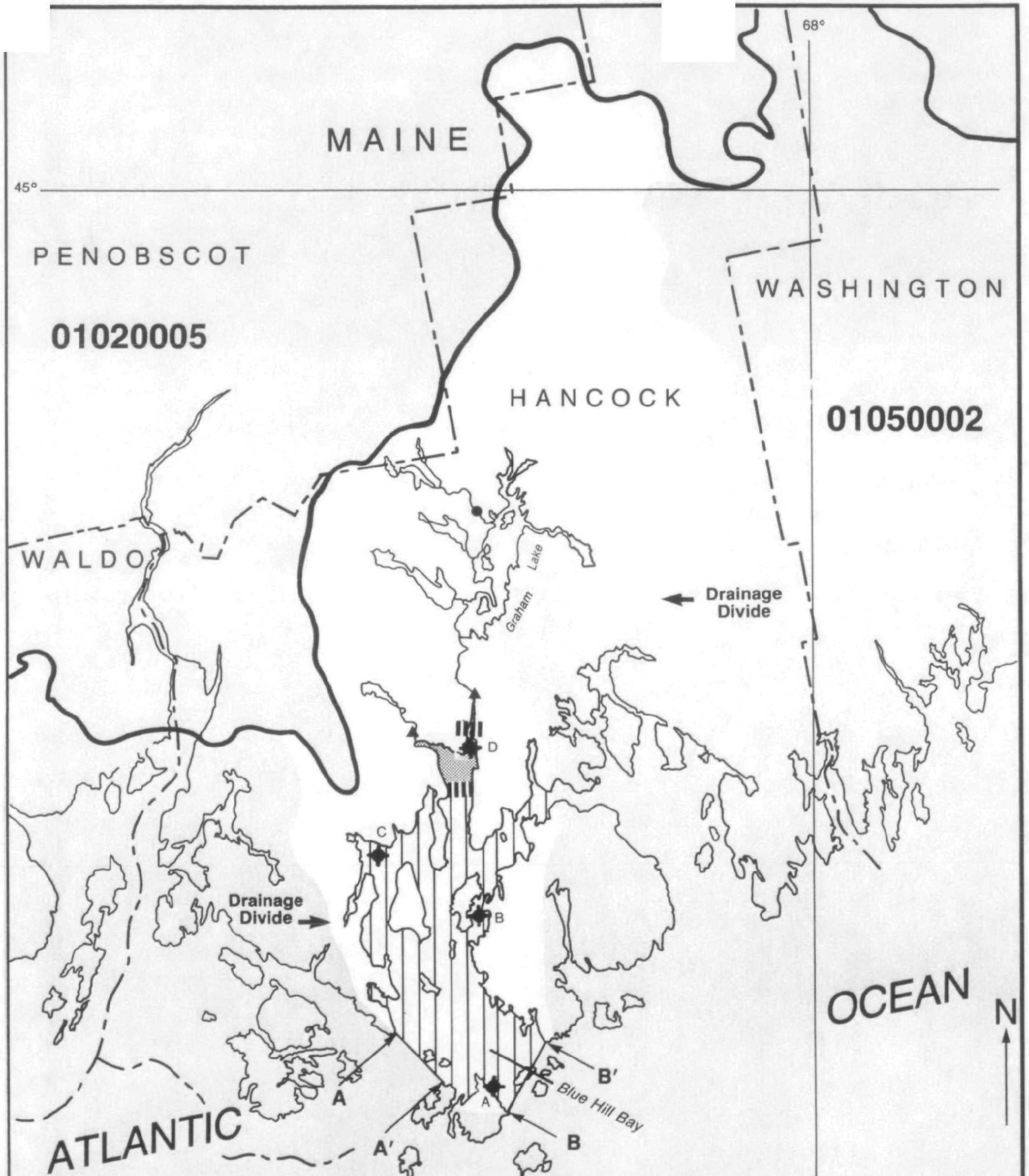
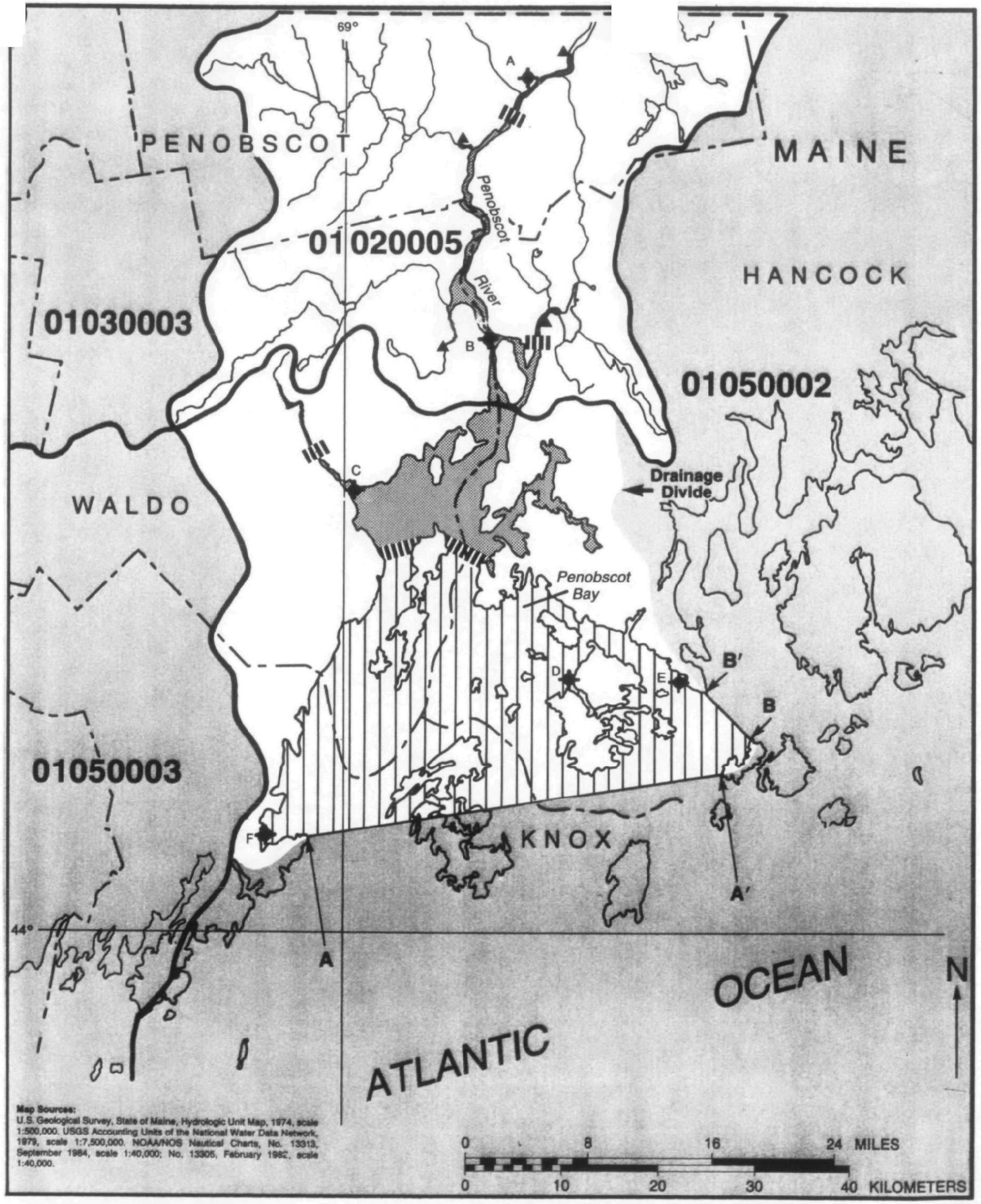
Blue Hill Bay
ME





Map Sources:
U.S. Geological Survey, State of Maine, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 13316, June 1982, scale 1:40,000.

Penobscot Bay
ME



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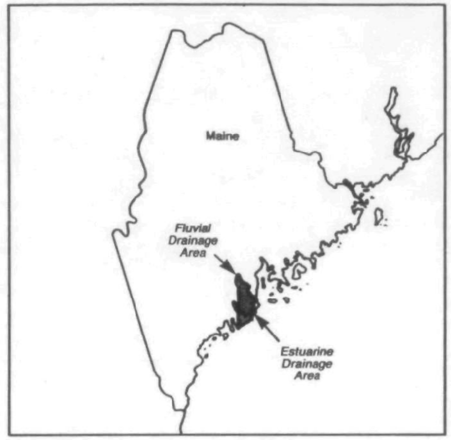
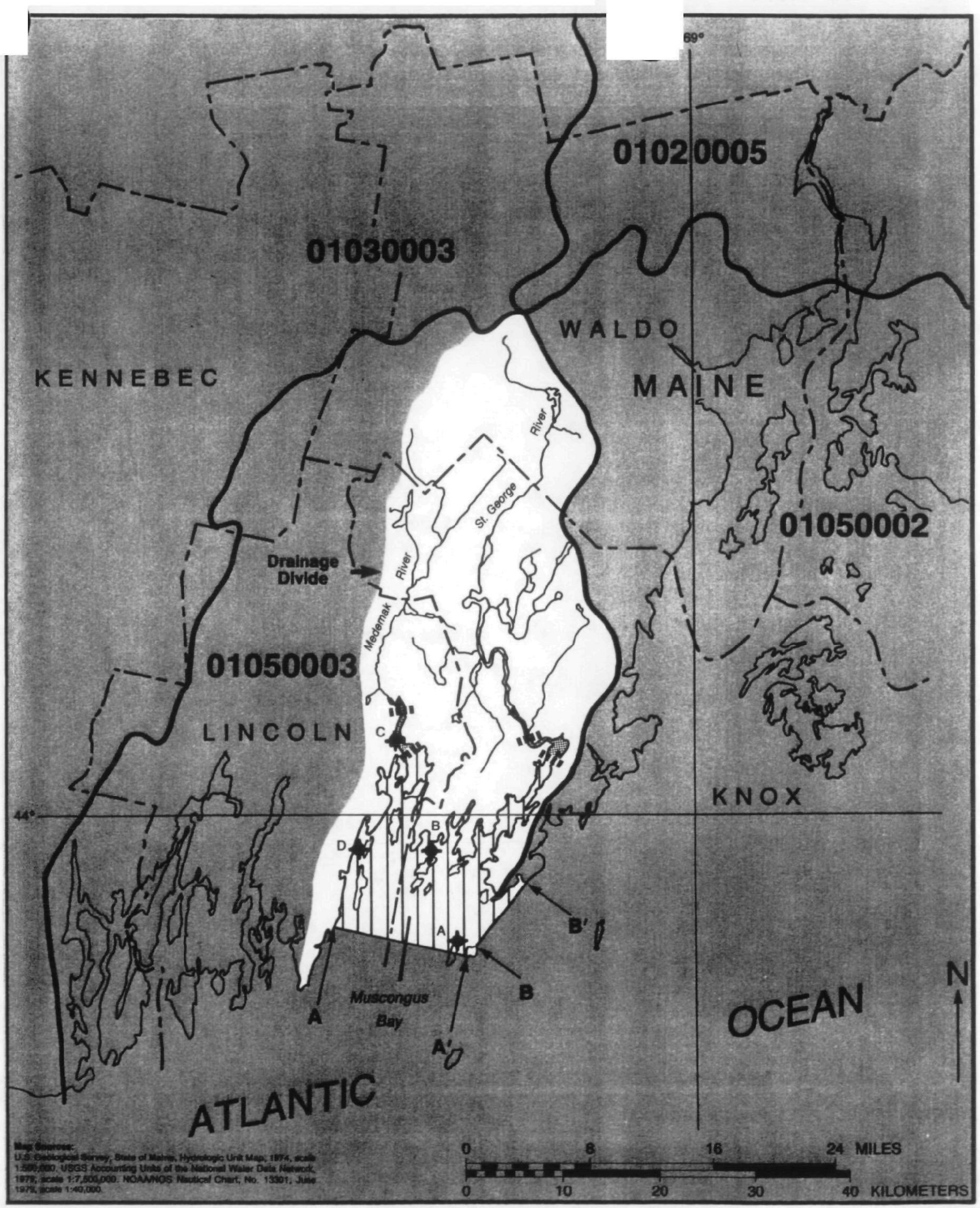
Muscongus Bay ME





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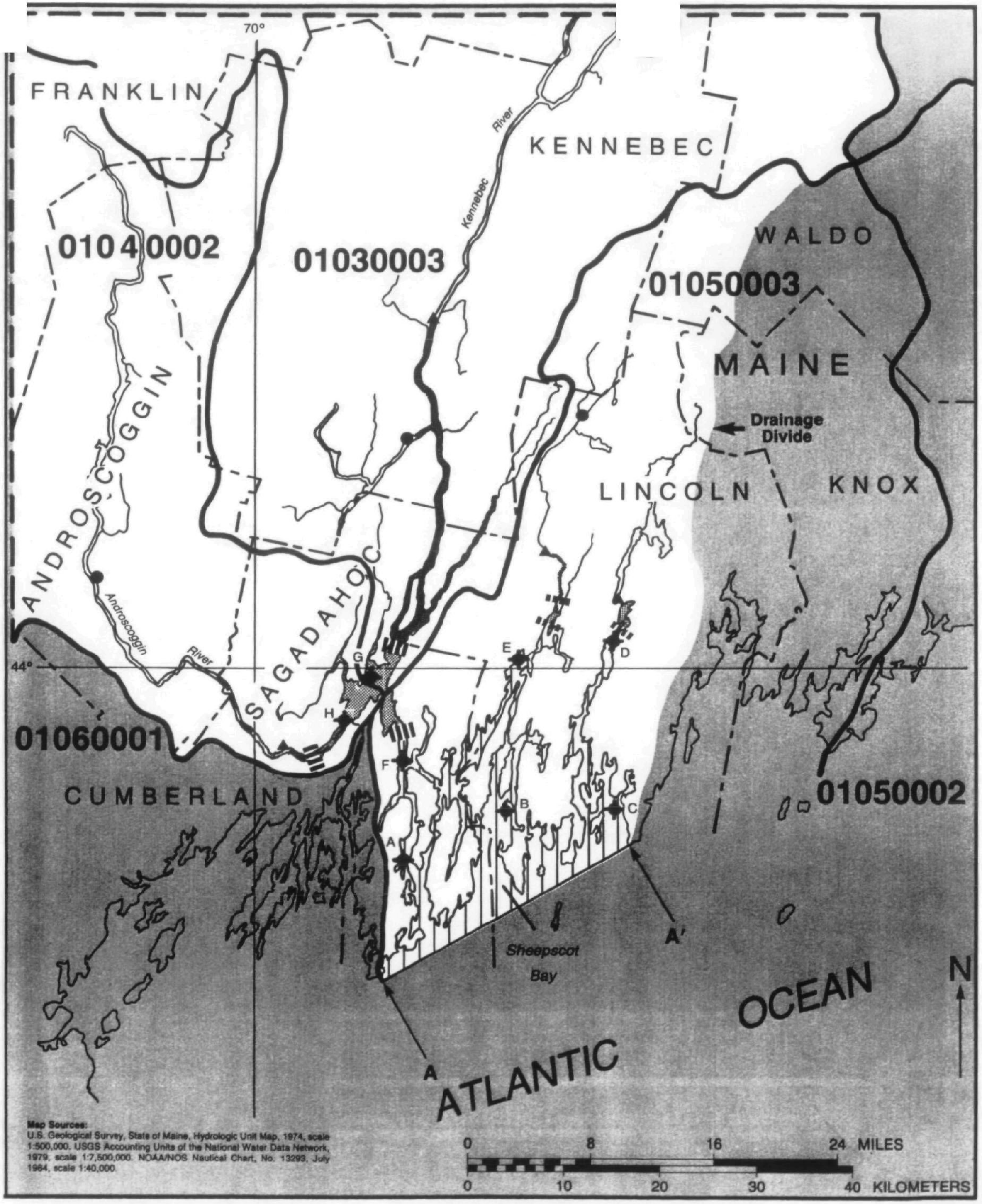
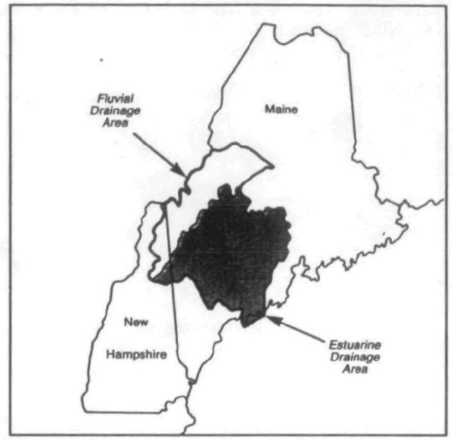
Sheepscot Bay
ME , NH





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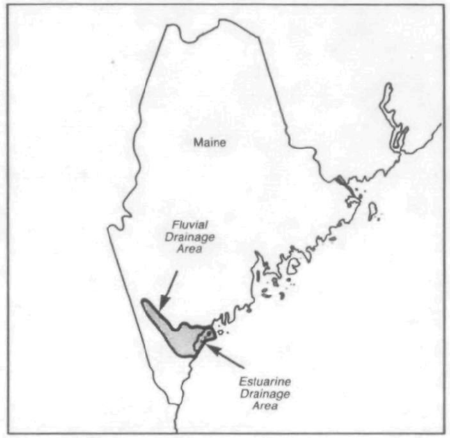
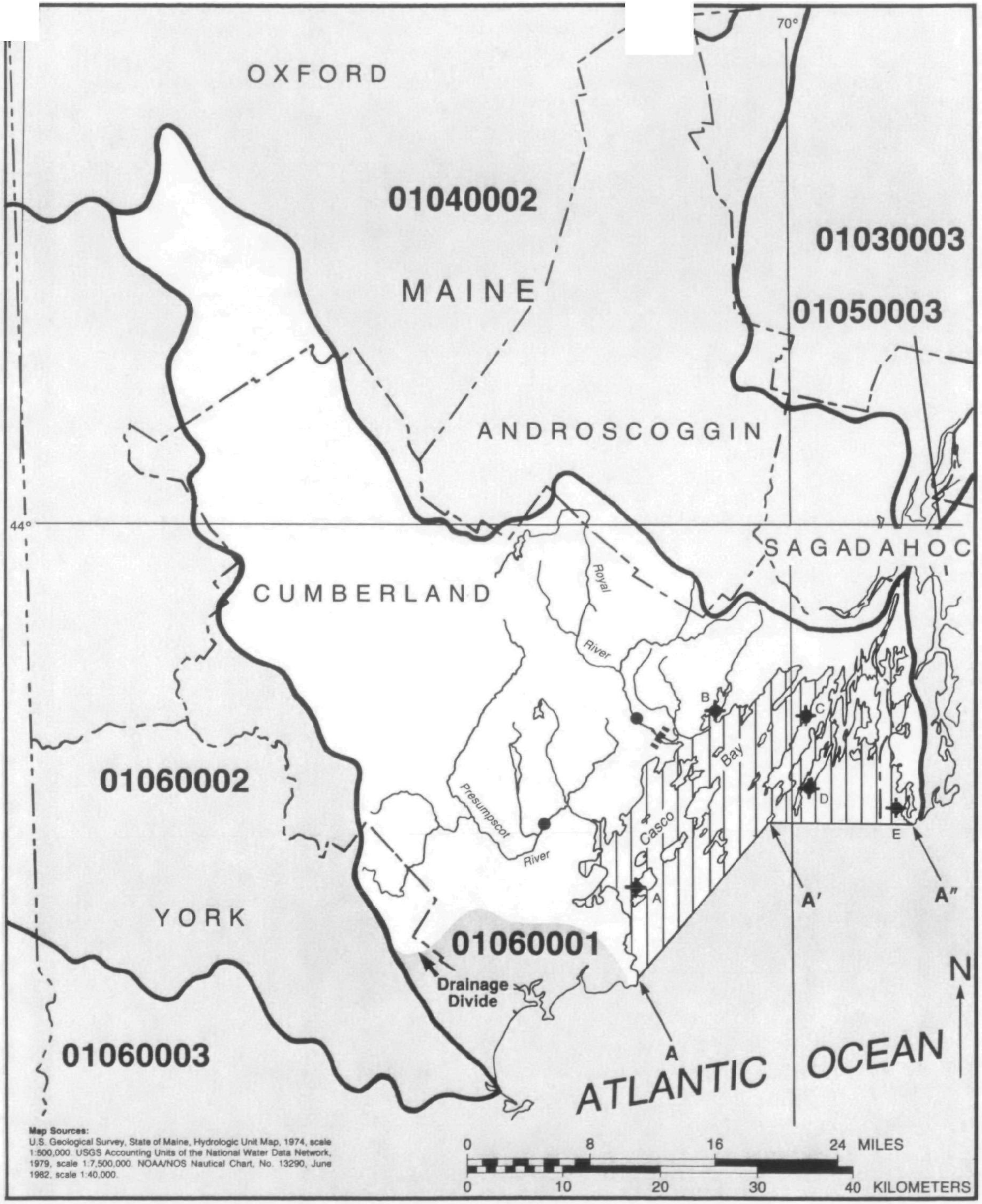
Casco Bay
ME





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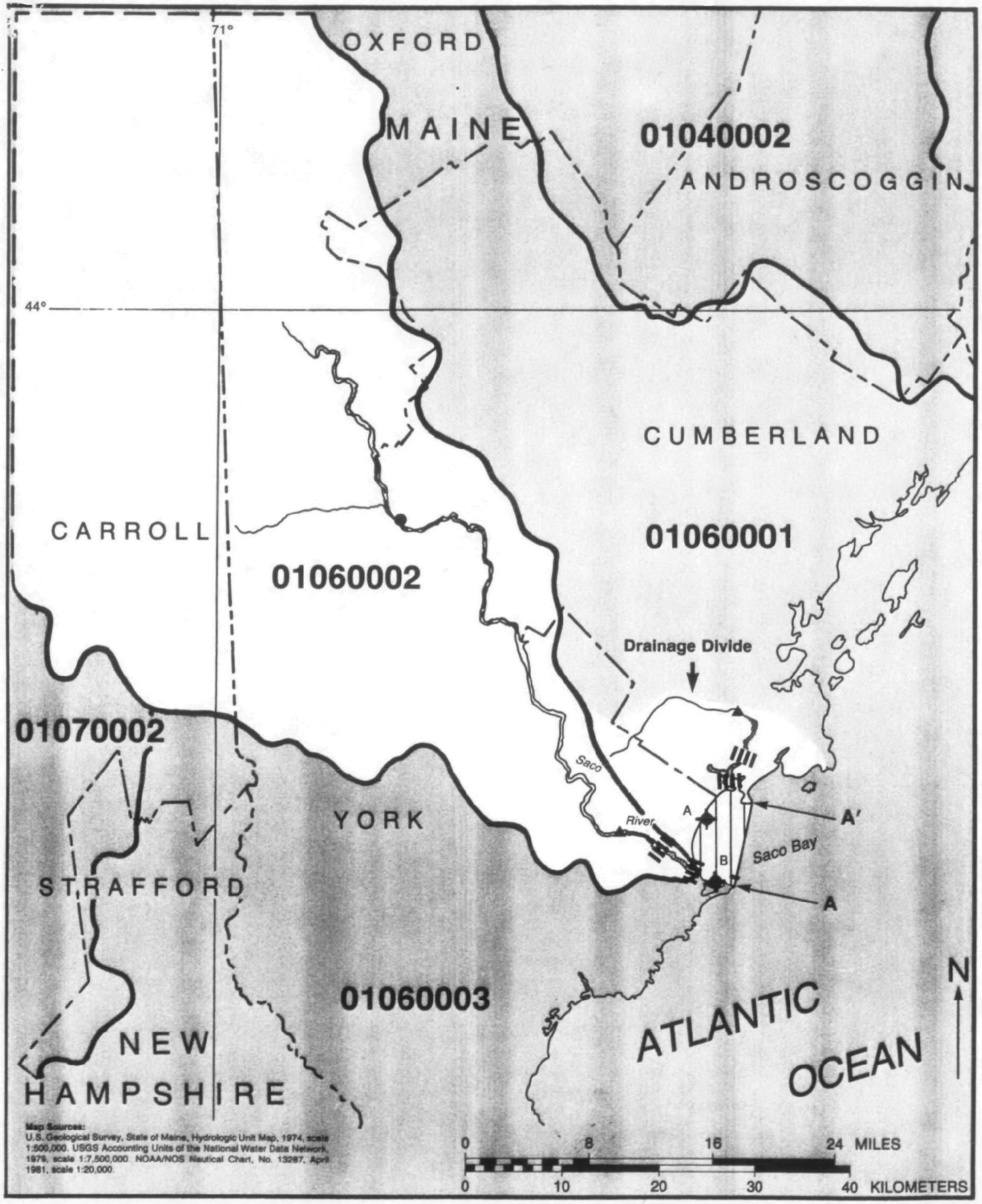
Saco Bay
ME, NH



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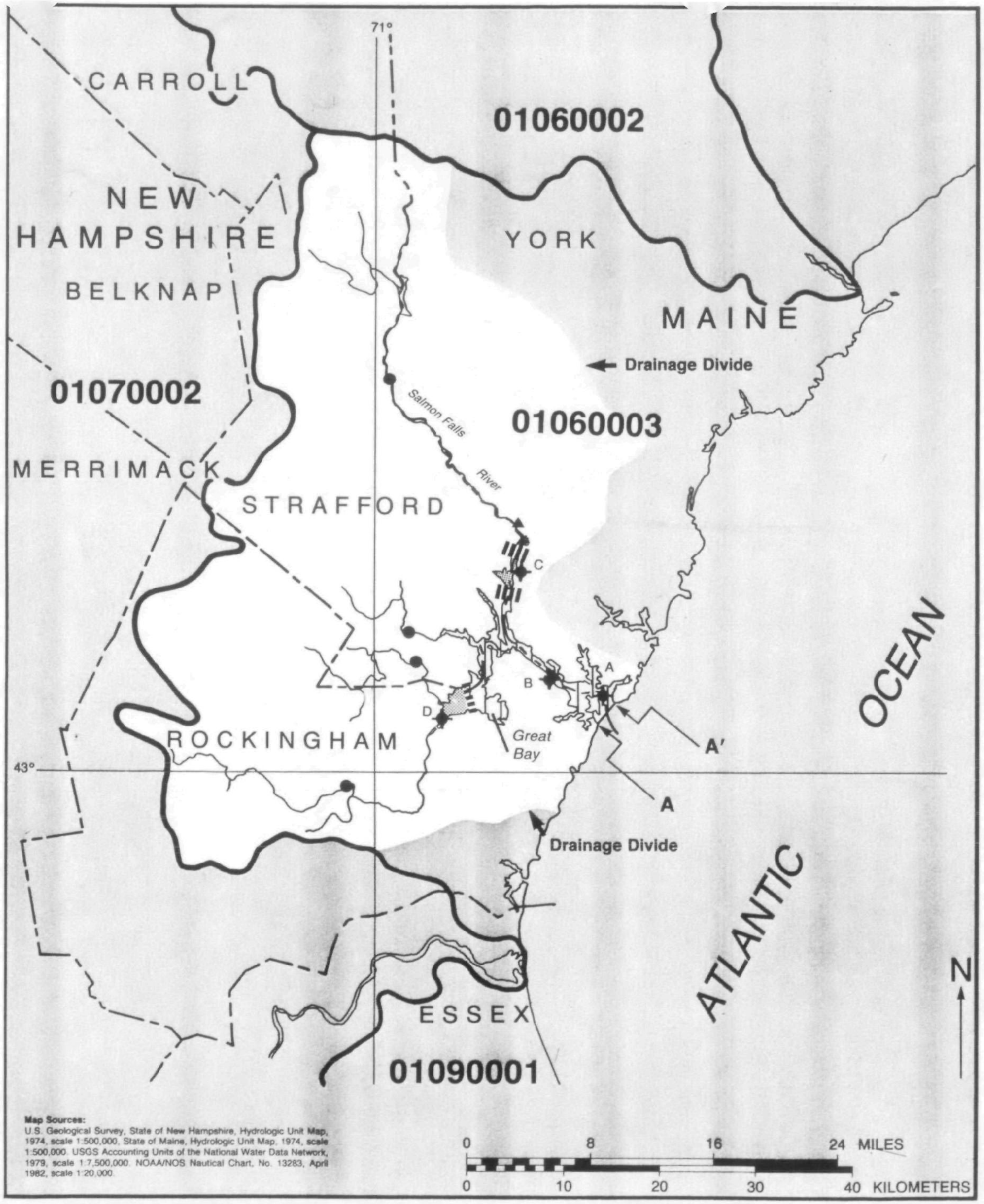
Great Bay
NH, ME



Map Sources:
U.S. Geological Survey, State of New Hampshire, Hydrologic Unit Map, 1974, scale 1:500,000. State of Maine, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 13283, April 1982, scale 1:20,000.

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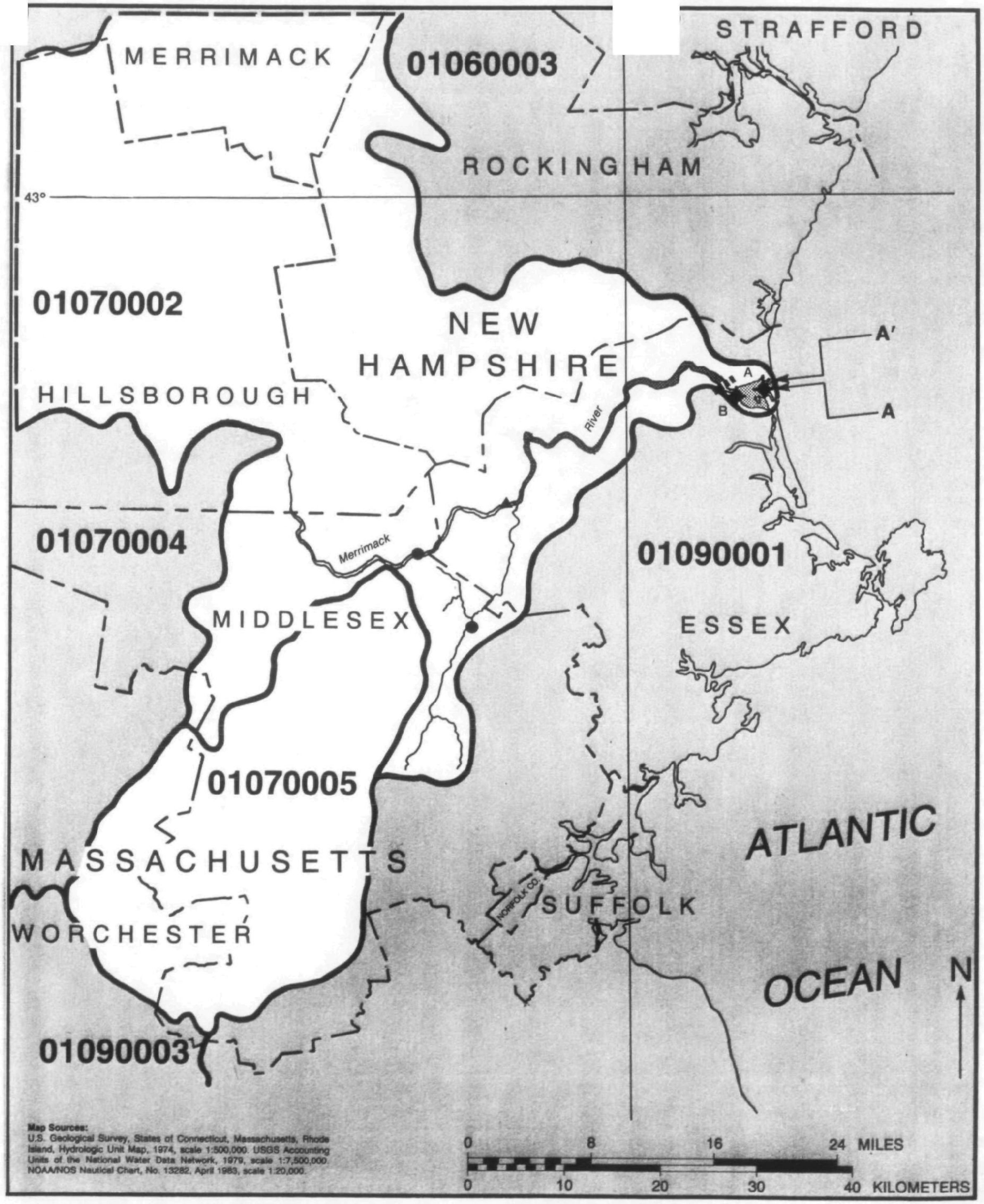
Merrimack River
MA, NH



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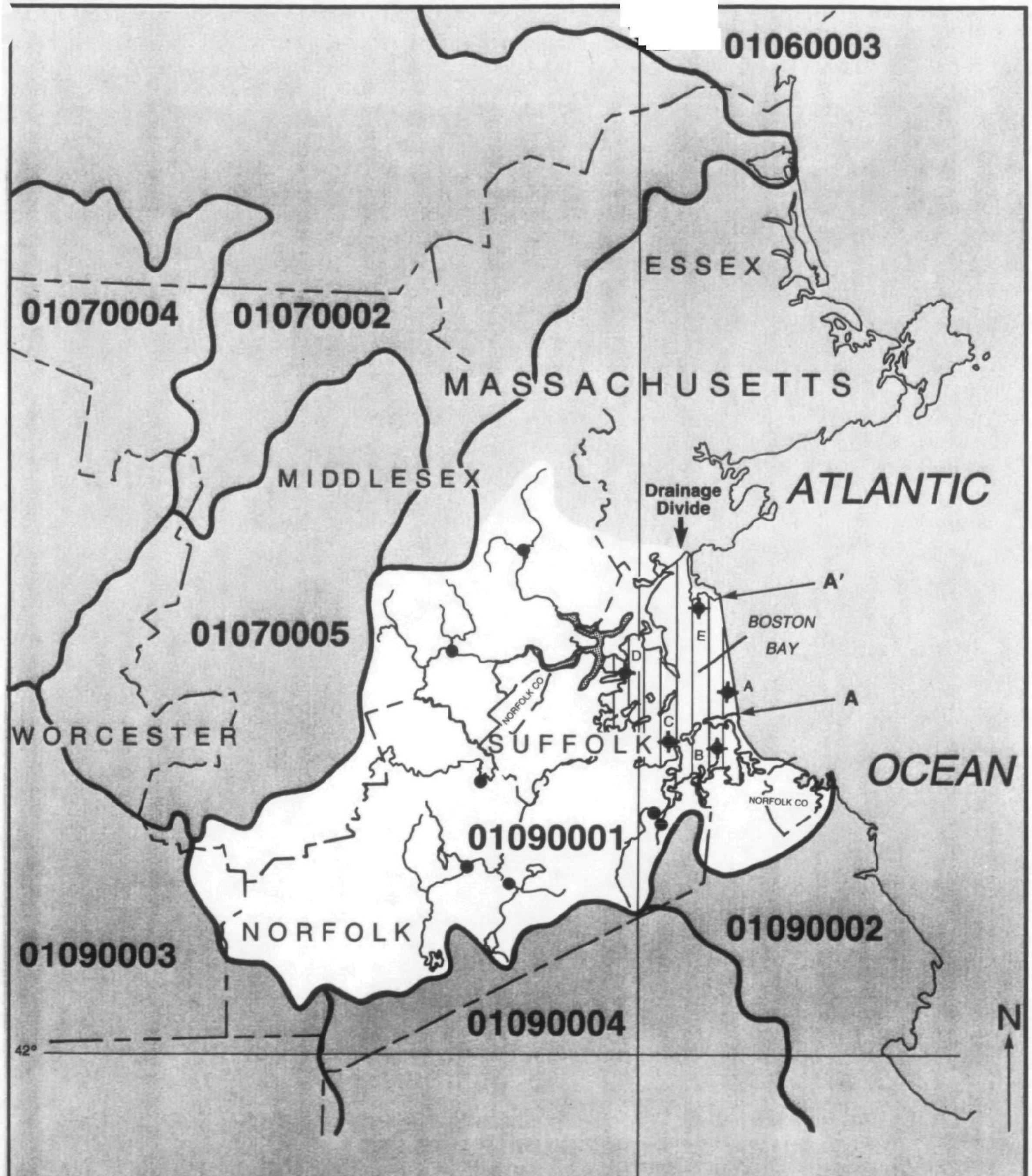
Boston Bay
MA



Map Sources:
U.S. Geological Survey, States of Connecticut, Massachusetts, Rhode Island, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 13270, November 1982, scale 1:25,000.

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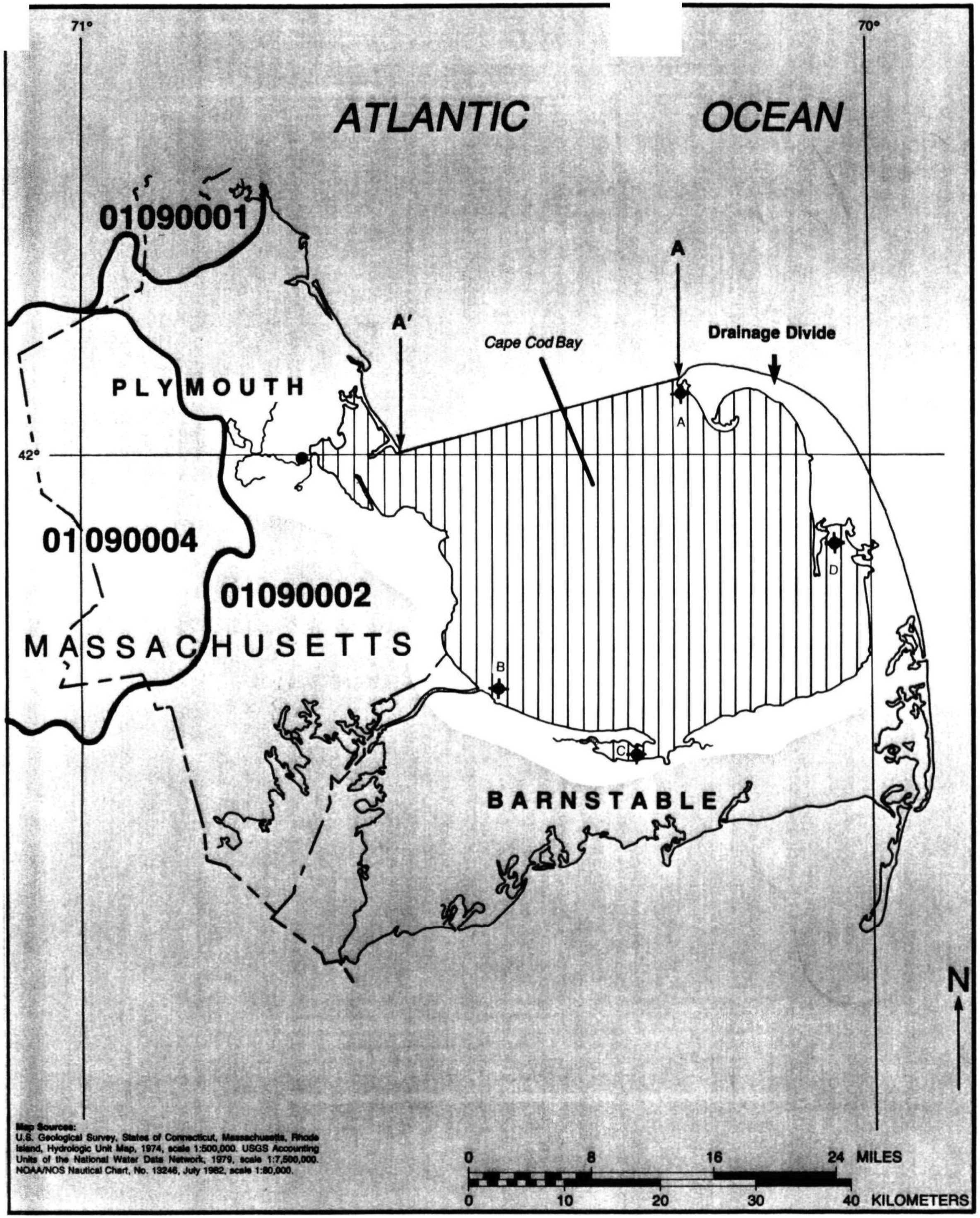
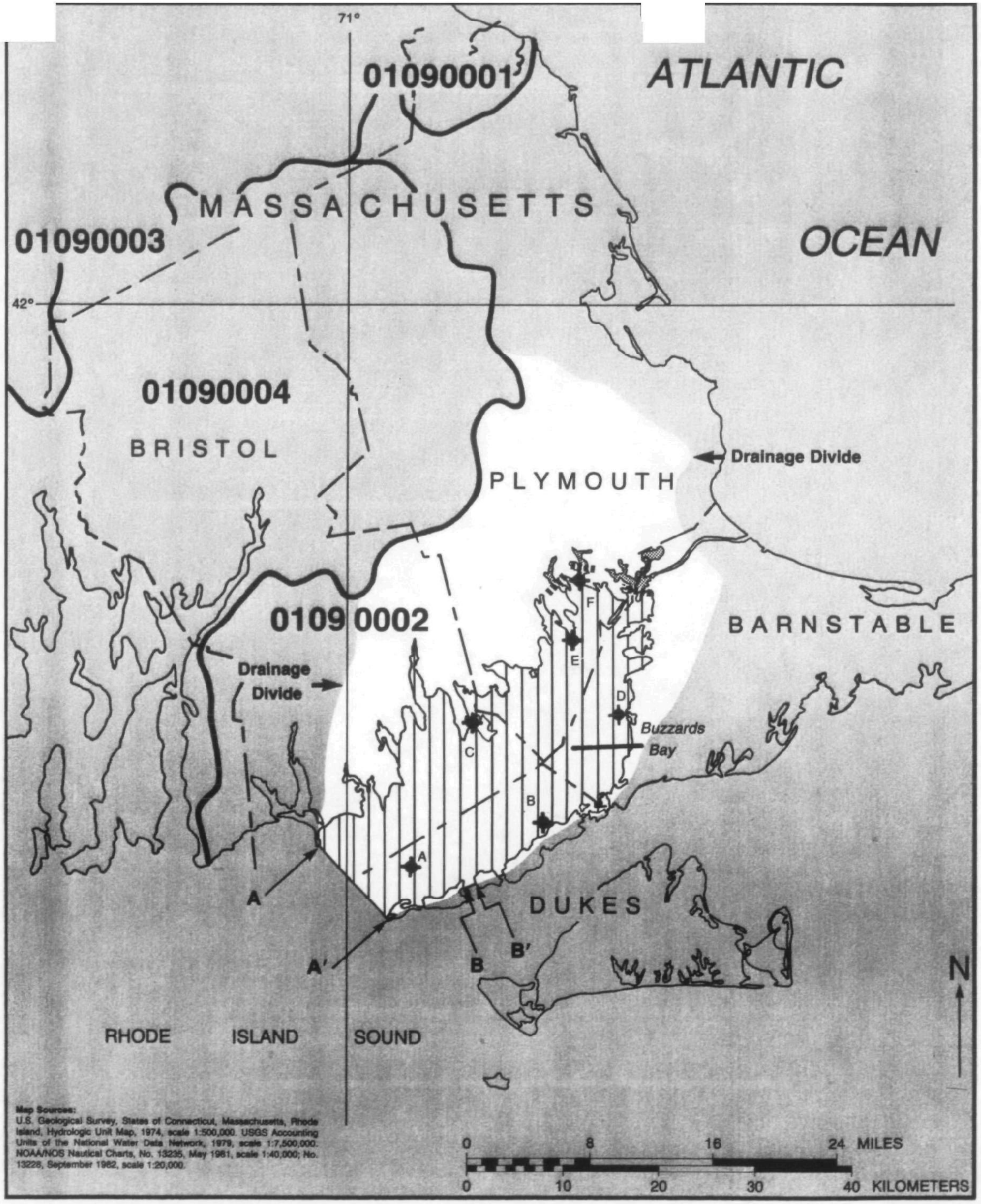
Cape Cod Bay
MA



Map Sources:
U.S. Geological Survey, States of Connecticut, Massachusetts, Rhode Island, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 13246, July 1982, scale 1:80,000.

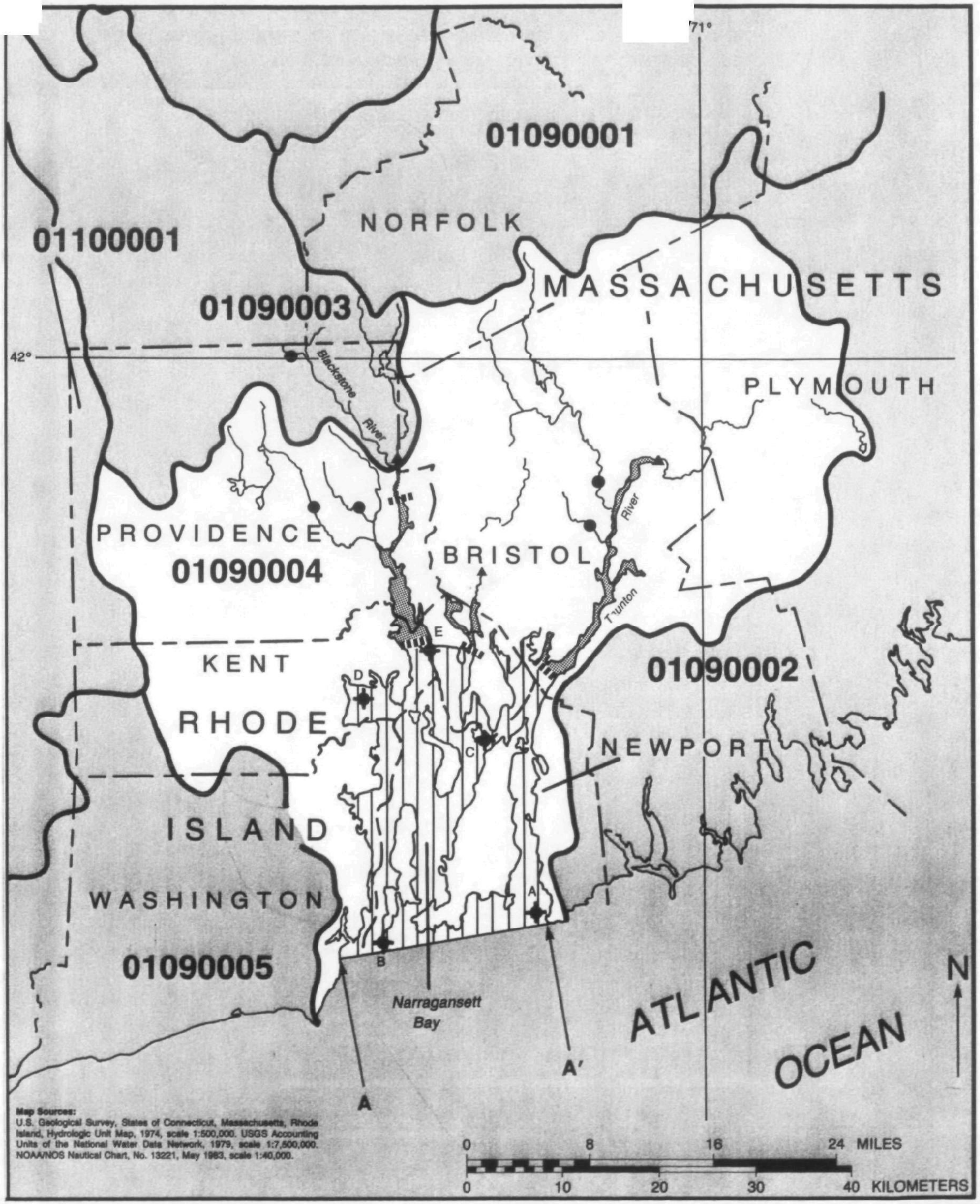
- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

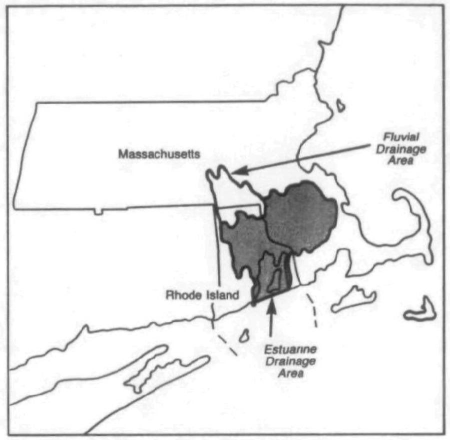
Buzzards Bay
MA



Tide Gage
Flow Gage
Head of Tide
Estuarine Drainage Area (EDA)
Tidal Fresh Zone
Mixing Zone
Seawater Zone
Hydrologic Cataloging Unit Boundary
County Boundary
Salinity Zone Boundary - Low Variability
Salinity Zone Boundary - Moderate Variability
Salinity Zone Boundary - High Variability

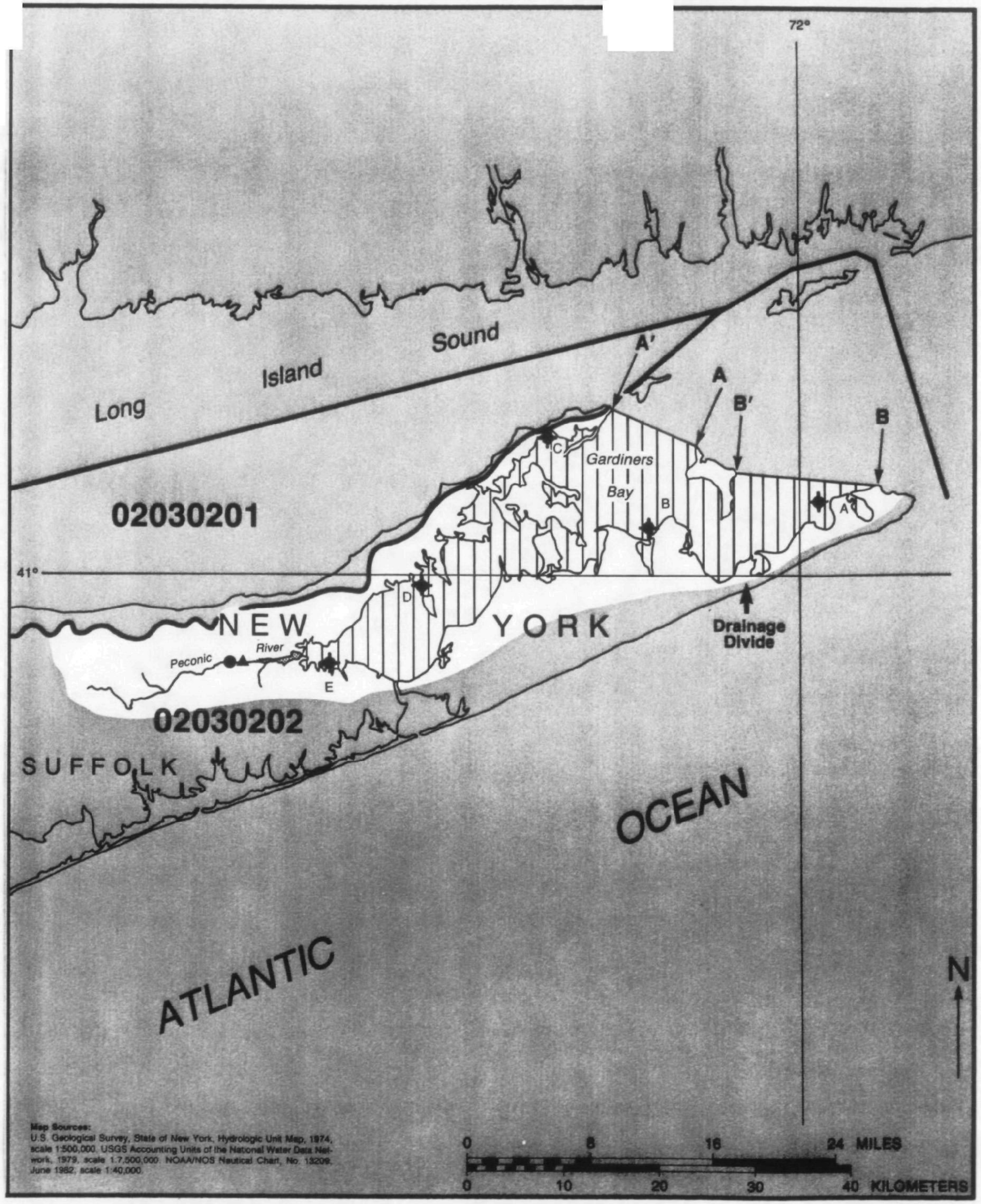
Narragansett Bay
MA, RI

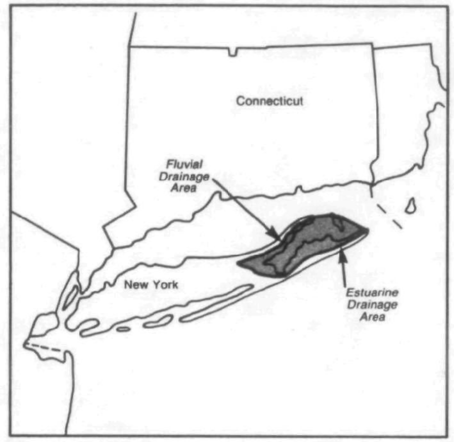




- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Gardiners Bay
NY





- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
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- Salinity Zone Boundary - High Variability

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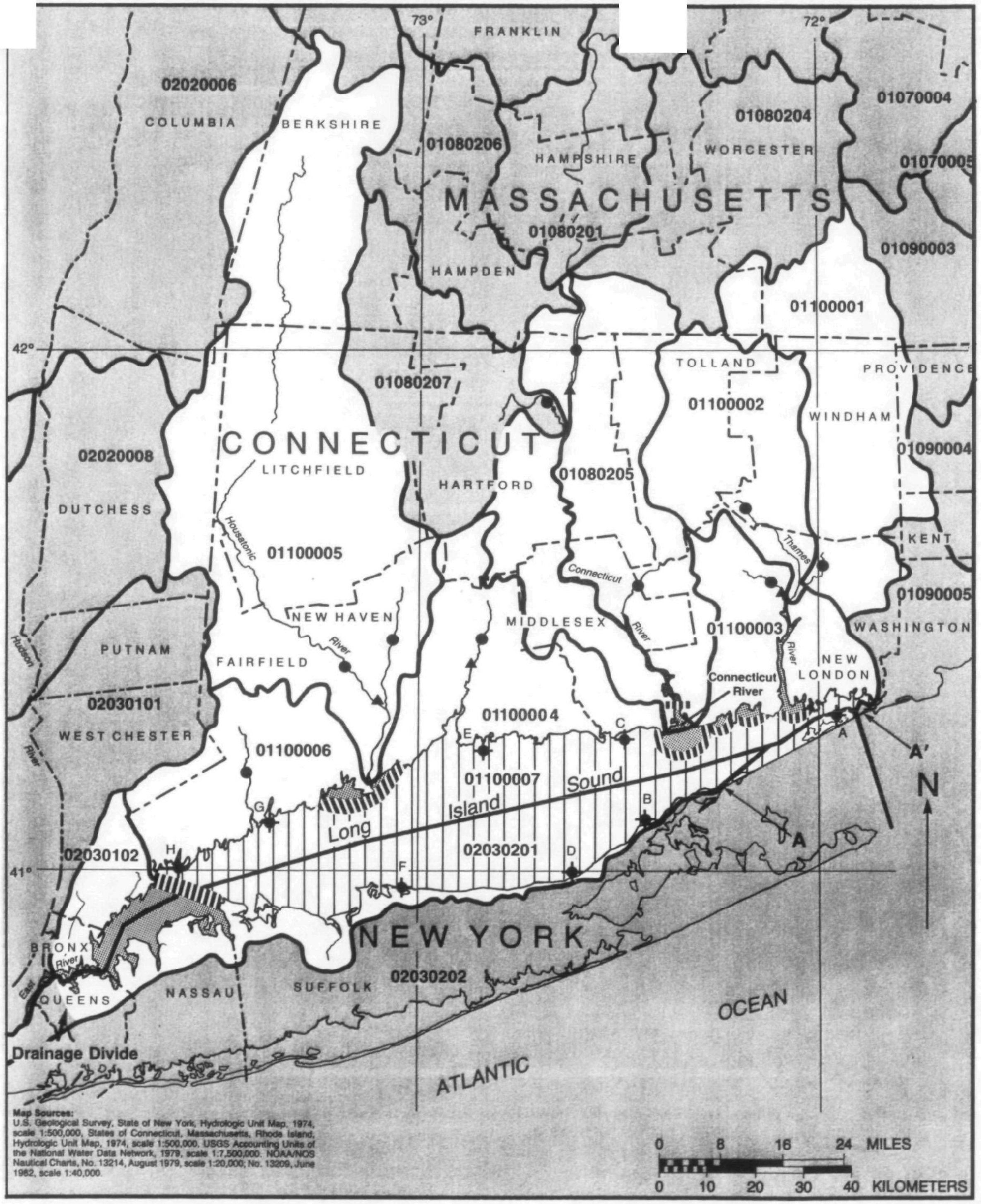
Long Island Sound
NY, CT, MA



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
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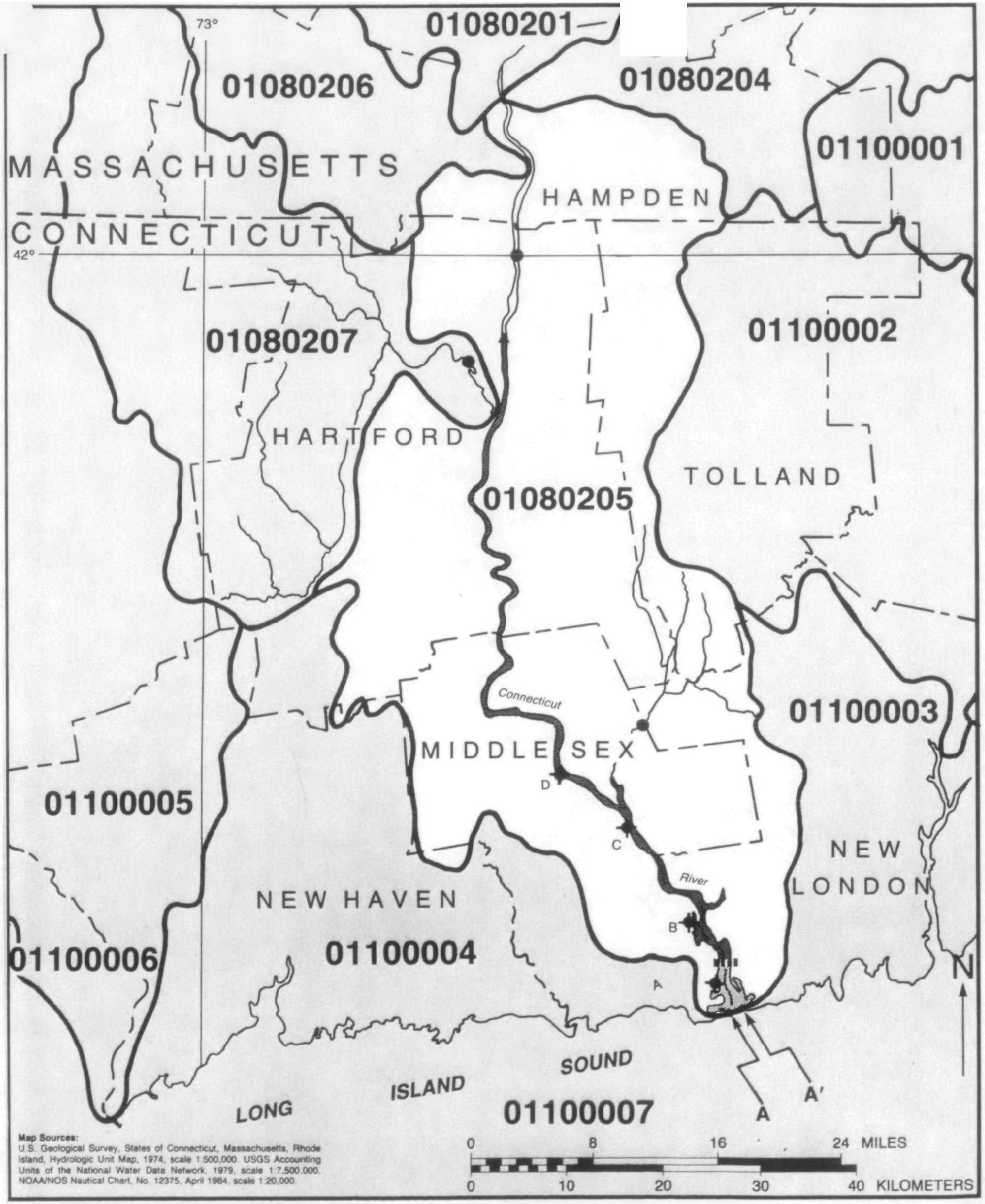
Connecticut River
CT, MA



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
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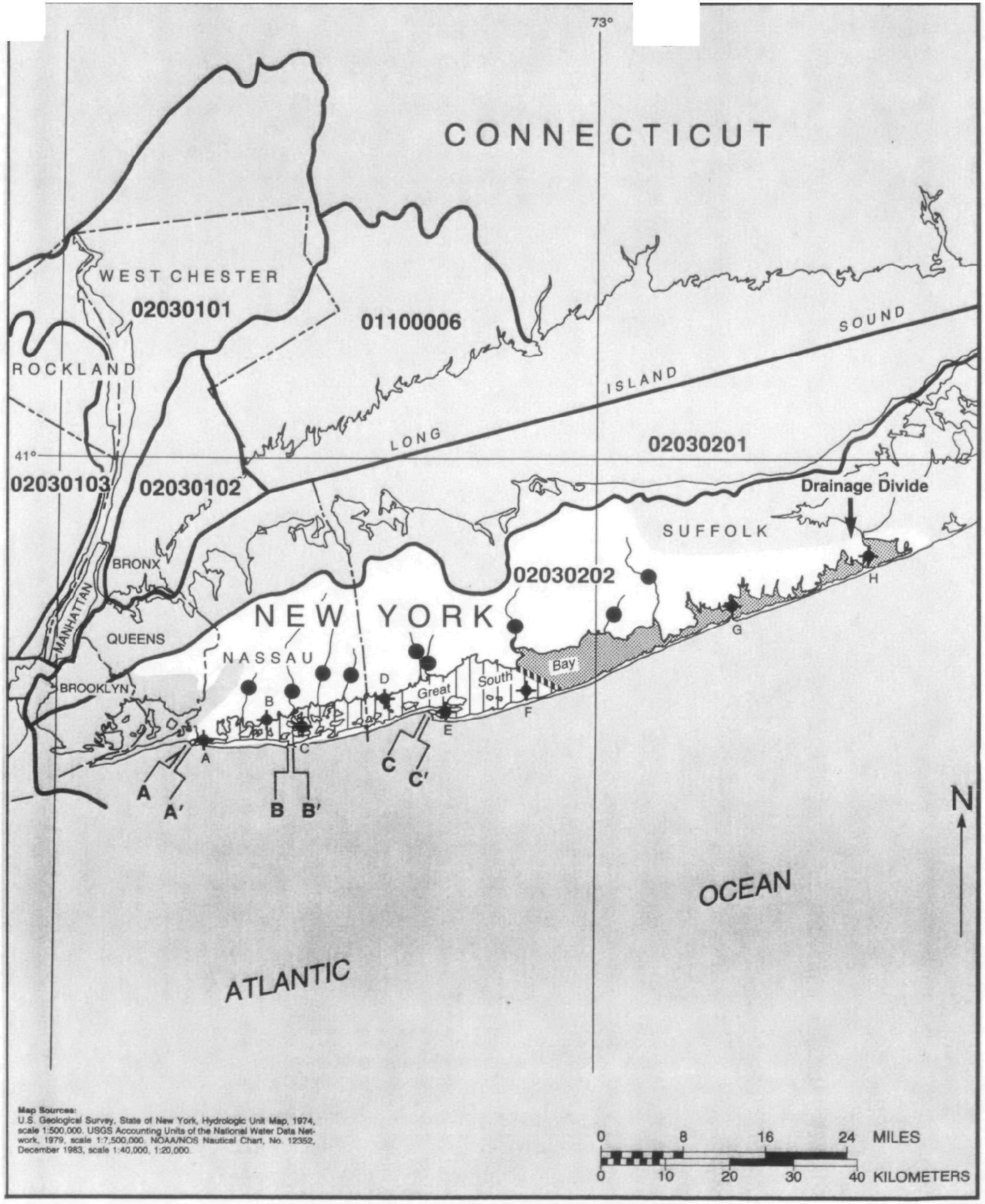
Great South Bay NY



Map Sources:
U.S. Geological Survey, State of New York, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 12352, December 1983, scale 1:40,000, 1:20,000.

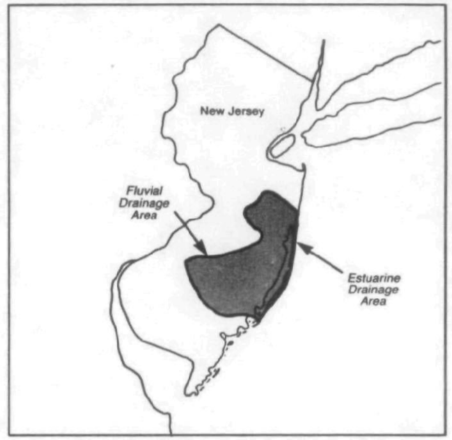
- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Hudson River/Raritan
NY, NJ, MA, CT

Map Sources:
U.S. Geological Survey, State of New Jersey, Hydrologic Unit Map, 1974, scale 1:500,000, State of New York, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 12327, July 1963, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Barnegat Bay
NJ



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
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Delaware Bay
DE, NJ, PA, MD

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
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- County Boundary
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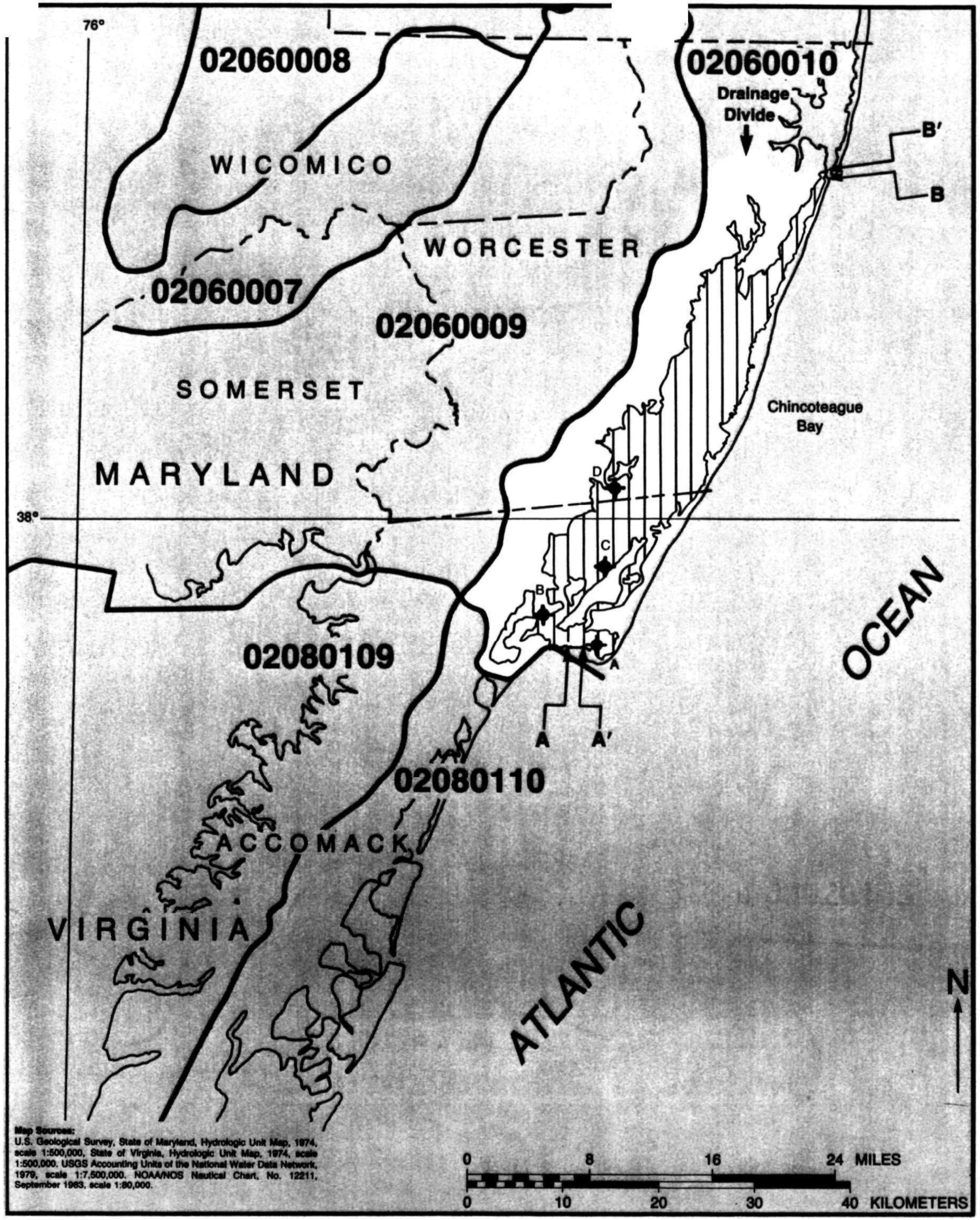
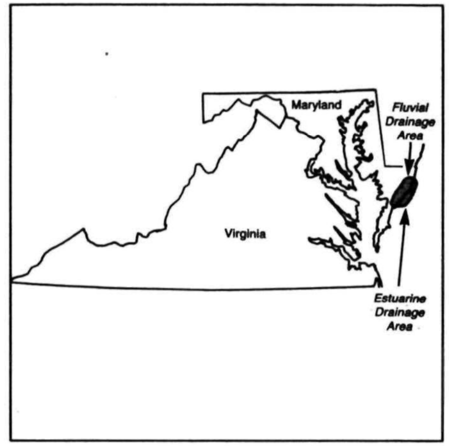
Chincoteague Bay
MD, VA



Map Sources:
U.S. Geological Survey, State of Maryland, Hydrologic Unit Map, 1974, scale 1:500,000, State of Virginia, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 12211, September 1983, scale 1:80,000.



- Tide Gage
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- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
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- Salinity Zone Boundary - Low Variability
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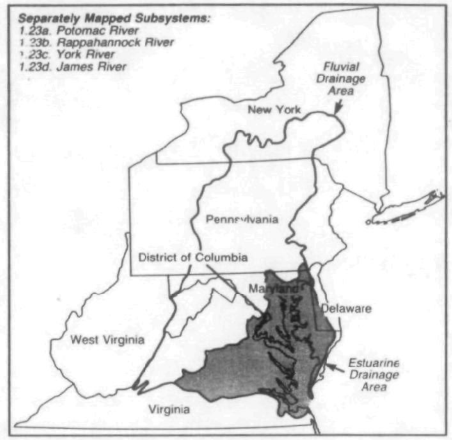
Chesapeake Bay
VA, MD, DE, PA, DC



Map Sources:
U.S. Geological Survey, State of Virginia, Hydrologic Unit Map, 1974, scale 1:500,000, State of Maryland, Hydrologic Unit Map, 1974, scale 1:500,000, State of Pennsylvania, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 12222, June 1983, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
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Potomac River
VA, MD, DC

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
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- County Boundary
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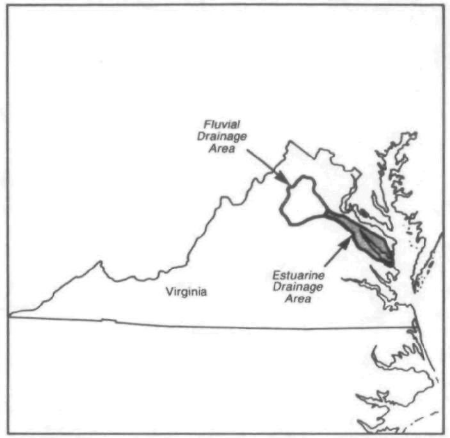
Rappahannock River VA



- Tide Gage
- Flow Gage
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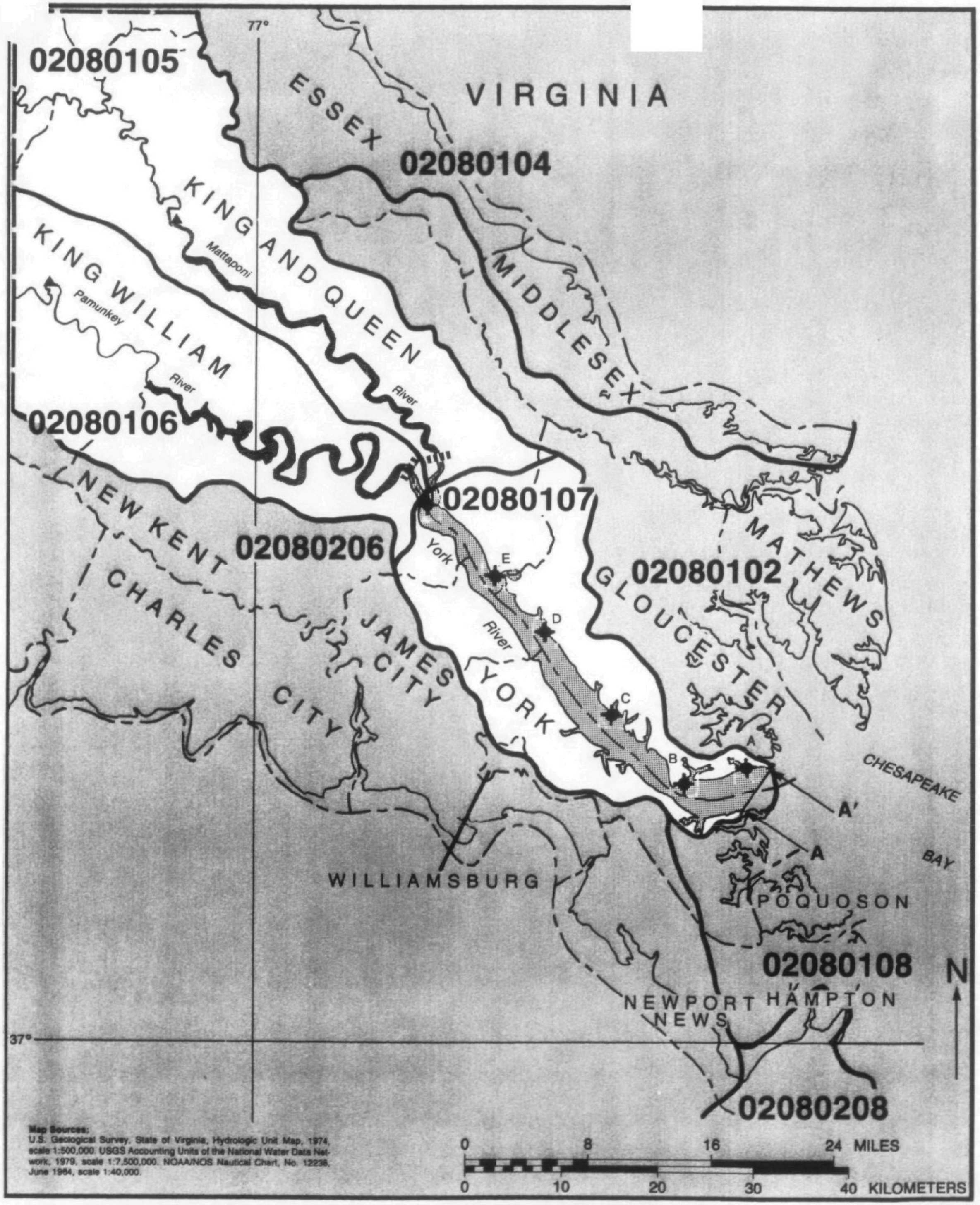
York River
VA



Map Sources:
U.S. Geological Survey, State of Virginia, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 12238, June 1984, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
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- County Boundary
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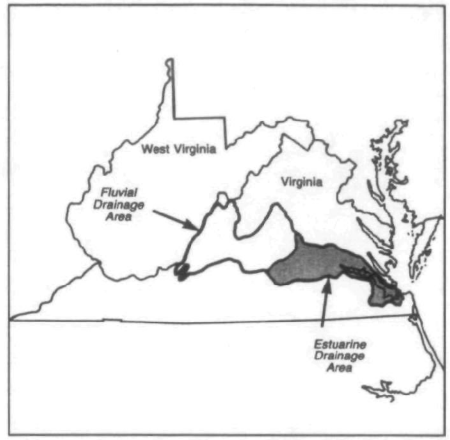
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

James River
VA



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
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- Seawater Zone
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Albemarle Sound
NC, VA

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
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- County Boundary
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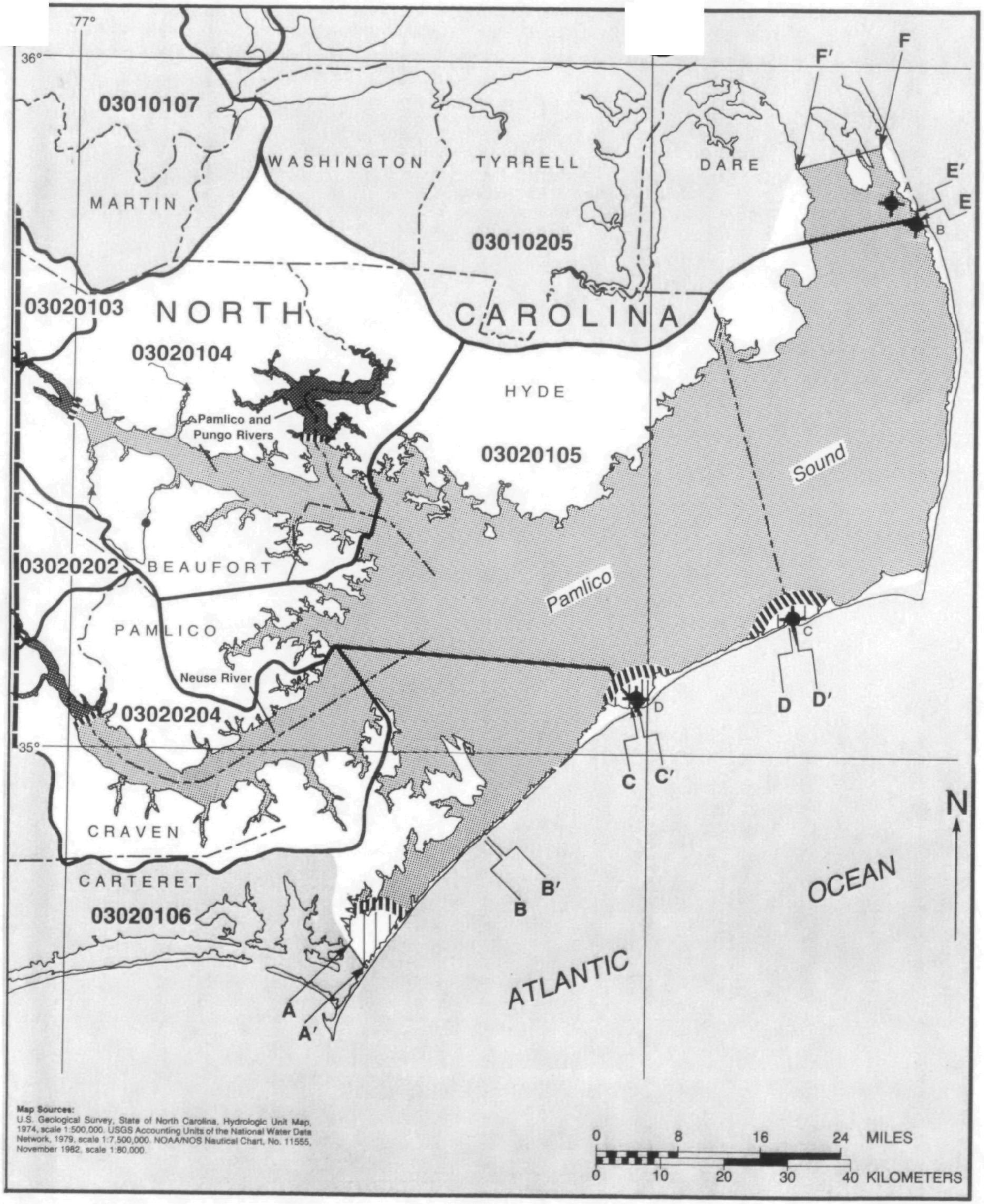
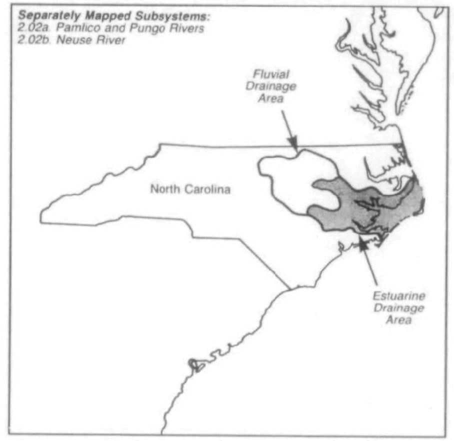
Pamlico Sound NC



Map Sources:
U.S. Geological Survey, State of North Carolina, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 11555, November 1982, scale 1:80,000.



- Tide Gage
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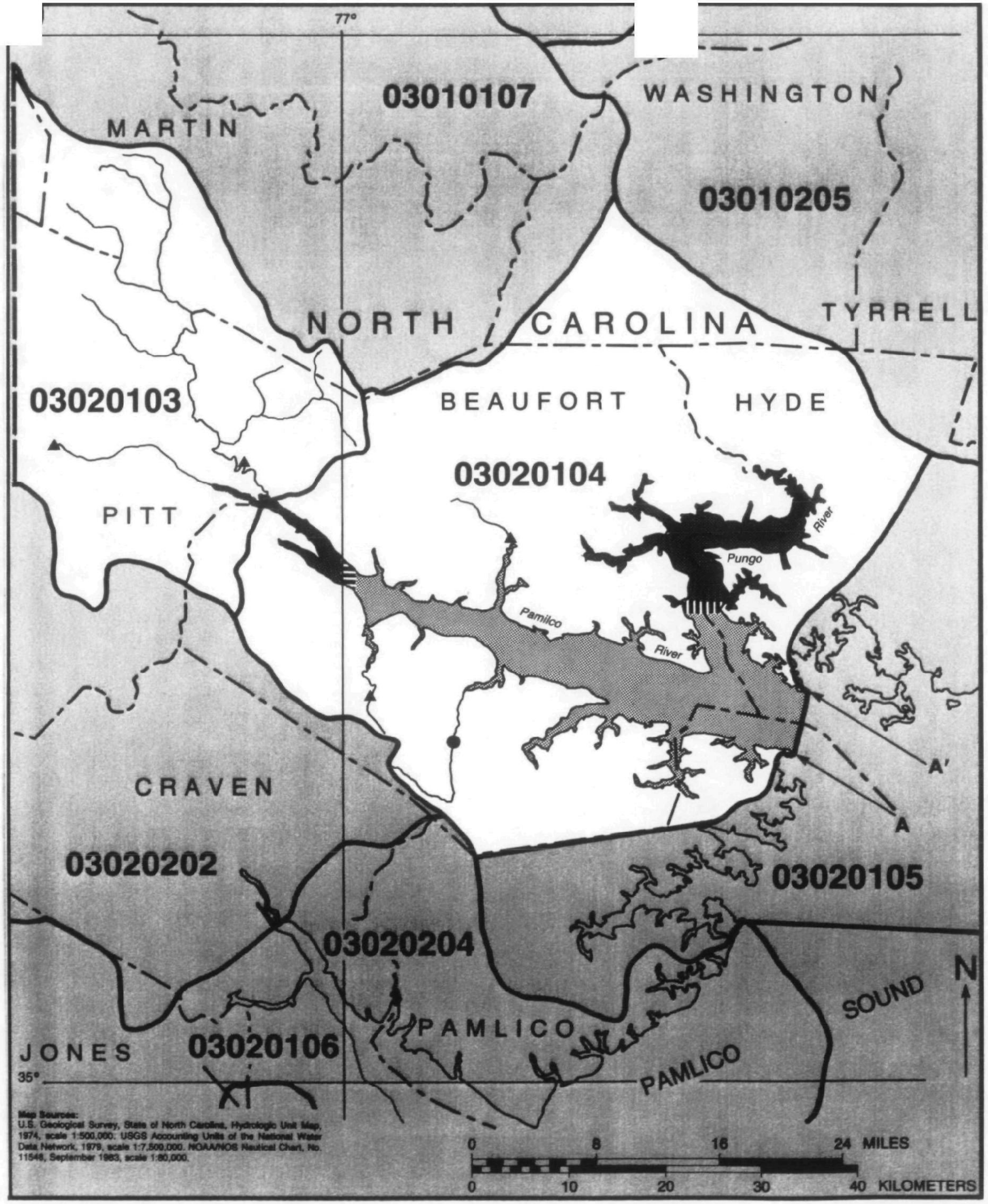
Pamlico and Pungo Ri
NC



- Tide Gage
- Flow Gage
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- Estuarine Drainage Area (EDA)
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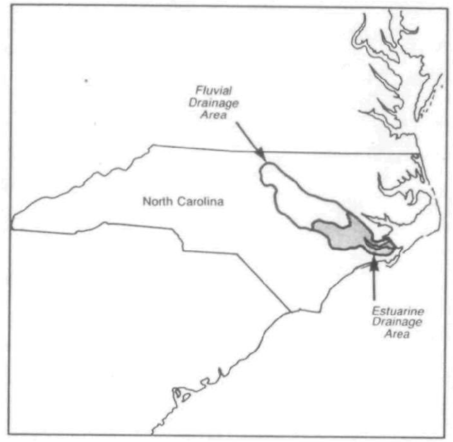
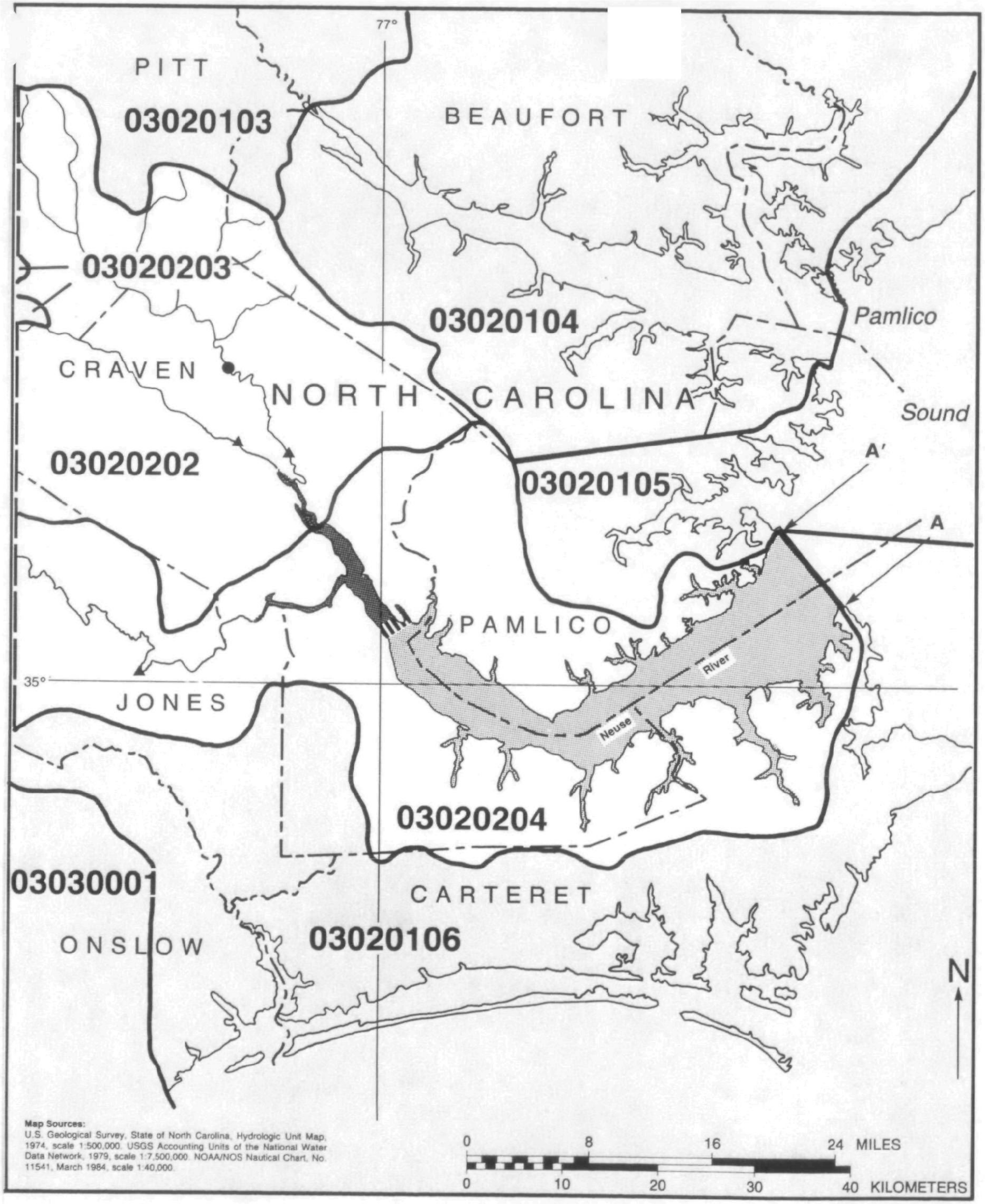
Neuse River
NC





Map Sources:
U.S. Geological Survey, State of North Carolina, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 11541, March 1984, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
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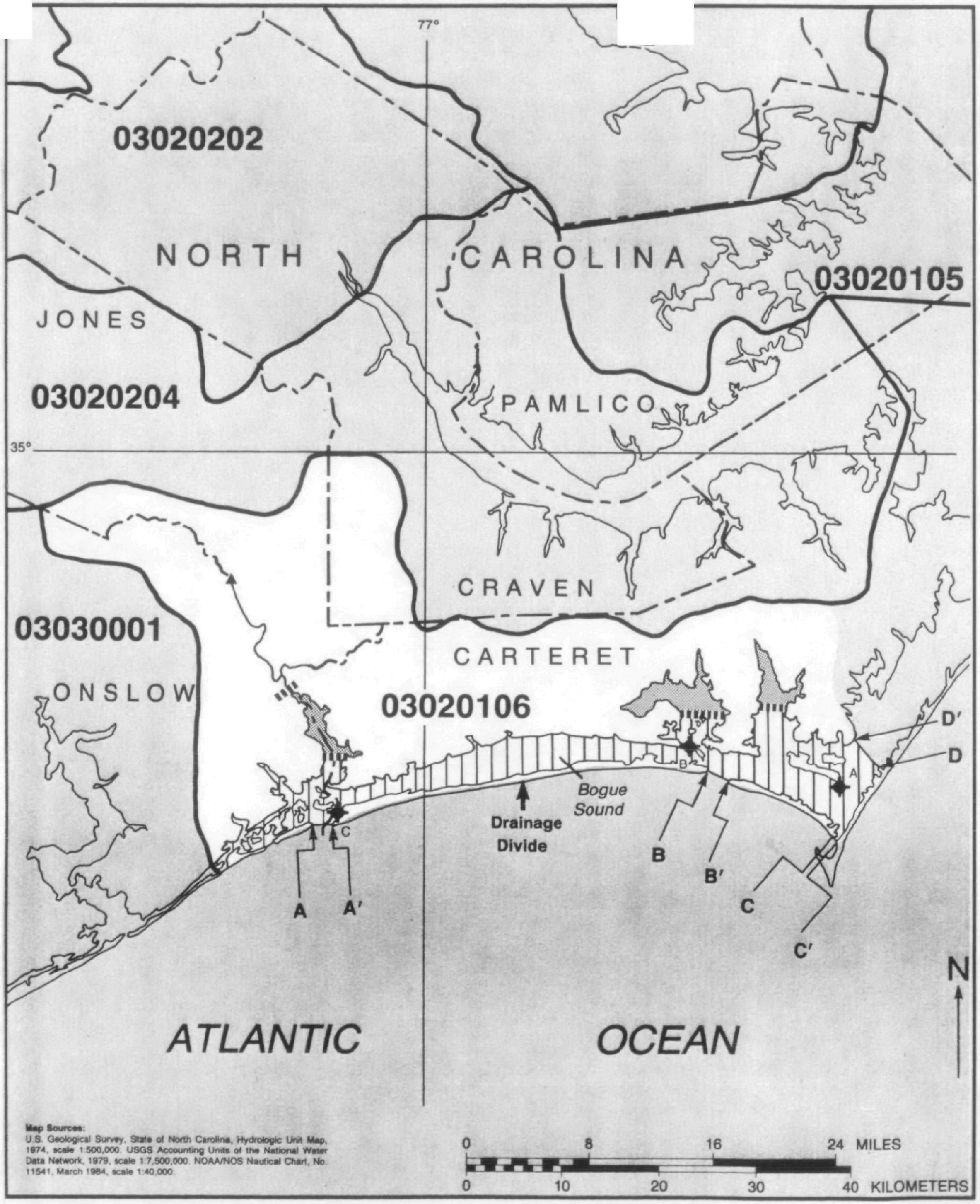
Bogue Sound
NC



- Tide Gage
- Flow Gage
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- Tidal Fresh Zone
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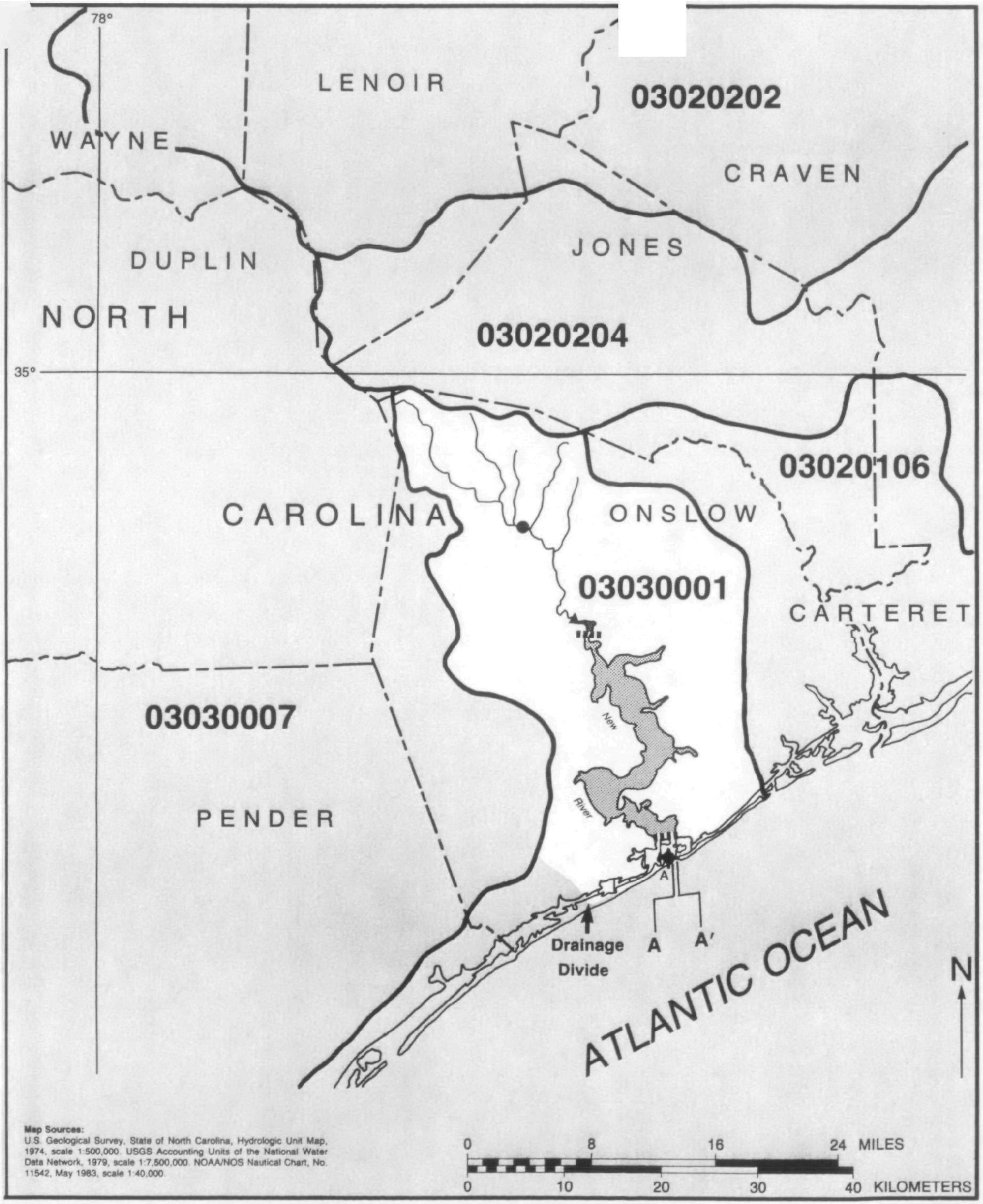
New River
NC



Map Sources:
U.S. Geological Survey, State of North Carolina, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 11542, May 1983, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
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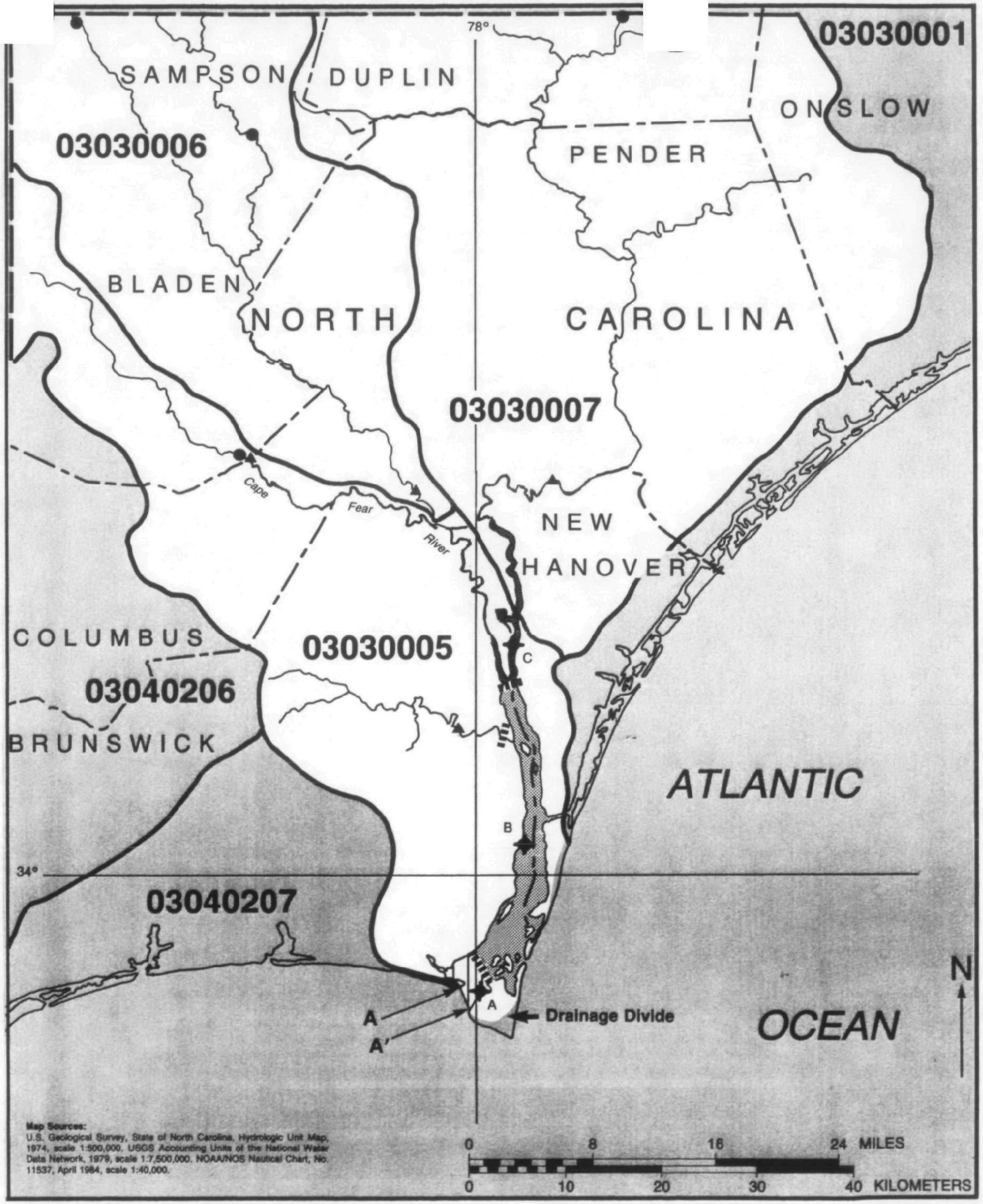
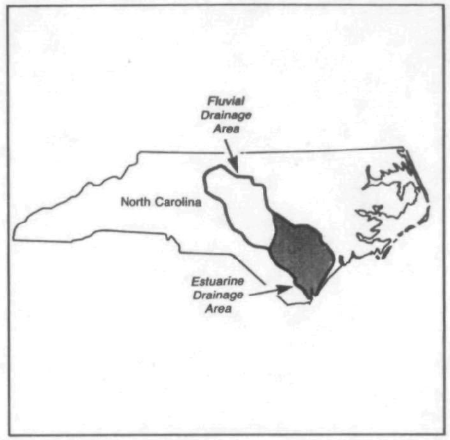
Cape Fear River NC





- Tide Gage
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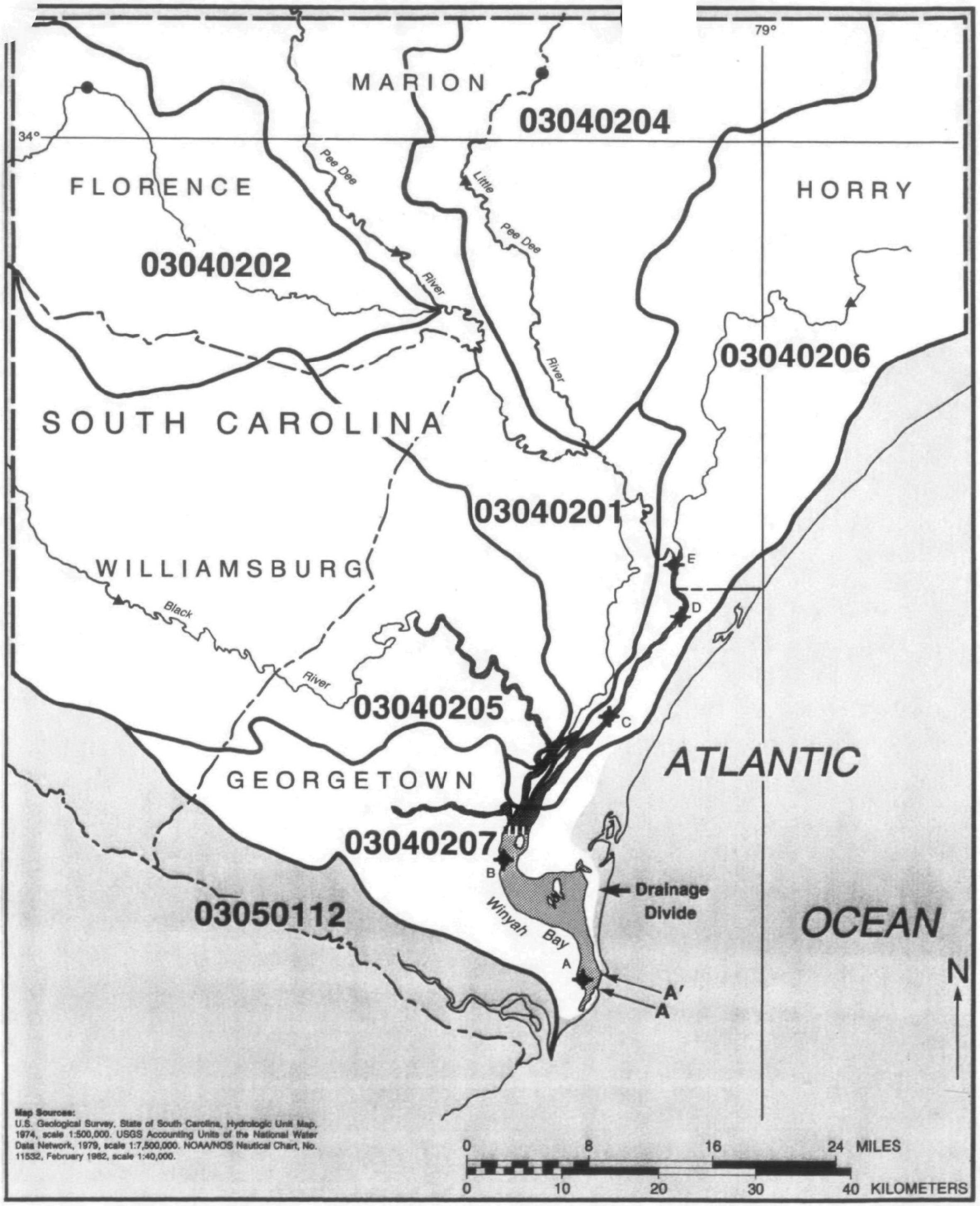
Winyah Bay
SC, NC



- Tide Gage
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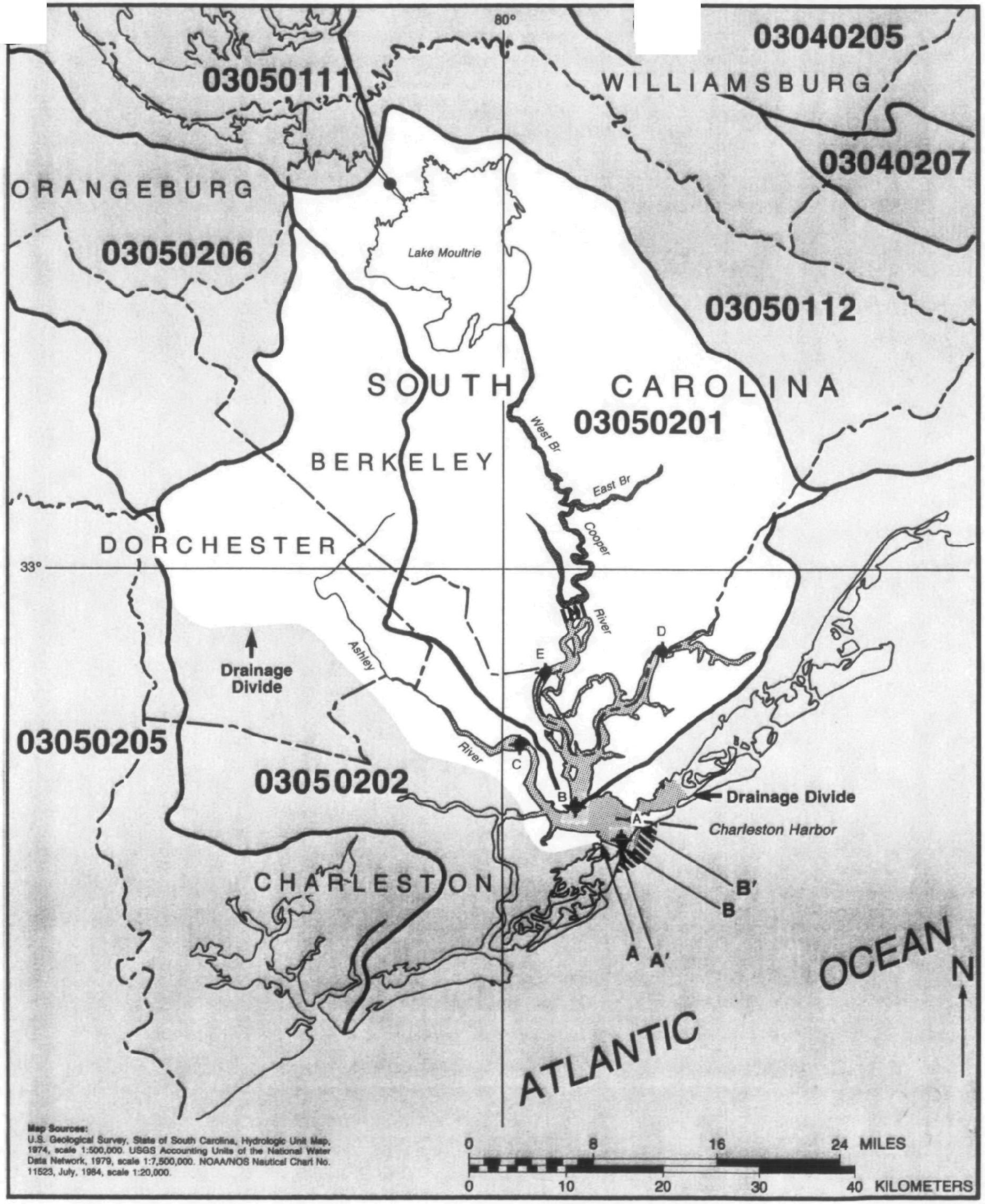
Charleston Harbor
SC



- Tide Gage
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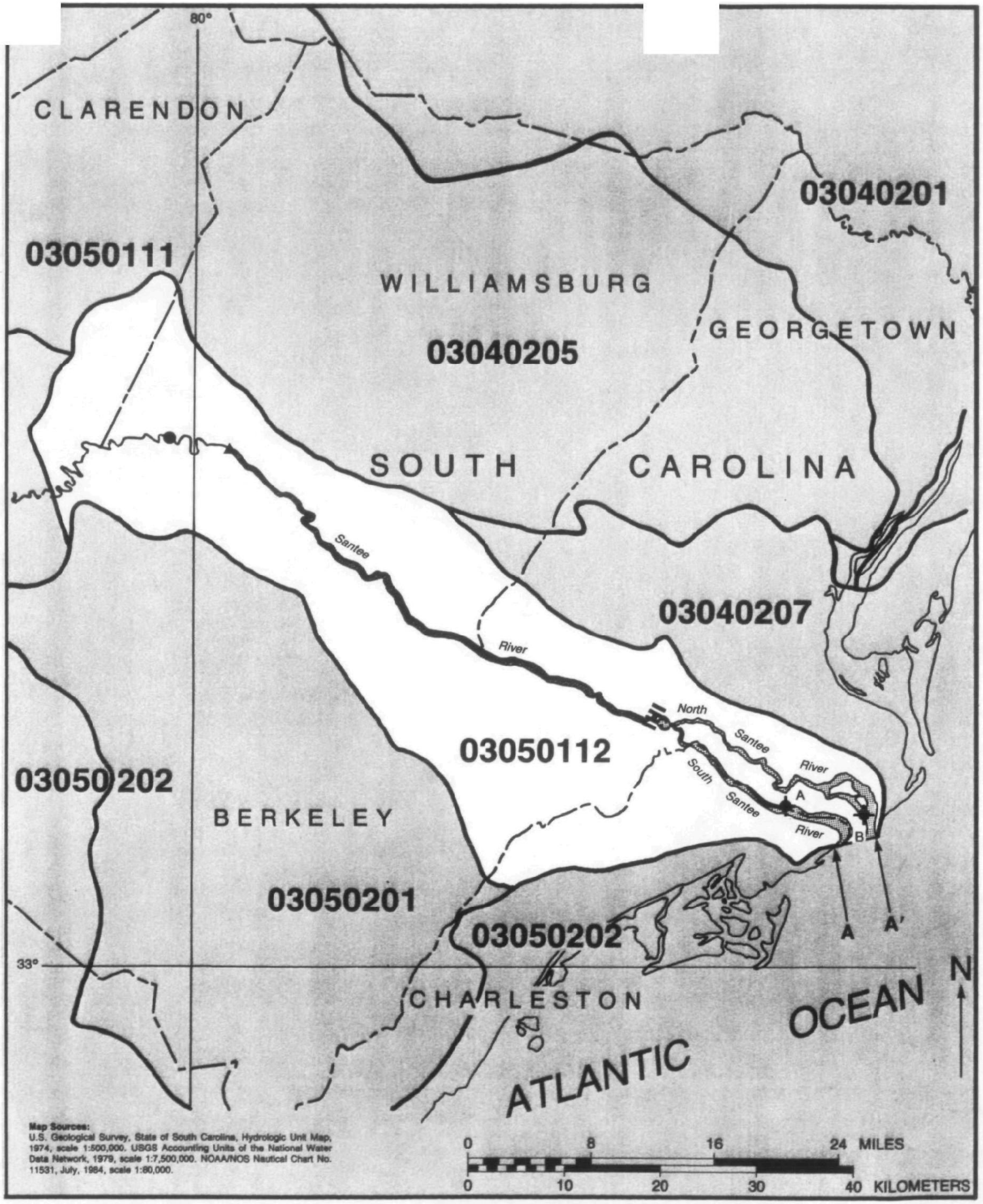
North and South Sante
Rivers
SC



Map Sources:
U.S. Geological Survey, State of South Carolina, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart No. 11531, July, 1984, scale 1:80,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
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- County Boundary
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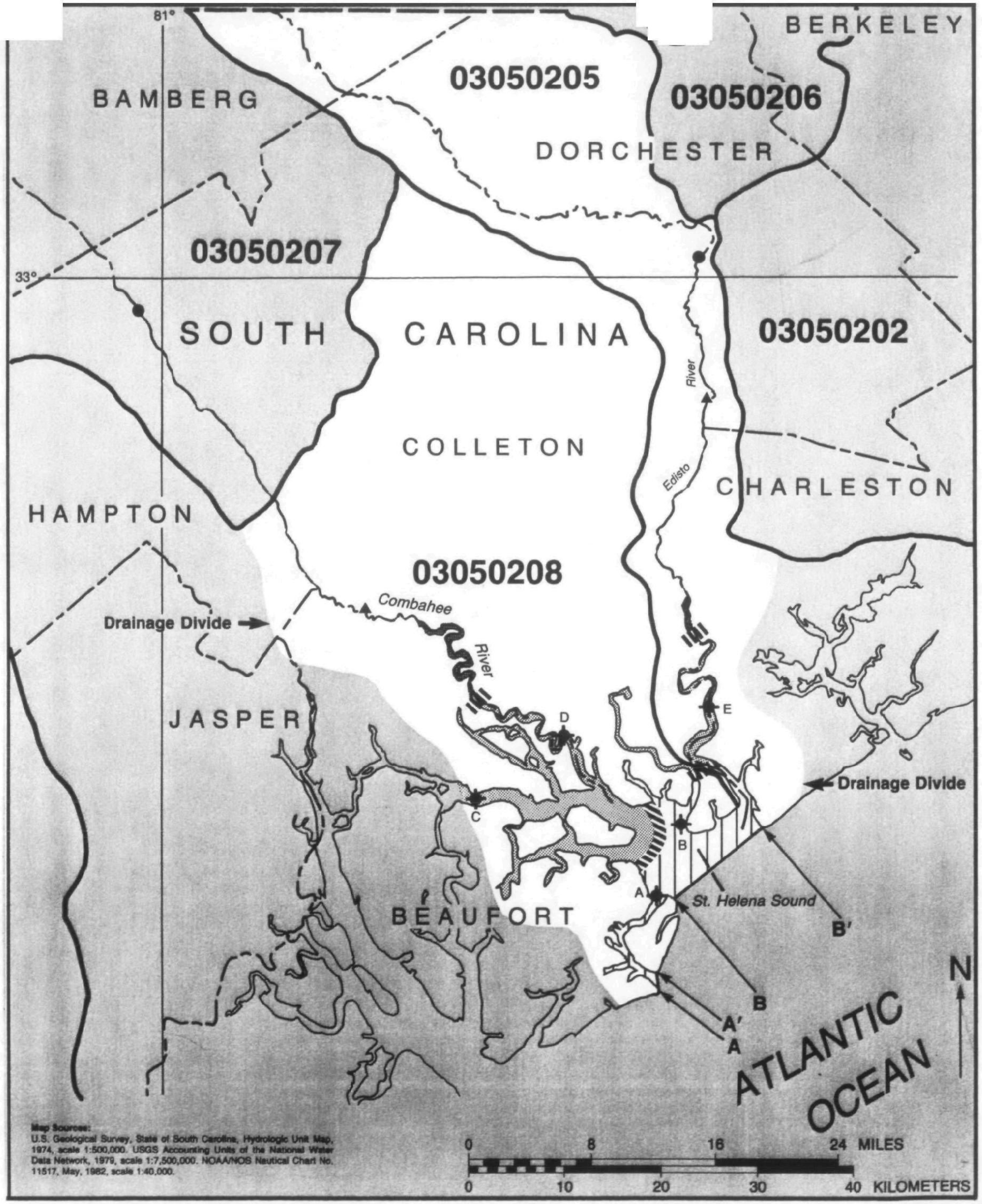
St. Helena Sound SC



- Tide Gage
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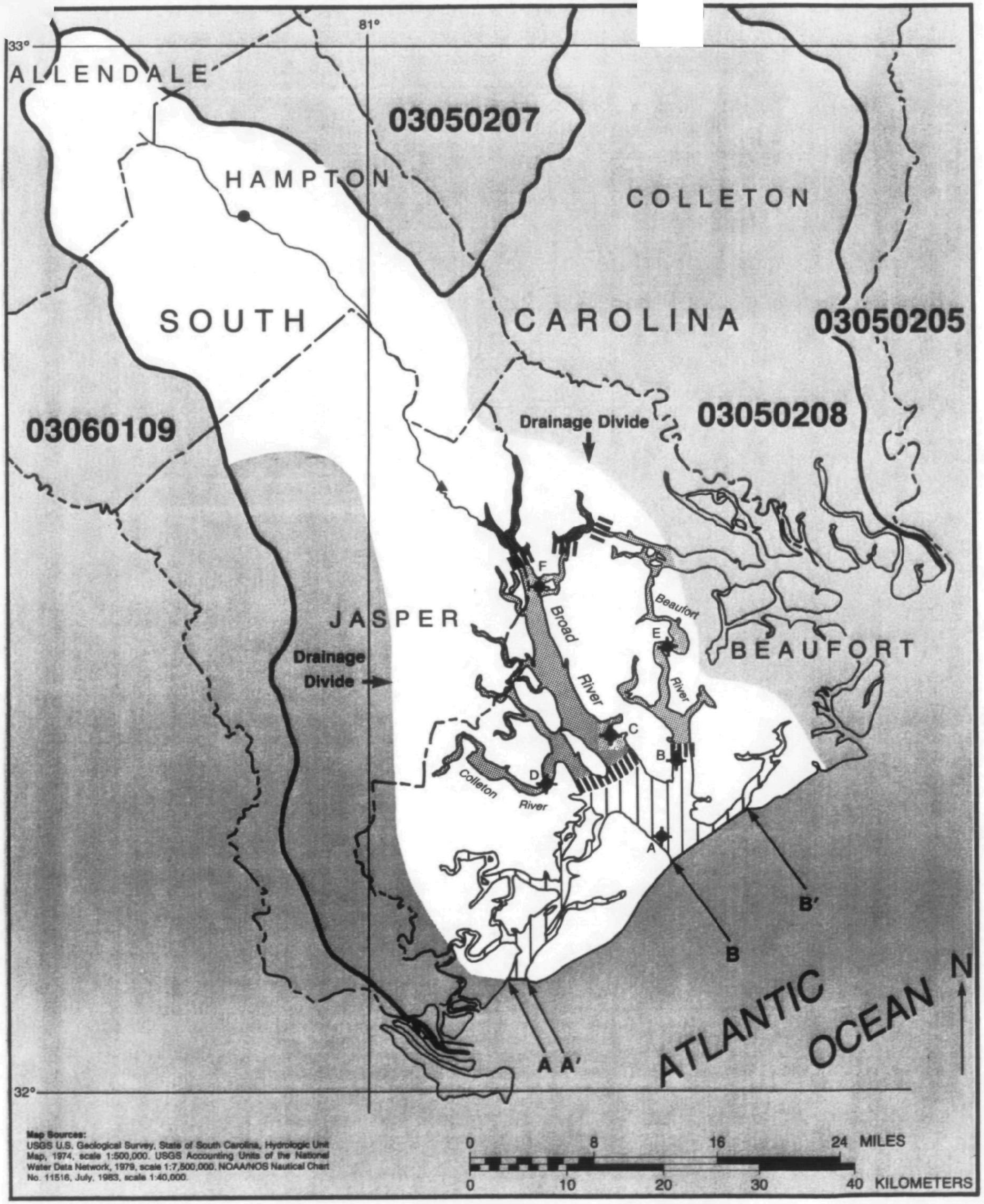
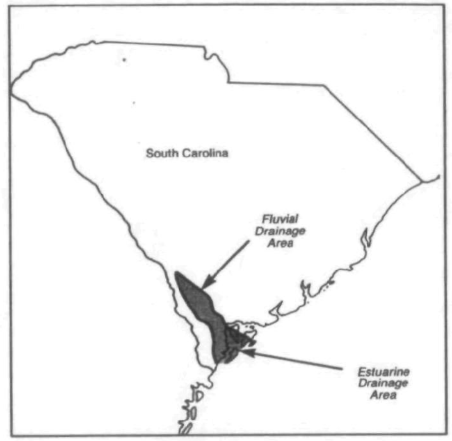
Broad River
SC





- Tide Gage
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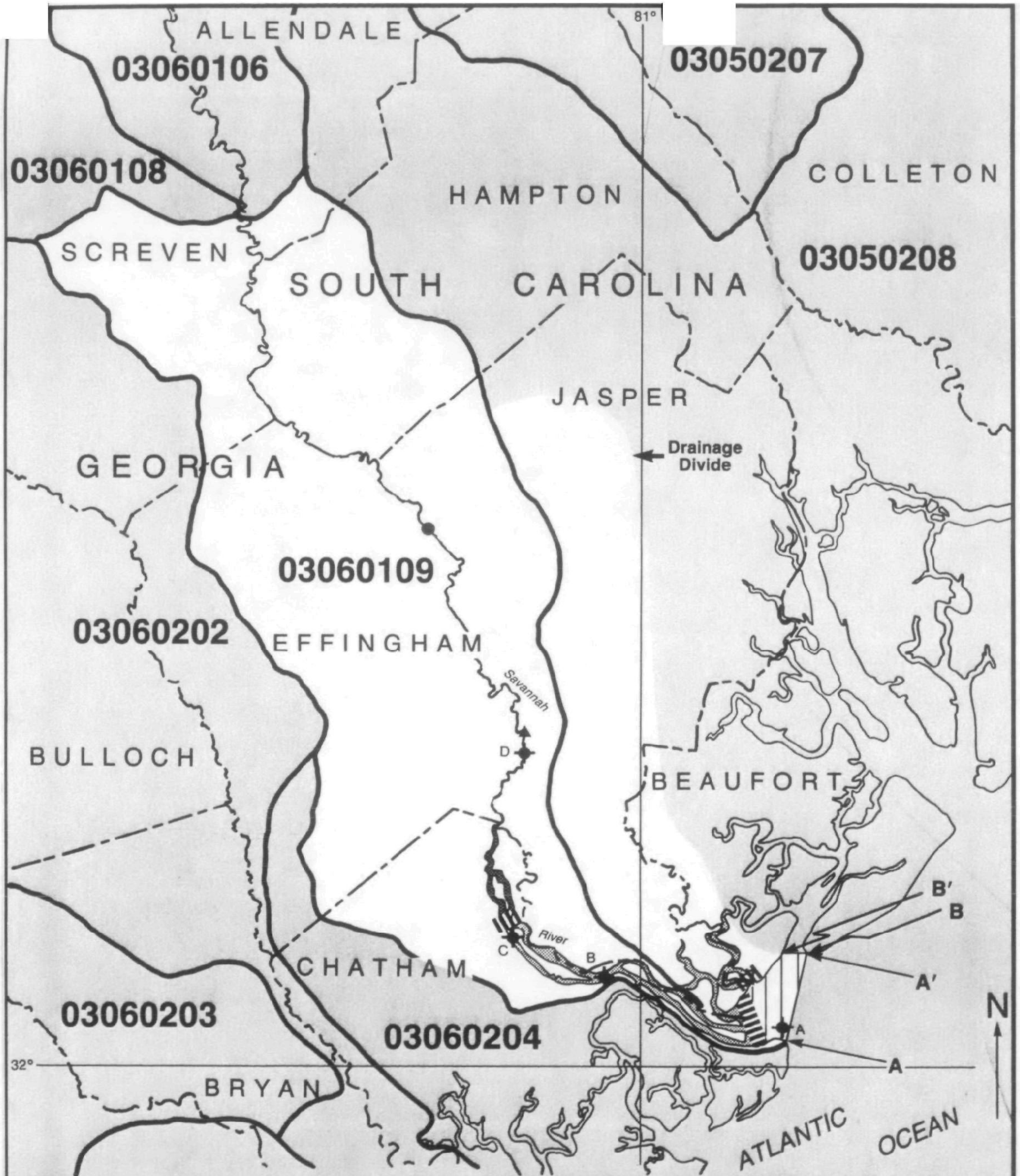
Savannah River
SC, GA



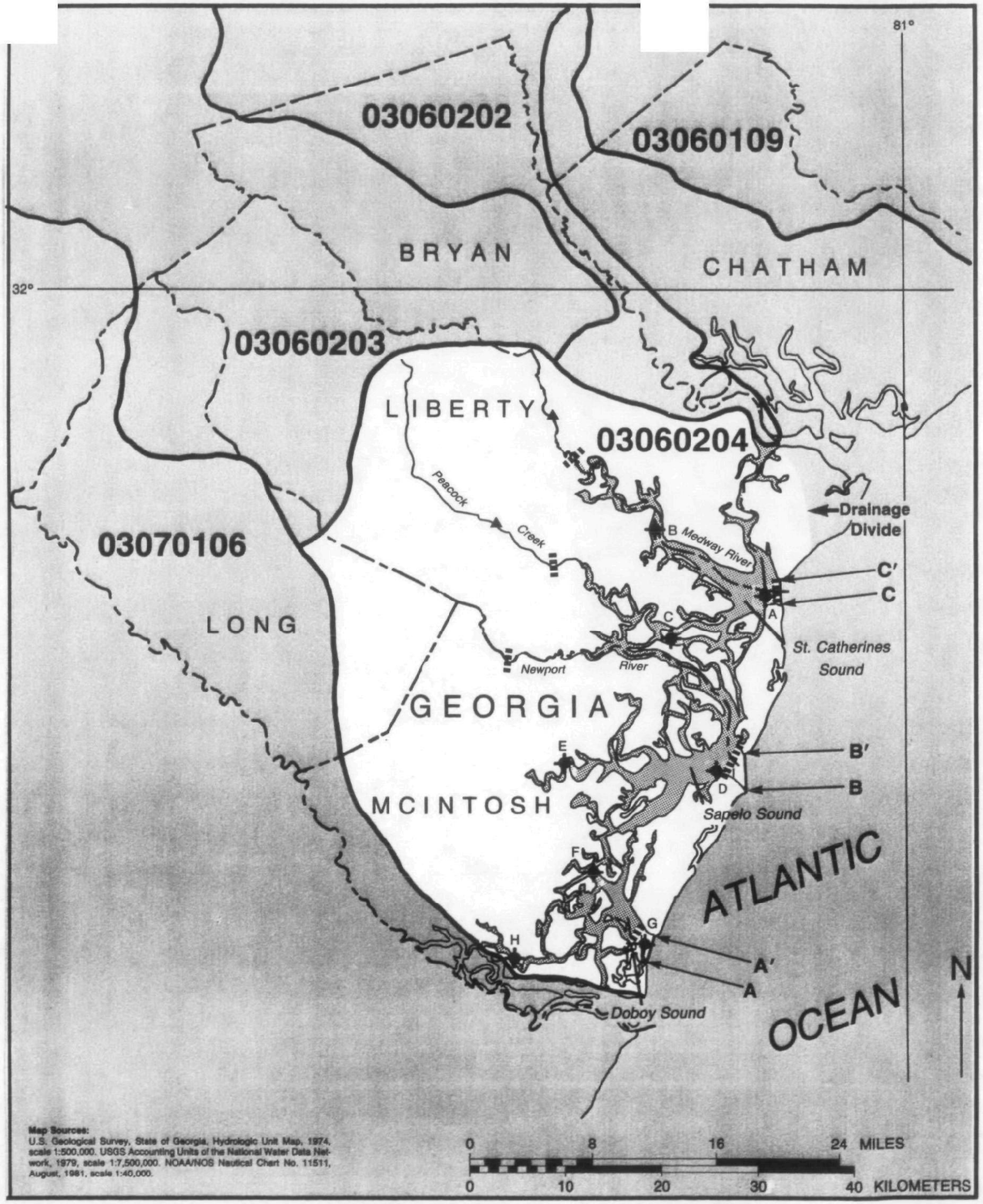
Map Sources:
U.S. Geological Survey, States of South Carolina and Georgia, Hydrologic Unit Maps, 1974, scale 1:500,000. NOAA/NOS Nautical Chart No. 11512, April, 1984, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Ossabaw Sound
GA

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

St. Catherines/Sapelo Sc GA



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
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- County Boundary
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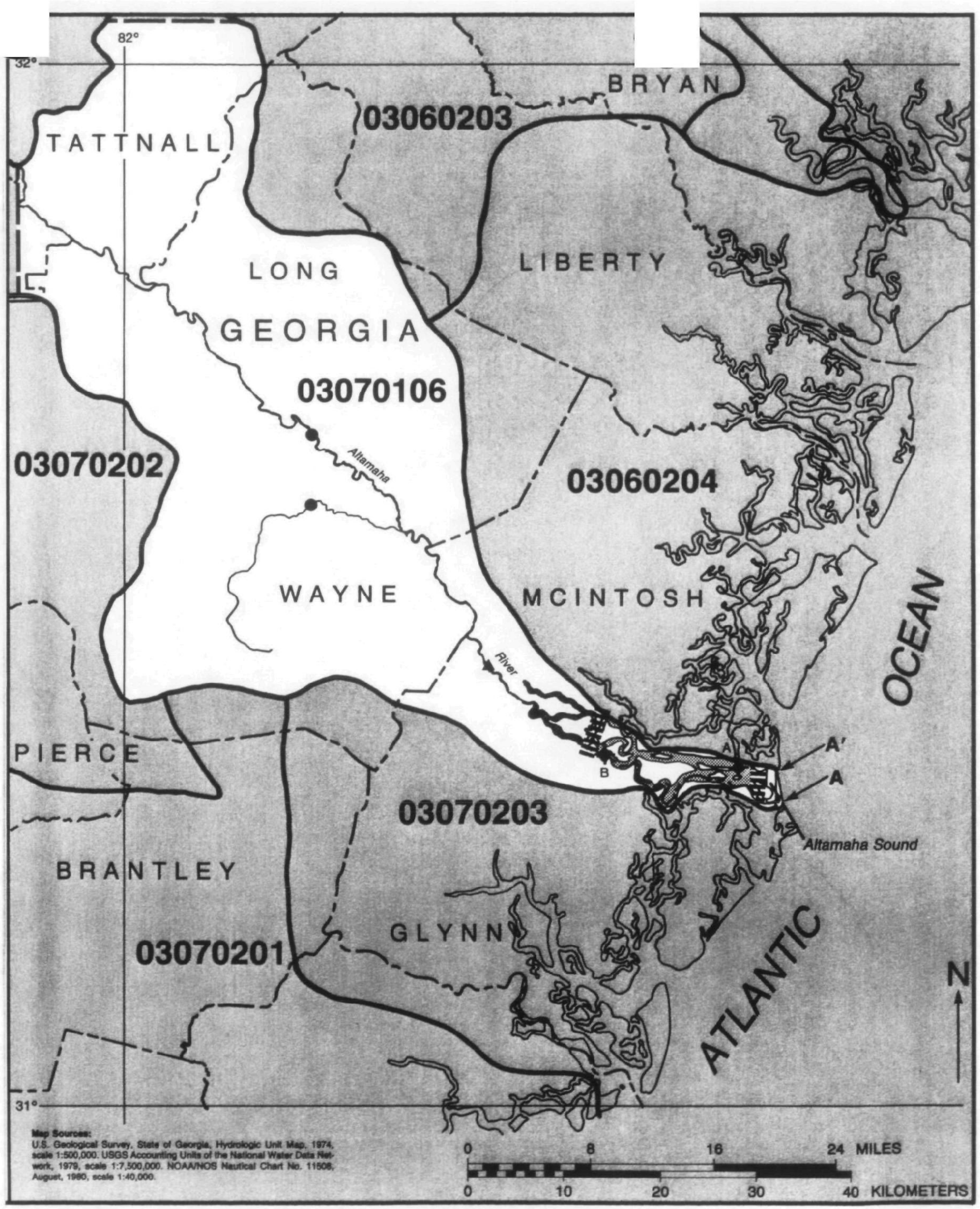
Altamaha River
GA



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
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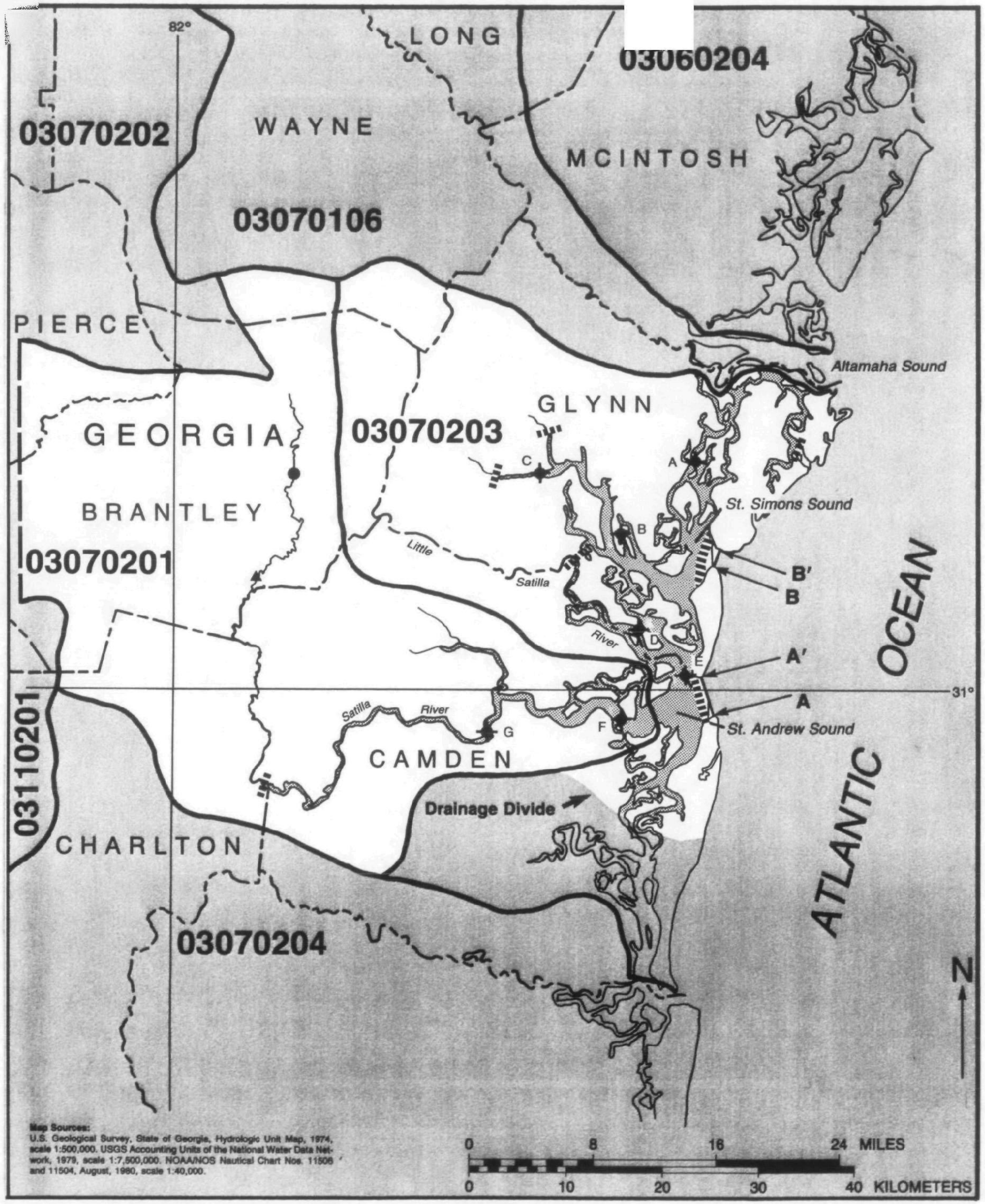
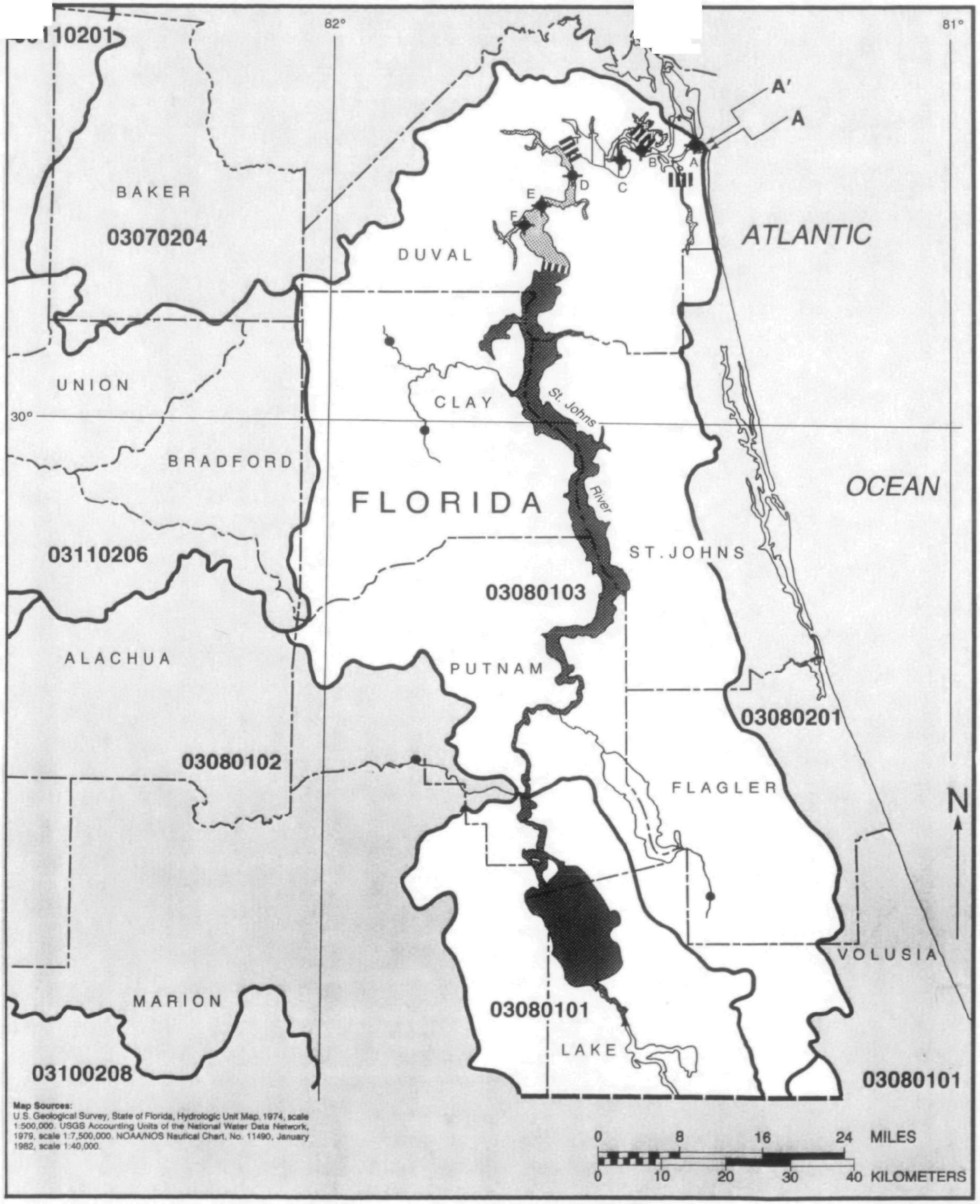
St. Andrew/St. Simons Sound GA



Map Sources:
U.S. Geological Survey, State of Georgia, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart Nos. 11506 and 11504, August, 1980, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

St. Johns River
FL



Map Sources:
U.S. Geological Survey, State of Florida, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 11490, January 1982, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
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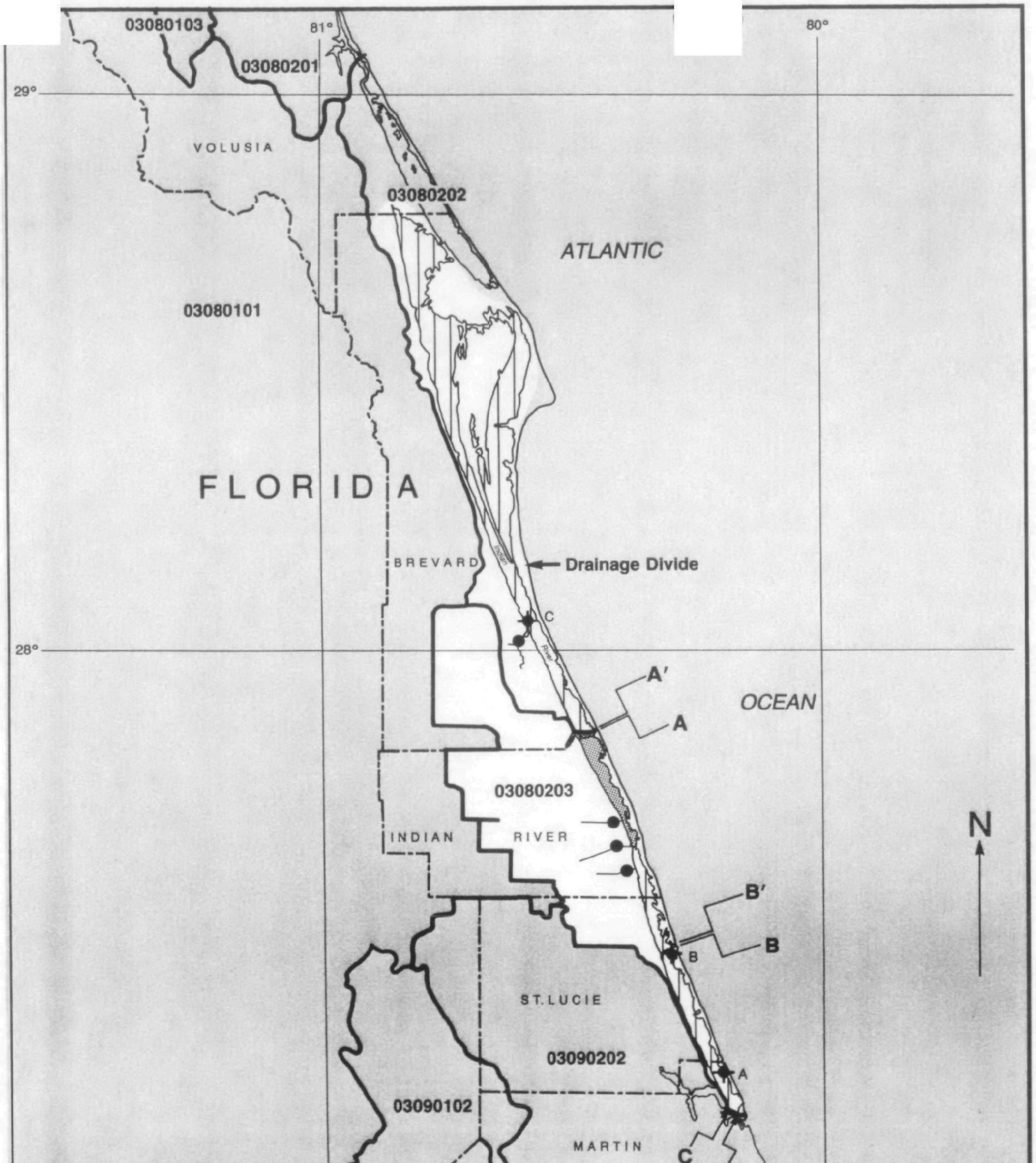
Indian River
FL



Map Sources:
U.S. Geological Survey, State of Florida, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 11472, September 1983, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
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- Salinity Zone Boundary - High Variability

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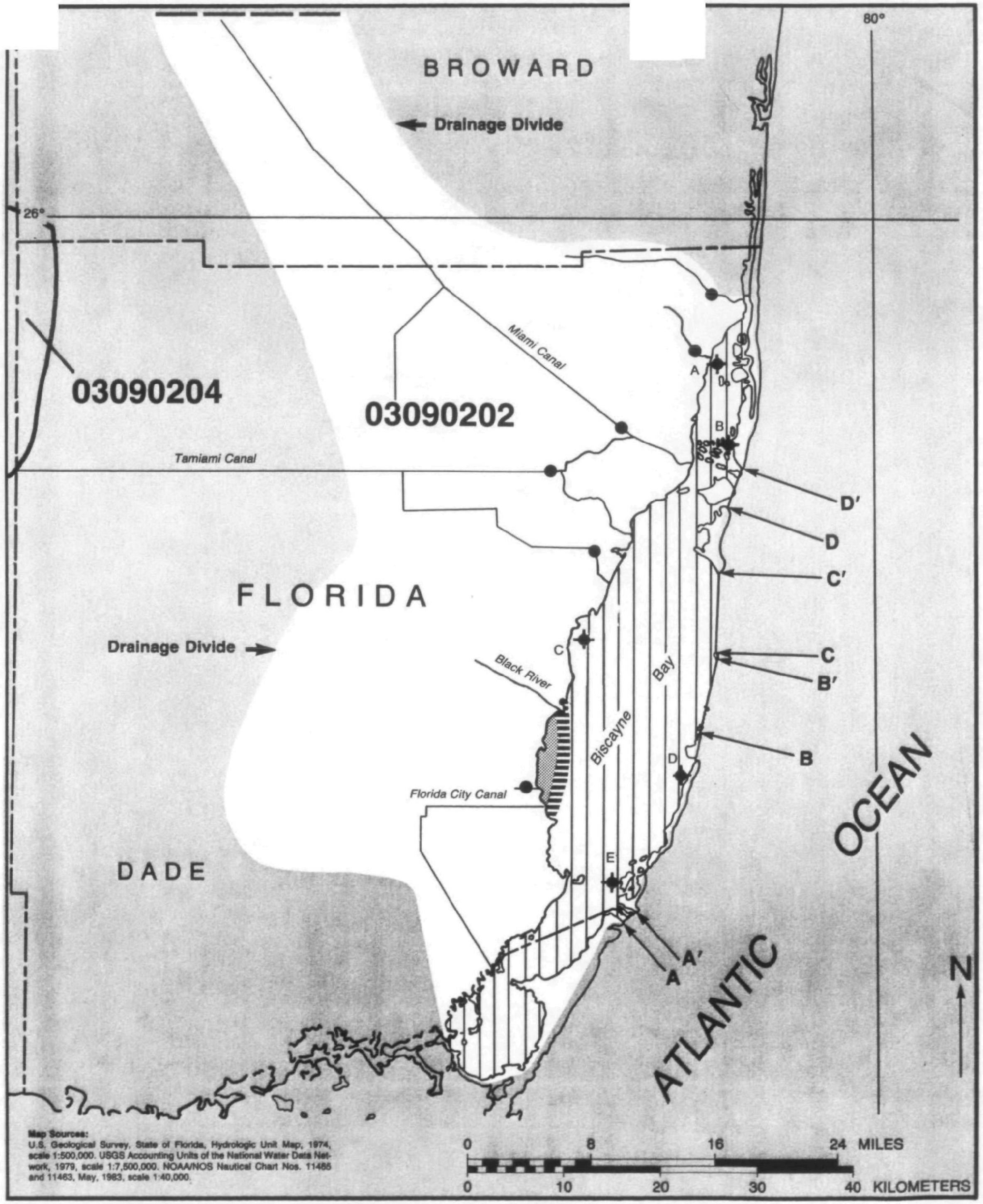
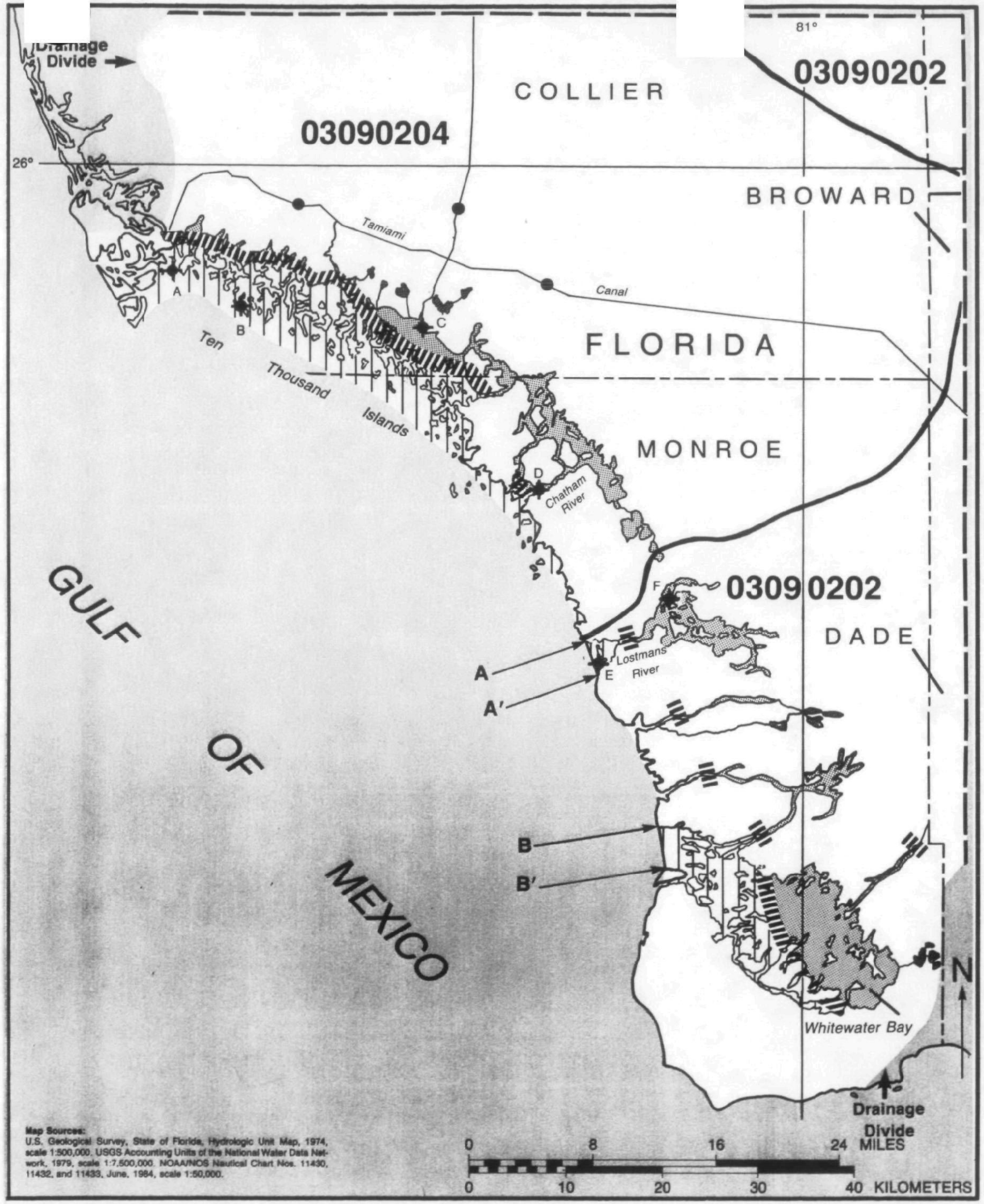
Biscayne Bay
FL



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Ten Thousand Islands FL



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
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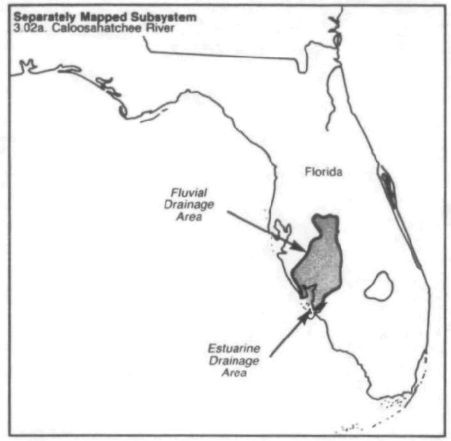
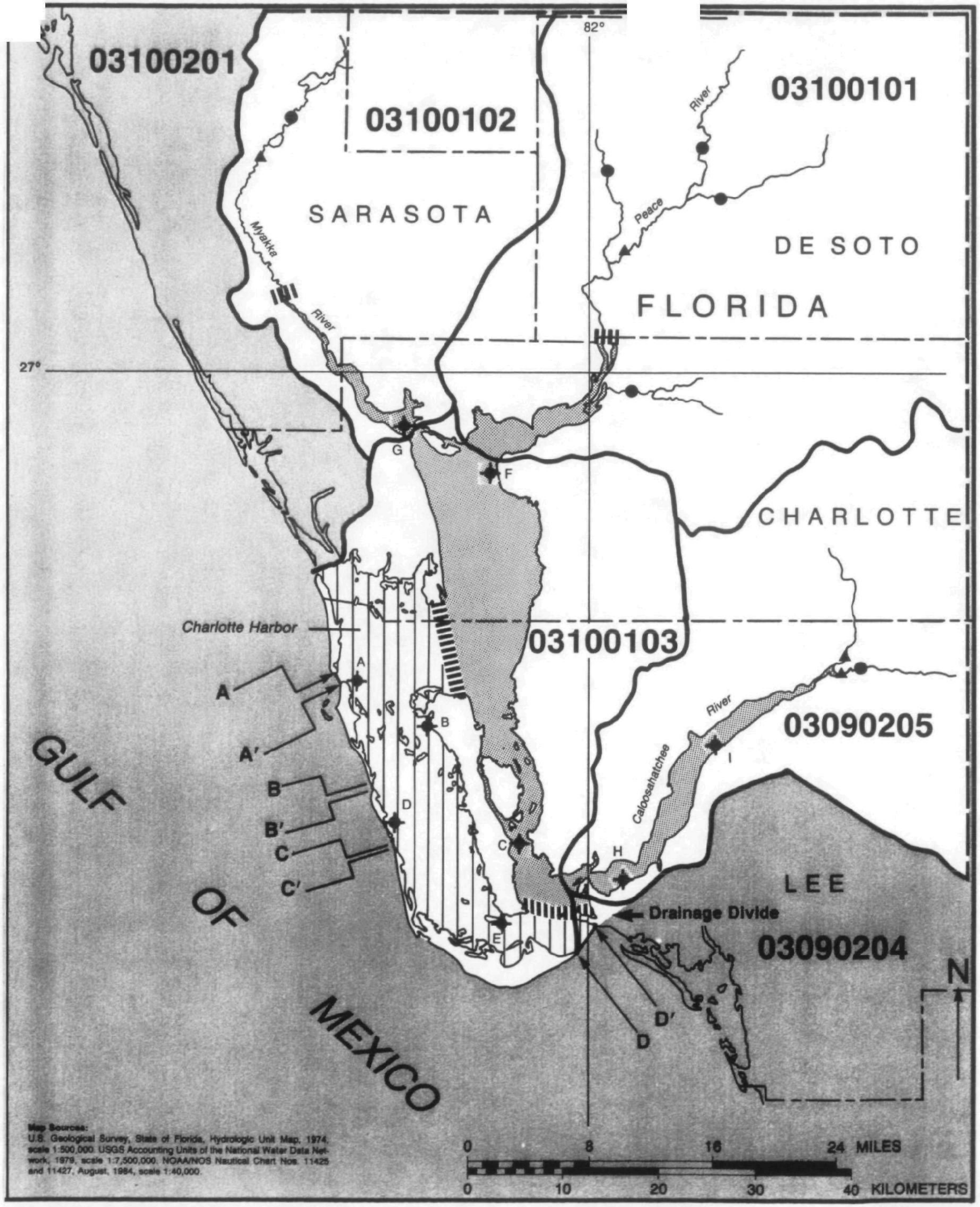
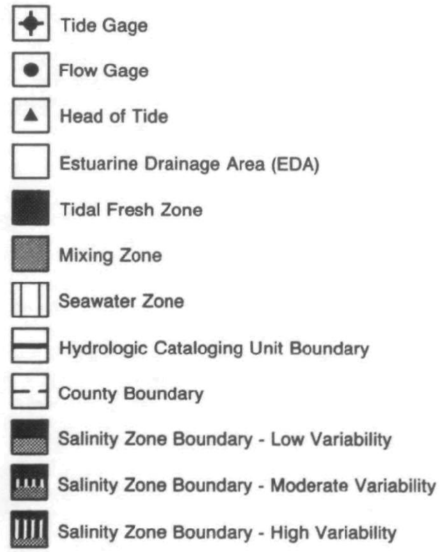
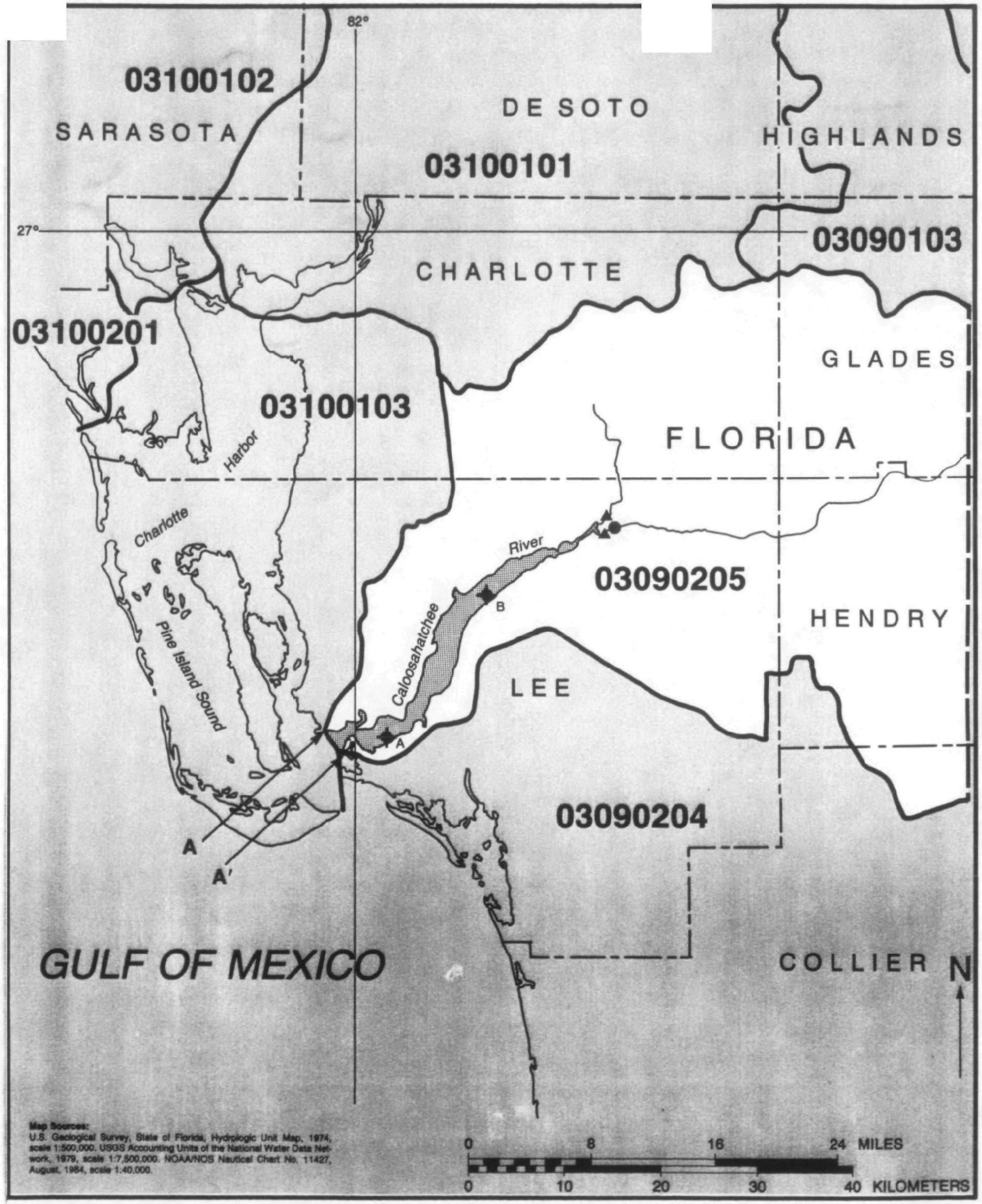
Charlotte Harbor
FL





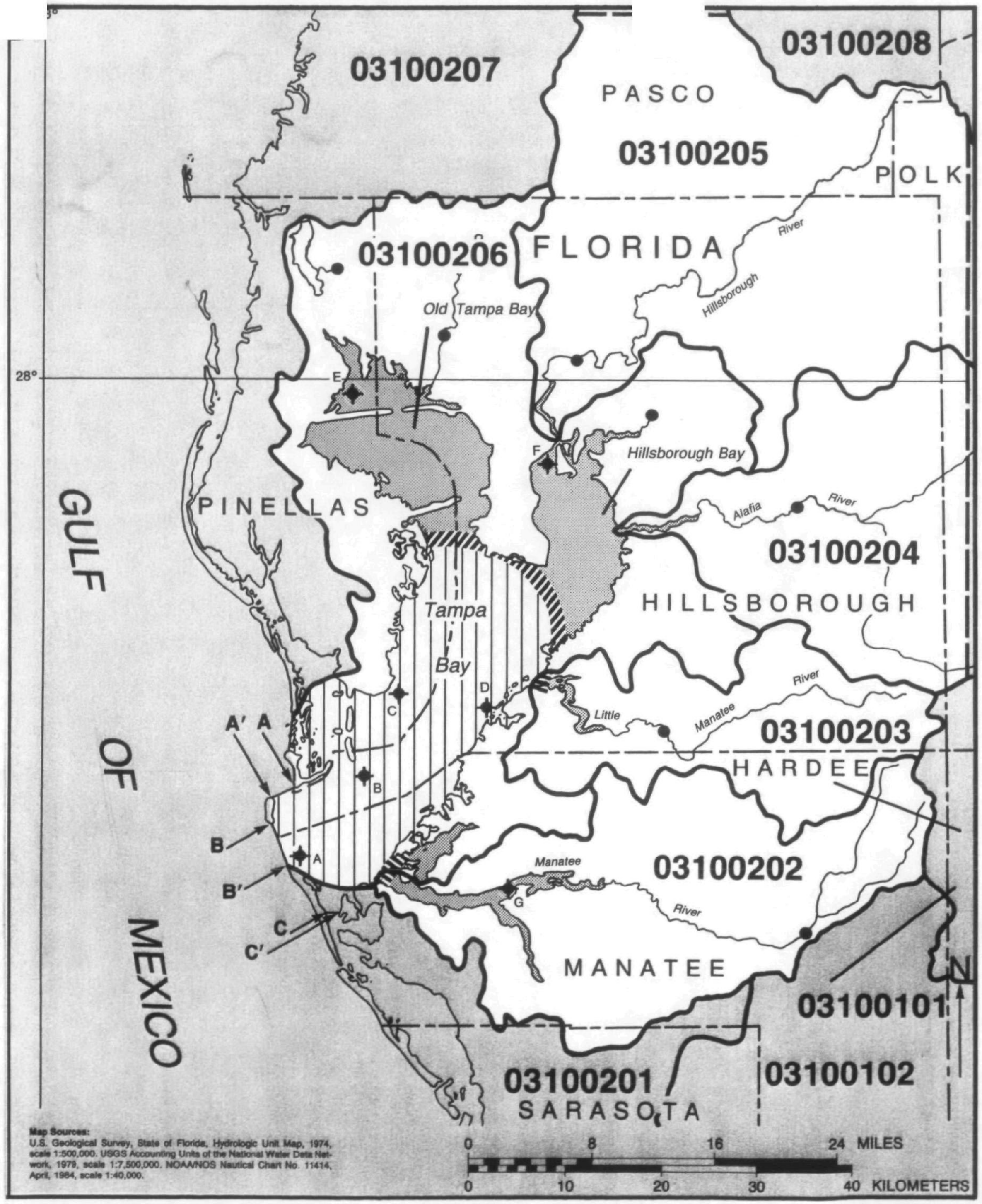


Caloosahatchee River FL



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Tampa Bay
FL



Map Sources:
U.S. Geological Survey, State of Florida, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart No. 11414, April, 1984, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
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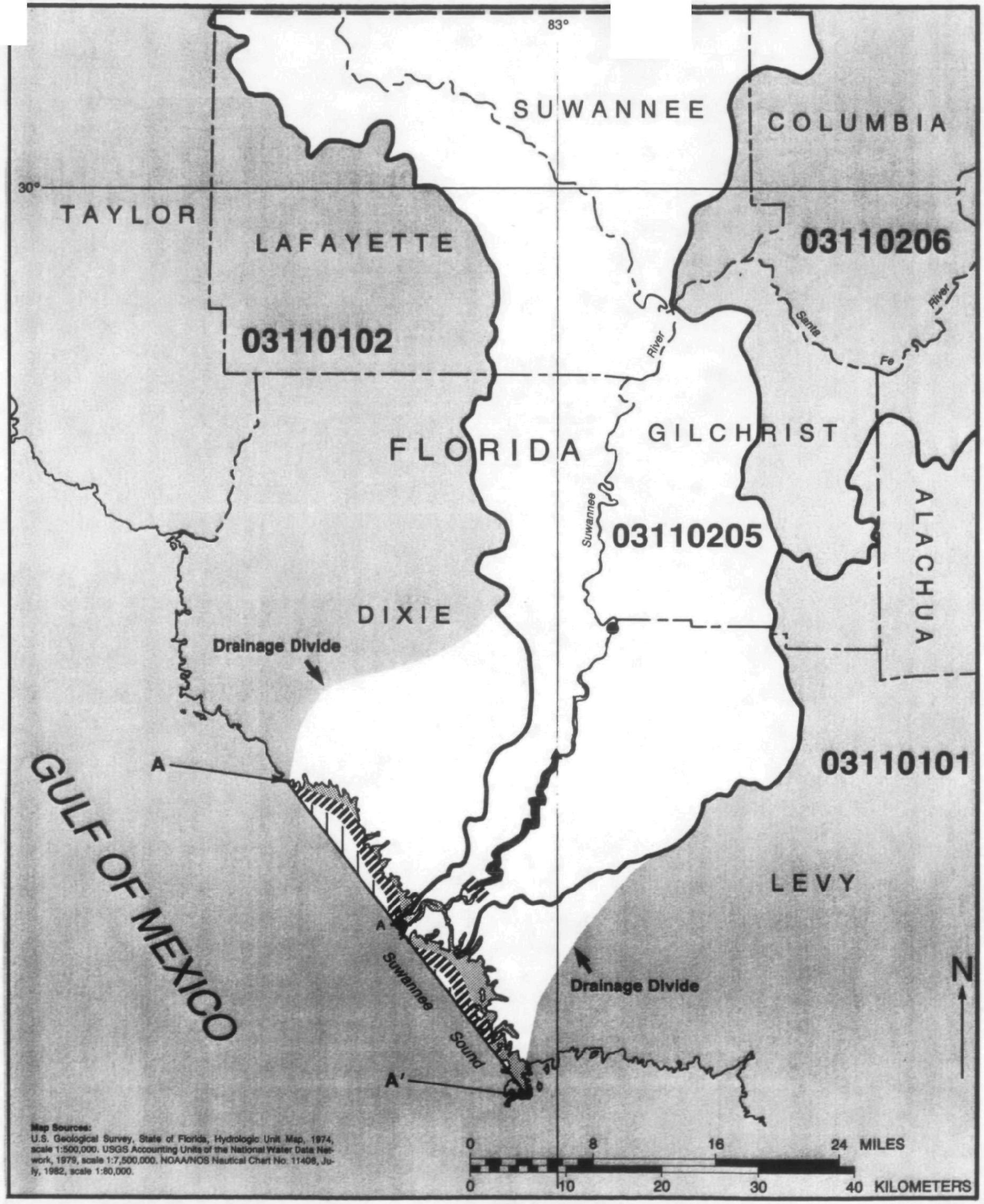
Suwannee River
FL



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
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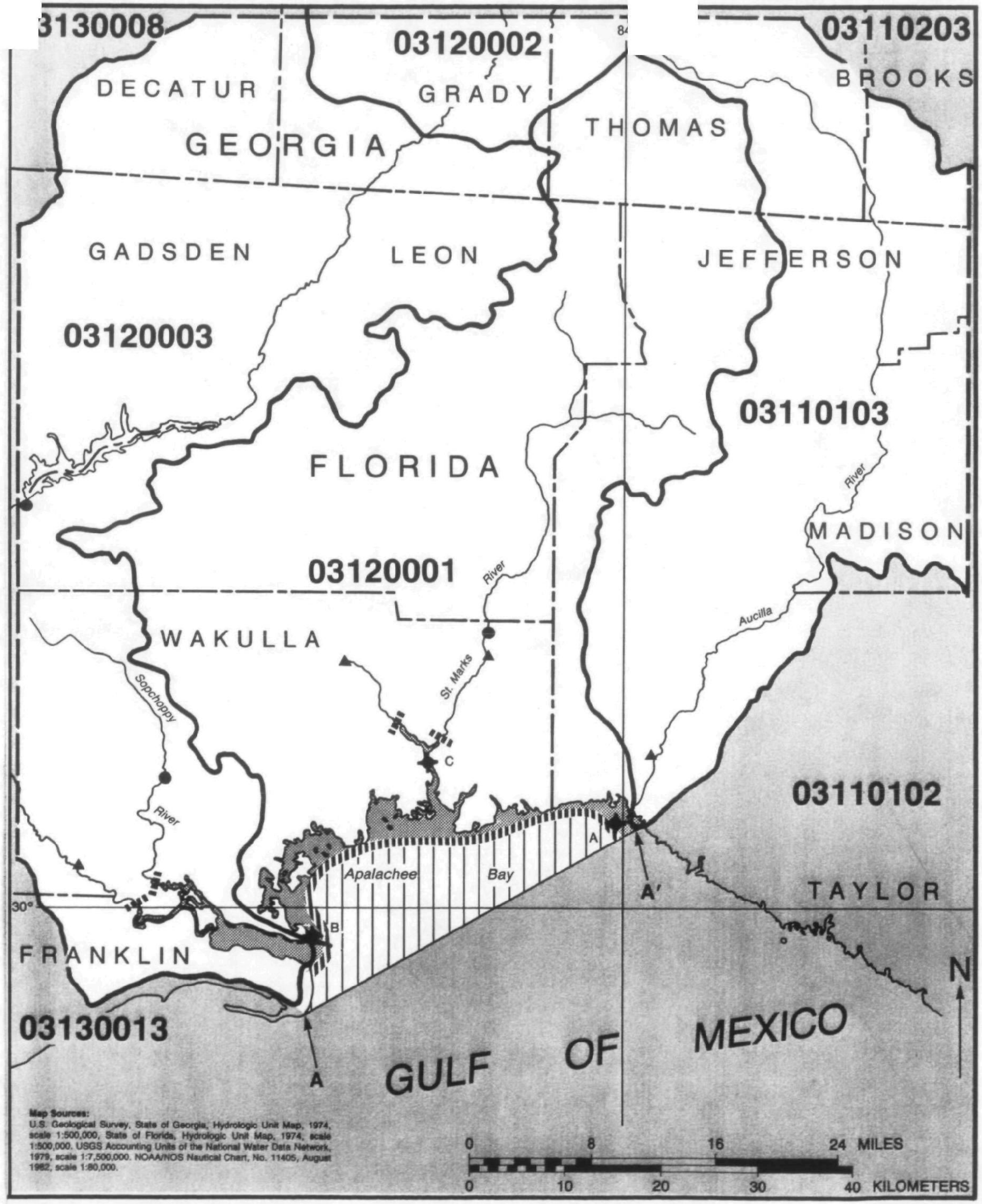
Apalachee Bay
FL, GA



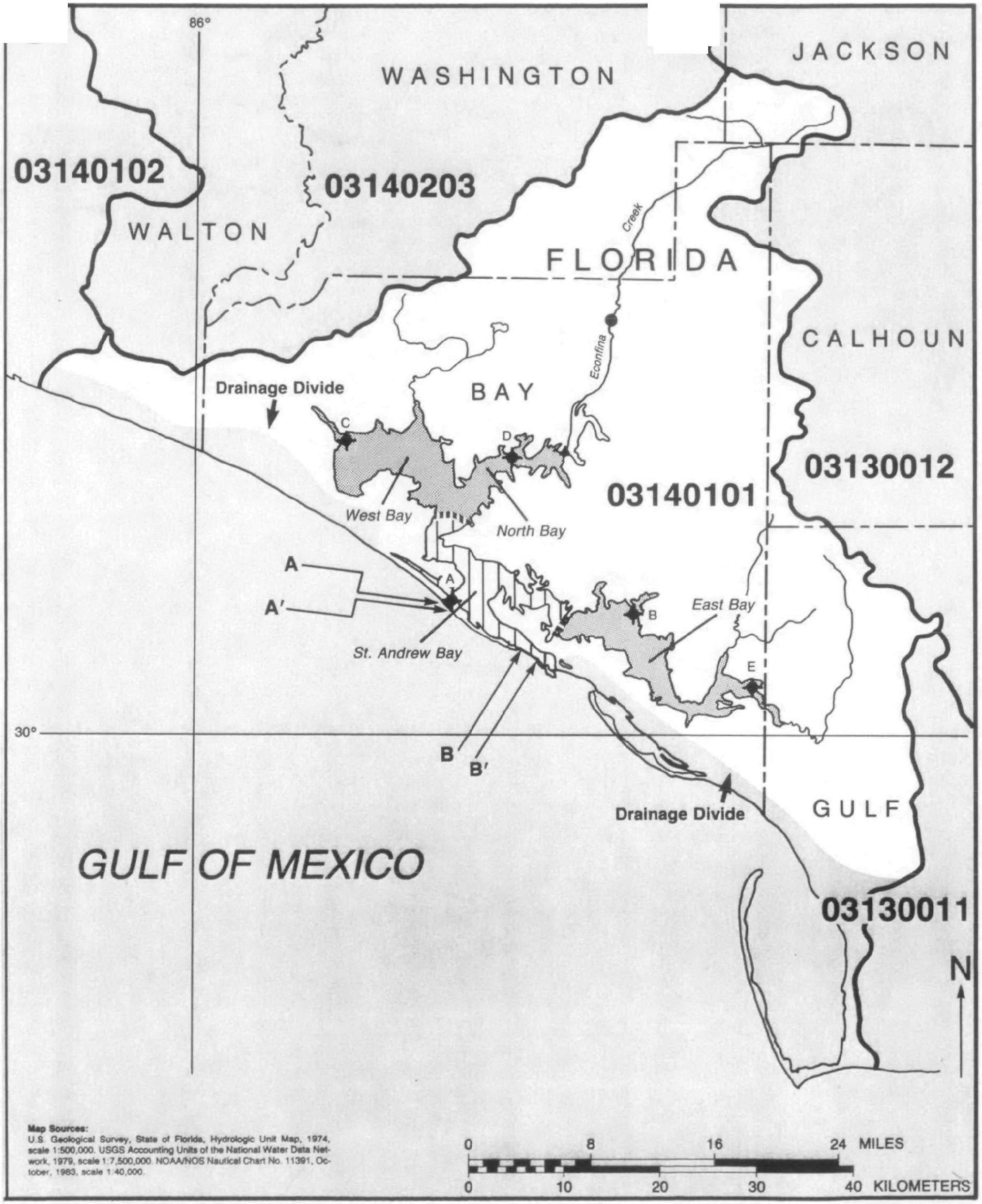
Map Sources:
U.S. Geological Survey, State of Georgia, Hydrologic Unit Map, 1974, scale 1:500,000, State of Florida, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart, No. 11405, August 1982, scale 1:80,000.

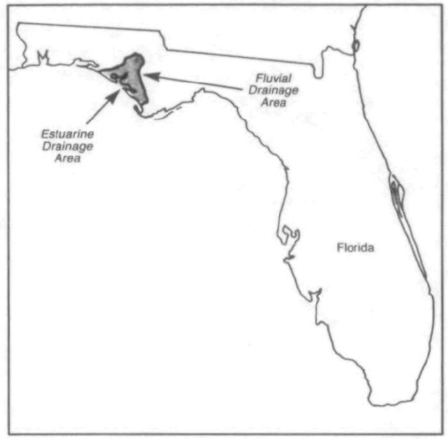
- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Apalachicola Bay
FL

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

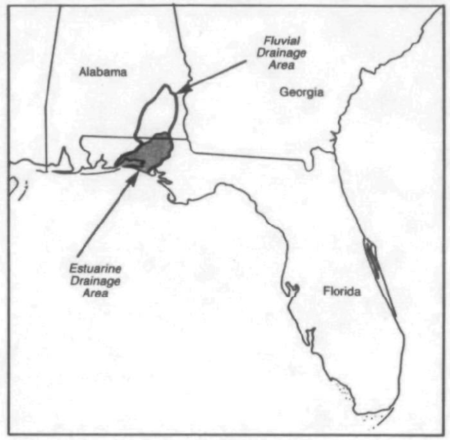
St. Andrew Bay
FL



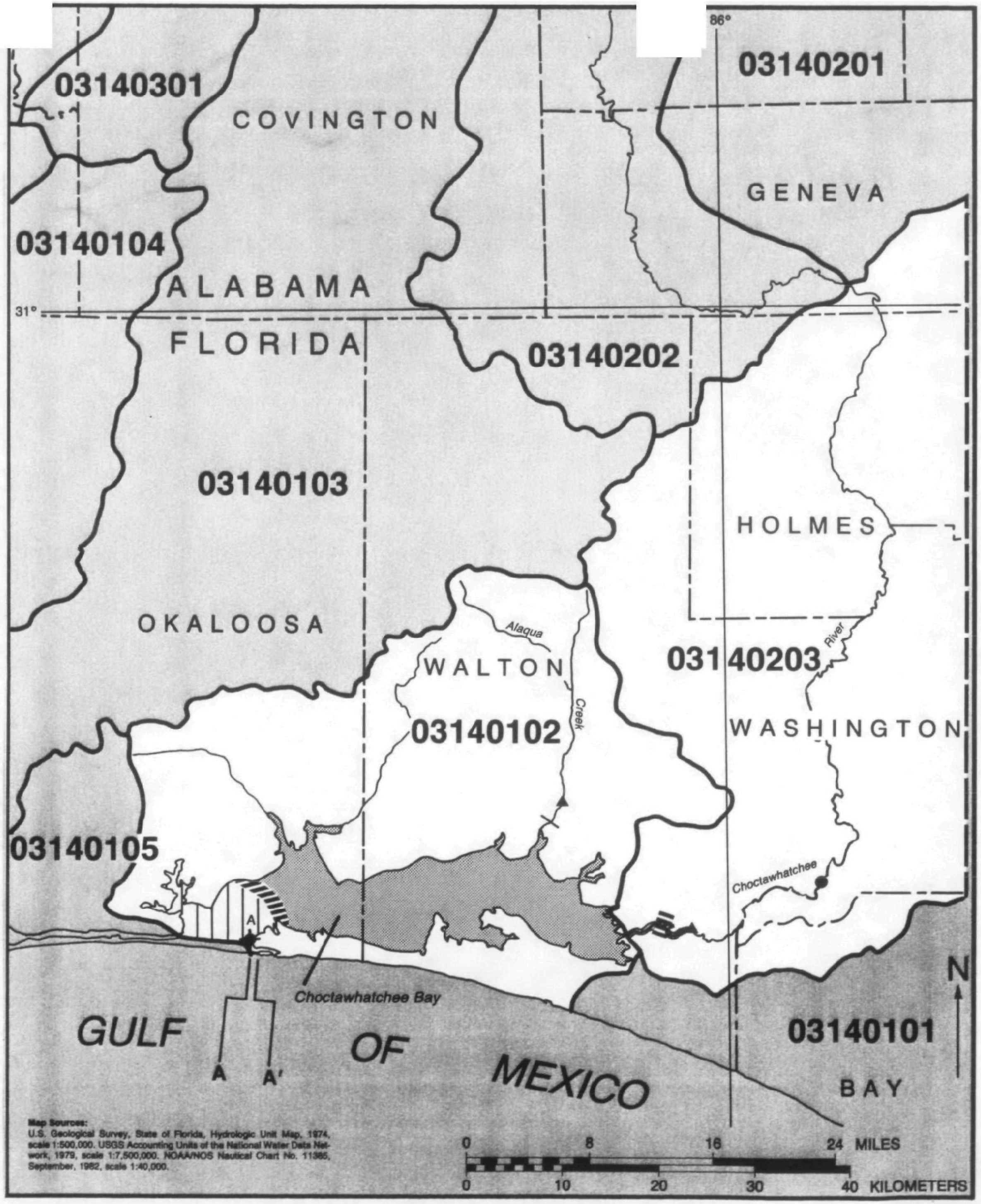


- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Choctawhatchee Bay
FL, AL

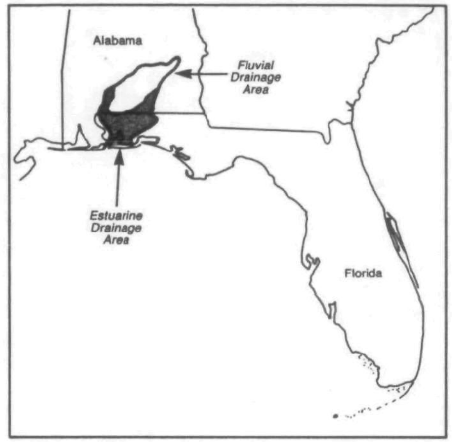


- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability



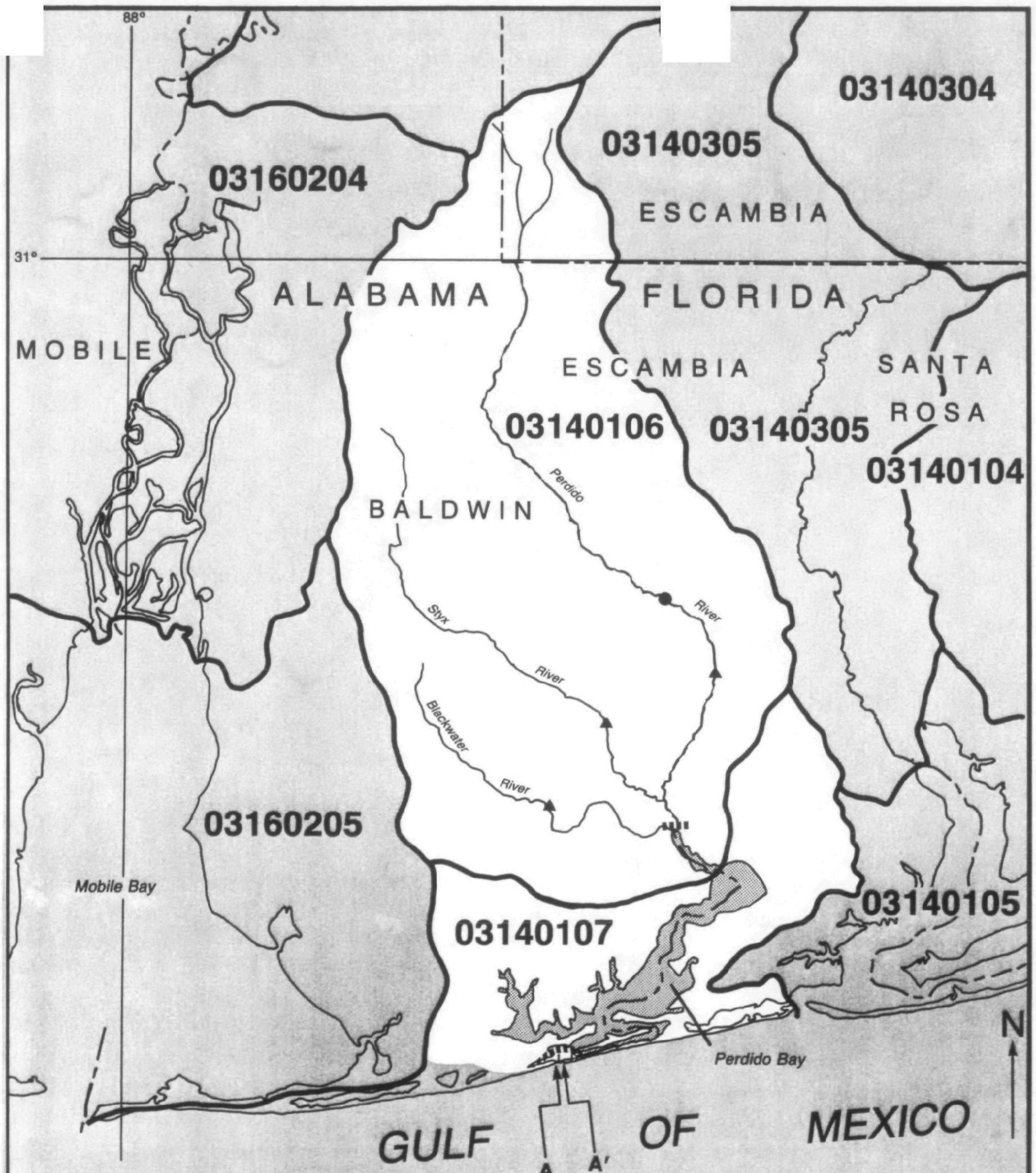
Map Sources:
U.S. Geological Survey, State of Florida, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart No. 11385, September, 1982, scale 1:40,000.

Pensacola Bay
FL, AL



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

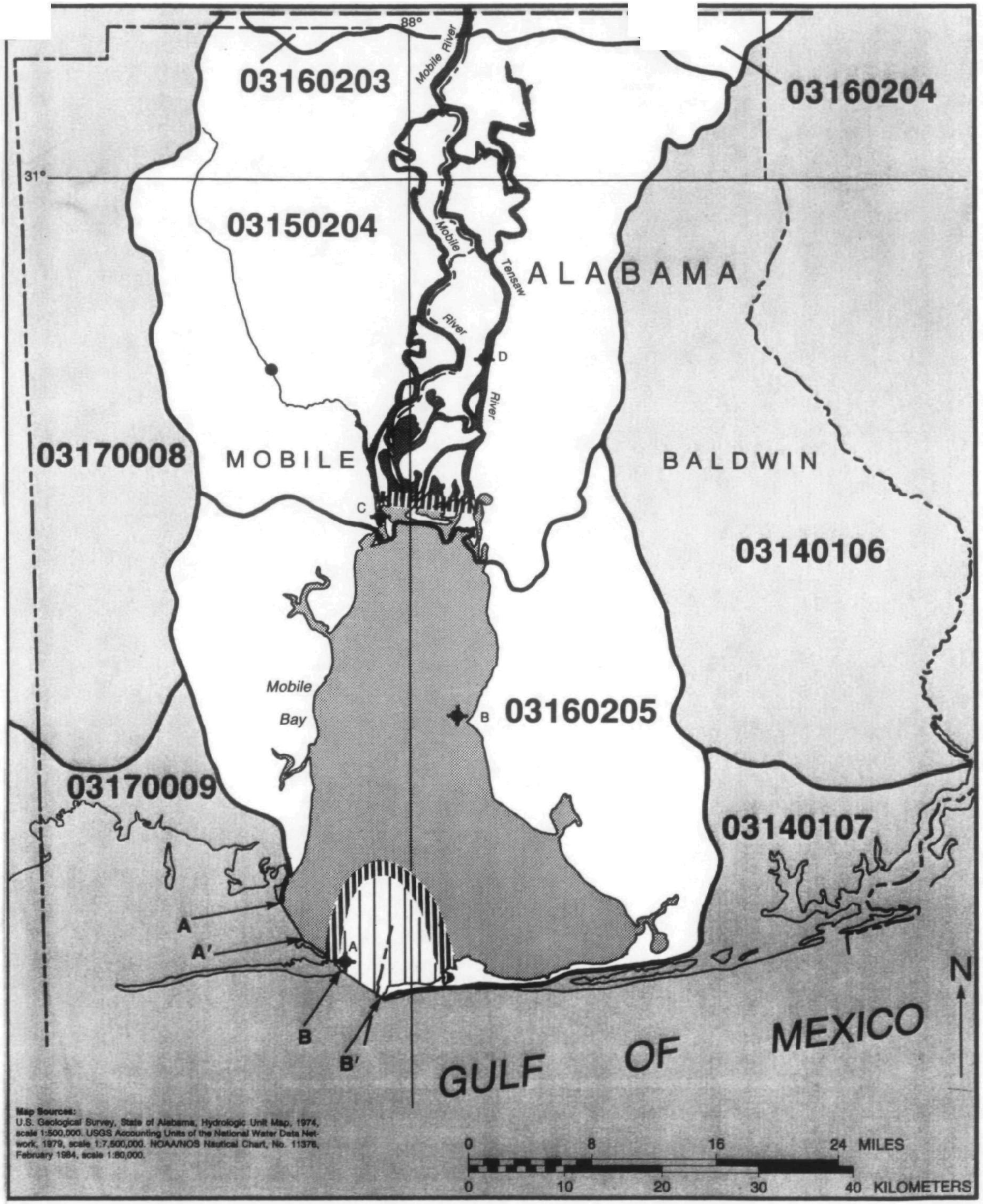
Perdido Bay
FL, AL



Map Sources:
U.S. Geological Survey, States of Alabama, Georgia, and Florida, Hydrologic Unit Maps, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart No. 11378, February, 1984, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Mobile Bay
AL



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

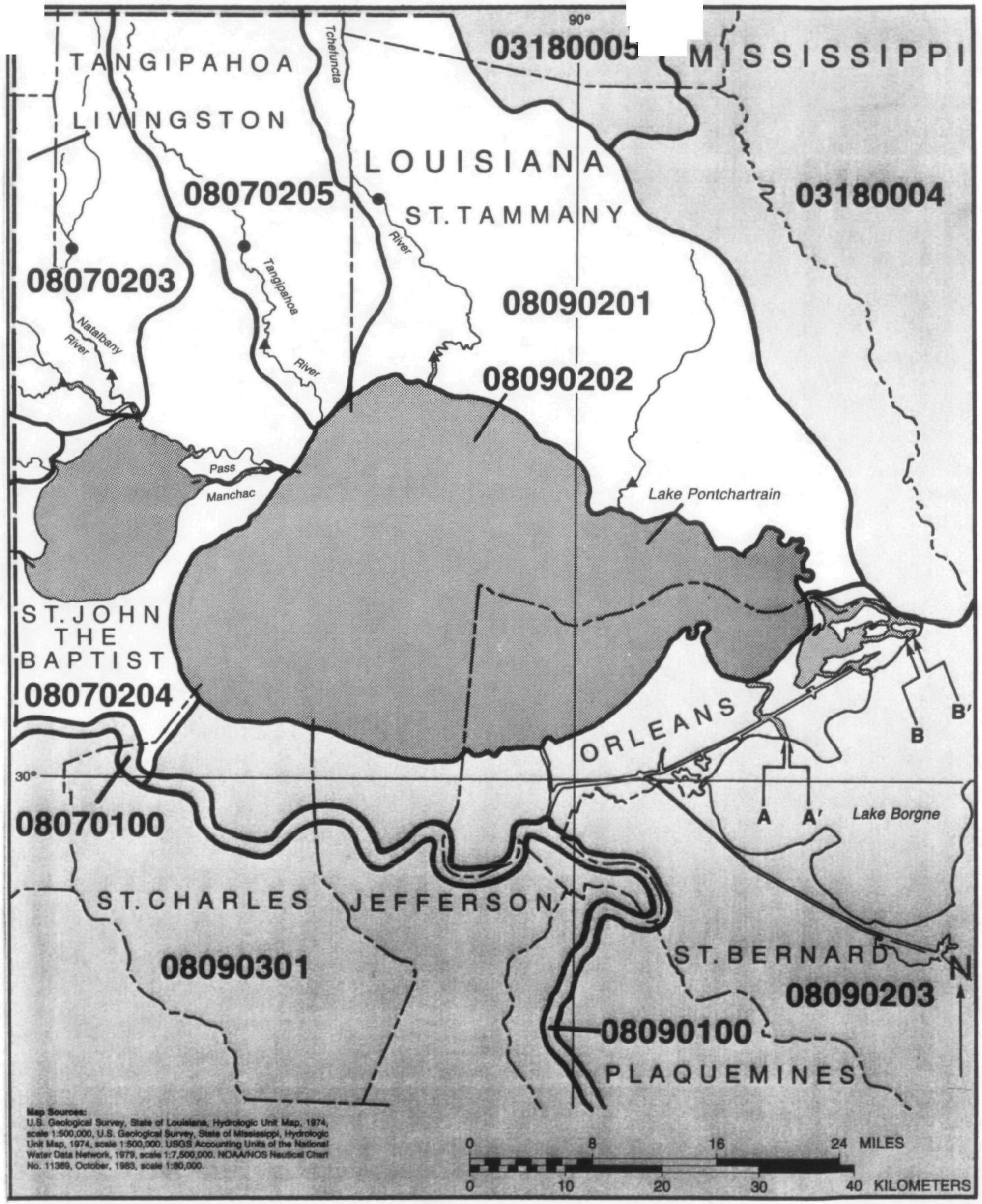
Mississippi Sound
LA, MS, AL

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Lake Borgne
LA, MS

Map Sources:
U.S. Geological Survey, State of Louisiana, Hydrologic Unit Map, 1974, scale 1:500,000. U.S. Geological Survey, State of Mississippi, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart No. 11371, June, 1984, scale 1:80,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability



Lake Pontchartrain LA, MS

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

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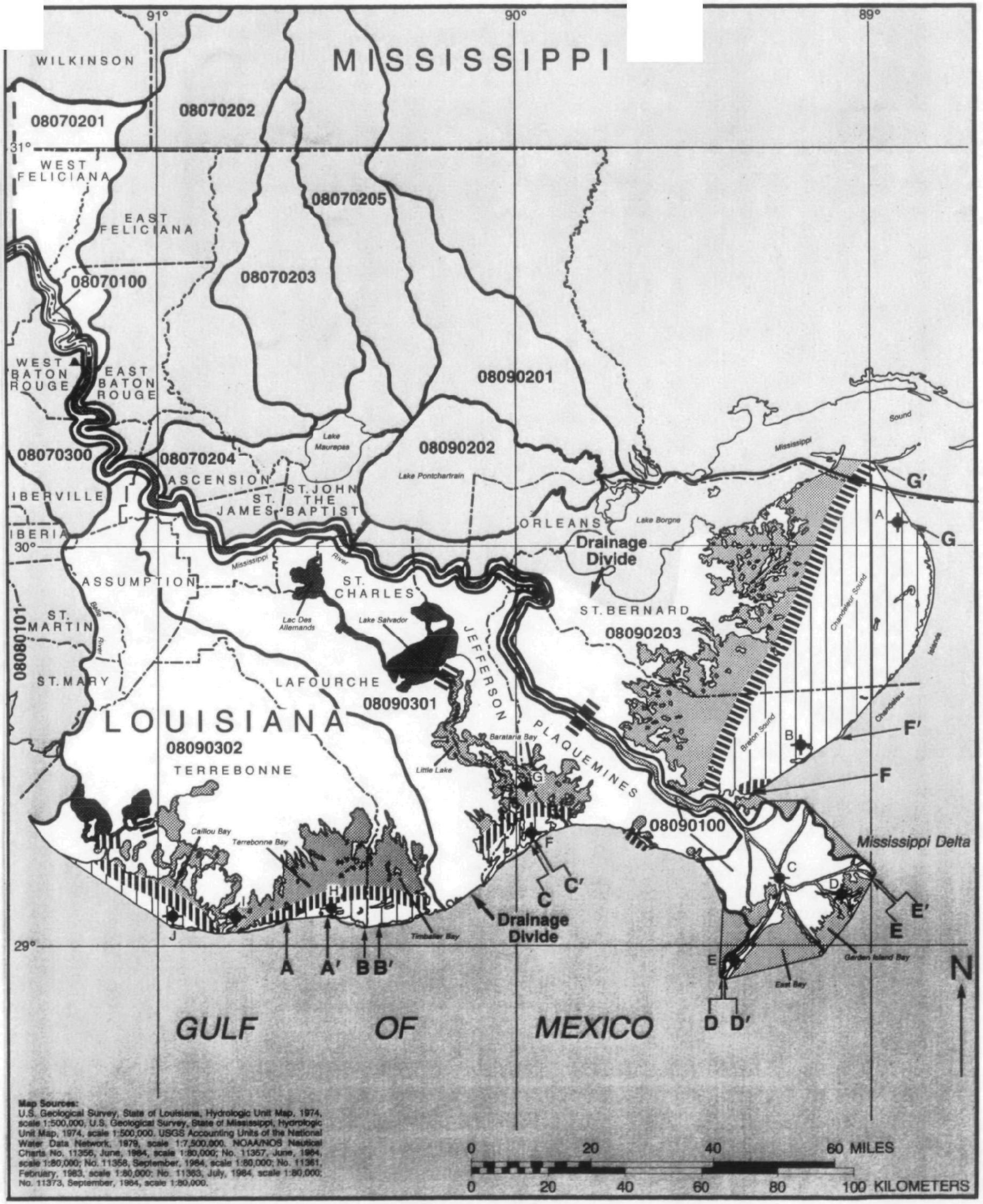
Mississippi Delta Regi
LA, MS



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
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- County Boundary
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- Salinity Zone Boundary - High Variability

Atchafalaya and Verm Bays LA

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
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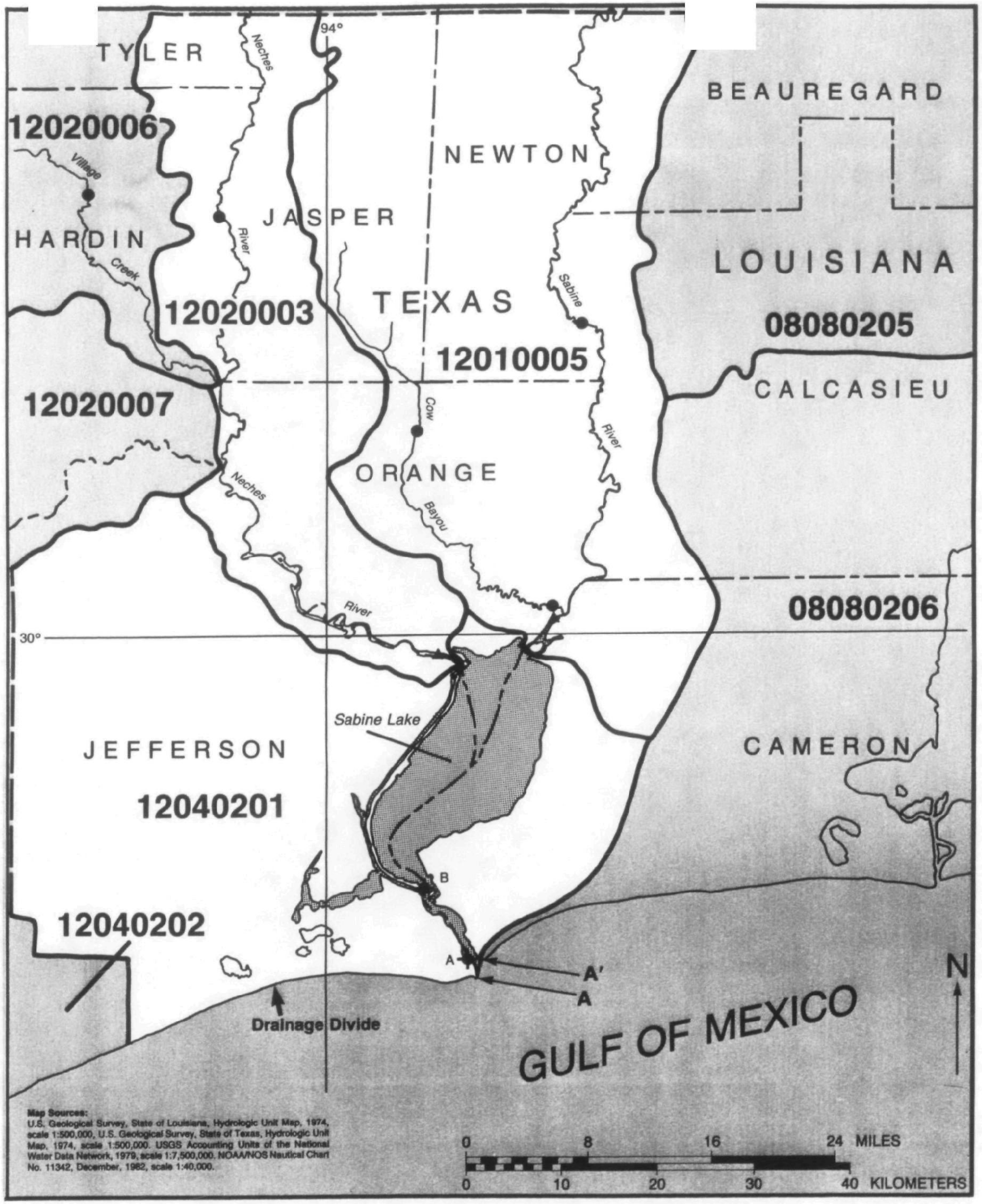
- Salinity Zone Boundary - High Variability

Calcasieu Lake
LA

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Sabine Lake
LA, TX



Map Sources:
U.S. Geological Survey, State of Louisiana, Hydrologic Unit Map, 1974, scale 1:500,000, U.S. Geological Survey, State of Texas, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart No. 11342, December, 1982, scale 1:40,000.

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
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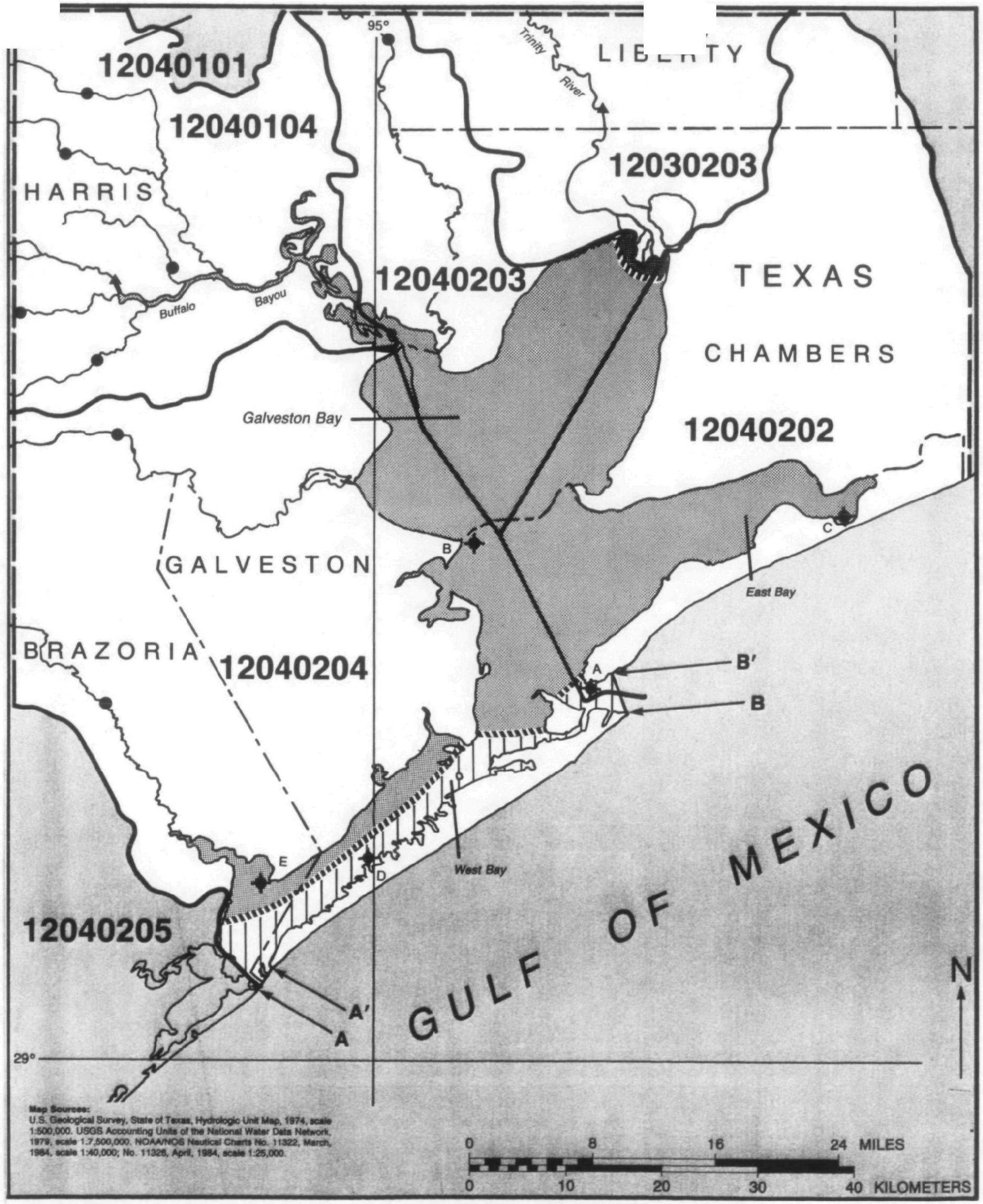
Galveston Bay
TX



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
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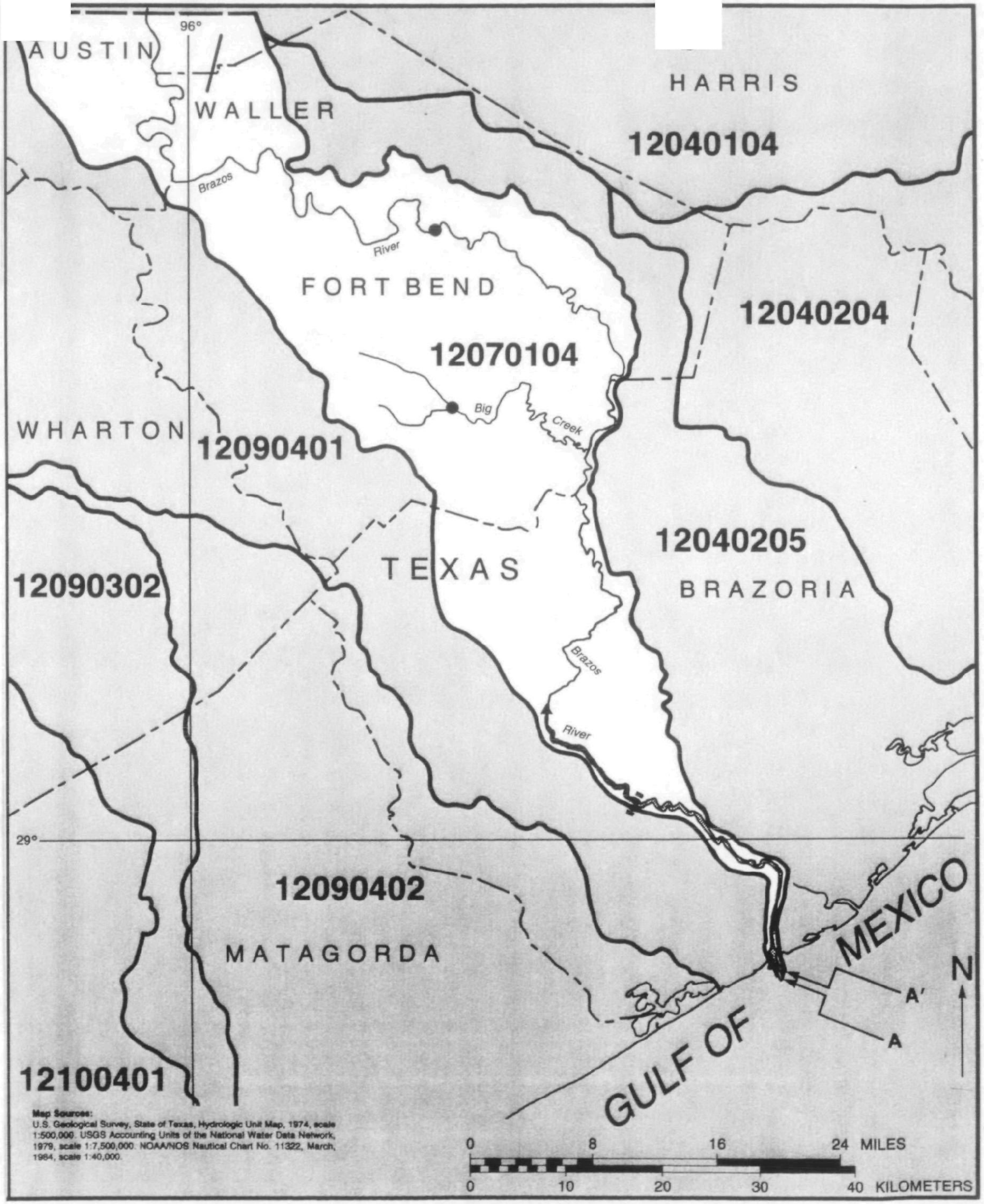
Brazos River TX



Tide Gage

Flow Gage

Head of Tide

Estuarine Drainage Area (EDA)

Tidal Fresh Zone

Mixing Zone

Seawater Zone

Hydrologic Cataloging Unit Boundary

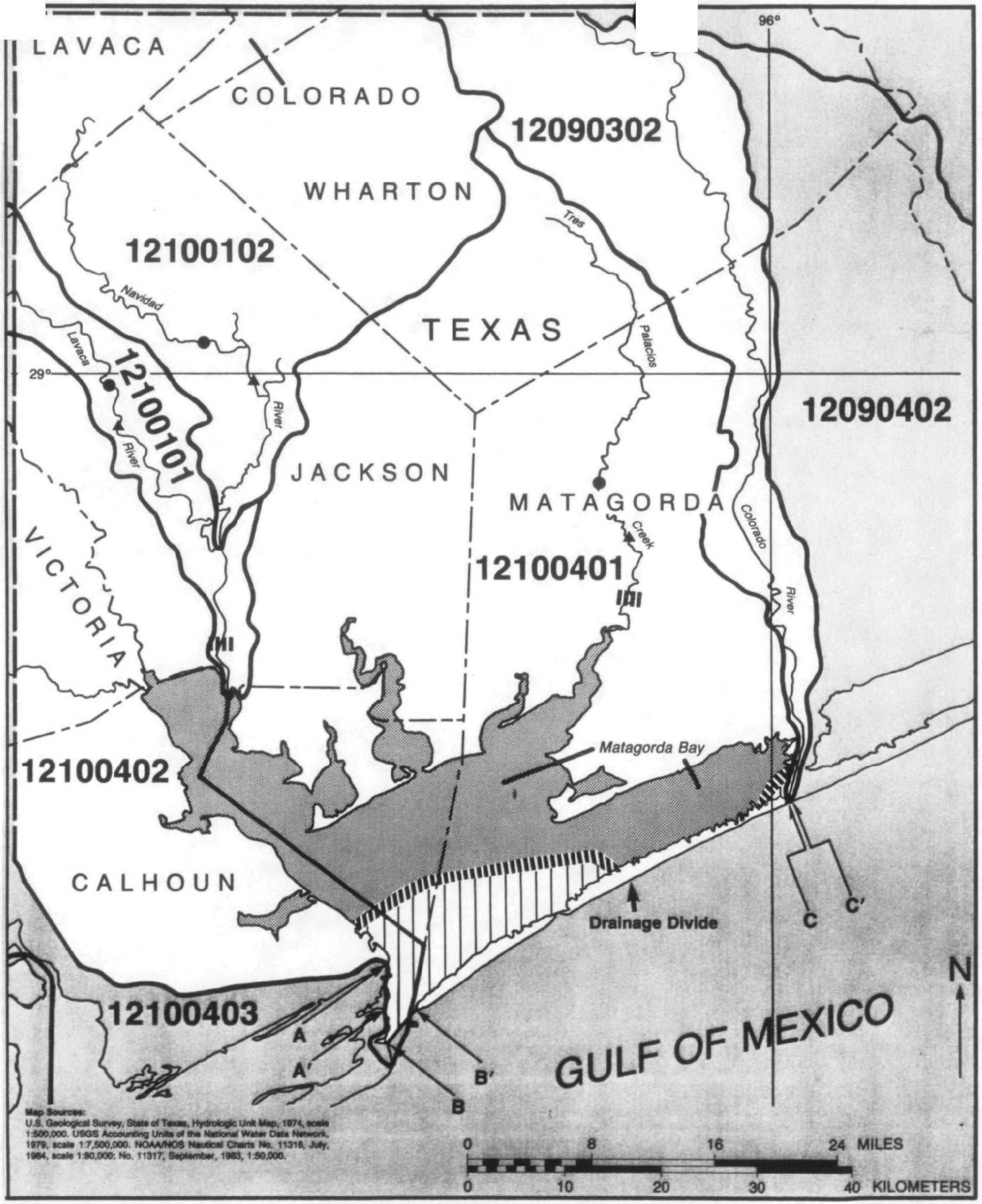
County Boundary

Salinity Zone Boundary - Low Variability

Salinity Zone Boundary - Moderate Variability

Salinity Zone Boundary - High Variability

Matagorda Bay
TX



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
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- County Boundary
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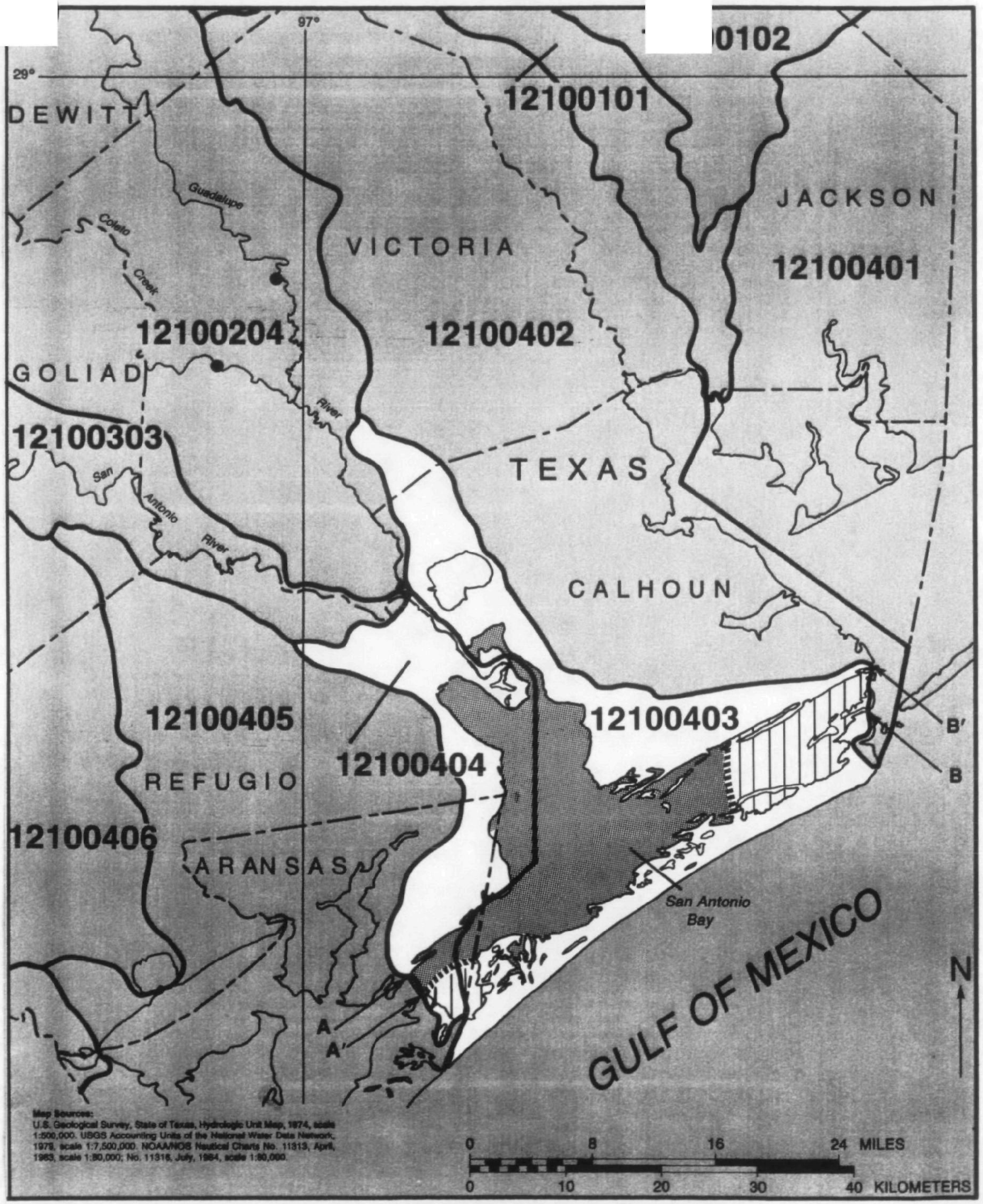
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

San Antonio Bay
TX



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
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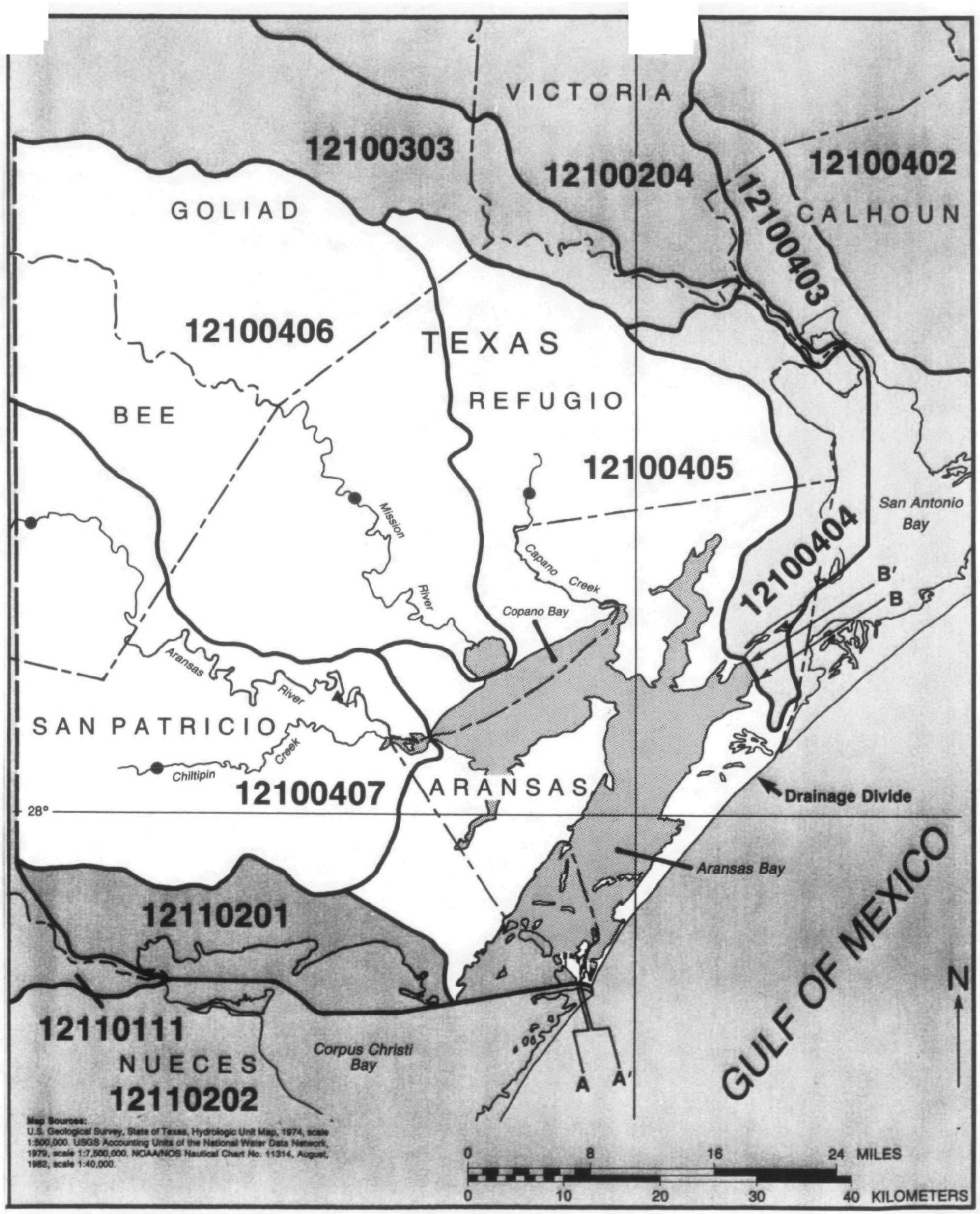
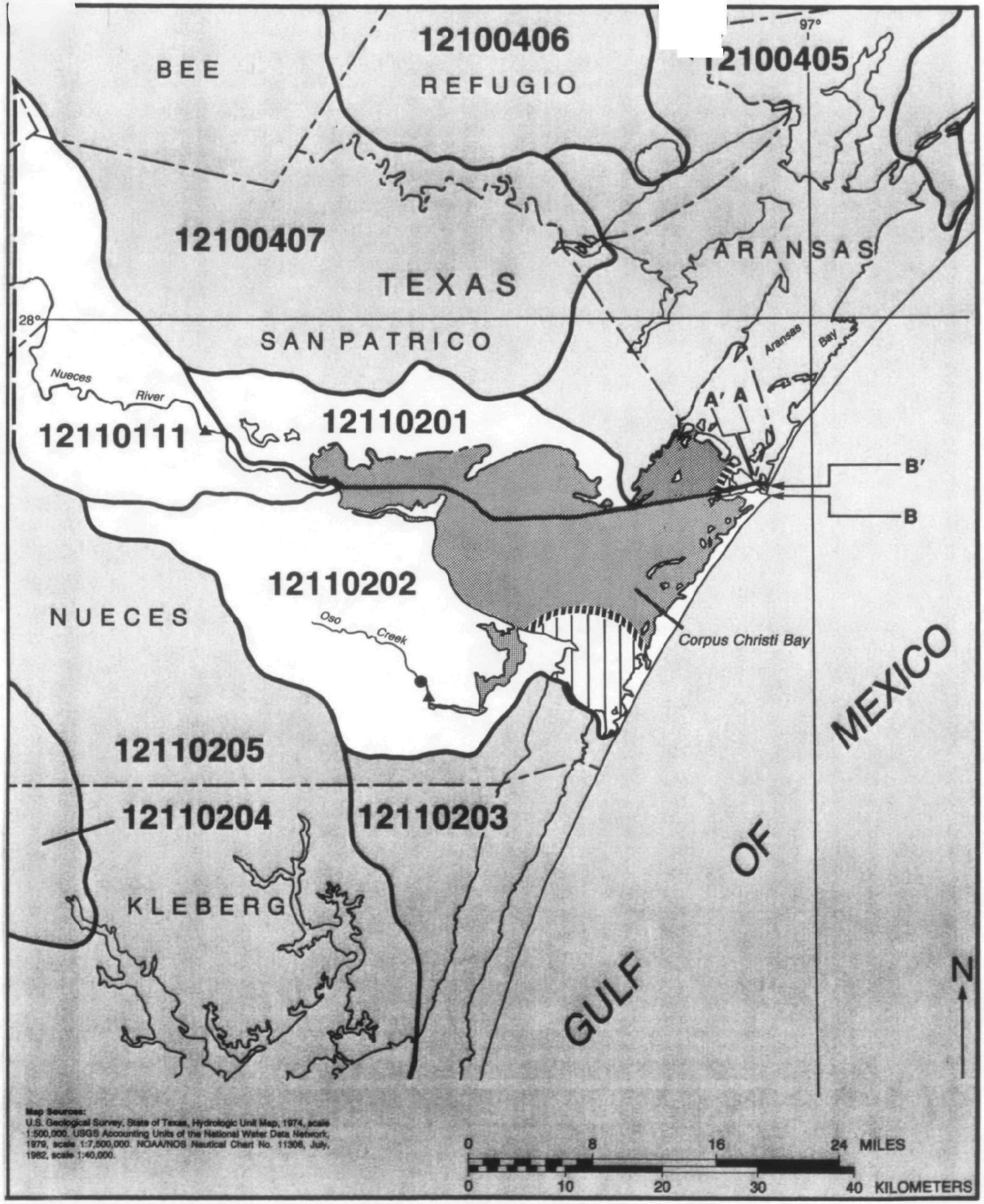
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Aransas Bay
TX



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
- Salinity Zone Boundary - Low Variability
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability



Corpus Christi Bay
TX

- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
- Mixing Zone
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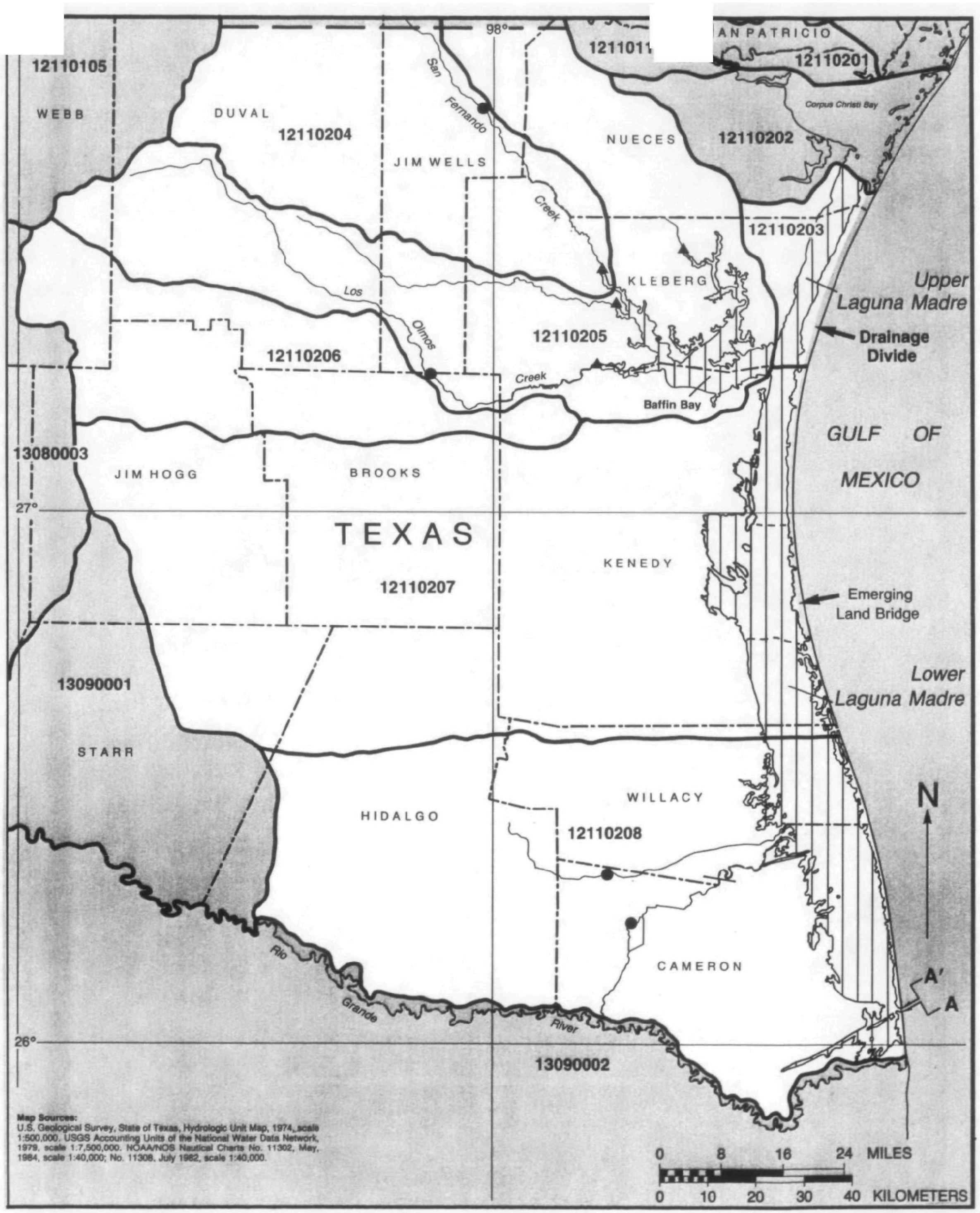
Laguna Madre TX



- Tide Gage
- Flow Gage
- Head of Tide
- Estuarine Drainage Area (EDA)
- Tidal Fresh Zone
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- Seawater Zone
- Hydrologic Cataloging Unit Boundary
- County Boundary
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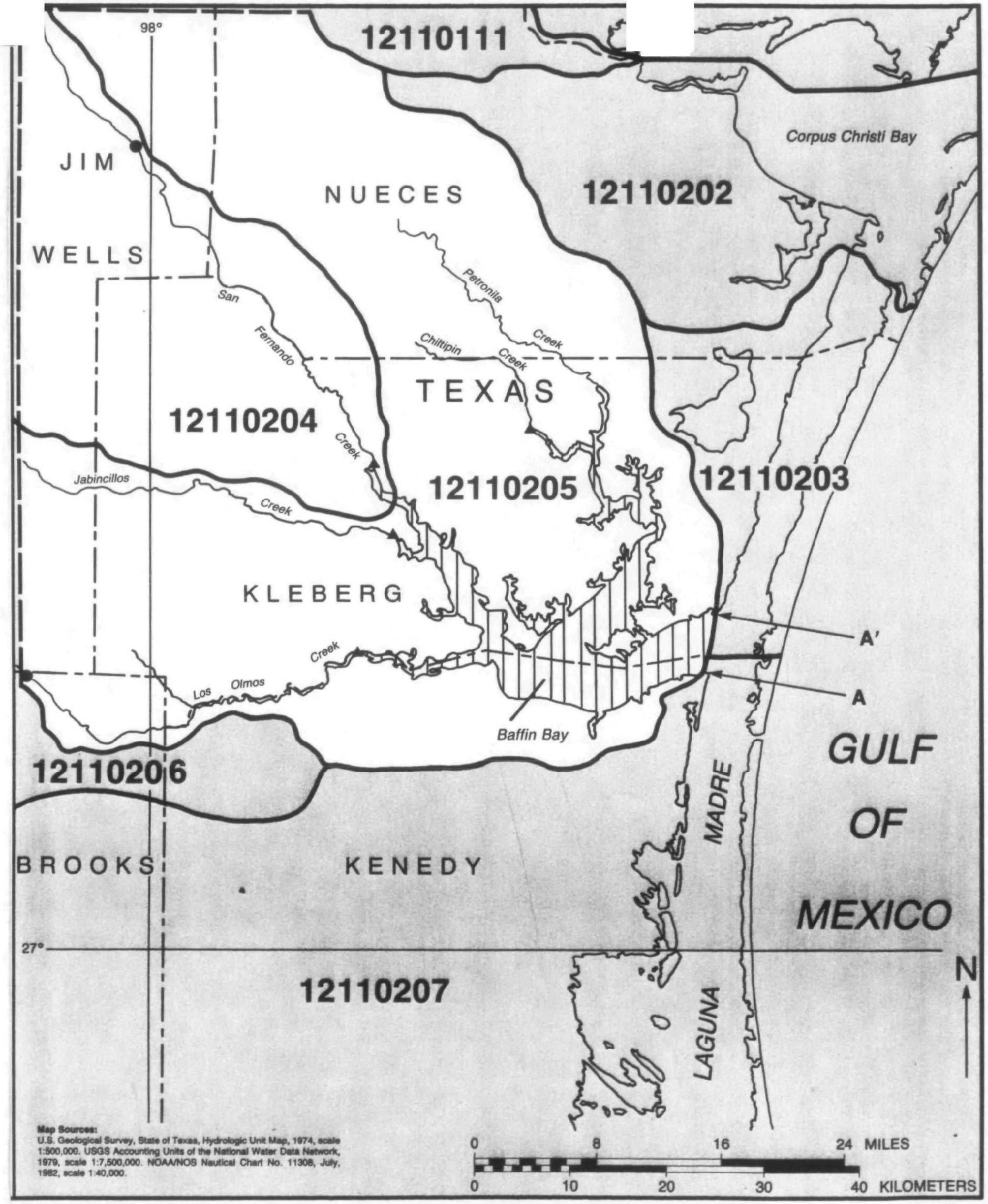
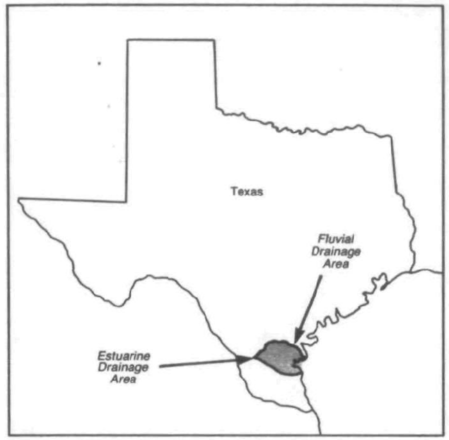
- Salinity Zone Boundary - Moderate Variability
- Salinity Zone Boundary - High Variability

Baffin Bay
TX





- Tide Gage
- Flow Gage
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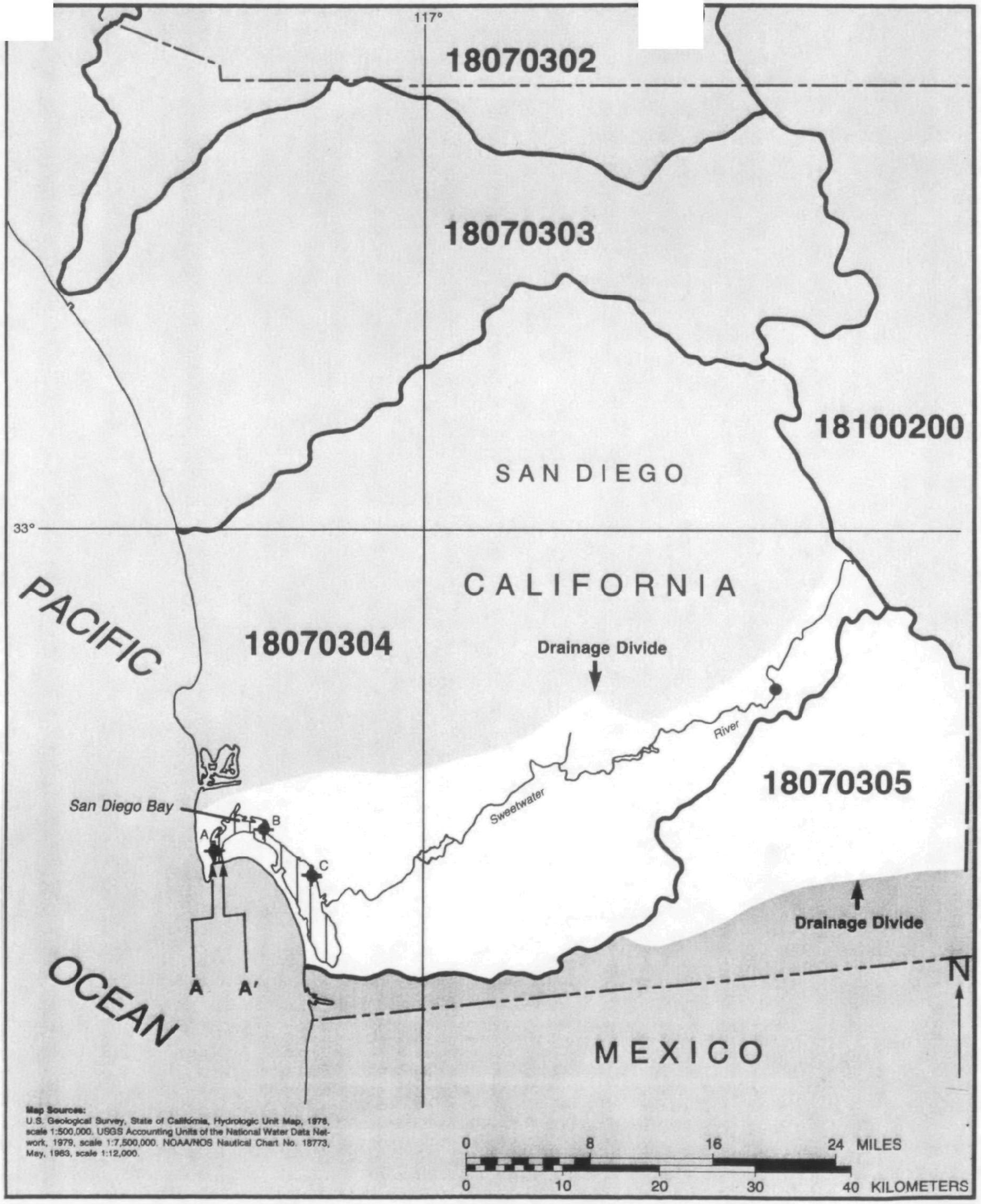
San Diego Bay
CA



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San Pedro Bay
CA

Map Sources:
U.S. Geological Survey, State of California, Hydrologic Unit Map, 1978, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart No. 18749, August, 1984, scale 1:20,000.

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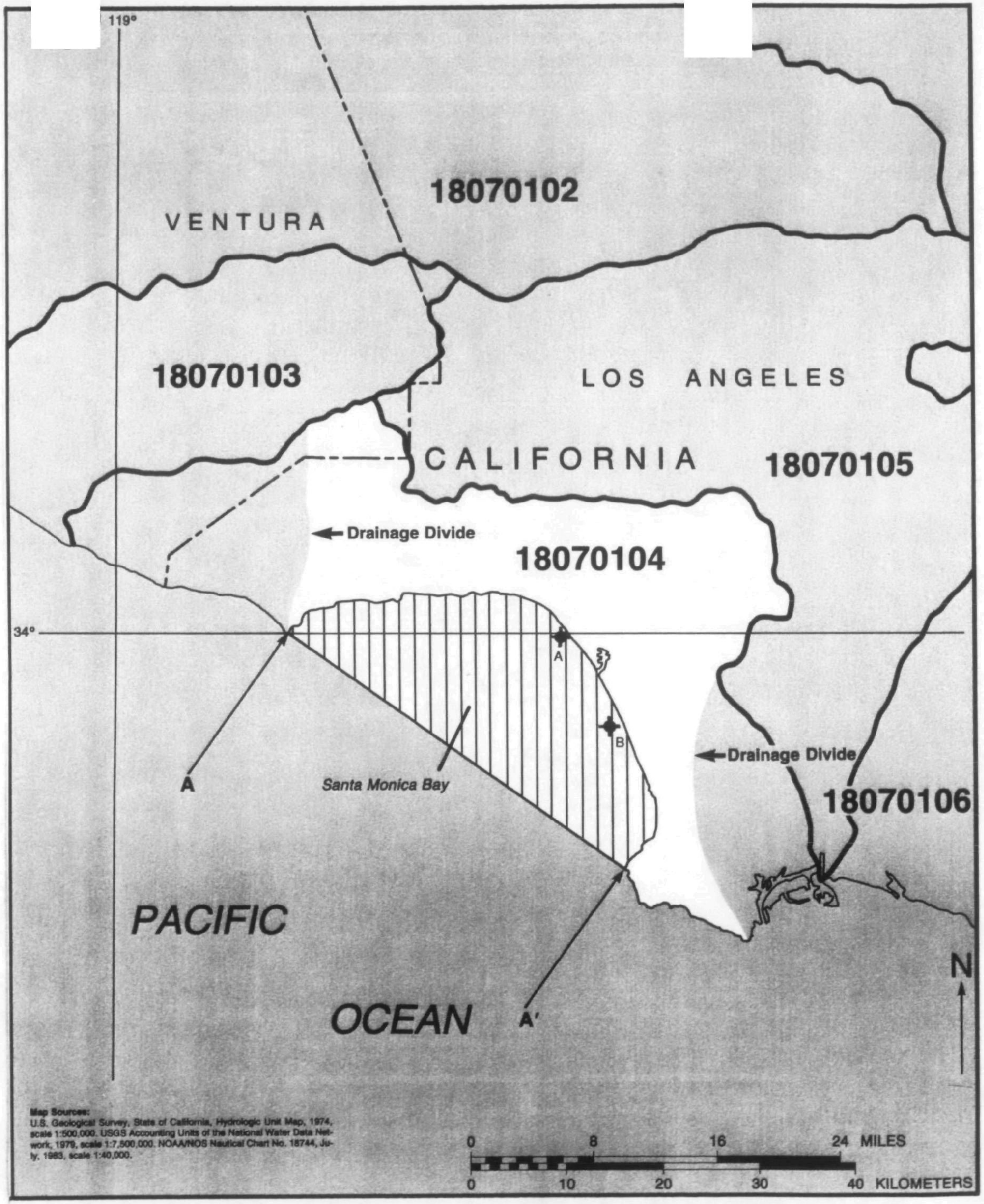
Santa Monica Bay
CA



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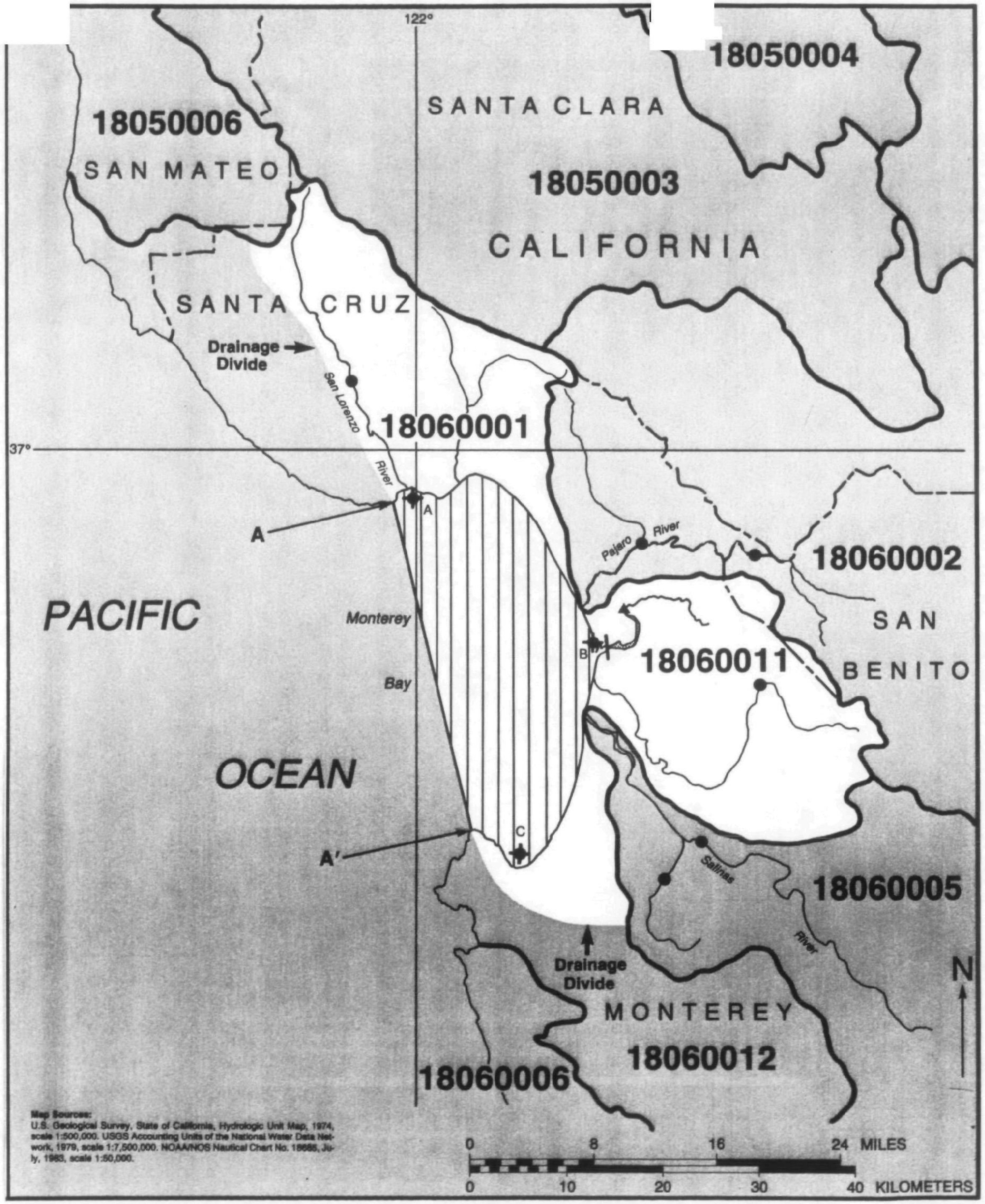
Monterey Bay
CA



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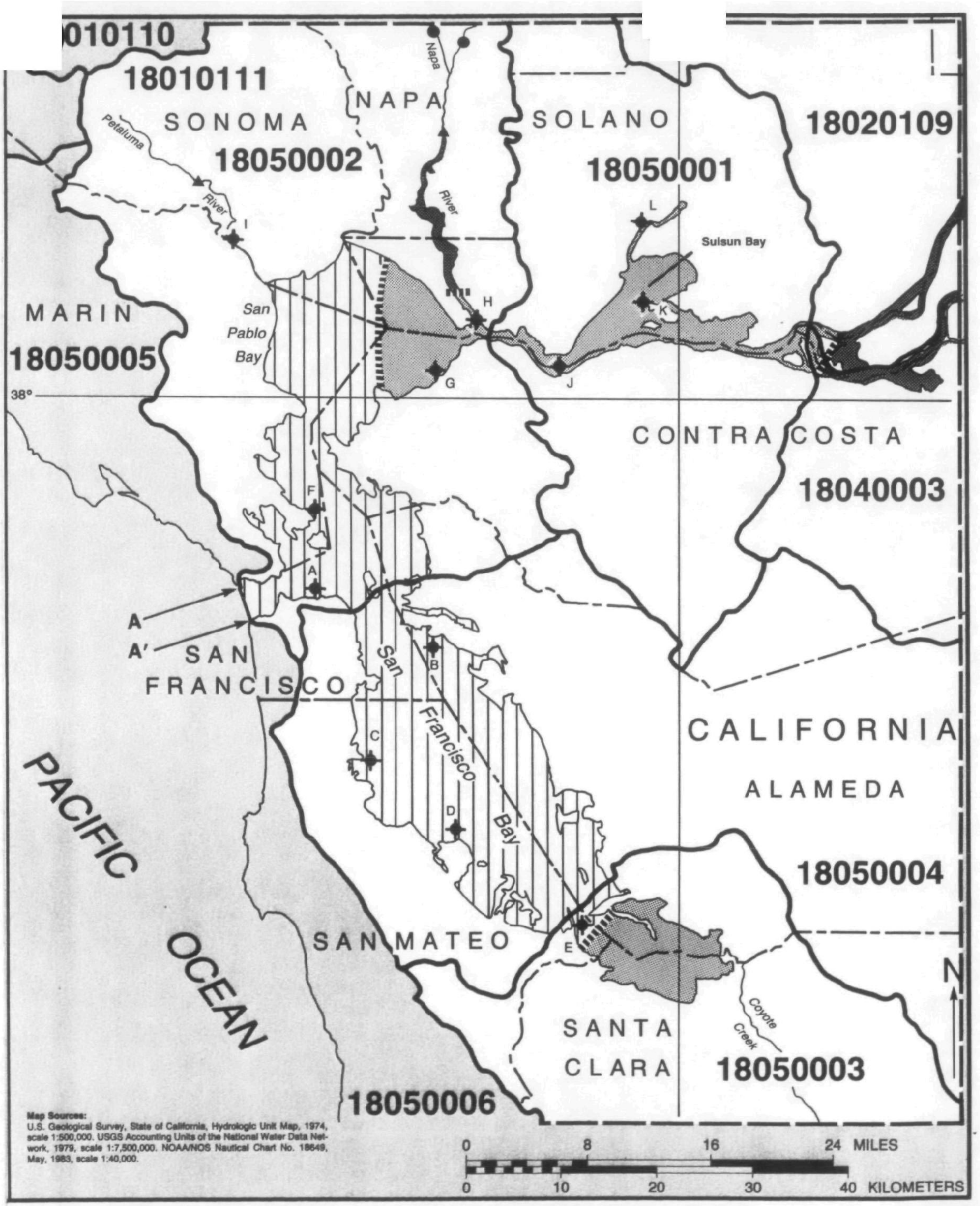
San Francisco Bay
CA



Map Sources:
U.S. Geological Survey, State of California, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart No. 18649, May, 1983, scale 1:40,000.

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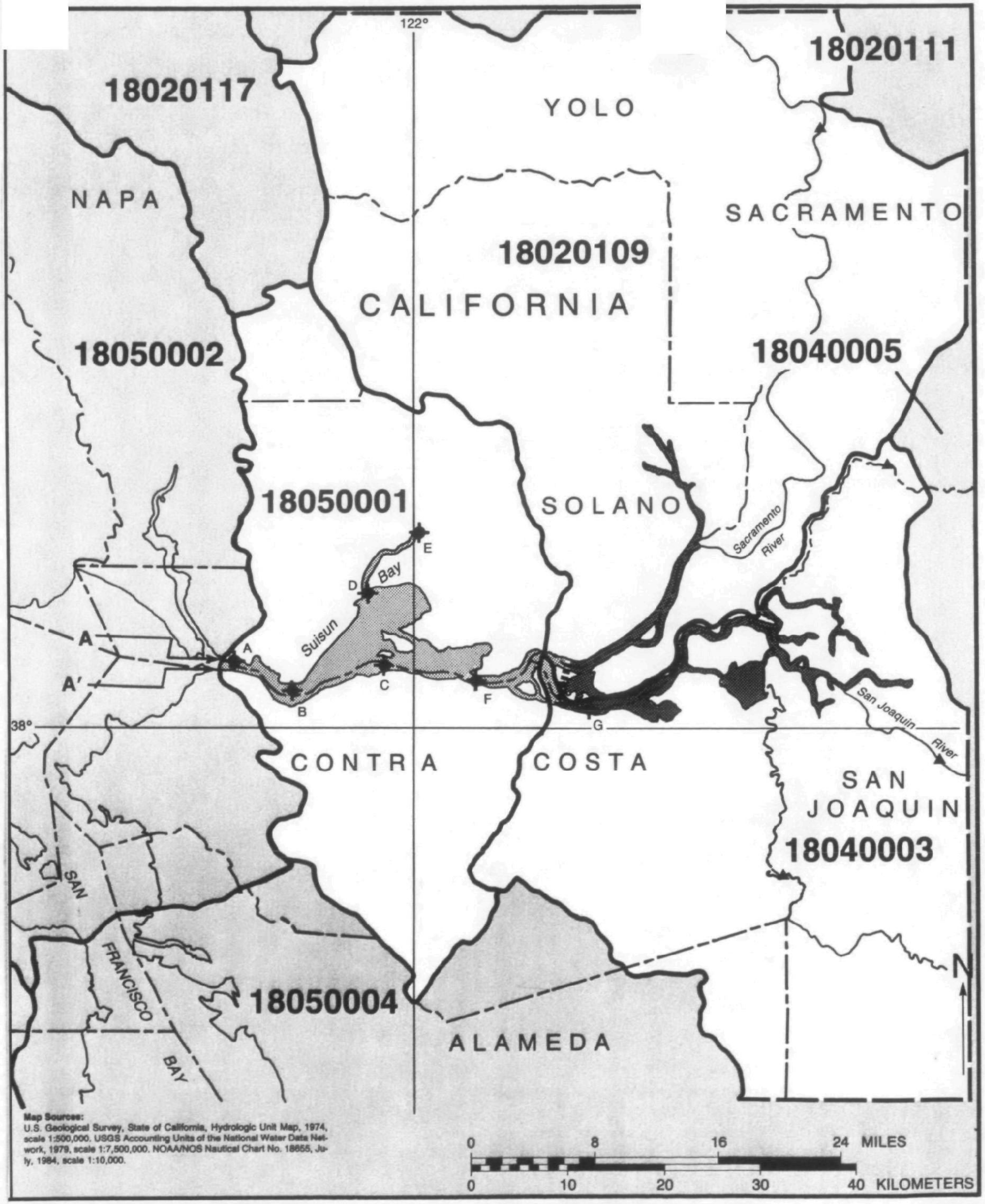
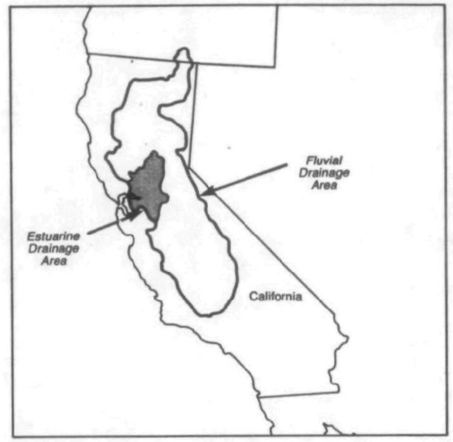
Suisun Bay
CA





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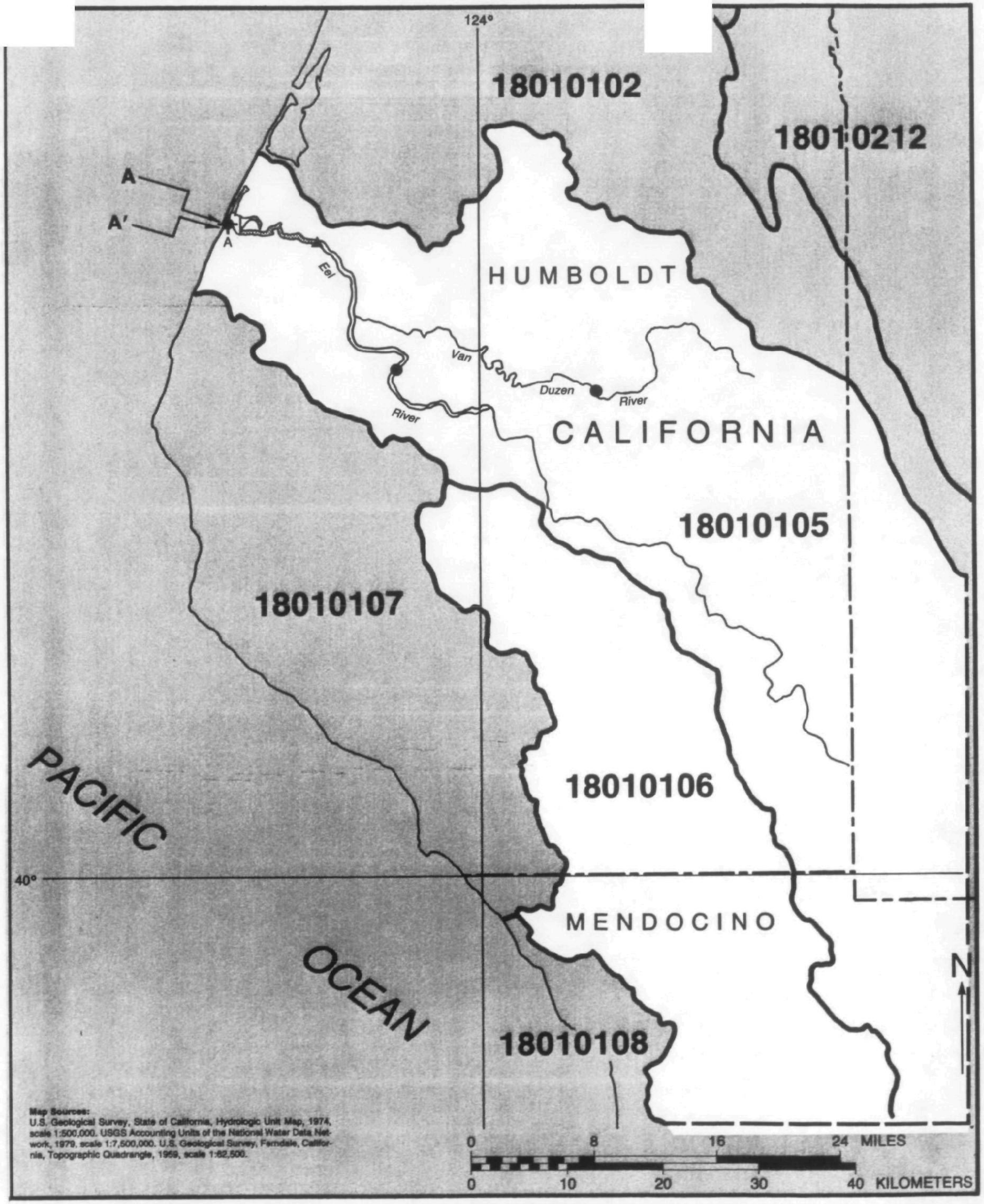
4.05a.

Eel River
CA



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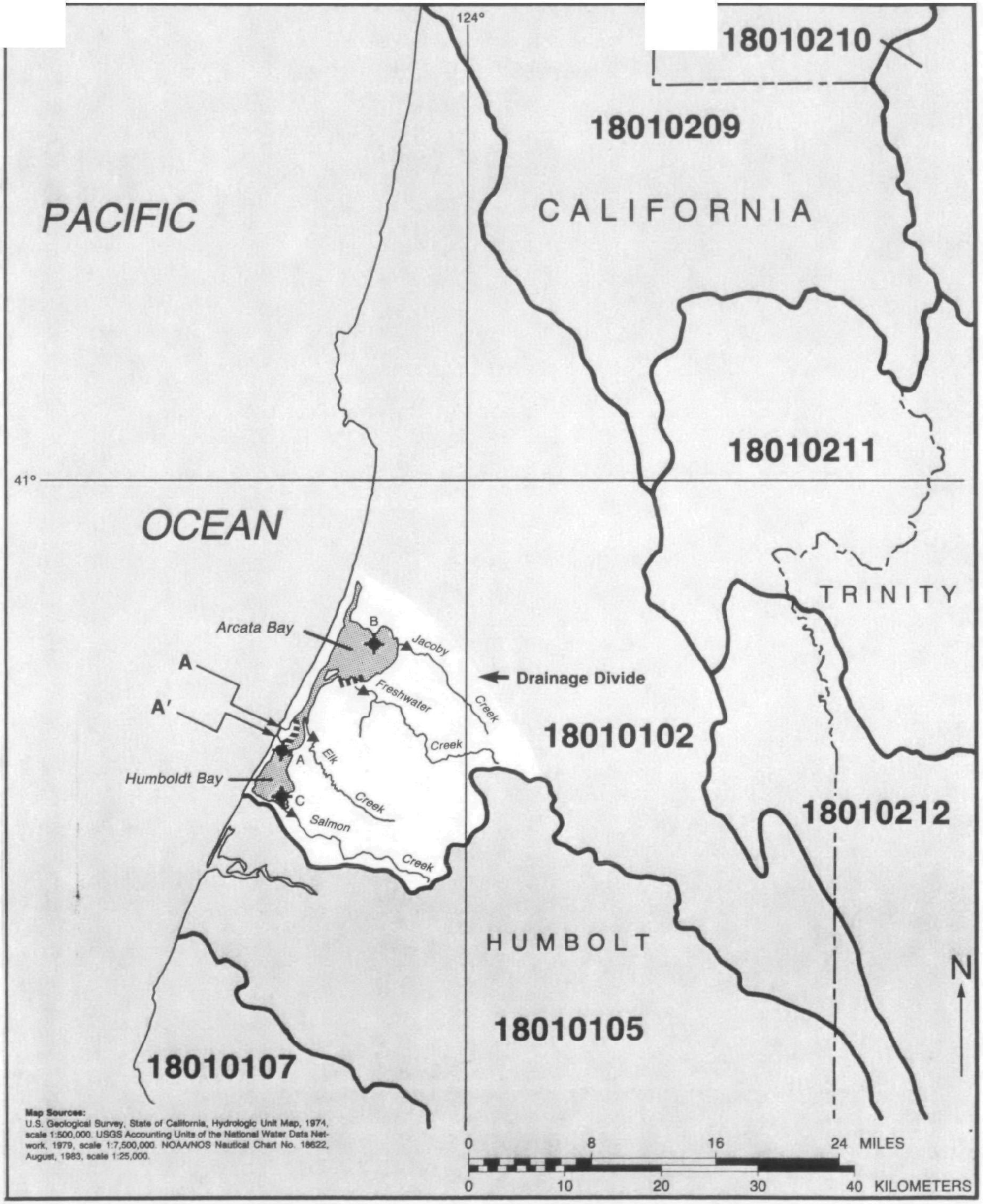
Humboldt Bay
CA



Map Sources:
U.S. Geological Survey, State of California, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart No. 18622, August, 1983, scale 1:25,000.

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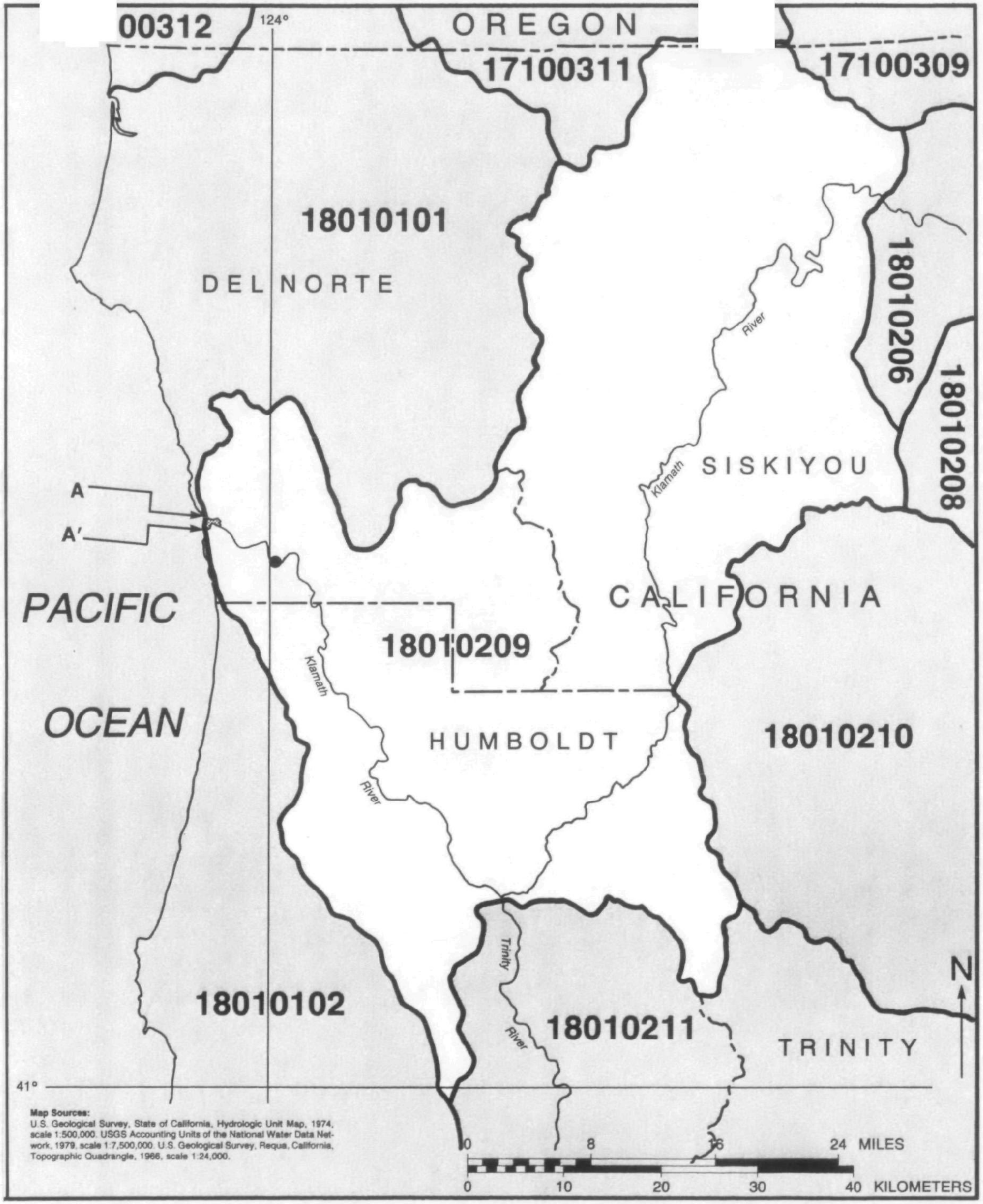
Klamath River
CA, OR



Map Sources:
U.S. Geological Survey, State of California, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. U.S. Geological Survey, Requa, California, Topographic Quadrangle, 1966, scale 1:24,000.

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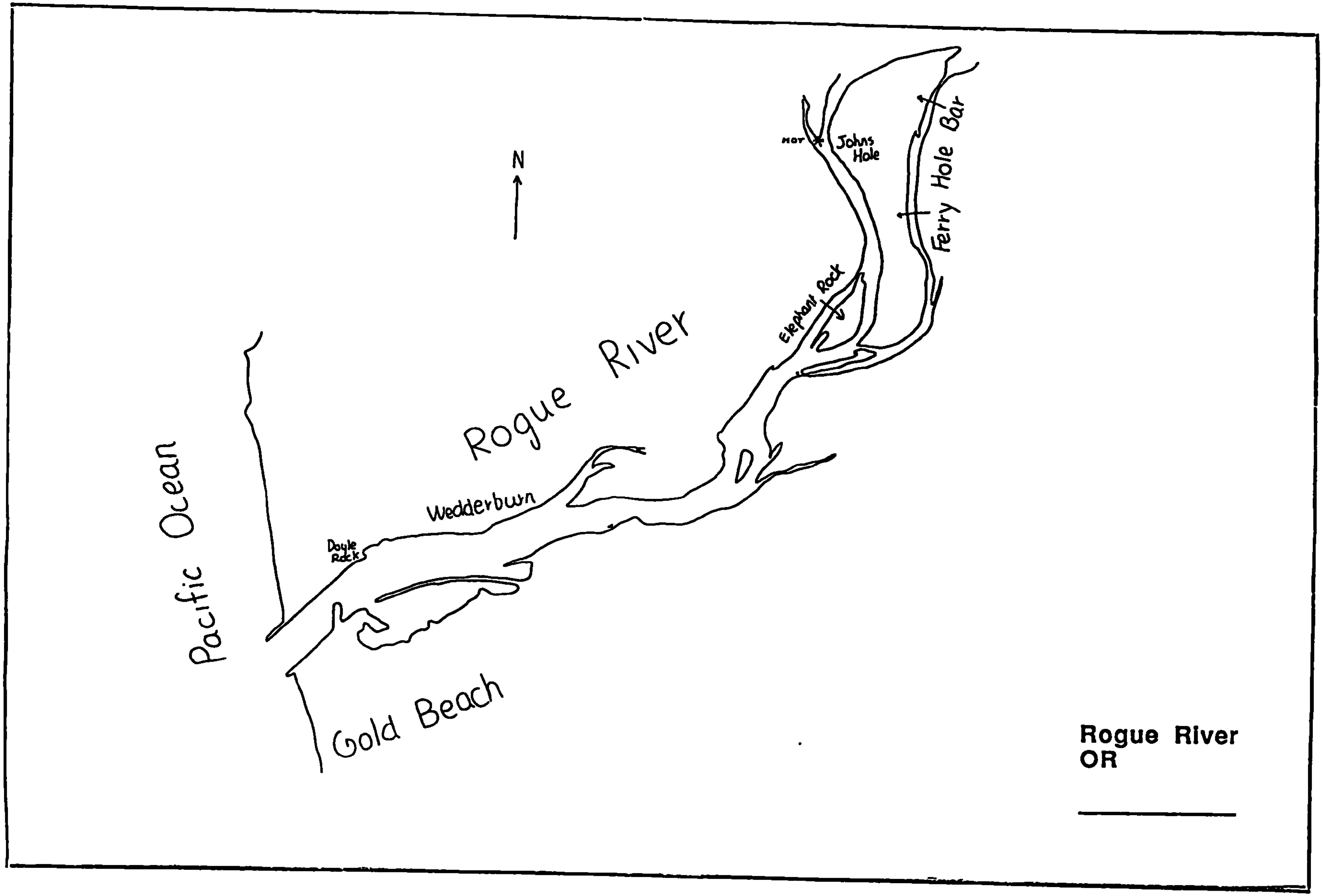
New NEI Estuary



Coos Bay
OR

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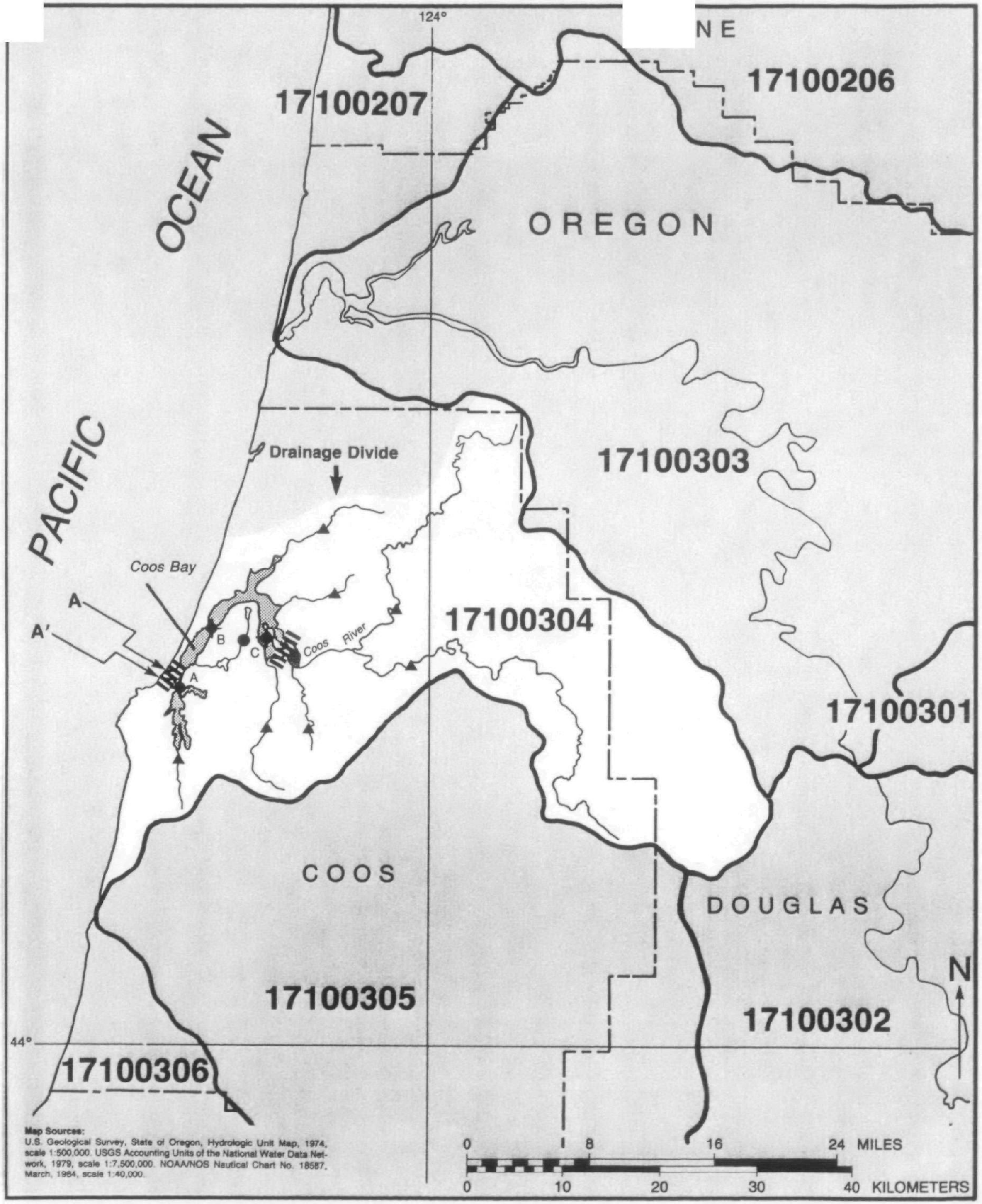

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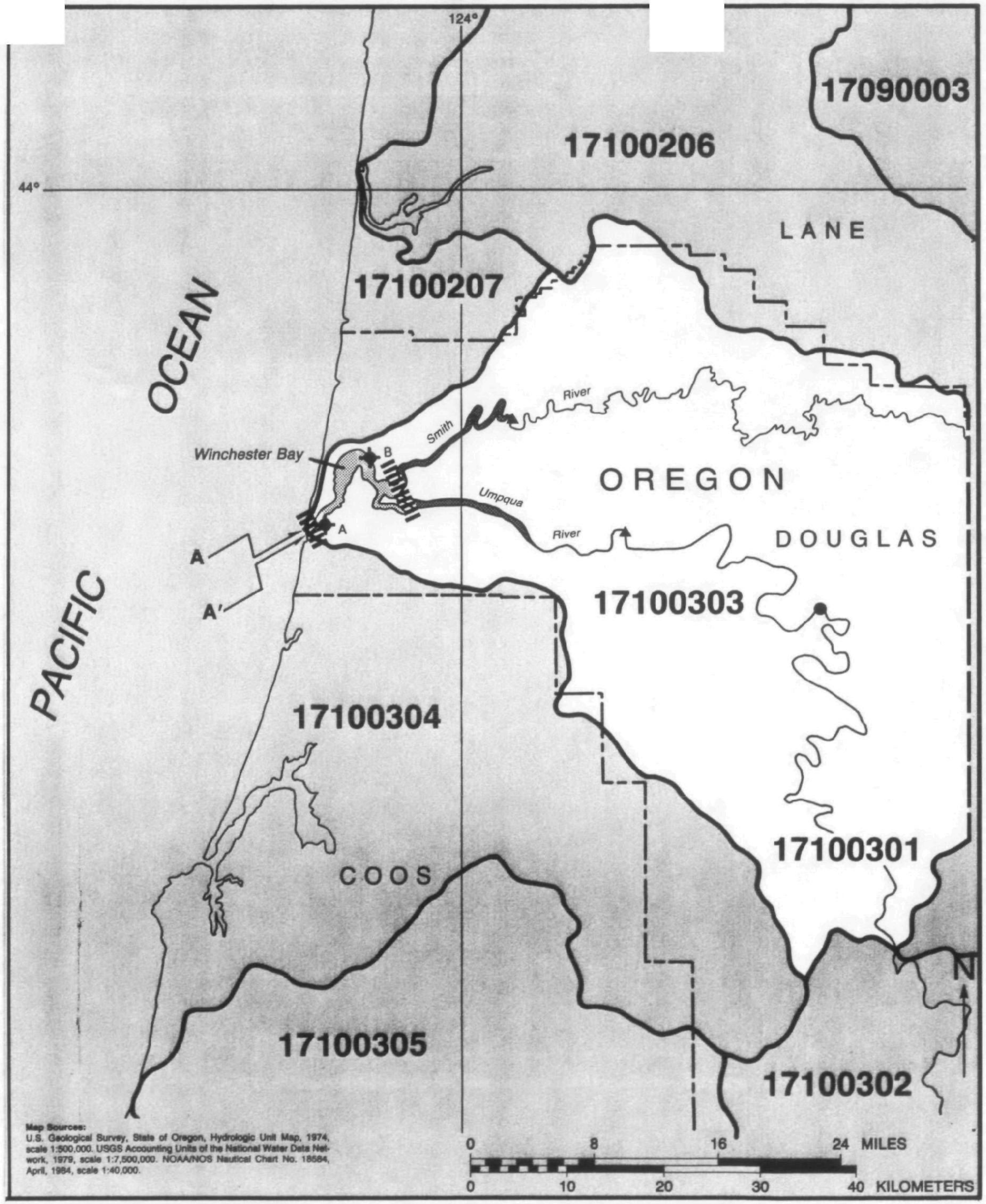
Winchester Bay
OR



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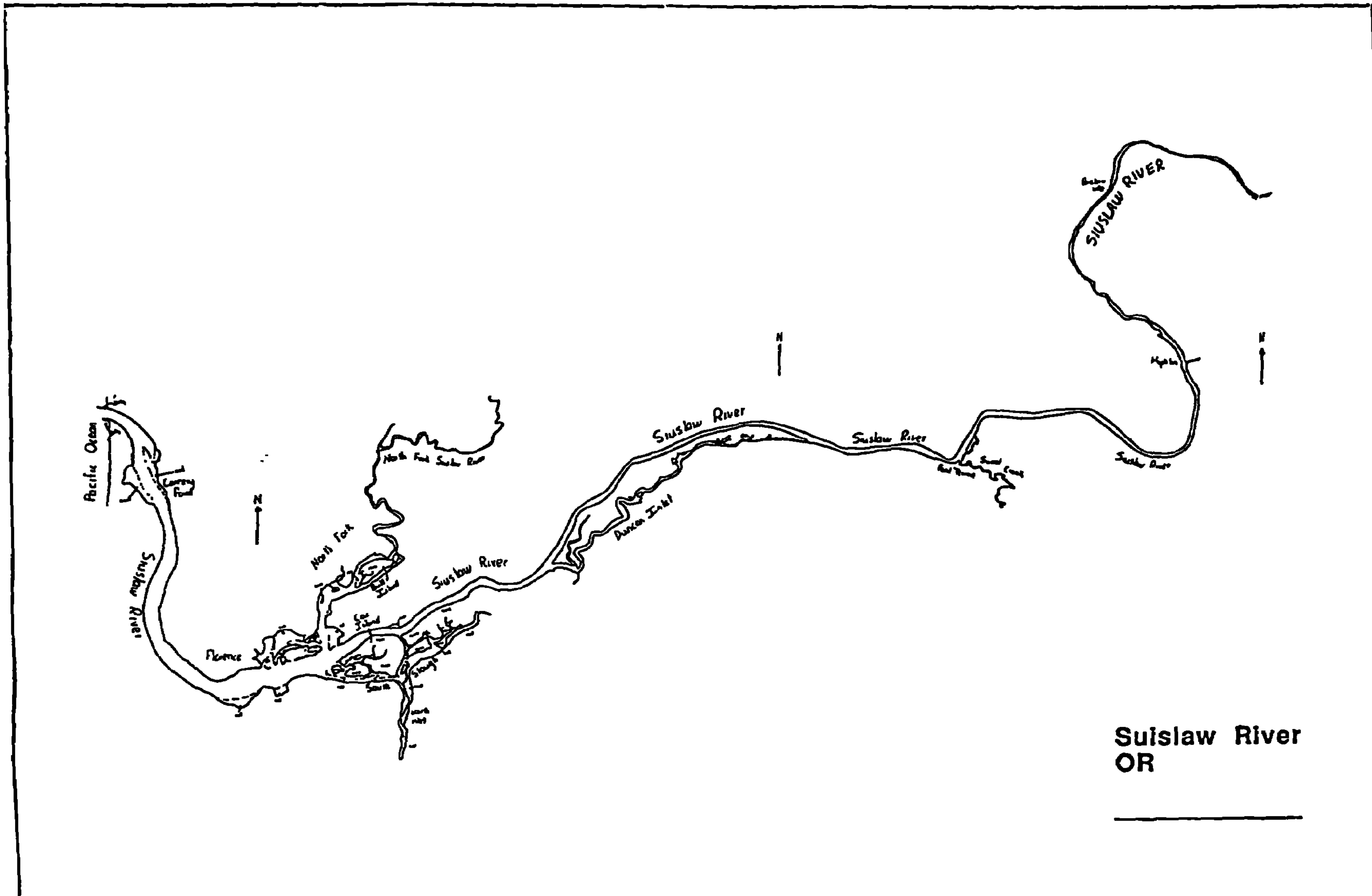
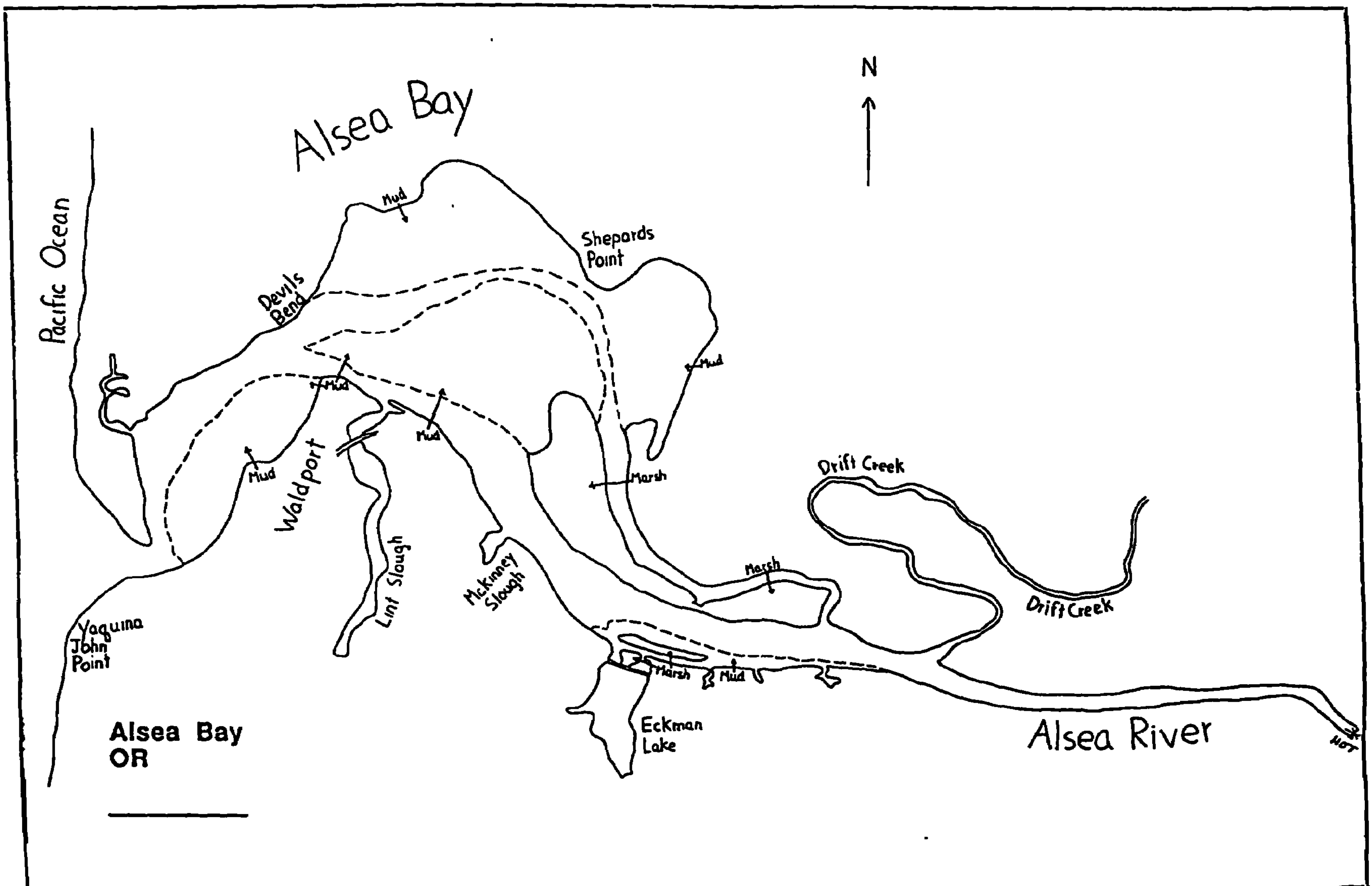
Map Sources:
U.S. Geological Survey, State of Oregon, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart No. 18584, April, 1984, scale 1:40,000.

New NEI Estuary

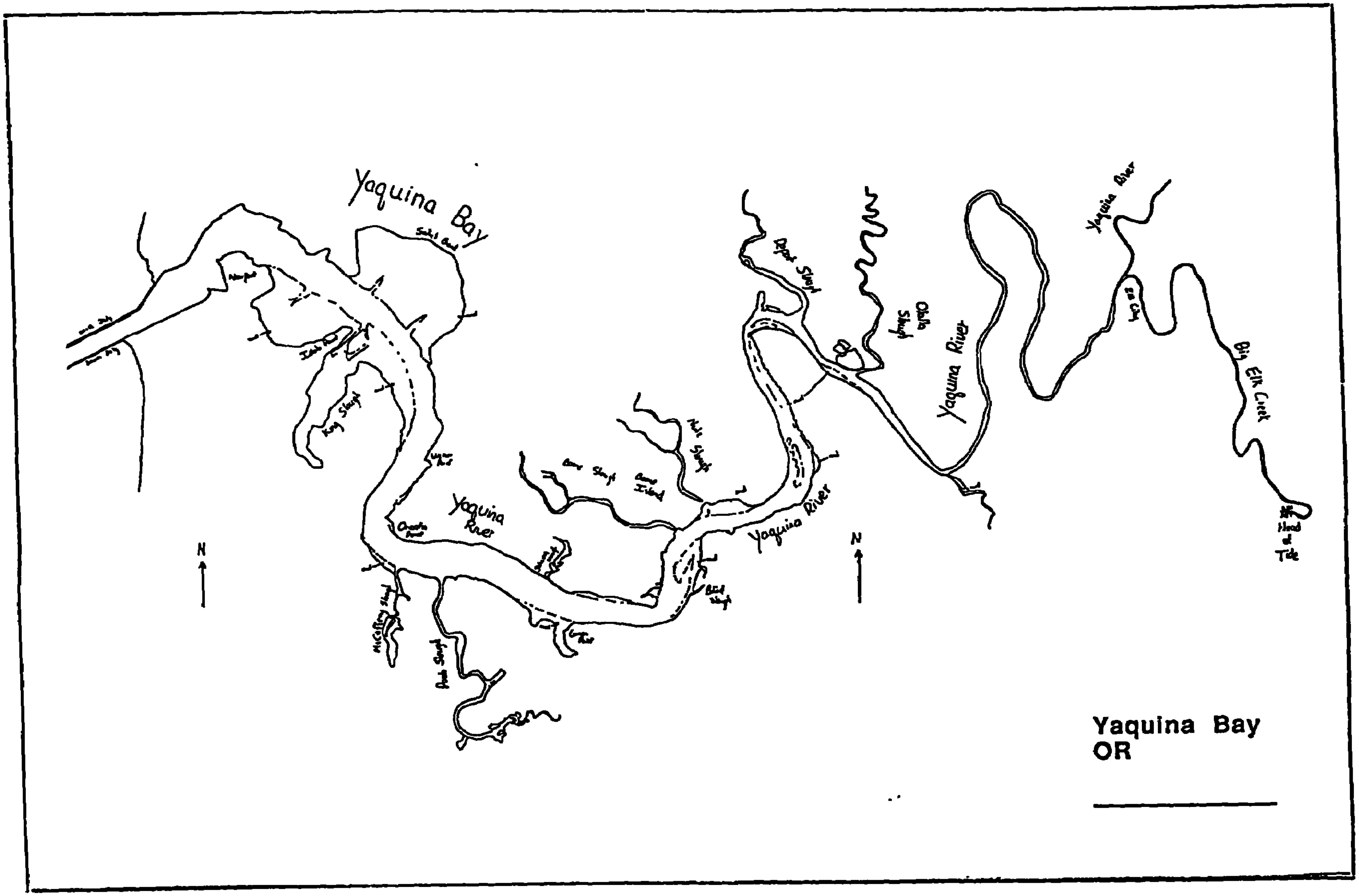


Suislaw River
OR

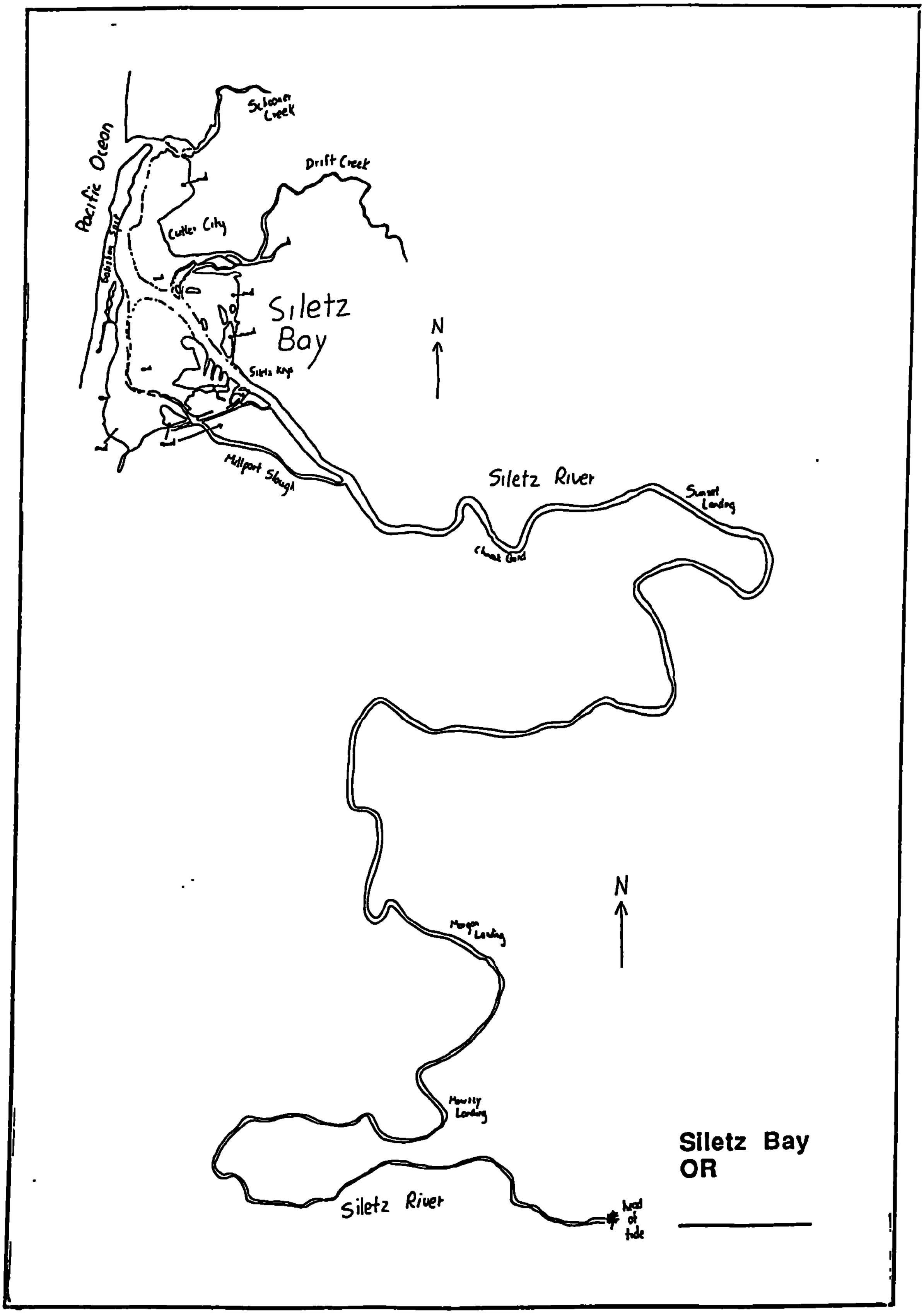
New NEI Estuary



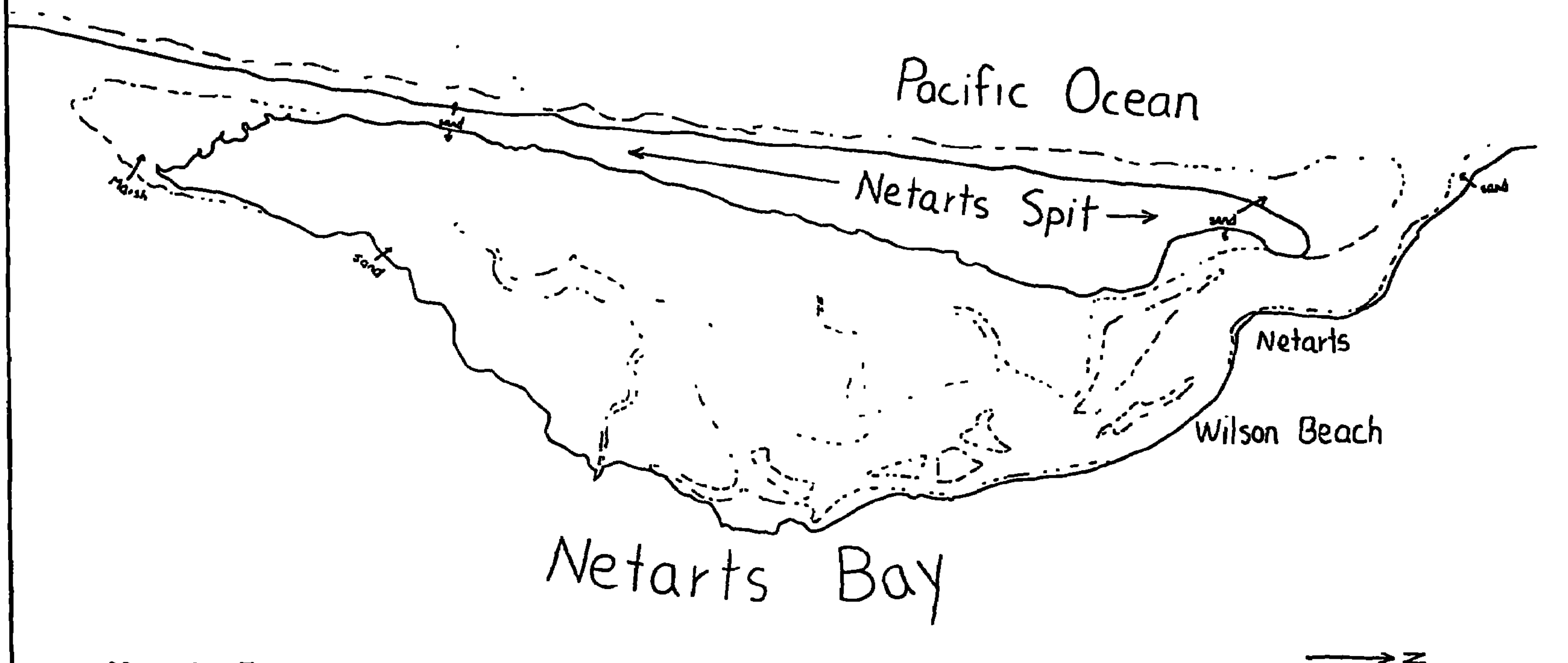
New NEI Estuary



New NEI Estuary

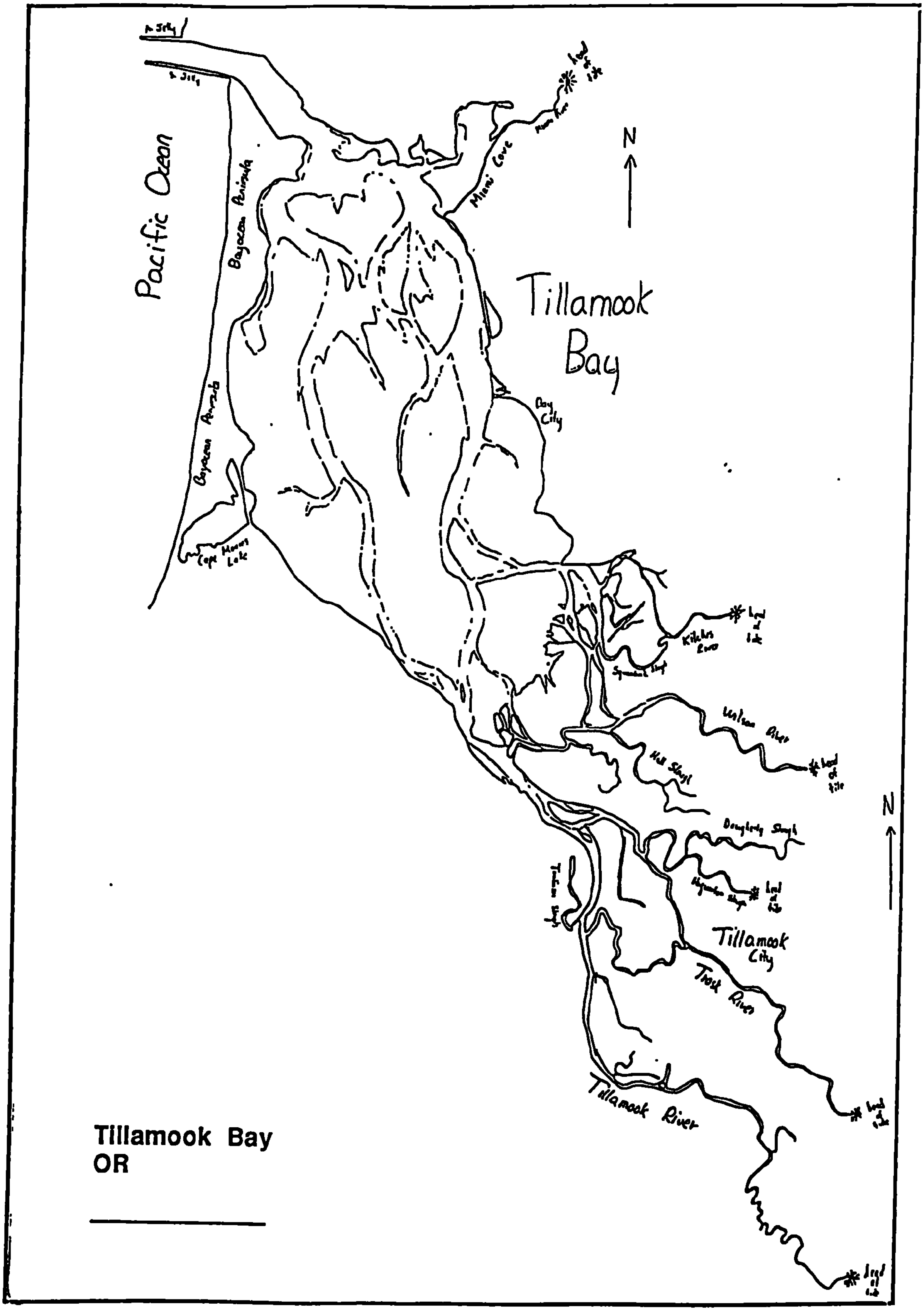


New NEI Estuary



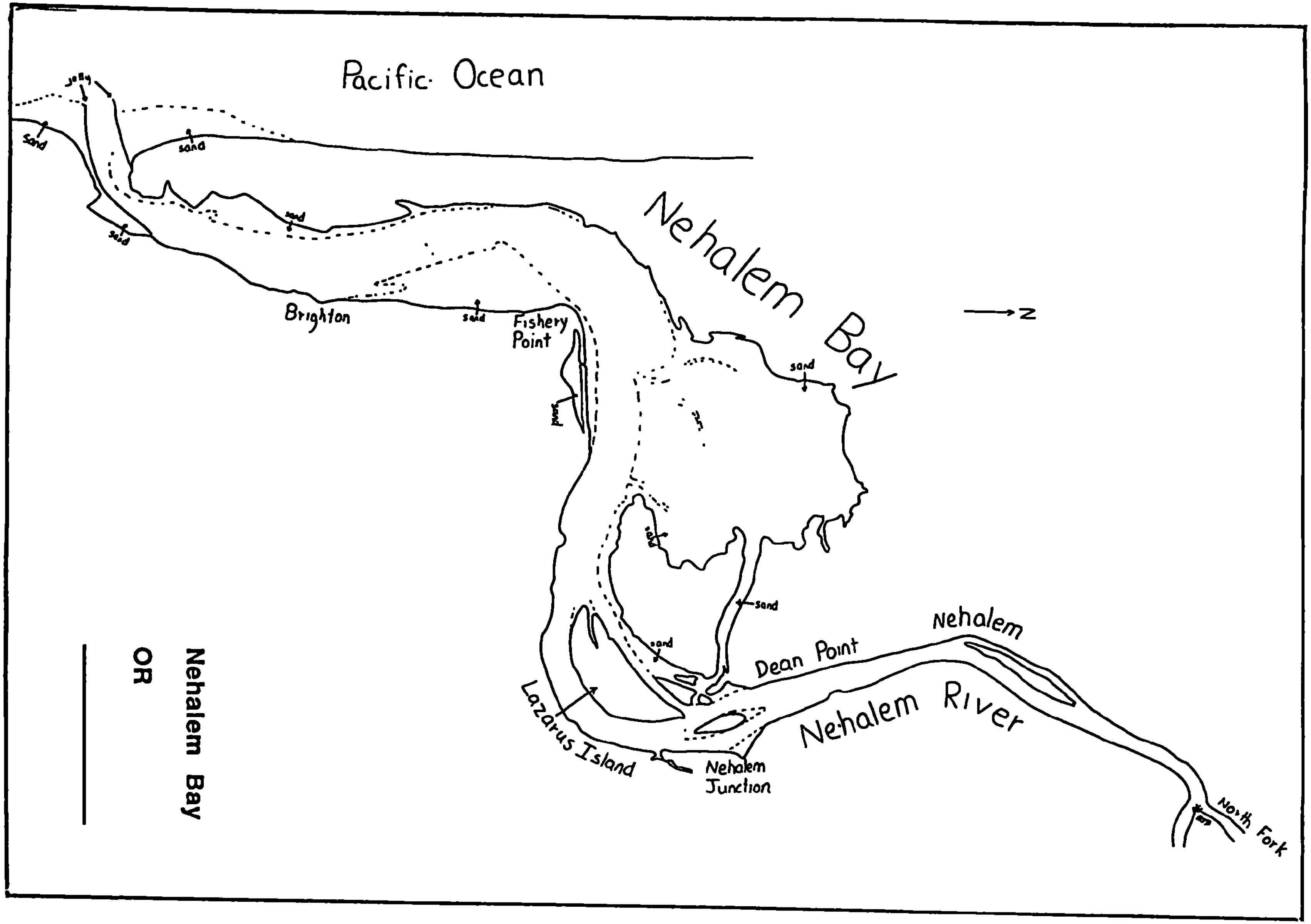
Netarts Bay
OR

New NEI Estuary



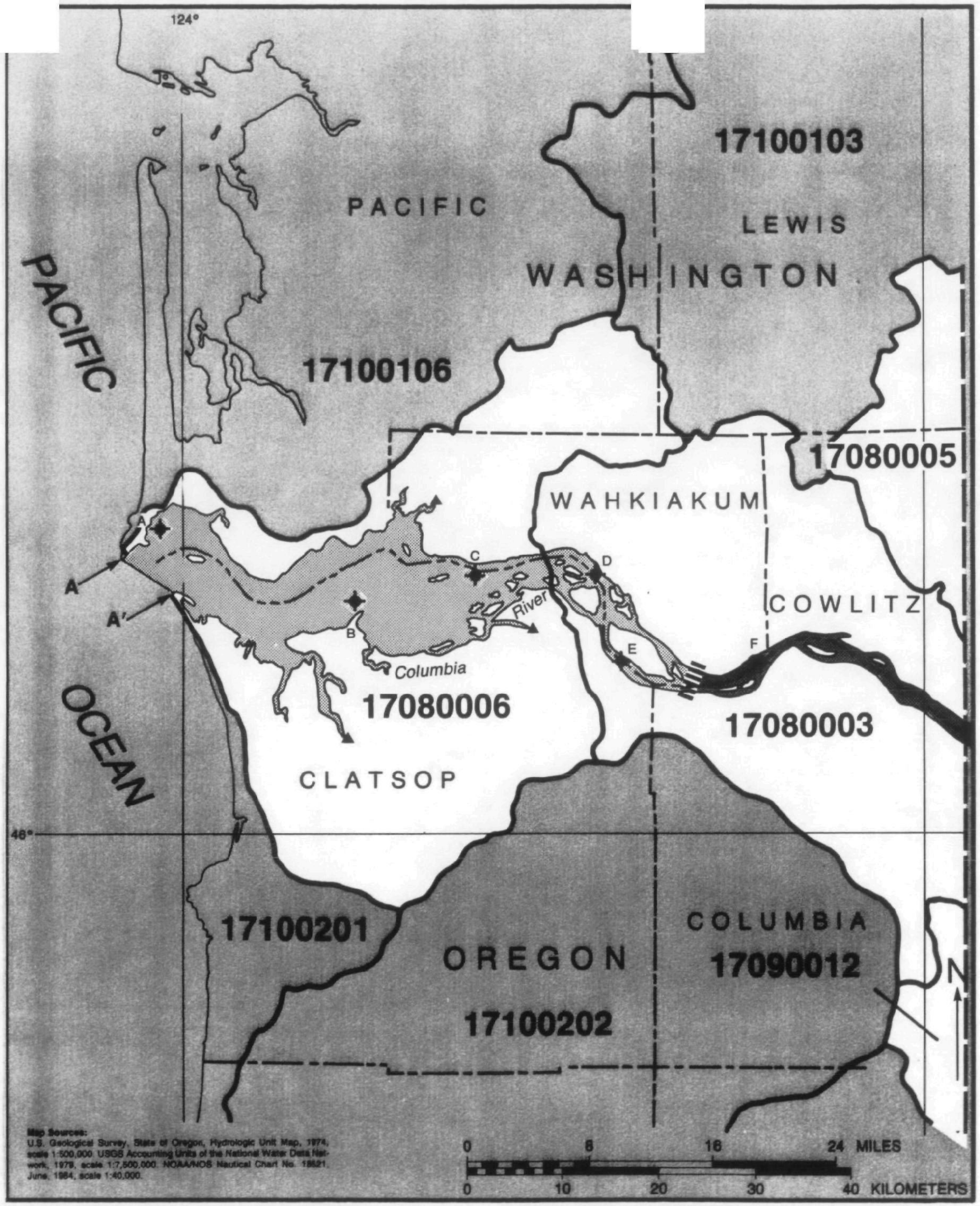
Tillamook Bay
OR

New NEI Estuary



Nehalem Bay
OR

Columbia River
WA, OR



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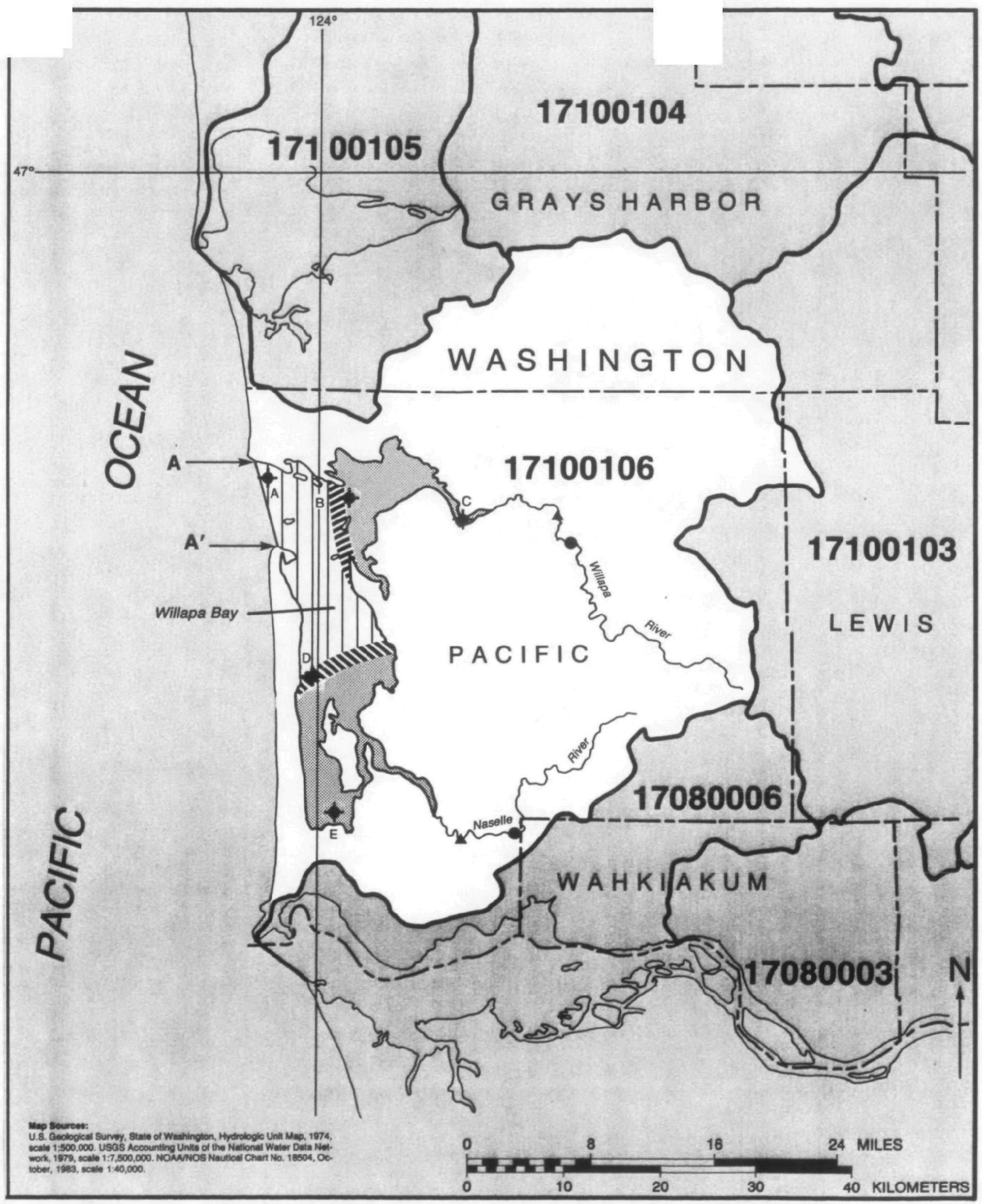
Willapa Bay
WA



Map Sources:
U.S. Geological Survey, State of Washington, Hydrologic Unit Map, 1974, scale 1:500,000. USGS Accounting Units of the National Water Data Network, 1979, scale 1:7,500,000. NOAA/NOS Nautical Chart No. 18504, October, 1983, scale 1:40,000.

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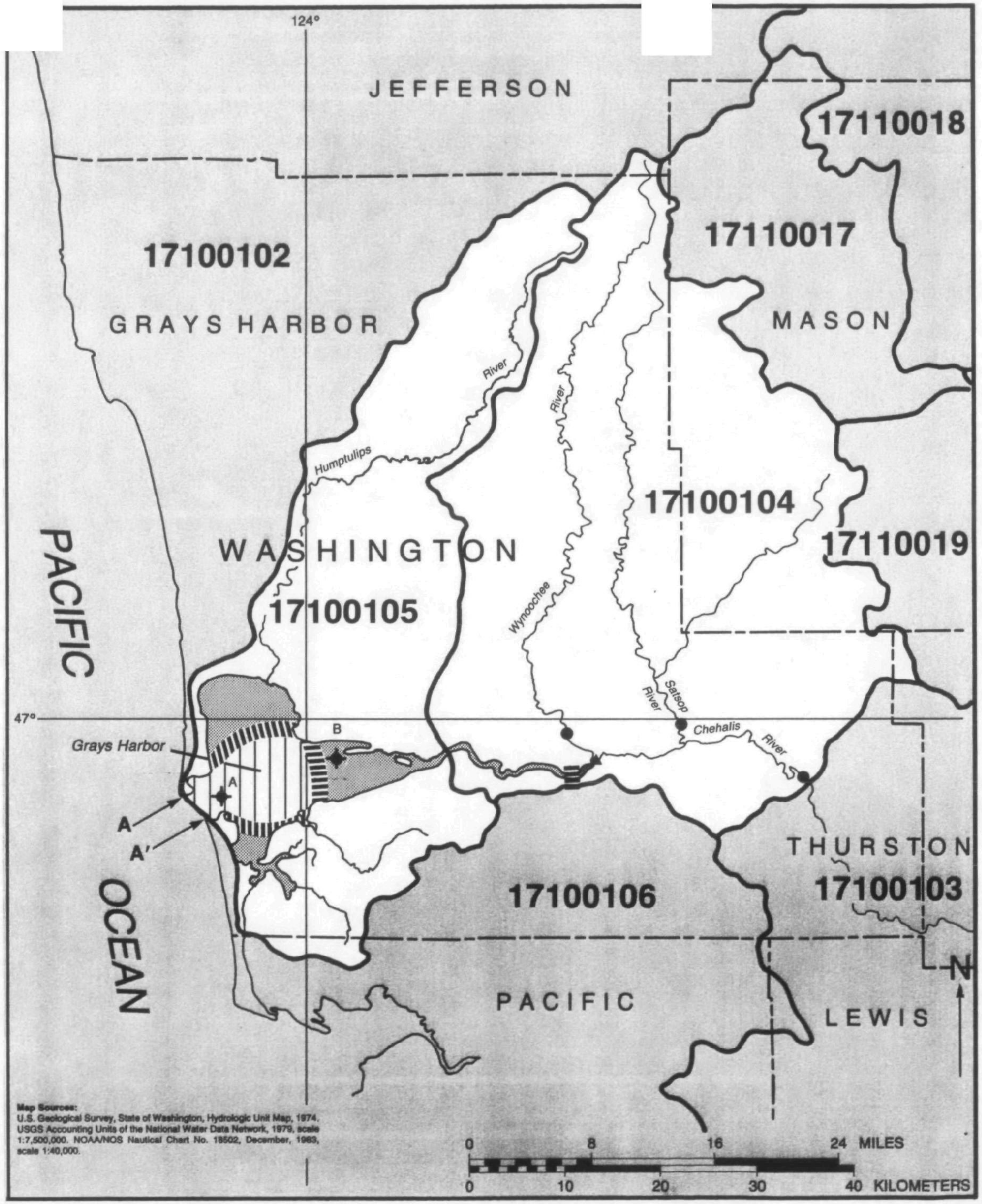
Grays Harbor
WA



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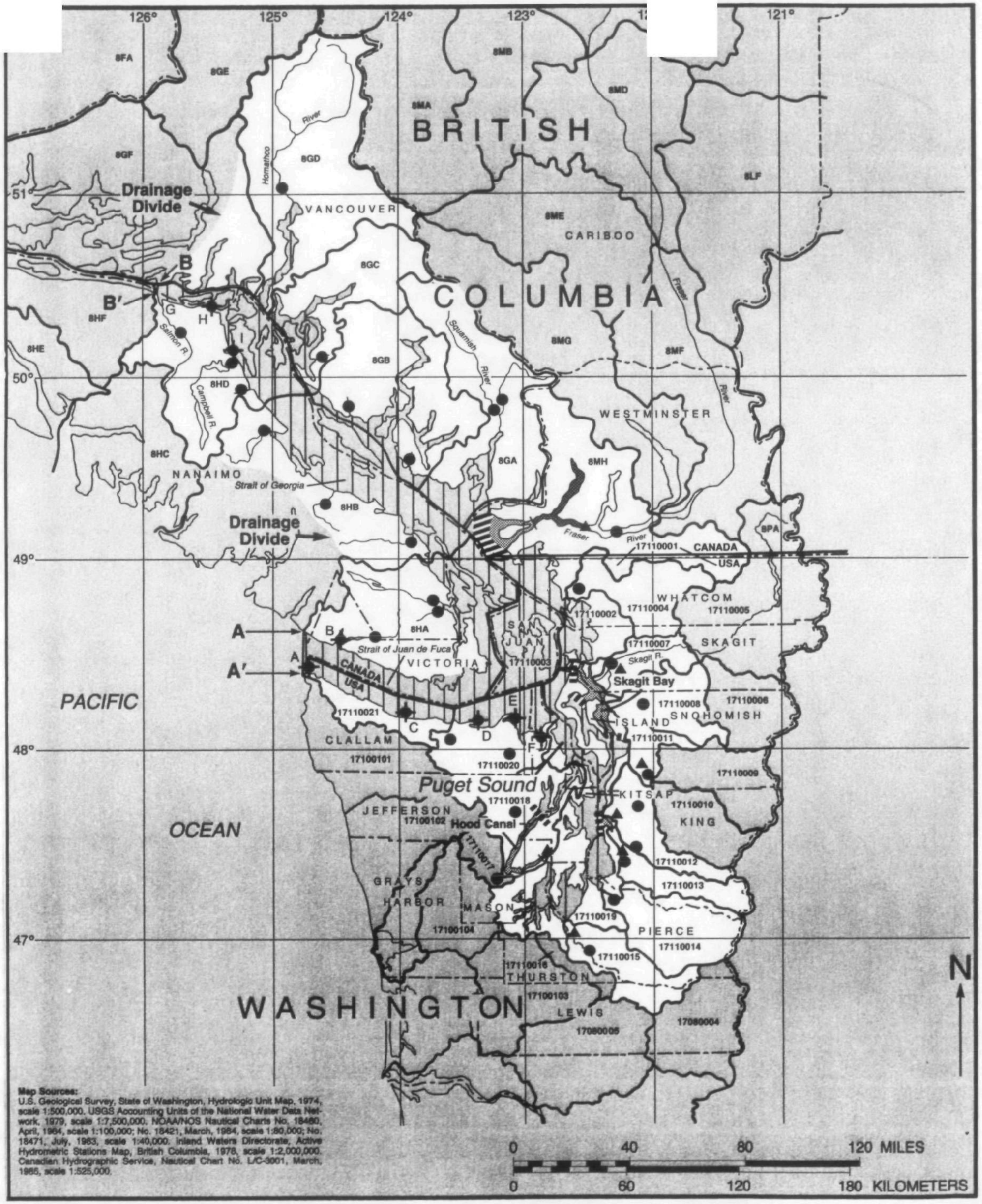
Puget Sound
WA, BC



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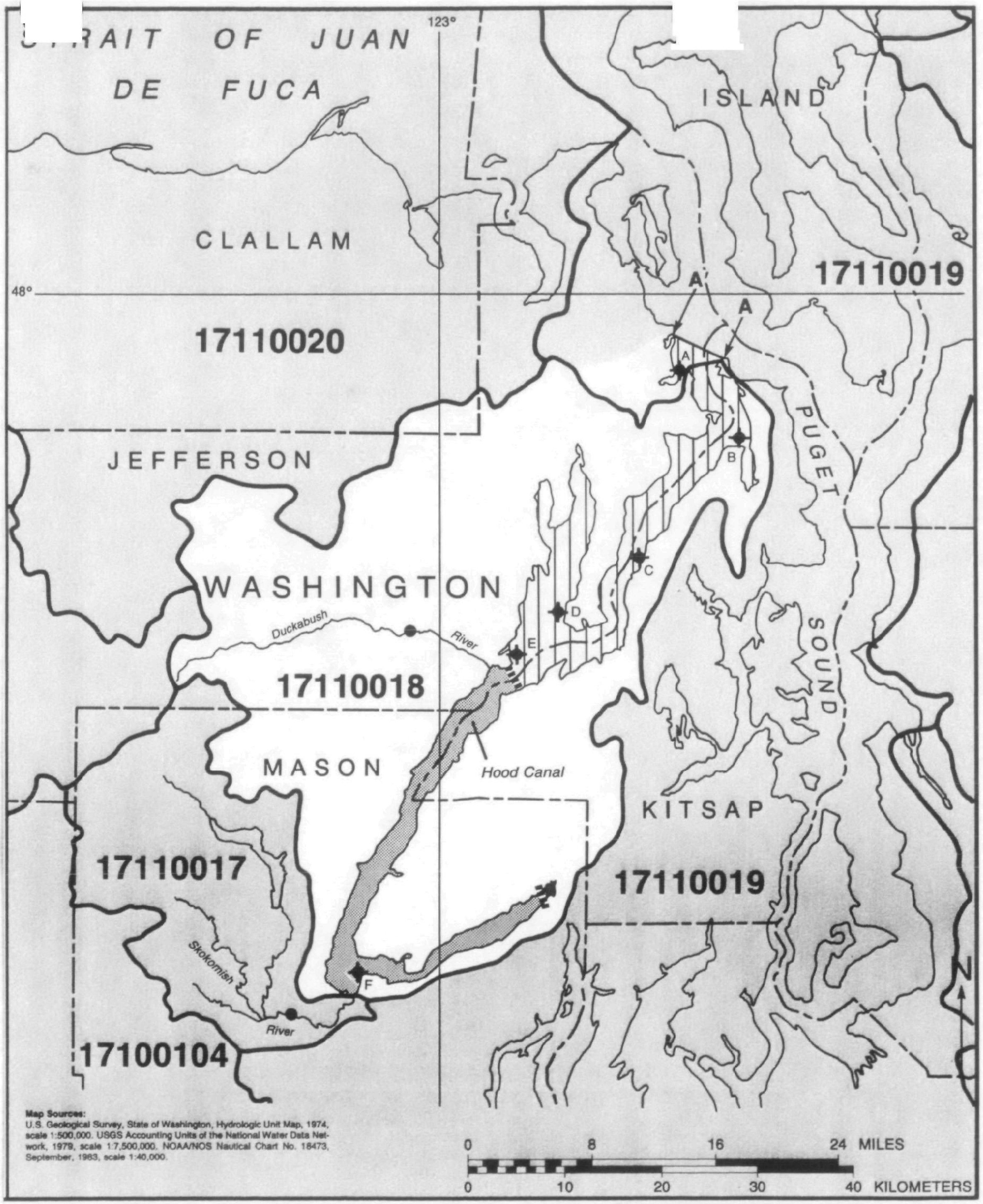
Hood Canal WA



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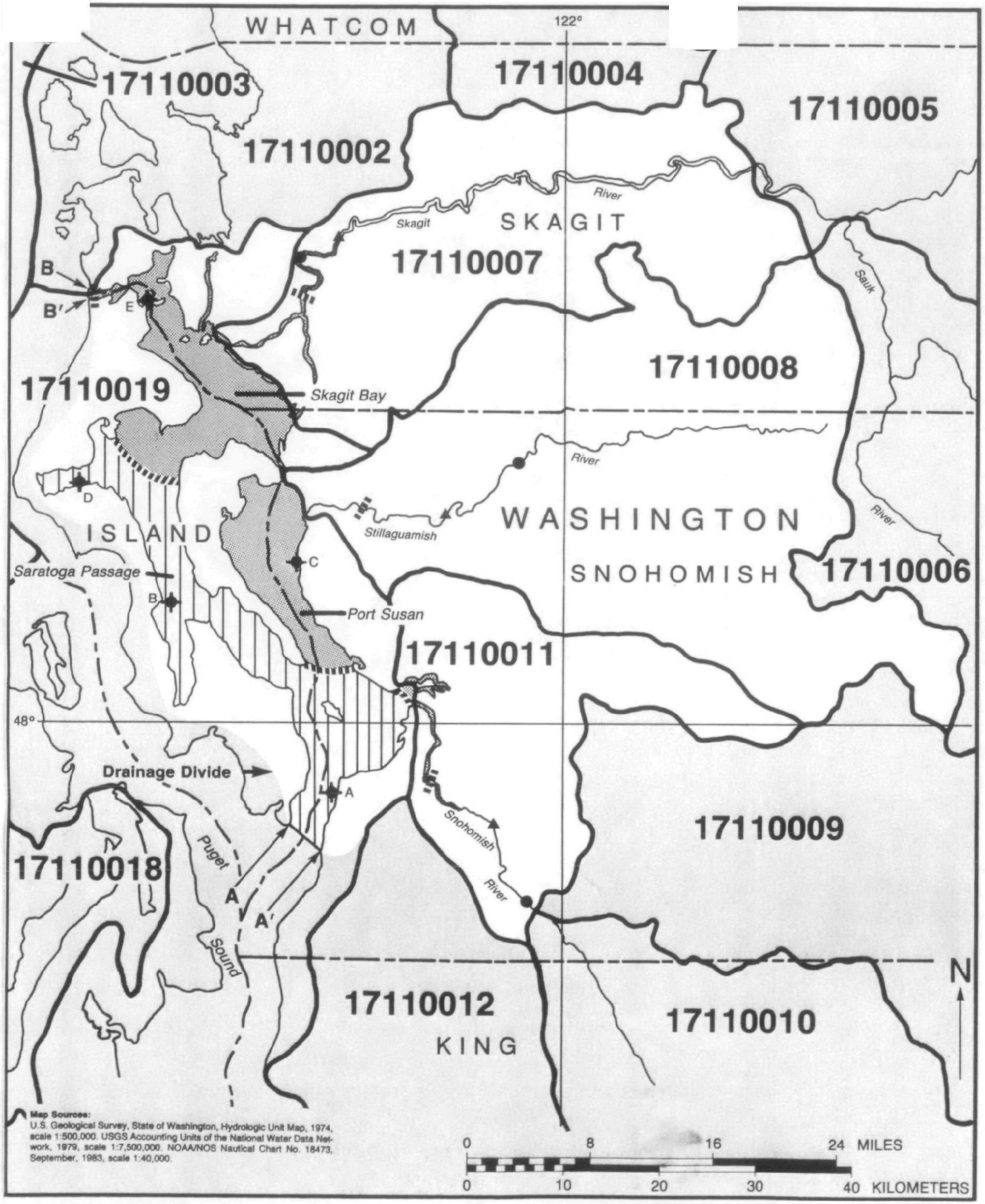
4.14a.

Skagit Bay
WA



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4.14b.

RIVERS AND STREAMS

Rivers and Streams

NATIONAL COASTAL POLLUTANT DISCHARGE INVENTORY
Rivers and Streams Entering Coastal Counties

EPA Region	State	River	Long term flow at coastal cty boundary (cfs)	In NCPDI	Reach Number	NEI Estuary Code	Estuary Name	River Discharges Directly to Estuary (Y/N)
1	ME	St. Croix River	462	N	01050001108	101	Passamaquoddy Bay	Y
1	ME	Junior Creek	114	N	01050001068	101	Passamaquoddy Bay	N
1	ME	Buffalo Stream	77	N	01050002132	104	Blue Hill Bay	N
1	ME	Penobscot River	14148	Y	01020005022	105	Penobscot Bay	Y
1	ME	Sheepscot River	122	N	01050003055	107	Sheepscot Bay	Y
1	ME	Eastern River	70	N	01030003003	107	Sheepscot Bay	Y
1	ME	Kennebec River	9516	Y	01030003004	107	Sheepscot Bay	Y
1	ME	Androscoggin River	6489	Y	01040002001	107	Sheepscot Bay	Y
1	ME	Crooked River	425	N	01060001027	108	Casco Bay	N
1	ME	Saco River	1841	Y	01060002003	109	Saco Bay	Y
1	ME	Ossipee River	886	N	01060002040	109	Saco Bay	N
1	NH	Salmon Falls River	137	N	01060003012	110	Great Bay	N
1	MA	Merrimack River	6622	Y	01070002010	111	Merrimack River	Y
1	MA	Nashua River	423	N	01070004005	111	Merrimack River	N
1	MA	Assabet River	242	N	01070005002	111	Merrimack River	N
1	RI	Mill River	18	N	01090003005	115	Narragansett Bay	N
1	RI	Blackstone River	760	N	01090003006	115	Narragansett Bay	Y
1	CT	Quinebaug River	1101	Y	01100001004	117	Long Island Sound	N
1	CT	Little River	57	N	01100002019	117	Long Island Sound	N
1	CT	Shetucket River	765	N	01100002002	117	Long Island Sound	N
1	CT	Blackledge River	91	N	01080205018	117	Long Island Sound	N
1	CT	Connecticut River	18077	Y	01080205022	117	Long Island Sound	Y
1	CT	Quinnipiac River	222	N	01100004026	117	Long Island Sound	Y
1	CT	Naugatuck River	221	N	01100005003	117	Long Island Sound	N
1	CT	Shepaug River	247	N	01100005013	117	Long Island Sound	N
1	CT	Pomperaug River	154	N	01100005010	117	Long Island Sound	N
1	CT	Housatonic River	2081	Y	01100005022	117	Long Island Sound	Y
2	NY	Owl Kill	100	N	02020003028	119	Hudson River/Raritan Bay	N
2	NY	Little White Creek	66	N	02020003027	119	Hudson River/Raritan Bay	N
2	NY	Walloomsac River	262	N	02020003022	119	Hudson River/Raritan Bay	N
2	NY	Hoosic River	440	N	02020003016	119	Hudson River/Raritan Bay	N
2	NY	Anthony Kill	580	N	02020003074	119	Hudson River/Raritan Bay	N
2	NY	Mohawk River	5801	N	02020004001	119	Hudson River/Raritan Bay	N
2	NY	Normans Kill	70	N	02020006056	119	Hudson River/Raritan Bay	N
2	NY	Sandburg Creek	52	N	02020007011	119	Hudson River/Raritan Bay	N
2	NY	Hudson River	8439	Y	02020003002	119	Hudson River/Raritan Bay	Y
2	NJ	Passaic River	1404	Y	02030103010	119	Hudson River/Raritan Bay	N
2	NJ	Raritan River	1189	Y	02030105004	119	Hudson River/Raritan Bay	Y
2	NJ	Green Brook	98	Y	02030105003	119	Hudson River/Raritan Bay	N

NATIONAL COASTAL POLLUTANT DISCHARGE INVENTORY
Rivers and Streams Entering Coastal Counties

EPA Region	State	River	Long term flow at coastal cty boundary (cfs)	In NCPDI	Reach Number	NEI Estuary Code	Estuary Name	River Discharges Directly to Estuary (Y/N)
DDDDDD	DDDD	DDDDDDDDDDDDDDDDDDDDDDDD	DDDDDDDD	DDDDD	DDDDDDDDDDDD	DDDDD	DDDDDDDDDDDDDDDDDDDDDDDDDDDDDD	DDDDDDD
3	PA	Delaware River	13884	N	02040201001	121	Delaware Bay	Y
3	PA	Schuylkill River	2943	Y	02040203003	121	Delaware Bay	N
3	PA	Wissahickon Creek	87	N	02040203002	121	Delaware Bay	N
3	PA	Pennypack Creek	73	N	02040202069	121	Delaware Bay	N
3	PA	Darby Creek	99	N	02040202075	121	Delaware Bay	N
3	PA	Crum Creek	41	N	02040202080	121	Delaware Bay	N
3	PA	Ridley Creek	71	N	02040202081	121	Delaware Bay	N
3	PA	Chester Creek	108	N	02040202082	121	Delaware Bay	N
3	DE	Brandywine Creek	512	N	02040205006	121	Delaware Bay	N
3	DE	Red Clay Creek	88	N	02040205013	121	Delaware Bay	N
3	DE	White Clay Creek	130	N	02040205014	121	Delaware Bay	N
3	MD	Elk Creek	111	N	02060002050	123	Chesapeake Bay	N
3	MD	Octoraro Creek	276	N	02050306010	123	Chesapeake Bay	N
3	MD	Conowingo Creek	69	N	02050306017	123	Chesapeake Bay	N
3	MD	Susquehanna River	37294	Y	02050306021	123	Chesapeake Bay	Y
3	MD	Patapsco River	320	N	02060003028	123	Chesapeake Bay	Y
3	MD	Deer Creek	233	N	02050306076	123	Chesapeake Bay	N
3	MD	Little Patuxent River	51	N	02060006020	123	Chesapeake Bay	N
3	MD	Middle Patuxent River	50	N	02060006021	123	Chesapeake Bay	N
3	MD	Patuxent River	160	N	02060006022	123	Chesapeake Bay	Y
3	MD	NE Branch Anacostia	99	N	02070010030	123a	Potomac River	N
3	MD	NW Branch Anacostia	59	N	02070010031	123a	Potomac River	N
3	DC	Potomac River	11373	Y	02070008001	123a	Potomac River	Y
3	DC	Rock Creek	94	N	02070008036	123a	Potomac River	N
3	VA	Tuckahoe Creek	74	N	02080205002	123	Chesapeake Bay	N
3	VA	James River	7287	Y	02080205003	123	Chesapeake Bay	Y
3	VA	Swift Creek	160	N	02080207002	123	Chesapeake Bay	N
3	VA	Appomattox River	1478	Y	02080207003	123	Chesapeake Bay	N
3	VA	Tributary North Anna	50	N	02080106018	123	Chesapeake Bay	N
3	VA	Terrys Run	31	N	02080106021	123	Chesapeake Bay	N
3	VA	Pamunkey Creek	53	N	02080106023	123	Chesapeake Bay	N
3	VA	Chickahominy River	411	N	02080206031	123	Chesapeake Bay	N
3	VA	Pamunkey River	1287	Y	02080106006	123	Chesapeake Bay	Y
3	VA	Bull Run	15	N	02070010055	123a	Potomac River	N
3	VA	Kettle Run	50	N	02070010065	123a	Potomac River	N
3	VA	Broad Run	52	N	02070010064	123a	Potomac River	N
3	VA	Rappahannock River	1685	Y	02080104042	123a	Potomac River	Y
3	VA	Cedar Run	219	N	02070010066	123a	Potomac River	N
4	NC	Meherrin River	1314	Y	03010204003	201	Albemarle Sound	N
4	NC	Nottoway River	1842	Y	03010201001	201	Albemarle Sound	N
4	NC	Potecasi Creek	164	N	03010204030	201	Albemarle Sound	N
4	NC	Roanoke River	7540	Y	03010107007	201	Albemarle Sound	Y

NATIONAL COASTAL POLLUTANT DISCHARGE INVENTORY
Rivers and Streams Entering Coastal Counties

EPA Region	State	River	Long term flow at coastal cty boundary (cfs)	In NCPDI	Reach Number	NEI Estuary Code	Estuary Name	River Discharges Directly to Estuary (Y/N)
4	NC	Blackwater River	804	N	03010202001	201	Albemarle Sound	N
4	NC	Kirbys Creek	134	N	03010204028	201	Albemarle Sound	N
4	NC	Neuse River	4016	Y	03020202011	202	Pamlico Sound	Y
4	NC	Tar River	3205	Y	03020103001	202a	Pamlico and Pungo Rivers	N
4	NC	Beaver Creek	137	N	03020204016	202b	Neuse River	N
4	NC	Little Chinquapin Brook	168	N	03020204019	202b	Neuse River	N
4	NC	Little Chinquapin Brook	132	N	03020204018	202b	Neuse River	N
4	NC	Swift Creek	238	N	03020202005	202b	Neuse River	N
4	NC	Black River	1874	Y	03030006005	205	Cape Fear River	N
4	NC	NE Cape Fear River	855	N	03030007007	205	Cape Fear River	N
4	NC	Angola Creek	240	N	03030007005	205	Cape Fear River	N
4	NC	Lyon Swamp Canal	147	N	03030006029	205	Cape Fear River	N
4	NC	Cape Fear River	6222	Y	03030005027	205	Cape Fear River	Y
4	SC	Waccamaw River	1047	Y	03040206008	206	Winyah Bay	Y
4	SC	Pee Dee River	16126	Y	03040201054	206	Winyah Bay	Y
4	SC	Black River Swamp	702	N	03040205007	206	Winyah Bay	N
4	SC	Pudding Swamp	95	N	03040205006	206	Winyah Bay	N
4	SC	Santee River	18341	Y	03050112006	208	North and South Santee Rivers	Y
4	SC	Edisto River	1330	Y	03050205018	209	St. Helena Sound	Y
4	SC	Lemon Creek River	137	N	03050207014	209	St. Helena Sound	N
4	SC	Salkehatchie River	1282	Y	03050208006	209	St. Helena Sound	N
4	SC	Four Hole Swamp	468	N	03050206001	209	St. Helena Sound	N
4	SC	Cattle Creek	51	N	03050205017	209	St. Helena Sound	N
4	SC	Coosawatchie River	627	N	03050208015	210	Broad River	N
4	GA	Savannah River	12345	Y	03060109005	211	Savannah River	Y
4	GA	Walthour Swamp	73	N	03060109008	211	Savannah River	N
4	GA	Little Ogeechee River	579	N	03060204007	212	Ossabaw Sound	Y
4	GA	Canoochee River	972	N	03060203002	212	Ossabaw Sound	N
4	GA	Canoochee Creek	46	N	03060203016	212	Ossabaw Sound	N
4	GA	Taylors Creek	71	N	03060203017	212	Ossabaw Sound	N
4	GA	Black Creek	316	N	03060202026	212	Ossabaw Sound	N
4	GA	Ogeechee River	2833	Y	03060202002	212	Ossabaw Sound	Y
4	GA	Altamaha River	15402	Y	03070106007	214	Altamaha River	Y
4	GA	Satilla River	2638	Y	03070201005	215	St. Andrew / St. Simons Sound	Y
4	GA	St. Marys River	1523	Y	03070204005	215	St. Andrew / St. Simons Sound	Y
4	FL	Suwanee River	1097	Y	03110201	304	Suwanee River	Y
4	FL	Withlahoochee River	1680	Y	03110203	304	Suwanee River	N
4	FL	Alapaha River	1050	Y	03110202	304	Suwanee River	N
4	FL	Ochlockonee River	1035	Y	03120003	305	Apalachee Bay	Y
4	FL	Swamp Creek	57	Y	03120003	305	Apalachee Bay	N
4	FL	Attapulgus Creek	49	Y	03120003	305	Apalachee Bay	N
4	FL	Aucilla River	499	Y	03110103	305	Apalachee Bay	Y
4	FL	Big Creek	201	Y	03130012	306	Apalachicola Bay	N
4	FL	Apalachicola River	22570	Y	03130011	306	Apalachicola Bay	Y
4	FL	Chipola Creek	NA	Y	03130012	306	Apalachicola Bay	N

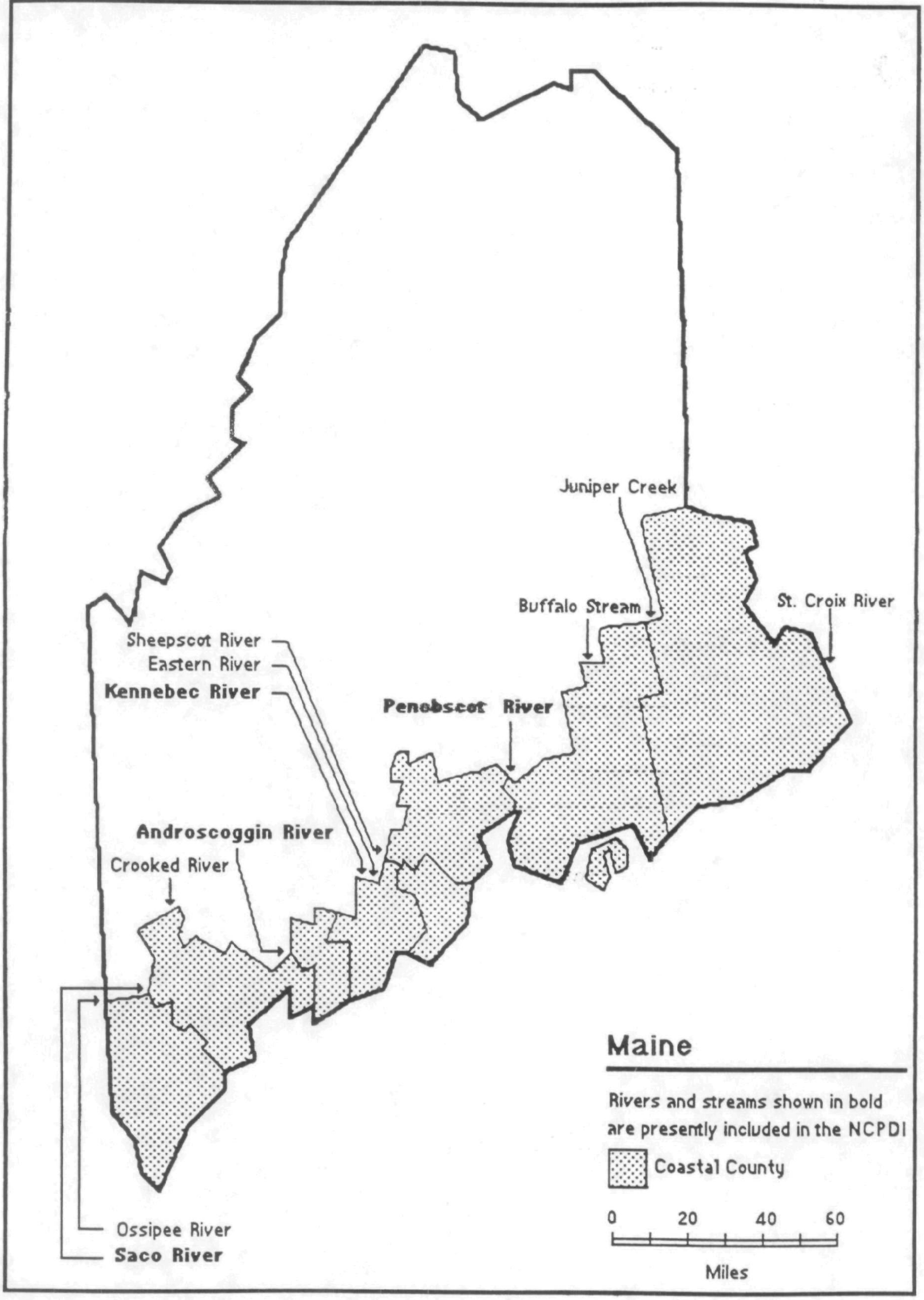
EPA Region	State	River	Long term flow at coastal cty boundary (cfs)	In NCPDI	Reach Number	NEI Estuary Code	Estuary Name	River Discharges Directly to Estuary (Y/N)
DDDDDD	DDDD	DDDDDDDDDDDDDDDDDDDDDDDD	DDDDDDDD	DDDDD	DDDDDDDDDDD	DDDDD	DDDDDDDDDDDDDDDDDDDDDDDDDDDDDD	DDDDDDD
4	FL	Cowerts Creek	258	Y	03130012	306	Apalachicola Bay	N
4	FL	Choctawhatchee River	6333	Y	03140203	308	Choctawhatchee Bay	Y
4	FL	Wrights Creek	6	Y	03140203	308	Choctawhatchee Bay	N
4	FL	Escambia River	6381	Y	03140305	309	Pensacola Bay	Y
4	FL	Yellow River	1187	Y	03140103	309	Pensacola Bay	Y
4	FL	Sweetwater Creek	35	Y	03140104	309	Pensacola Bay	N
4	FL	Canoe Creek	NA	Y	03140305	309	Pensacola Bay	N
4	FL	Pond Creek	80	Y	03140103	309	Pensacola Bay	N
4	FL	Perdido River	769	Y	03140106	310	Perdido Bay	Y
4	FL	Brushy Creek	108	Y	03140106	310	Perdido Bay	N
4	FL	Ward Creek	NA	Y	03120001	999	Does not enter NEI estuary	N
4	AL	Tombigbee River	30770	Y	03160204	311	Mobile Bay	Y
4	AL	Alabama River	40876	Y	03160204	311	Mobile Bay	N
4	MS	Jourdan River	24	Y	03170009	312	Mississippi Sound	Y
4	MS	Wolf River	736	Y	03170009	312	Mississippi Sound	Y
4	MS	Little Biloxi	57	Y	03170009	312	Mississippi Sound	Y
4	MS	Big Cedar Creek	141	Y	03170006	312	Mississippi Sound	N
4	MS	Biloxi River	192	Y	03170009	312	Mississippi Sound	Y
4	MS	Black Creek	1609	Y	03170007	312	Mississippi Sound	N
4	MS	Red Creek	885	Y	03170007	312	Mississippi Sound	N
4	MS	Crane Creek	63	Y	03170009	312	Mississippi Sound	N
4	MS	Pascagoula River	10000	Y	03170006	312	Mississippi Sound	Y
4	MS	Escatawapa River	1414	Y	03170009	312	Mississippi Sound	Y
6	MS	Pearl River	9768	Y	03180005	312a	Lake Borgne	Y
6	LA	Boque Chitto	1941	Y	03180005	312a	Lake Borgne	N
6	LA	Tangipahoa River	1142	Y	08070205	312b	Lake Pontchartrain	Y
6	LA	Hog Branch	59	Y	08070203	312b	Lake Pontchartrain	Y
6	LA	Sandy Creek	125	Y	08070202	312b	Lake Pontchartrain	N
6	LA	Comite River	232	Y	08070202	312b	Lake Pontchartrain	N
6	LA	White Bayou	86	Y	08070202	312b	Lake Pontchartrain	N
6	LA	Redwood Creek	85	Y	08070202	312b	Lake Pontchartrain	N
6	LA	Amite River	907	Y	08070202	312b	Lake Pontchartrain	Y
6	LA	Tickfaw River	372	Y	08070203	312b	Lake Pontchartrain	Y
6	LA	Bayou des Glaises	435	Y	08080102	313	Mississippi Delta Region	Y
6	LA	Mississippi River	537000	Y	08070100	313	Mississippi Delta Region	Y
6	LA	Atchafalaya River	256800	Y	08080101	313	Mississippi Delta Region	Y
6	LA	Bayou Grosse Tete	295	Y	08070300	314	Atchafalaya and Vermilion Bays	N
6	LA	Vermillion River	157	Y	08080103	314	Atchafalaya and Vermilion Bays	Y
6	LA	Bayou Teche	830	Y	08080102	314	Atchafalaya and Vermilion Bays	Y
6	LA	Hickory Branch	53	Y	08080205	315	Calcasieu Lake	N
6	LA	Clear Creek	90	Y	08080203	315	Calcasieu Lake	N
6	LA	Beckwith Creek	199	Y	08080205	315	Calcasieu Lake	N
6	LA	Indian Bayou	18	Y	08080205	315	Calcasieu Lake	N

EPA Region	State	River	Long term flow at coastal cty boundary (cfs)	In NCPDI	Reach Number	NEI Estuary Code	Estuary Name	River Discharges Directly to Estuary (Y/N)
6	LA	Calcasieu River	2581	Y	08080206	315	Calcasieu Lake	Y
6	LA	Bear Head Creek	236	Y	08080205	315	Calcasieu Lake	N
6	LA	Bayou Plaquemine Brule	110	Y	08080201	999	Does not enter NEI estuary	N
6	LA	Bayou Mallet	96	Y	08080201	999	Does not enter NEI estuary	N
6	LA	Bayou des Cannes	268	Y	08080201	999	Does not enter NEI estuary	N
6	LA	Bayou Nezpique	825	Y	08080201	999	Does not enter NEI estuary	N
6	TX	Neches River	5379	Y	12020003	316	Sabine Lake	Y
6	TX	Sabine River	7743	Y	12010005	316	Sabine Lake	Y
6	TX	Cow Bayou	102	Y	12010005	316	Sabine Lake	Y
6	TX	Village Creek	839	Y	12020007	316	Sabine Lake	Y
6	TX	East Fork San Jacinto	226	Y	12040103	317	Galveston Bay	N
6	TX	Caney Creek	75	Y	12070104	317	Galveston Bay	N
6	TX	Spring Creek	219	Y	12040101	317	Galveston Bay	N
6	TX	West Fork San Jacinto	619	Y	12040101	317	Galveston Bay	N
6	TX	Trinity River	7528	Y	12030203	317	Galveston Bay	Y
6	TX	Peach Creek	53	Y	12040103	317	Galveston Bay	Y
6	TX	Pine Island Bayou	472	Y	12020007	317	Galveston Bay	N
6	TX	Brazos River	6660	Y	12070104	318	Brazos River	Y
6	TX	San Bernard River	500	Y	12090401	318	Brazos River	Y
6	TX	Lavaca River	48	Y	12100101	319	Matagorda Bay	Y
6	TX	Sandy Creek	209	Y	12100102	319	Matagorda Bay	N
6	TX	Navidad River	159	Y	12100102	319	Matagorda Bay	Y
6	TX	Colorado River	2931	Y	12090302	319	Matagorda Bay	Y
6	TX	Coleto Creek	95	Y	12100204	320	San Antonio Bay	N
6	TX	Guadalupe River	2104	Y	12100204	320	San Antonio Bay	Y
6	TX	San Antonio River	666	Y	12100303	320	San Antonio Bay	Y
6	TX	Blanco Creek	15	Y	12100406	321	Aransas Bay	N
6	TX	Aransas River	45	Y	12100407	321	Aransas Bay	Y
6	TX	Medio Creek	22	Y	12100406	321	Aransas Bay	N
6	TX	Nueces River	849	Y	12110111	322	Corpus Christi Bay	Y
6	TX	Rio Grande River	2047	Y	12110208	323	Laguna Madre	Y
6	TX	North Floodway	309	Y	12110208	323	Laguna Madre	Y
6	TX	Arroyo Colorado River	318	Y	12110208	323	Laguna Madre	Y
6	TX	San Fernando Creek	29	Y	12110204	323a	Baffin Bay	Y
6	TX	Los Olmos Creek	5	Y	12110205	323a	Baffin Bay	Y
9	CA	Santa Ana River	3	Y	18070203005	402	San Pedro Bay	Y
9	CA	UT of San Gabriel River	NA	N	18070106	402	San Pedro Bay	N
9	CA	UT of Lewis Creek	NA	Y	18060005	404	Monterey Bay	N
9	CA	Chalone Creek	0	Y	18060005073	404	Monterey Bay	N
9	CA	Topo Creek	0	Y	18060005072	404	Monterey Bay	N
9	CA	Pacheco Creek	60	N	18060002018	404	Monterey Bay	N
9	CA	UT of Cuyama River	NA	N	18060007	404	Monterey Bay	N
9	CA	San Benito River	32	Y	18060002004	404	Monterey Bay	Y
9	CA	Hospital Creek	NA	N	18040014	405	San Francisco Bay	N
9	CA	Hunting Creek	18	N	18020117013	405a	Suisun Bay	N

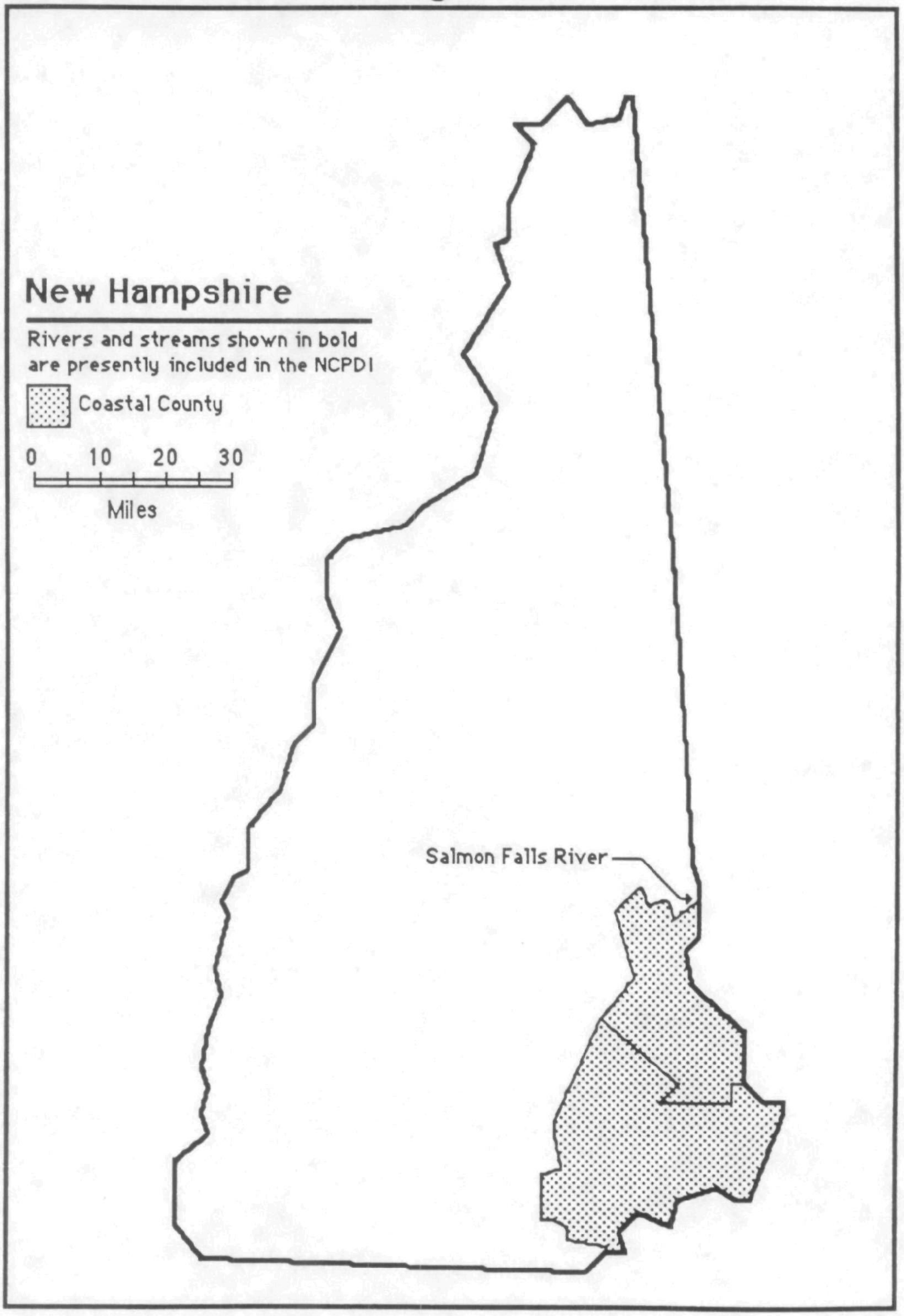
EPA Region	State	River	Long term flow at coastal cty boundary (cfs)	In NCPDI	Reach Number	NEI Estuary Code	Estuary Name	River Discharges Directly to Estuary (Y/N)
9	CA	Colusa Basin Canal	NA	N	18020104001	405a	Suisun Bay	N
9	CA	Modesto Main Canal	15	N	18040002015	405a	Suisun Bay	N
9	CA	Butts Creek	NA	N	18020117	405a	Suisun Bay	N
9	CA	Duck Creek	22	N	18040002006	405a	Suisun Bay	N
9	CA	Littlejohn Creek	51	N	18040002005	405a	Suisun Bay	N
9	CA	Lone Tree Creek	NA	N	18040002	405a	Suisun Bay	N
9	CA	North Fork, Duck Creek	47	N	18040002007	405a	Suisun Bay	N
9	CA	Stanislaus River	756	N	18040002016	405a	Suisun Bay	N
9	CA	San Joaquin River	4403	Y	18040002009	405a	Suisun Bay	Y
9	CA	Cosumnes River	482	Y	18040013001	405a	Suisun Bay	Y
9	CA	Dry Creek #1	407	Y	18020111003	405a	Suisun Bay	N
9	CA	Willow Creek	NA	N	18040013	405a	Suisun Bay	N
9	CA	Dry Creek #2	147	N	18040005007	405a	Suisun Bay	N
9	CA	Mokelumne River	612	Y	18040005002	405a	Suisun Bay	N
9	CA	Calaveras River	229	Y	18040004002	405a	Suisun Bay	N
9	CA	American River	3943	Y	18020111002	405a	Suisun Bay	N
9	CA	Putah Creek	229	N	18020117014	405a	Suisun Bay	N
9	CA	Cache Creek	1225	Y	18020109	405a	Suisun Bay	N
9	CA	Coon Creek	505	N	18020109007	405a	Suisun Bay	N
9	CA	Feather River	8054	N	18020106001	405a	Suisun Bay	N
9	CA	Sacramento River	10701	Y	18020104001	405a	Suisun Bay	Y
9	CA	Deer Creek	NA	N	18040013	405a	Suisun Bay	N
9	CA	Balm of Gilead Creek	658	N	18010104012	406	Eel River	N
9	CA	North Fork, Eel River	697	N	18010105011	406	Eel River	N
9	CA	Eel River	450	Y	18010103007	406	Eel River	Y
9	CA	Cold Creek	100	N	18010104011	406	Eel River	N
9	CA	Black Butte River	104	N	18010104010	406	Eel River	N
9	CA	Van Duzen River	393	Y	18010105020	406	Eel River	N
9	CA	UT of Balm of Gilead	NA	N	18010104	406	Eel River	N
9	CA	UT of Eel River	98	N	18010105015	406	Eel River	N
9	CA	Camp Creek	268	N	18010209030	408	Klamath River	N
9	CA	Salmon River	1809	N	18010210001	408	Klamath River	N
9	CA	Klamath River	6273	Y	18010209013	408	Klamath River	Y
9	CA	South Fork, Trinity	1553	N	18010212005	408	Klamath River	N
9	CA	Trinity River	2837	Y	18010211009	408	Klamath River	N
9	CA	Deluz Creek	NA	N	18070302	999	Does not enter NEI estuary	N
9	CA	UT of Deluz Creek	NA	N	18070302	999	Does not enter NEI estuary	N
9	CA	Santa Margarita River	24	Y	18070302002	999	Does not enter NEI estuary	N
9	CA	Mad River	594	Y	18010102015	999	Does not enter NEI estuary	N
9	CA	San Juan Creek	NA	N	18070301010	999	Does not enter NEI estuary	N
9	CA	San Mateo Canyon River	14	Y	18070301006	999	Does not enter NEI estuary	N
10	OR	Cow Creek	14	N	17100302058	410	Winchester Bay	N
10	OR	Columbia River	195526	Y	17070105001	411	Columbia River	Y
10	OR	UT of Bull Run River	146	N	17080001036	411	Columbia River	N
10	OR	Bull Run River	153	N	17080001037	411	Columbia River	N
10	OR	Eagle Creek	51	N	17070105005	411	Columbia River	N

EPA Region	State	River	Long term flow at coastal cty boundary (cfs)	In NCPDI	Reach Number	NEI Estuary Code	Estuary Name	River Discharges Directly to Estuary (Y/N)
10	OR	Sandy River	2406	Y	17080001016	411	Columbia River	N
10	OR	Willamette River	35587	Y	17090012020	411	Columbia River	N
10	OR	UT of Willamette River	NA	N	17090012	411	Columbia River	N
10	OR	Silver Creek	517	N	17100311056	417	Rogue River	N
10	OR	Illinois River	2726	Y	17100311007	417	Rogue River	N
10	OR	Kelsey Creek	31	N	17100310057	417	Rogue River	N
10	OR	East Fork, Indigo Creek	168	N	17100311063	417	Rogue River	N
10	OR	Rogue River	5674	Y	17100310011	417	Rogue River	Y
10	OR	Lobster Creek	318	N	17100205037	419	Alesa Bay	N
10	OR	Alsea River	901	Y	17100205040	419	Alesa Bay	Y
10	OR	Yaquina River	257	N	17100204003	420	Yaquina Bay	Y
10	OR	Big Rock Creek	NA	N	17100204	421	Siletz Bay	N
10	OR	Siletz River	1031	Y	17100204009	421	Siletz Bay	Y
10	OR	Wilson River	285	N	17100203021	423	Tillamook Bay	N
10	OR	North Fork, Trask River	486	N	17100203015	423	Tillamook Bay	N
10	OR	Nehalem River	270	N	17100202033	424	Nehalem Bay	Y
10	OR	Pedee Creek	50	N	17100202038	424	Nehalem Bay	N
10	OR	Nestucca River	704	N	17100203006	425	Nestucca Bay*	Y
10	WA	Cowlitz River	6834	Y	17080005035	411	Columbia River	N
10	WA	Coldwater Creek	103	Y	17080005028	411	Columbia River	N
10	WA	North Fork,Toutle River	90	Y	17080005026	411	Columbia River	N
10	WA	Castle Creek	85	N	17080005024	411	Columbia River	N
10	WA	Lewis River	2958	Y	17080002025	411	Columbia River	N
10	WA	Siouxon Creek	340	N	17080002023	411	Columbia River	N
10	WA	Canyon Creek	267	N	17080002017	411	Columbia River	N
10	WA	UT of Canyon Creek	132	N	17080002016	411	Columbia River	N
10	WA	East Fork, Lewis River	430	Y	17080002005	411	Columbia River	N
10	WA	Copper Creek	256	N	17080002004	411	Columbia River	N
10	WA	Washougal River	927	N	17080001051	411	Columbia River	N
10	WA	UT of Cowlitz River	201	N	17080005072	411	Columbia River	N
10	WA	Green River	204	Y	17080005032	411	Columbia River	N
10	WA	Lewis River	2958	Y	17080002025	411	Columbia River	N
10	WA	Devils Creek	89	N	17080005033	411	Columbia River	N
10	WA	Elk Creek	NA	N	17080005	411	Columbia River	N
10	WA	UT of Green River	44	N	17080005031	411	Columbia River	N
10	WA	East Fork, Grays River	342	N	17080006050	411	Columbia River	N
10	WA	Fall River	253	N	17100106046	412	Willapa Bay	N
10	WA	Chehalis River	2877	Y	17100103013	413	Grays Harbor	Y
10	WA	Skookmuchuck River	414	N	17100103048	413	Grays Harbor	N
10	WA	UT of Chehalis River	89	N	17100103008	413	Grays Harbor	N
10	WA	Catt & Big Creek	102	N	17110015020	414	Puget Sound	Y
10	WA	Mineral Creek	387	N	17110015015	414	Puget Sound	N
10	WA	Deschutes River	52	Y	17110016002	414	Puget Sound	Y
10	WA	Little Nisqually	118	N	17110015012	414	Puget Sound	Y
10	WA	Nisqually River	1711	Y	17110015	414	Puget Sound	Y

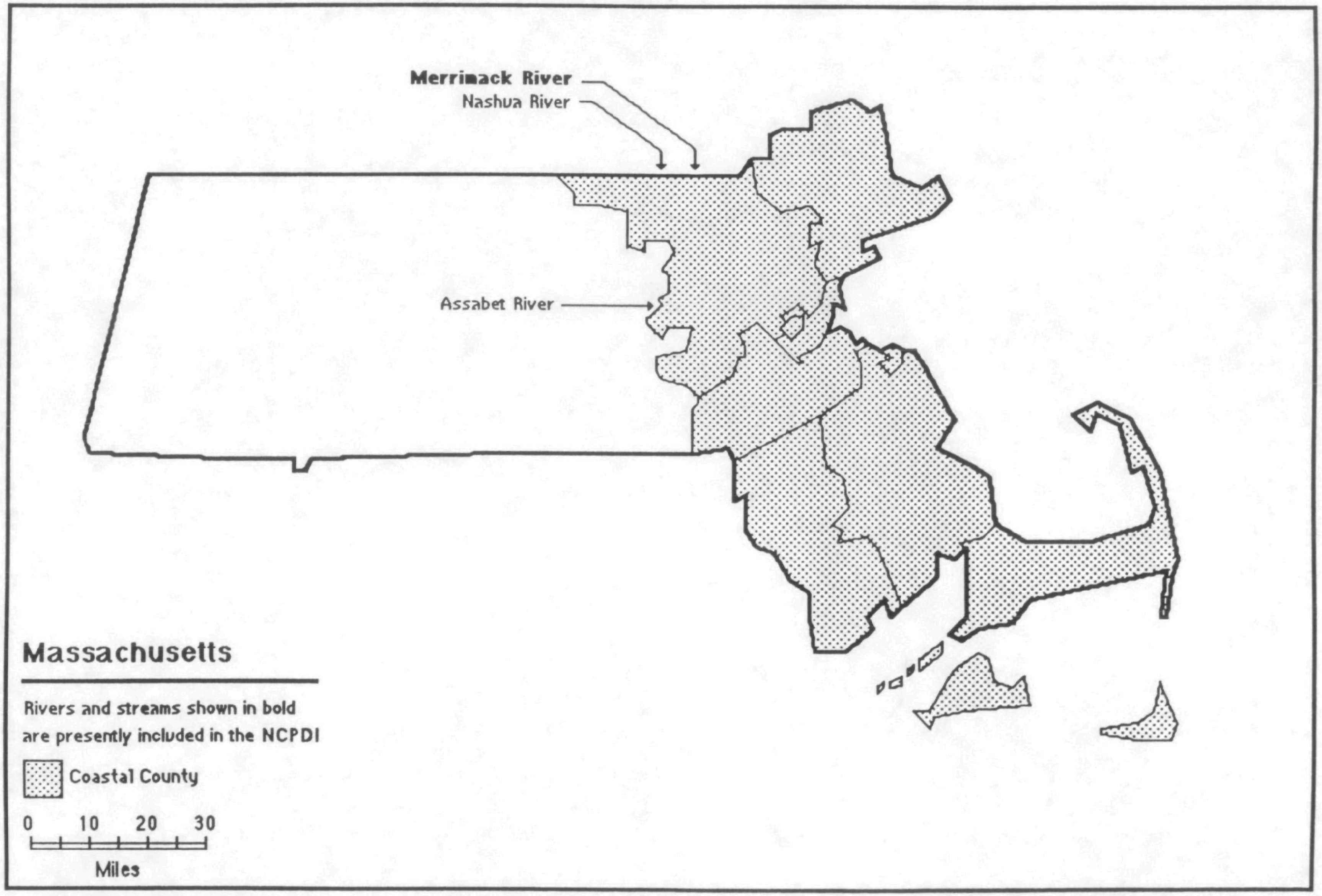
Rivers and Streams Entering Coastal Counties



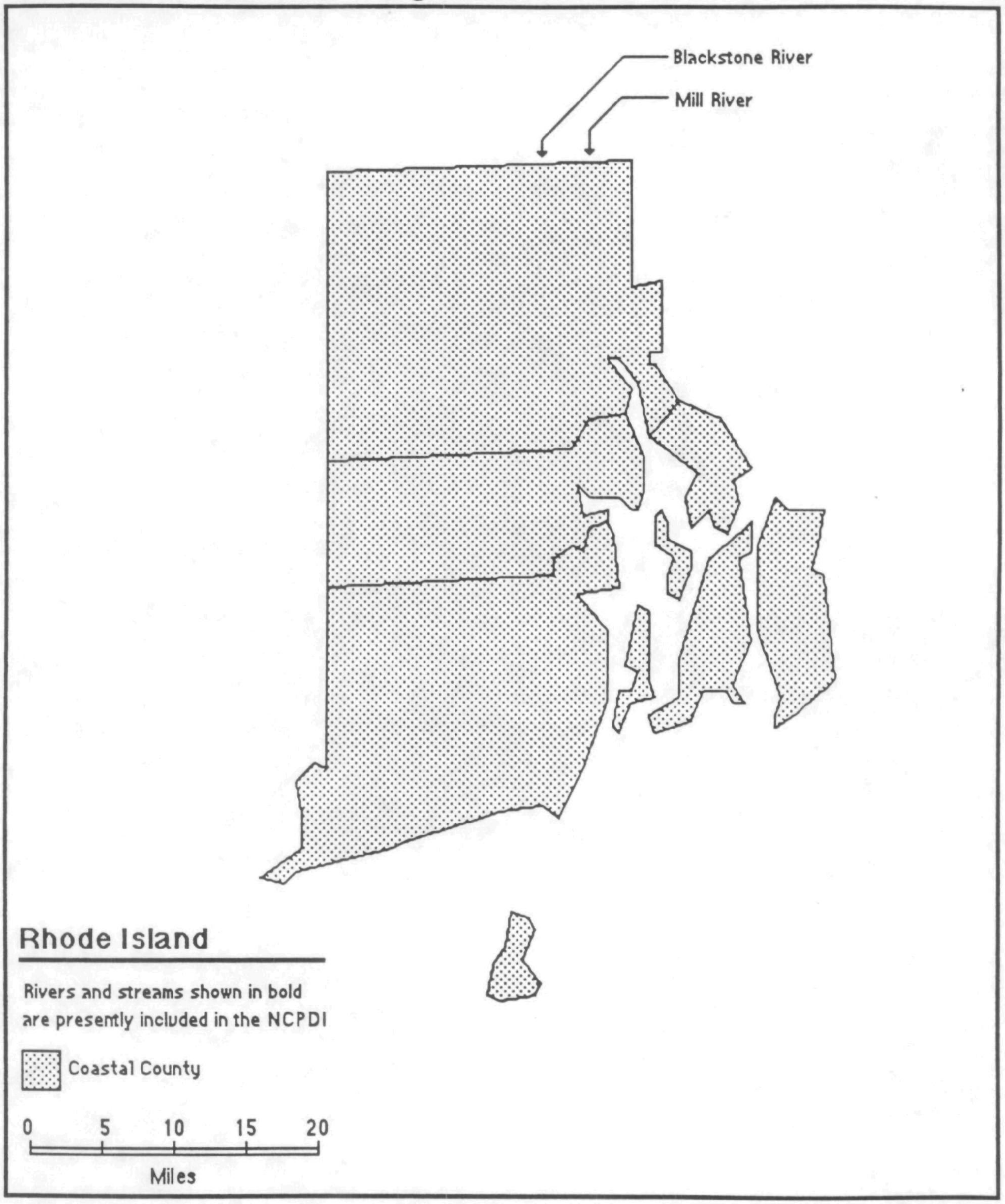
River and Streams Entering Coastal Counties



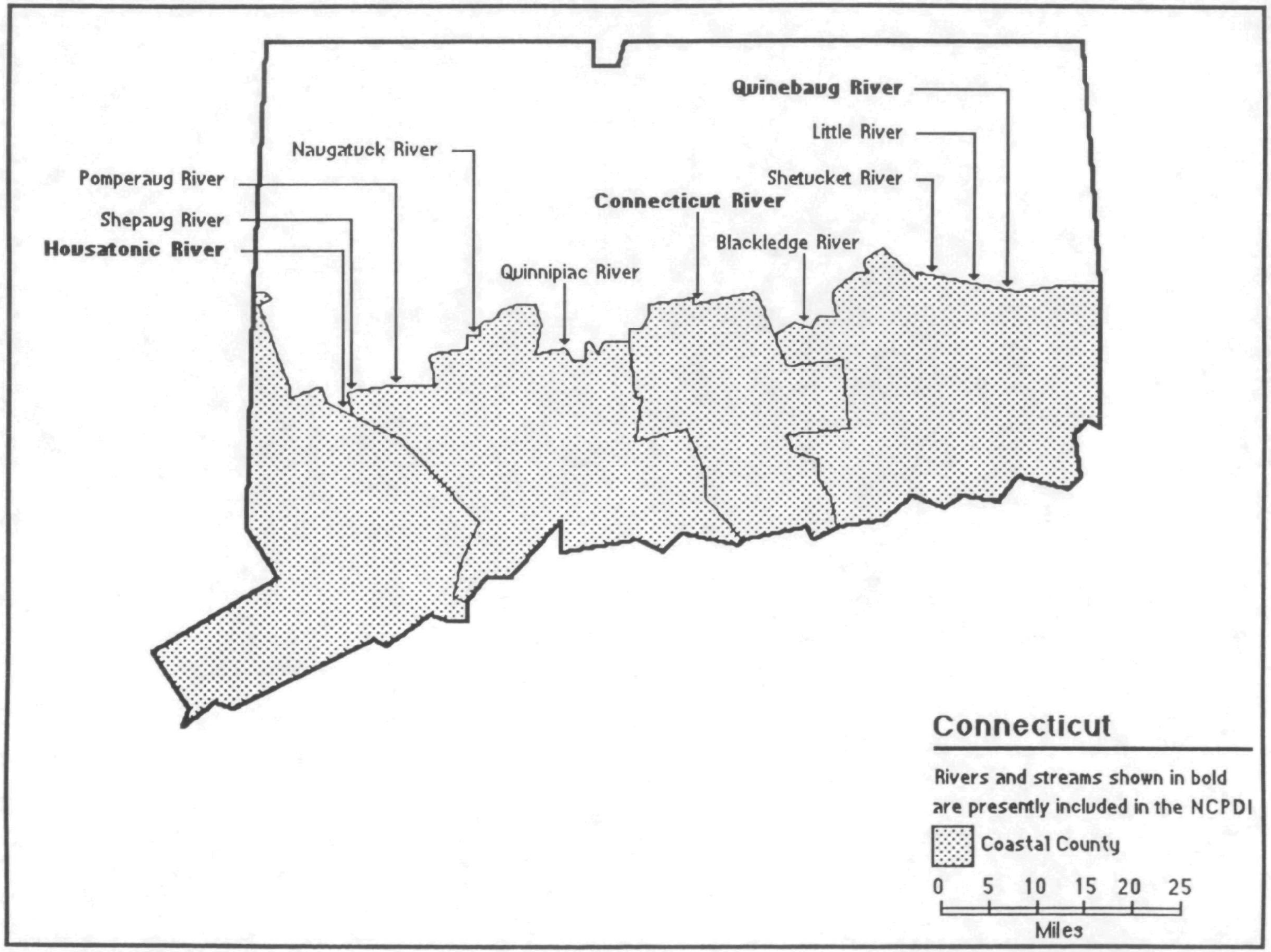
Rivers and Streams Entering Coastal Counties



Rivers and Streams Entering Coastal Counties



Rivers and Streams Entering Coastal Counties



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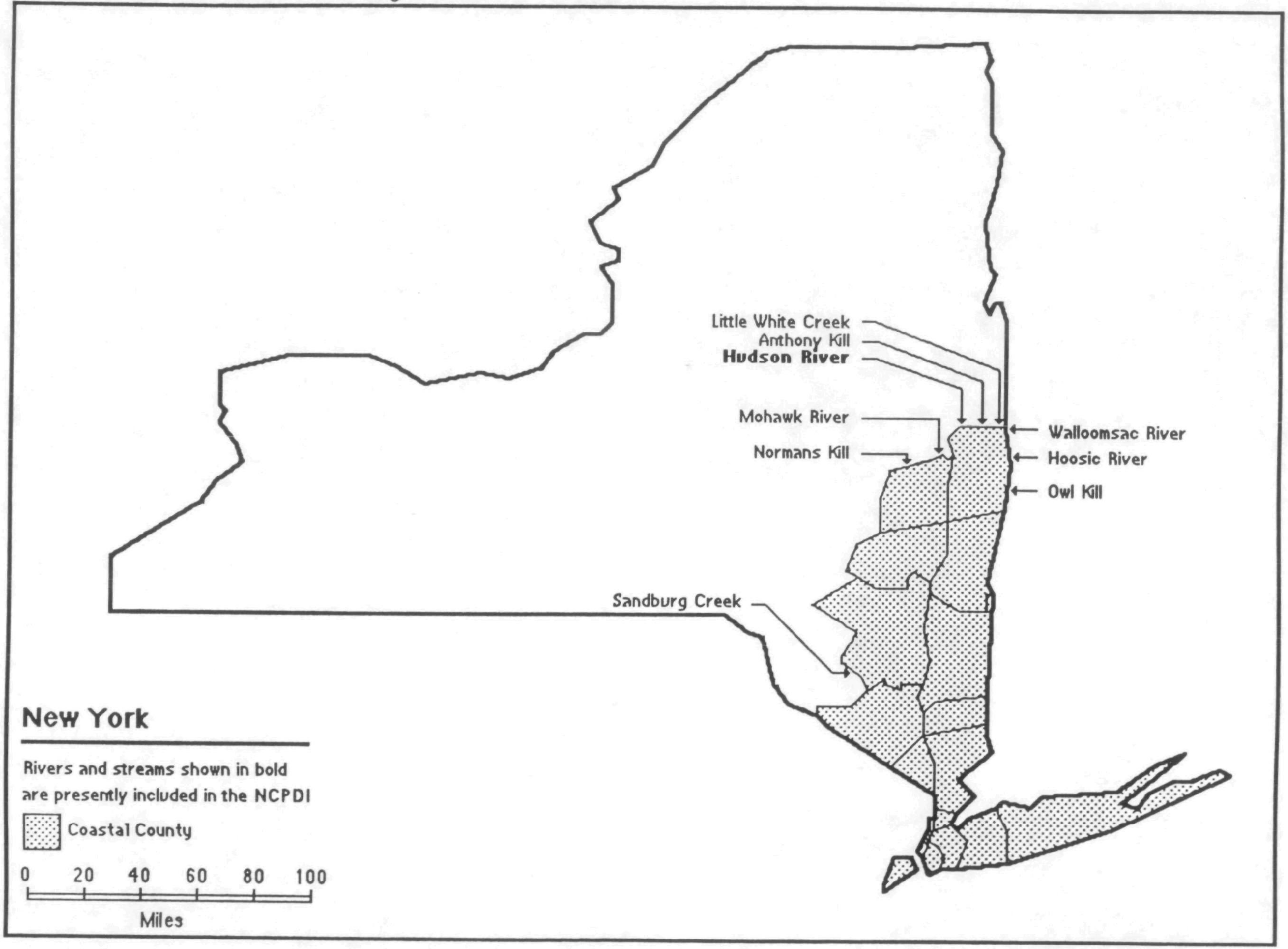
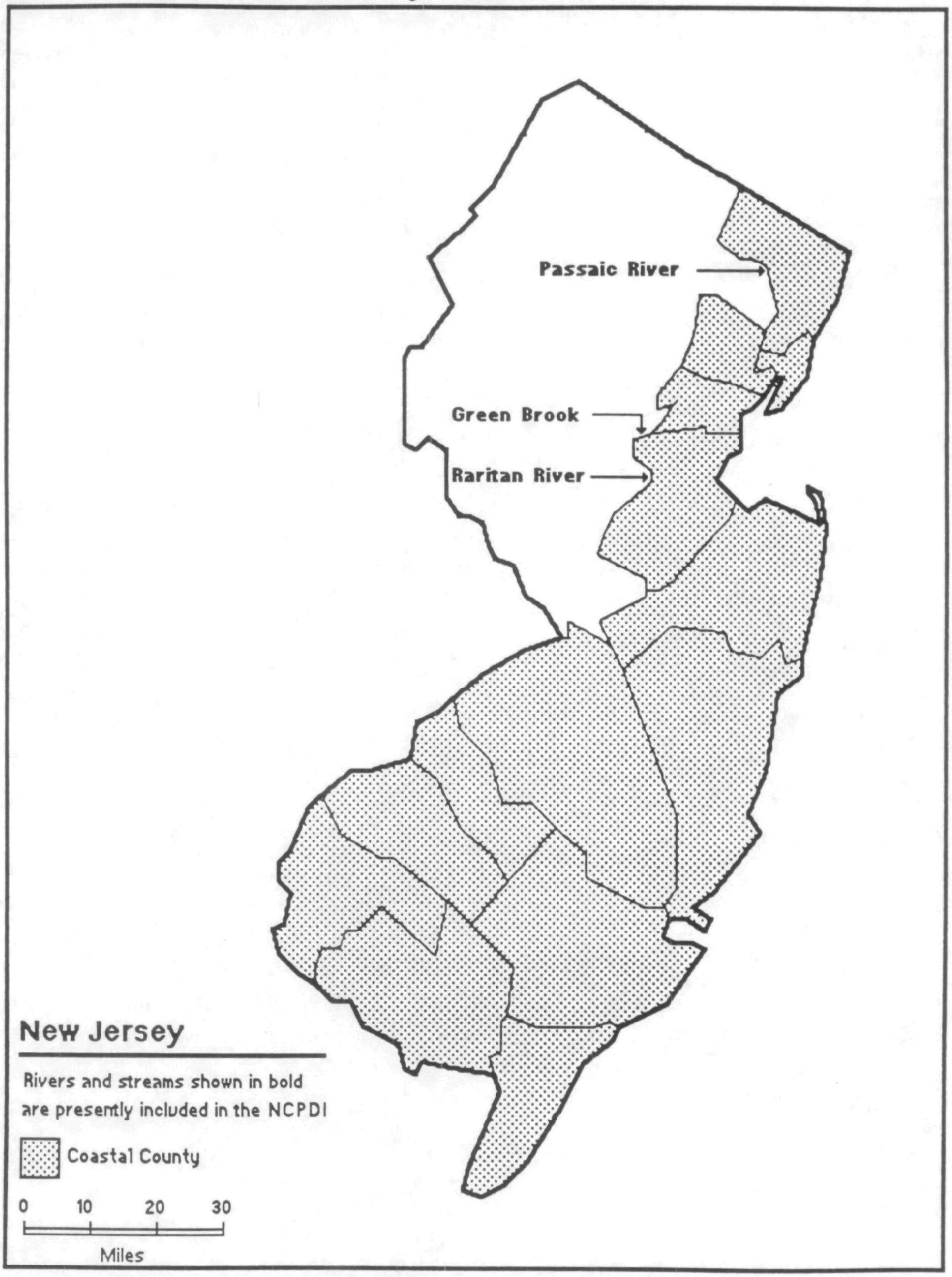


Rivers and Streams Entering Coastal Counties



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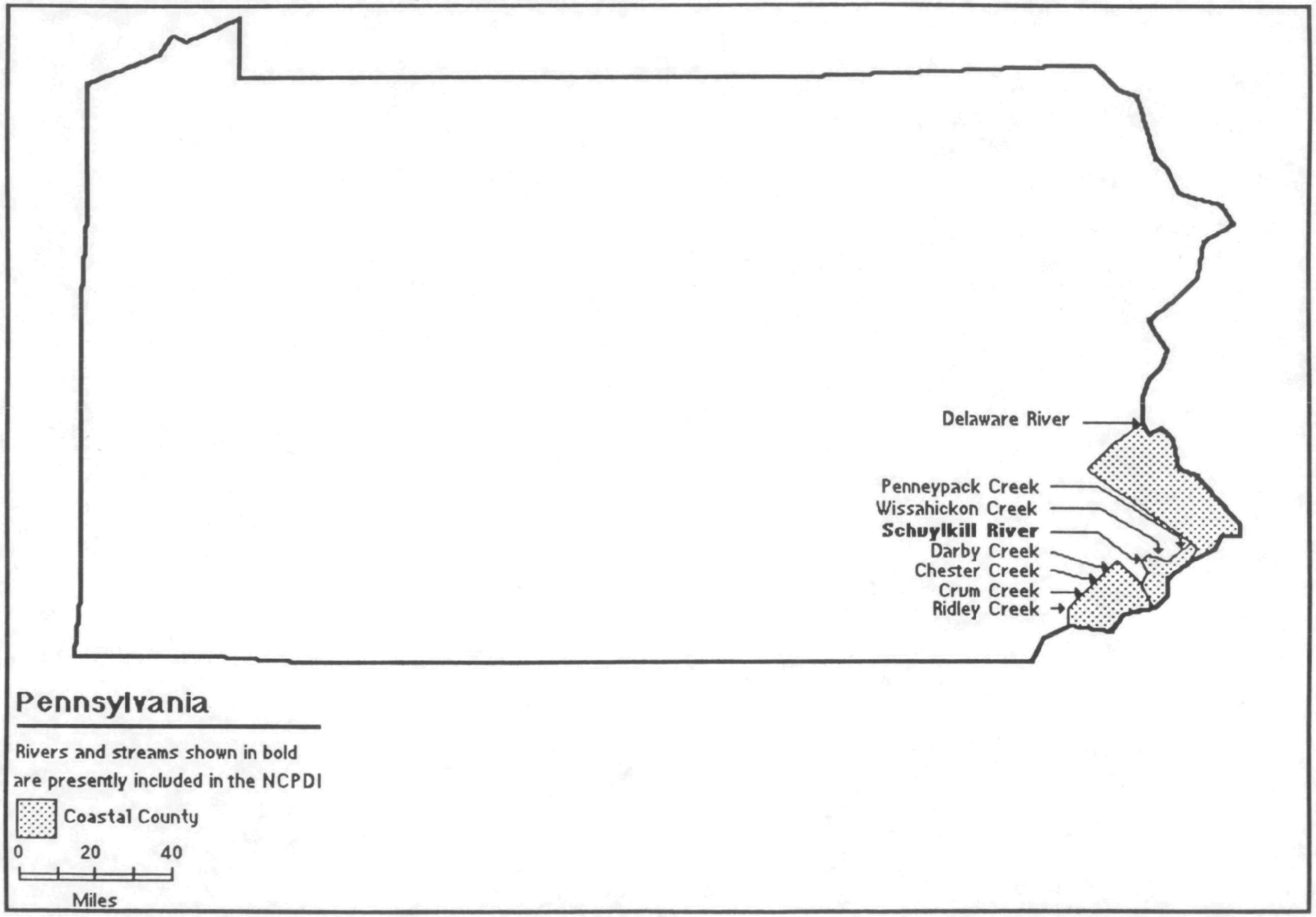

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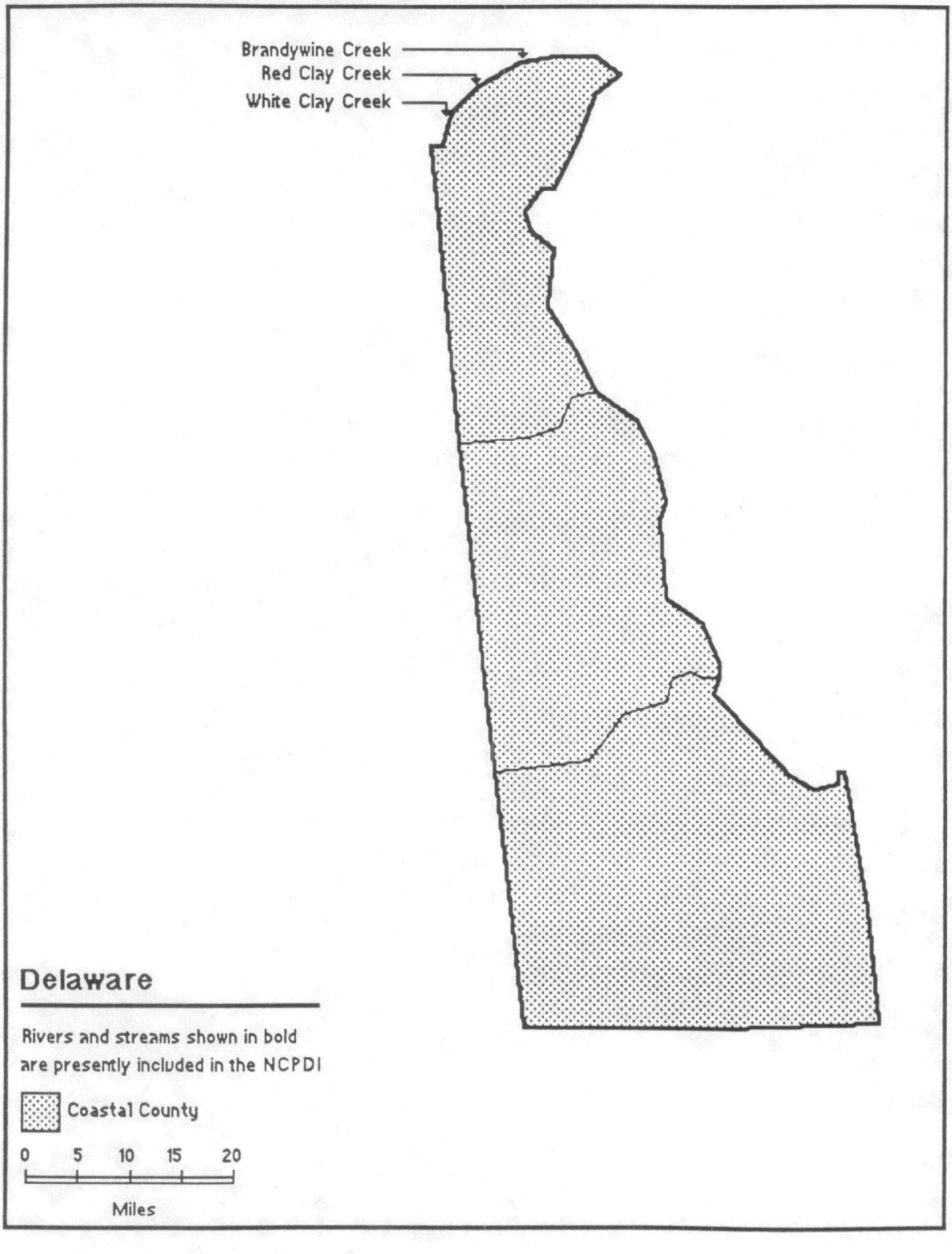
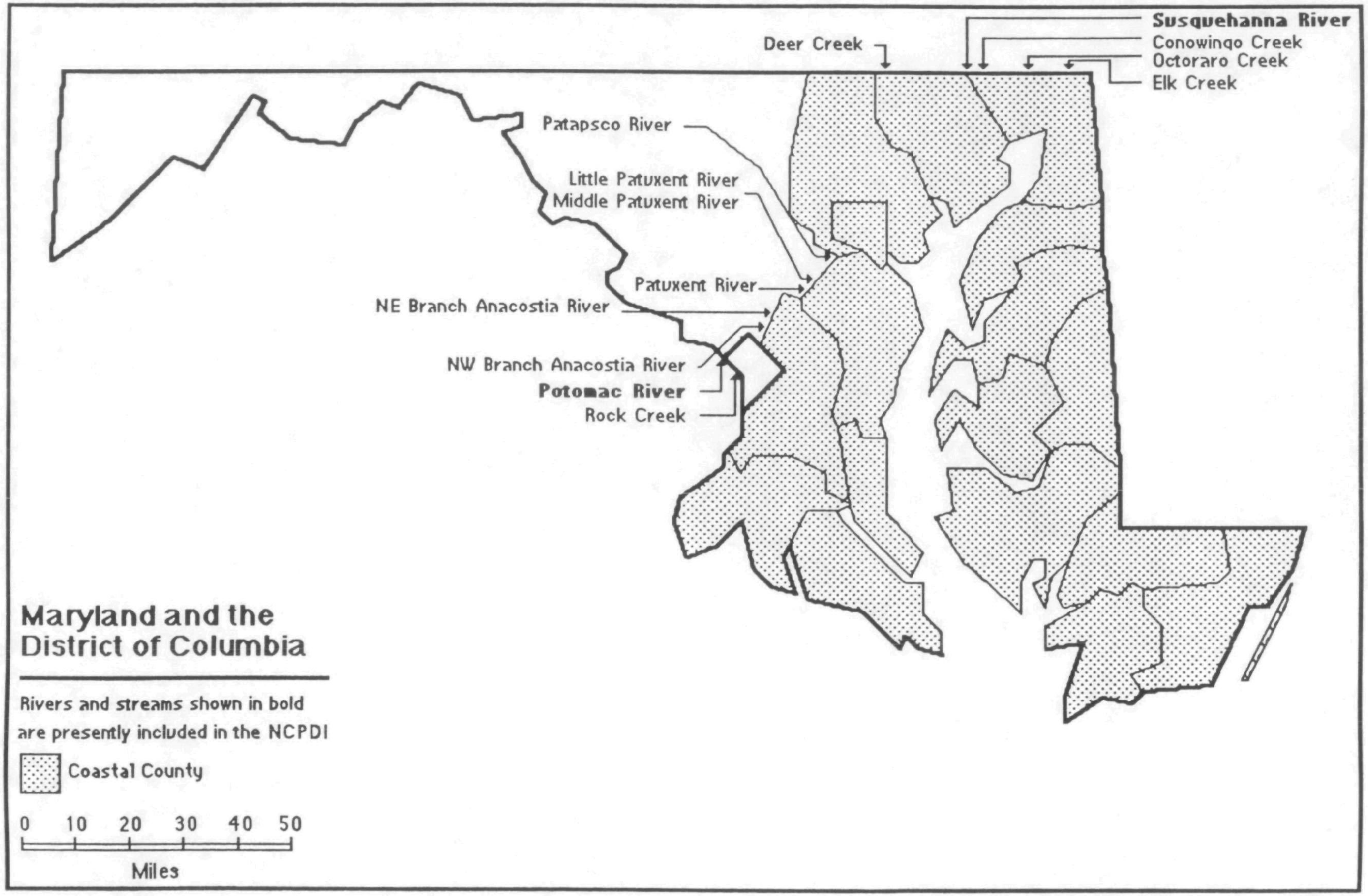
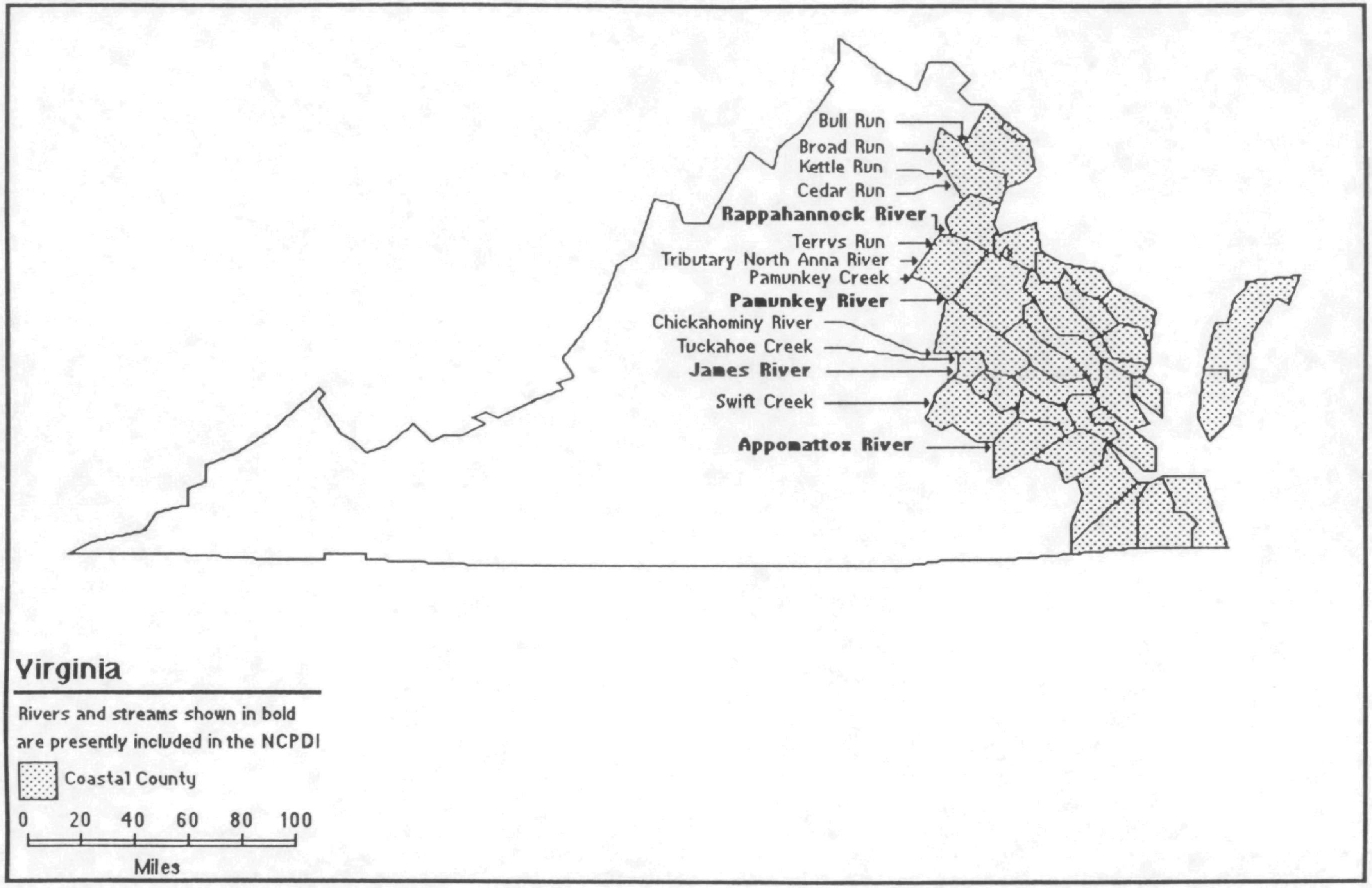


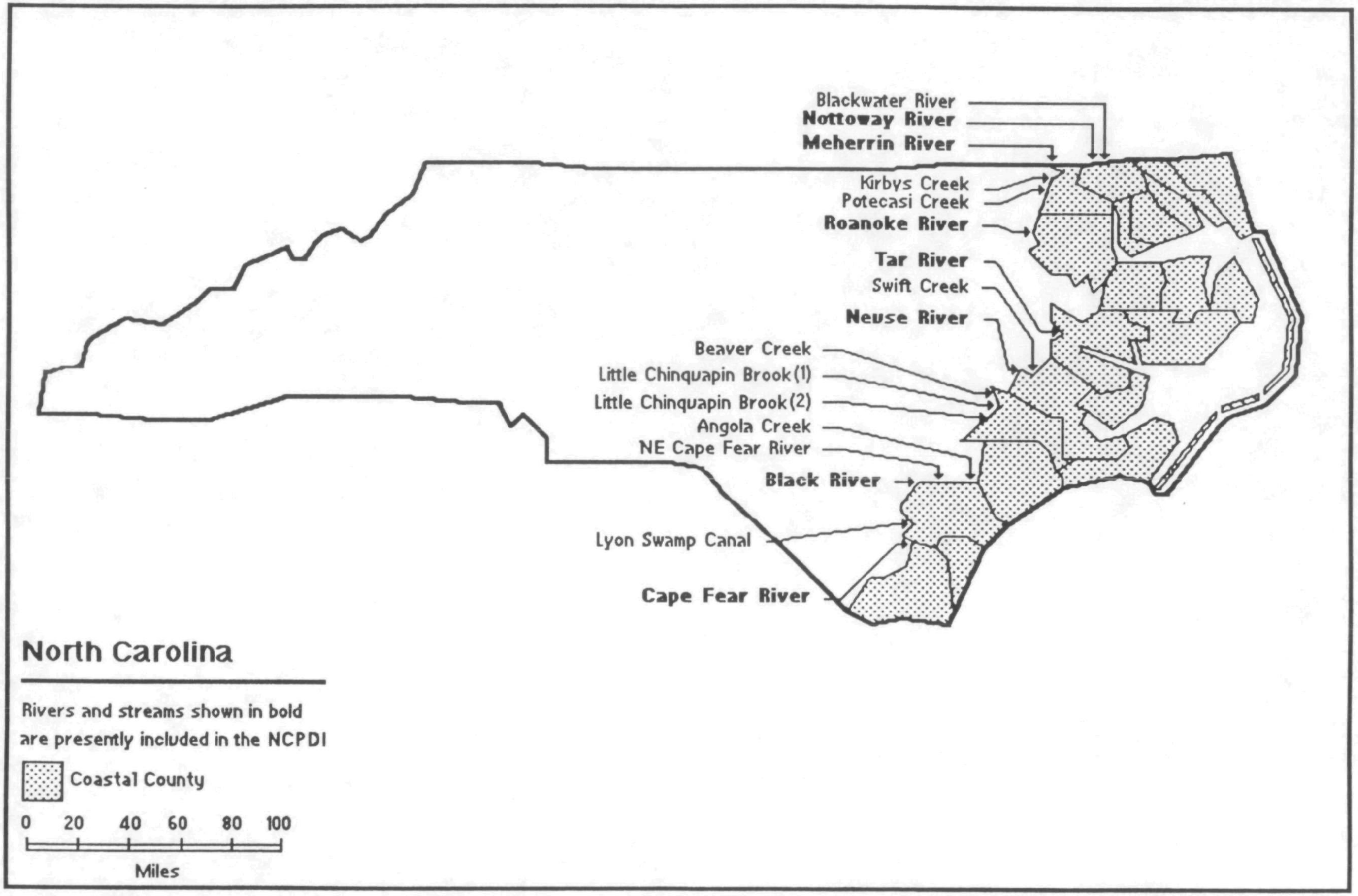
Rivers and Streams Entering Coastal Counties



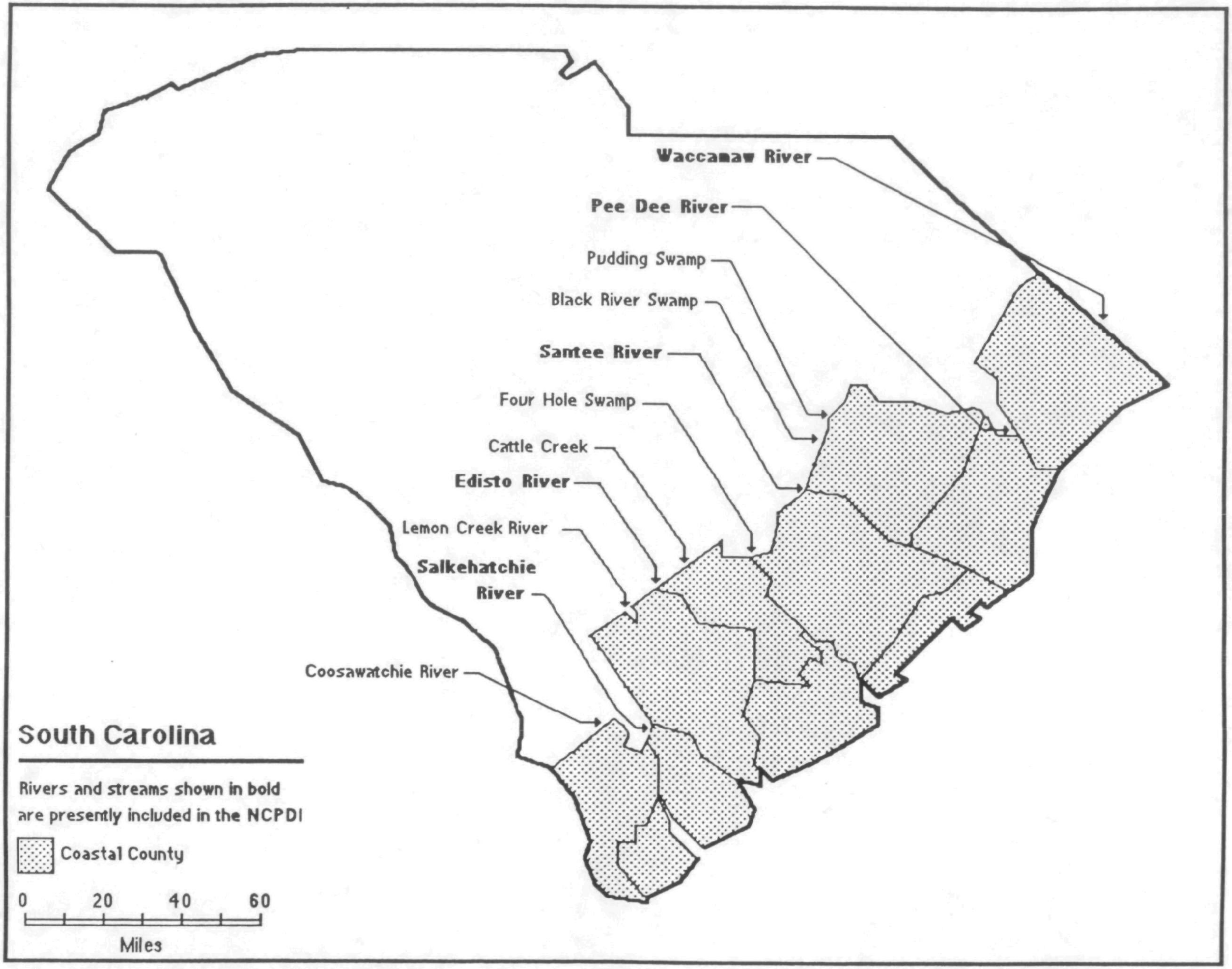
Rivers and Streams Entering Coastal Counties



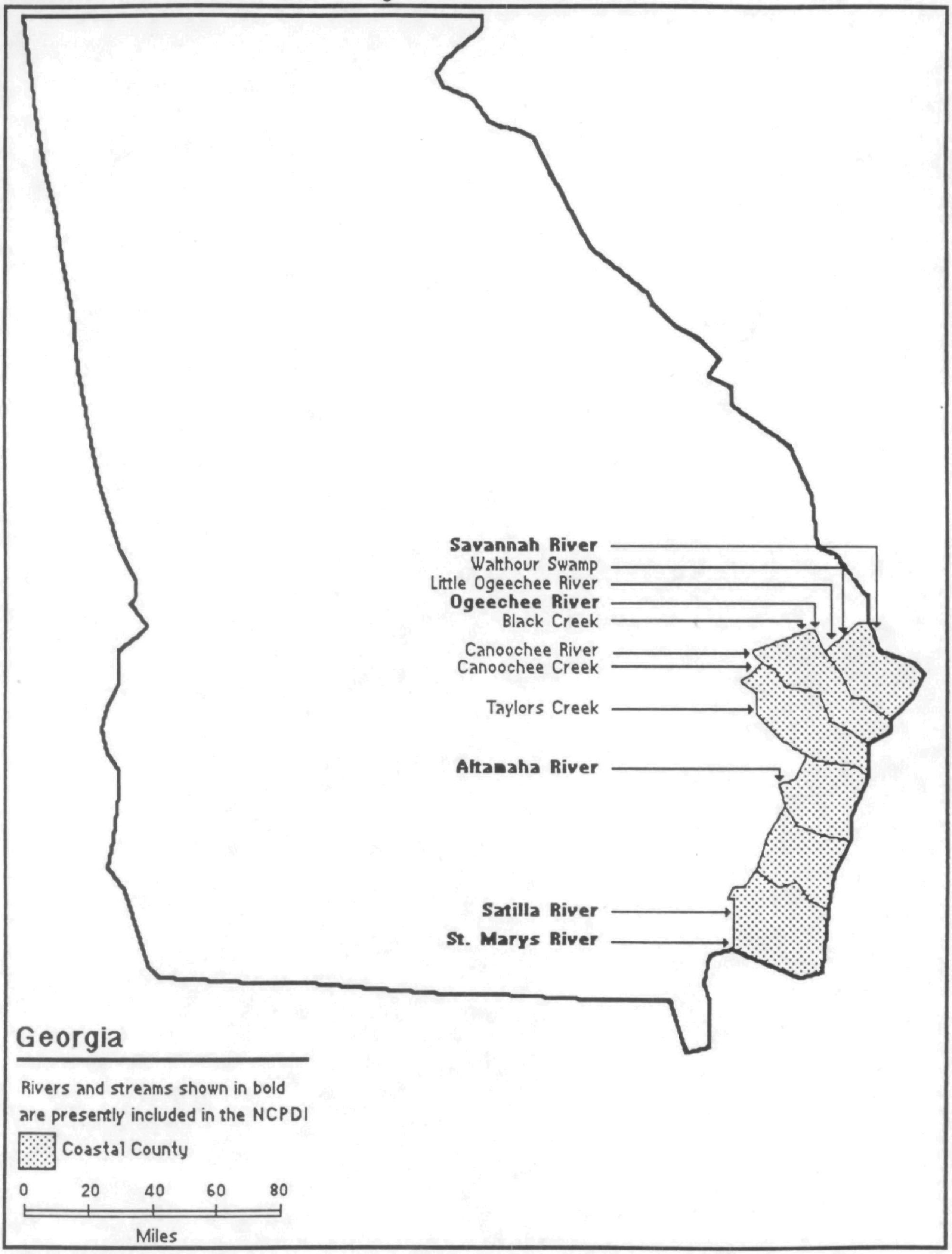
Rivers and Streams Entering Coastal Counties



Rivers and Streams Entering Coastal Counties

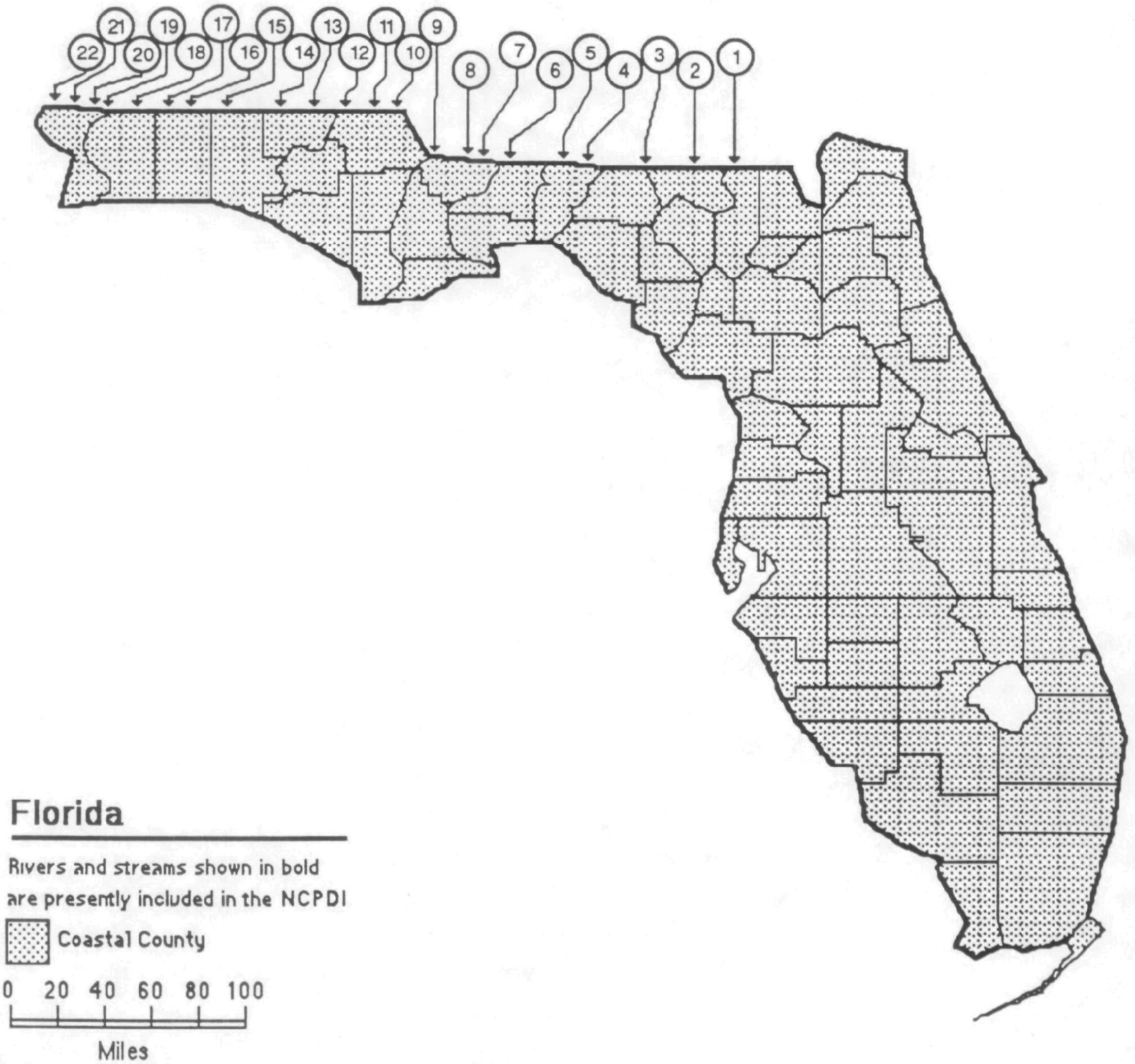


Rivers and Streams Entering Coastal Counties

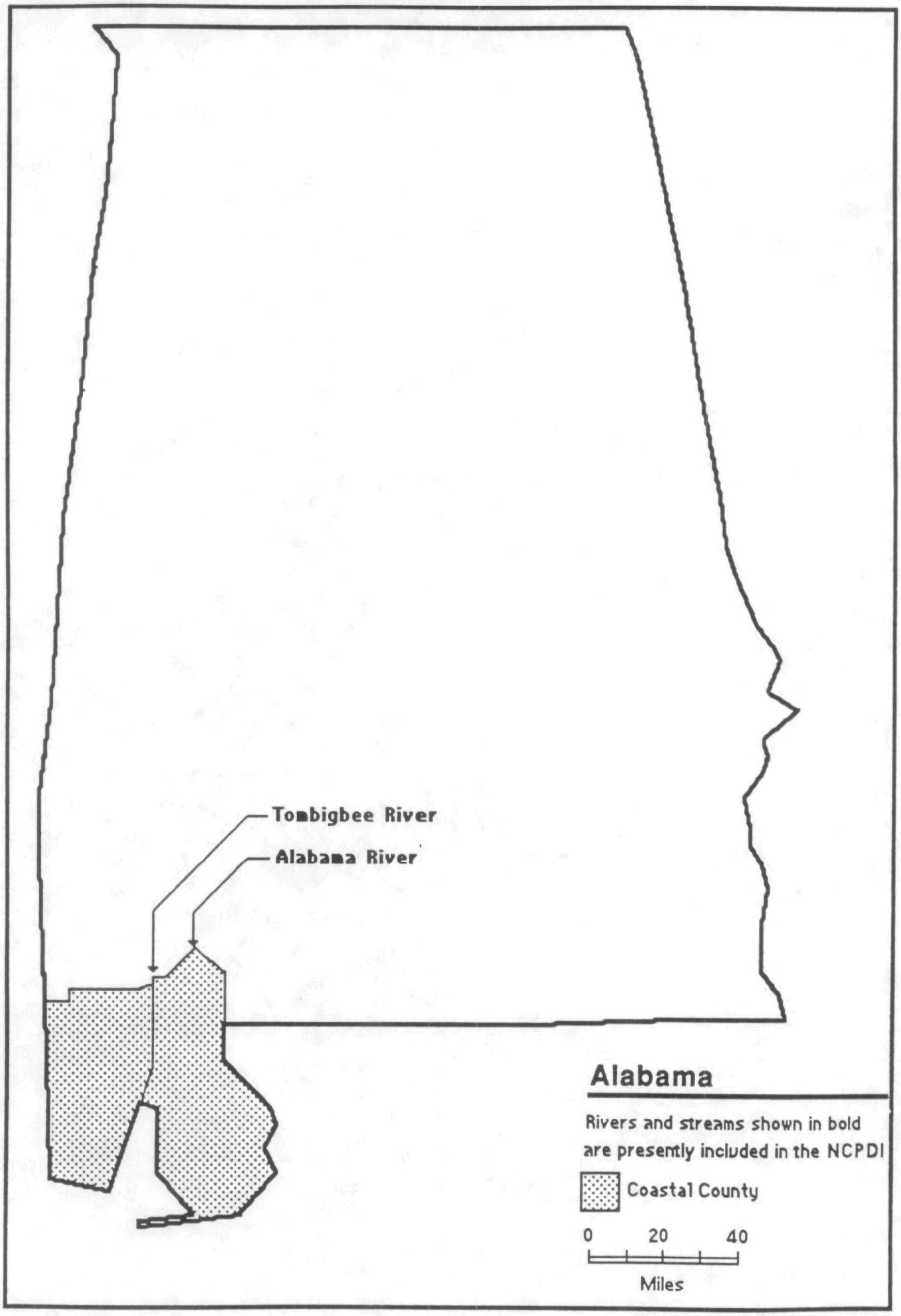


Rivers and Streams Entering Coastal Counties

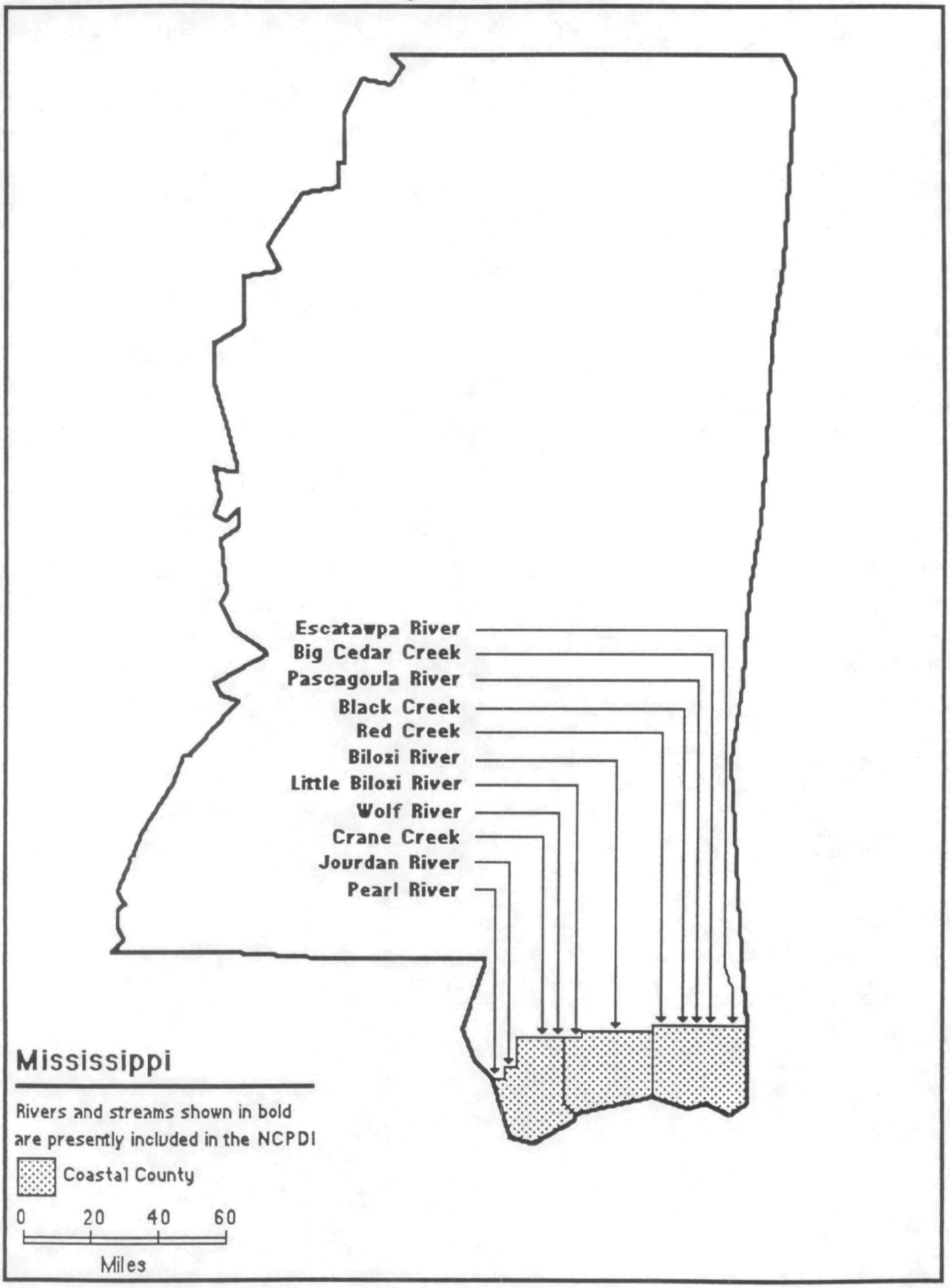
1. Suwanee River
2. Alapaha River
3. Withlahoochee River
4. Aucilla River
5. Ward Creeek
6. Ochlockonee River
7. Swamp Creek
8. Attapulgus Creek
9. Apalachicola River
10. Cowerts Creek
11. Chipola Creek
12. Big Creek
13. Wrights Creek
14. Choctawhatchee River
15. Pond Creek
16. Yellow River
17. Blackwater River
18. Sweetwater River
19. Escambia River
20. Canoe Creek
21. Brushy Creek
22. Perdido River



Rivers and Streams Entering Coastal Counties

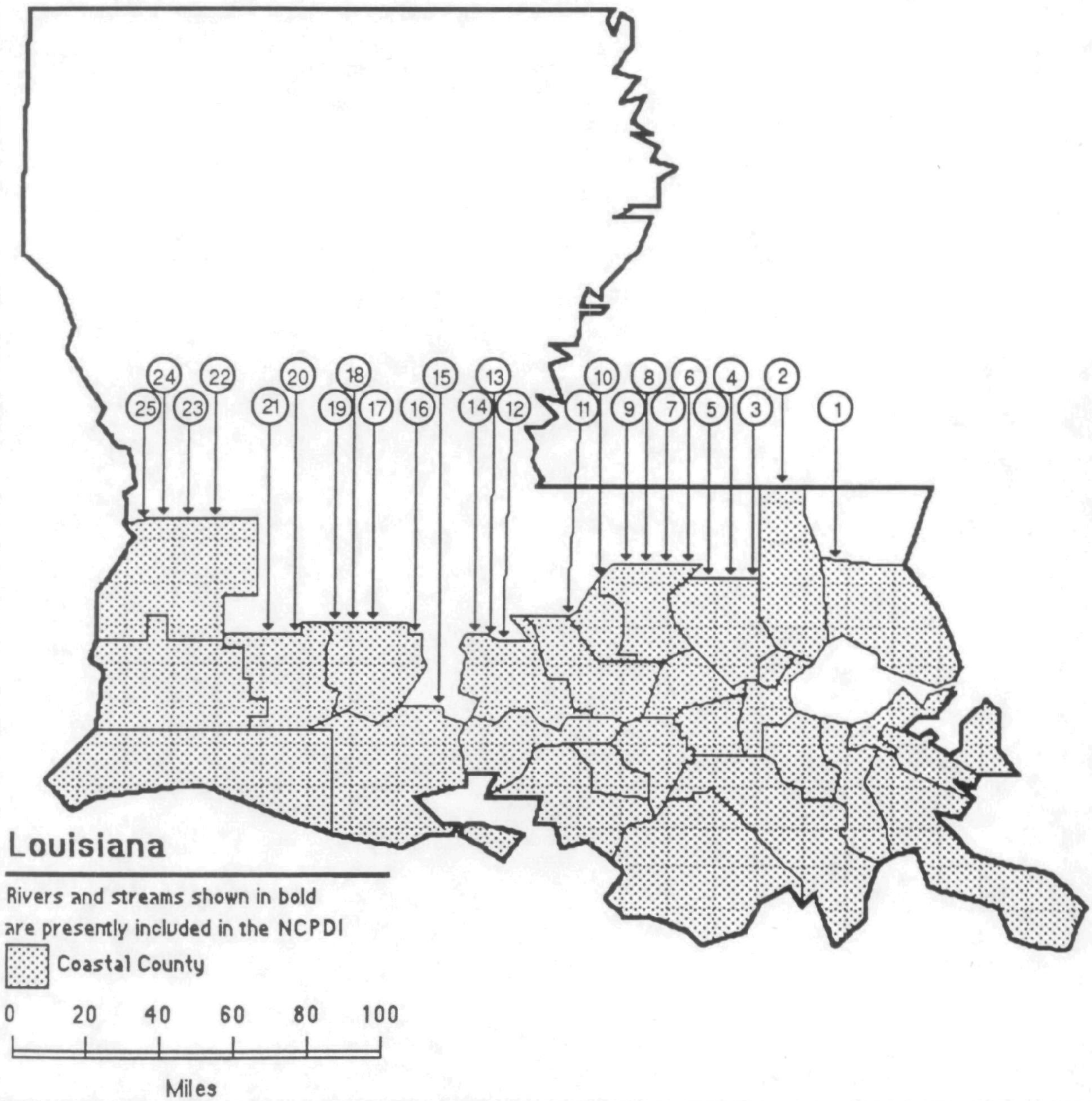


Rivers and Streams Entering Coastal Counties

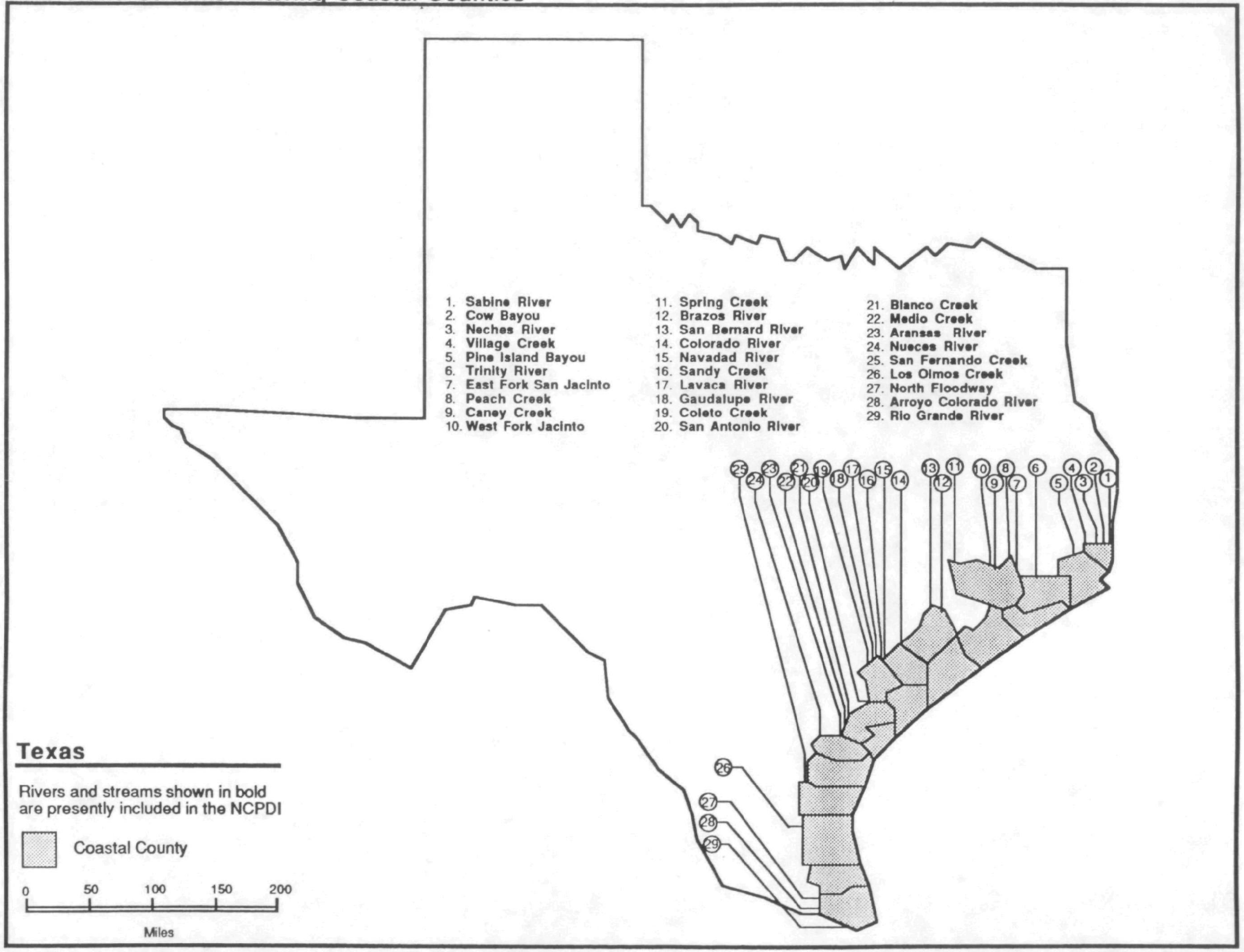


Rivers and Streams Entering Coastal Counties

1. Boque Chitto River
2. Tangipahoa River
3. Tickfaw River
4. Hog Branch River
5. Amite River
6. Sandy Creek
7. Comite River
8. Redwood Creek
9. White Bayou
10. Mississippi River
11. Bayou Grosse Tete
12. Atchafalaya River
13. Bayou des Glaises
14. Bayou Teche
15. Vermillion River
16. Bayou Plaquemine Brule
17. Bayou Mallet
18. Bayou des Cannes
19. Bayou Nezpique
20. Calcasieu River
21. Clear Creek
22. Indian Bayou
23. Hickory Branch River
24. Beckwith Creek
25. Bear Head Creek

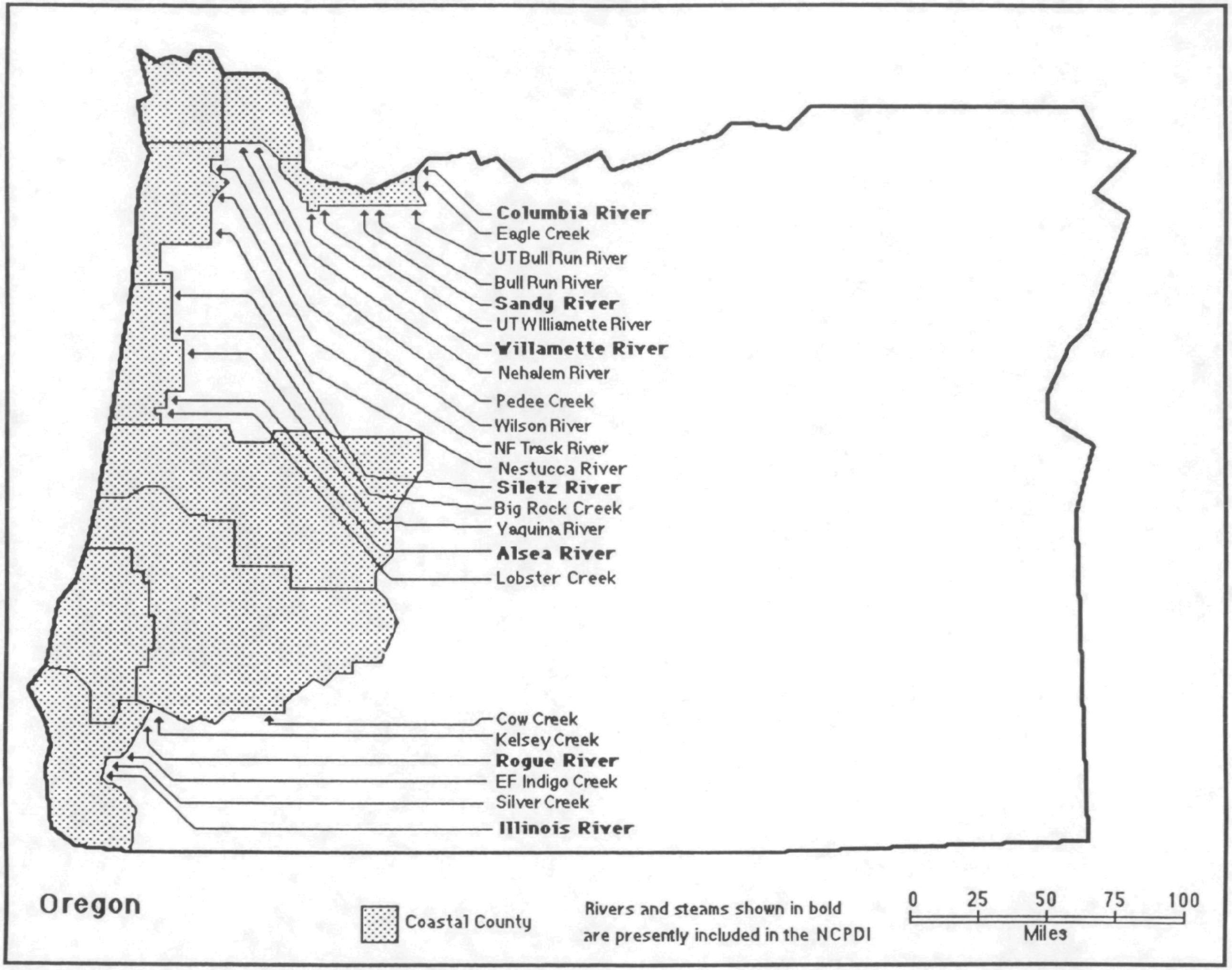


Rivers and Streams Entering Coastal Counties

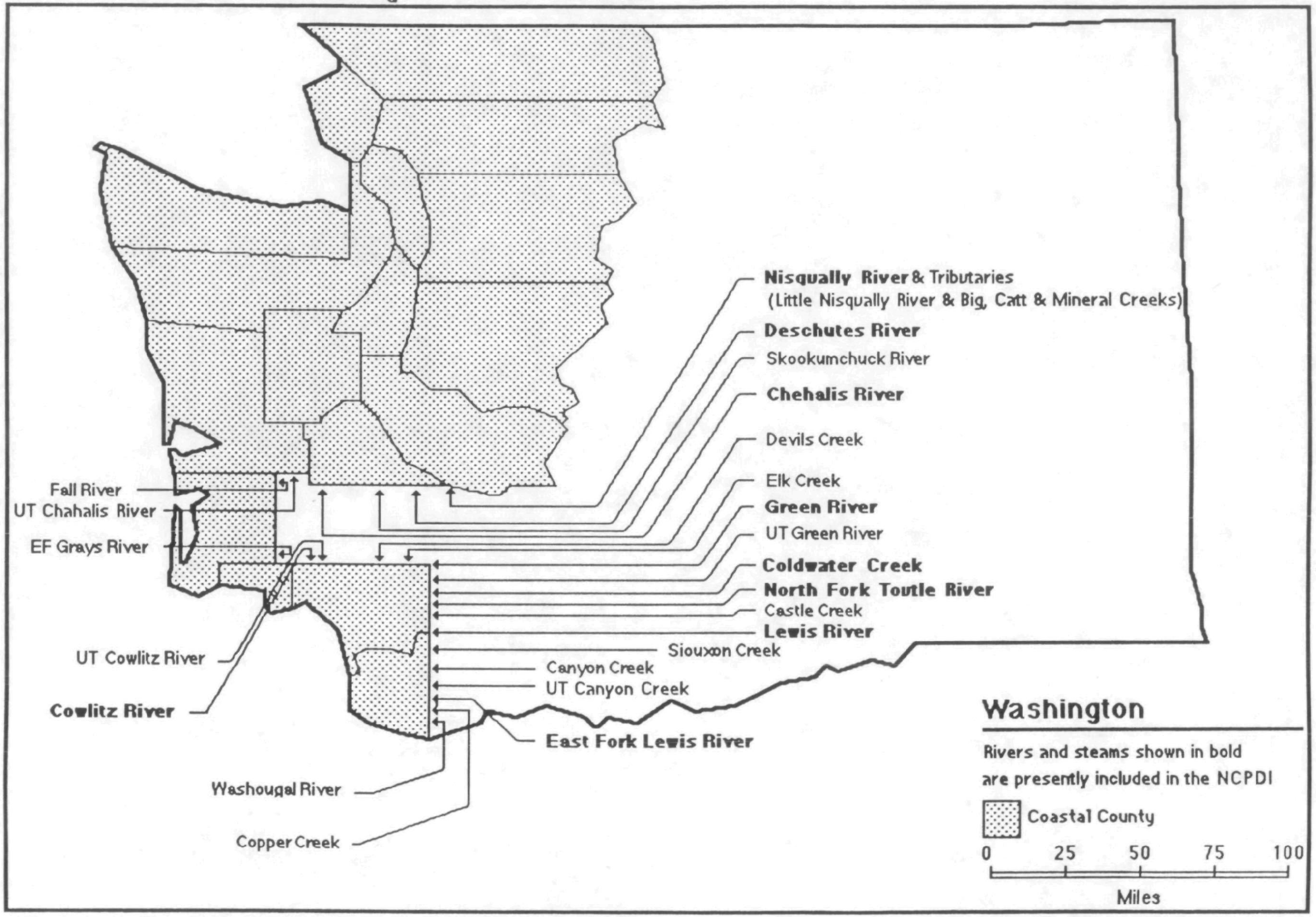


Rivers and Streams Entering Coastal Counties

Rivers and Streams Entering Coastal Counties



Rivers and Streams Entering Coastal Counties



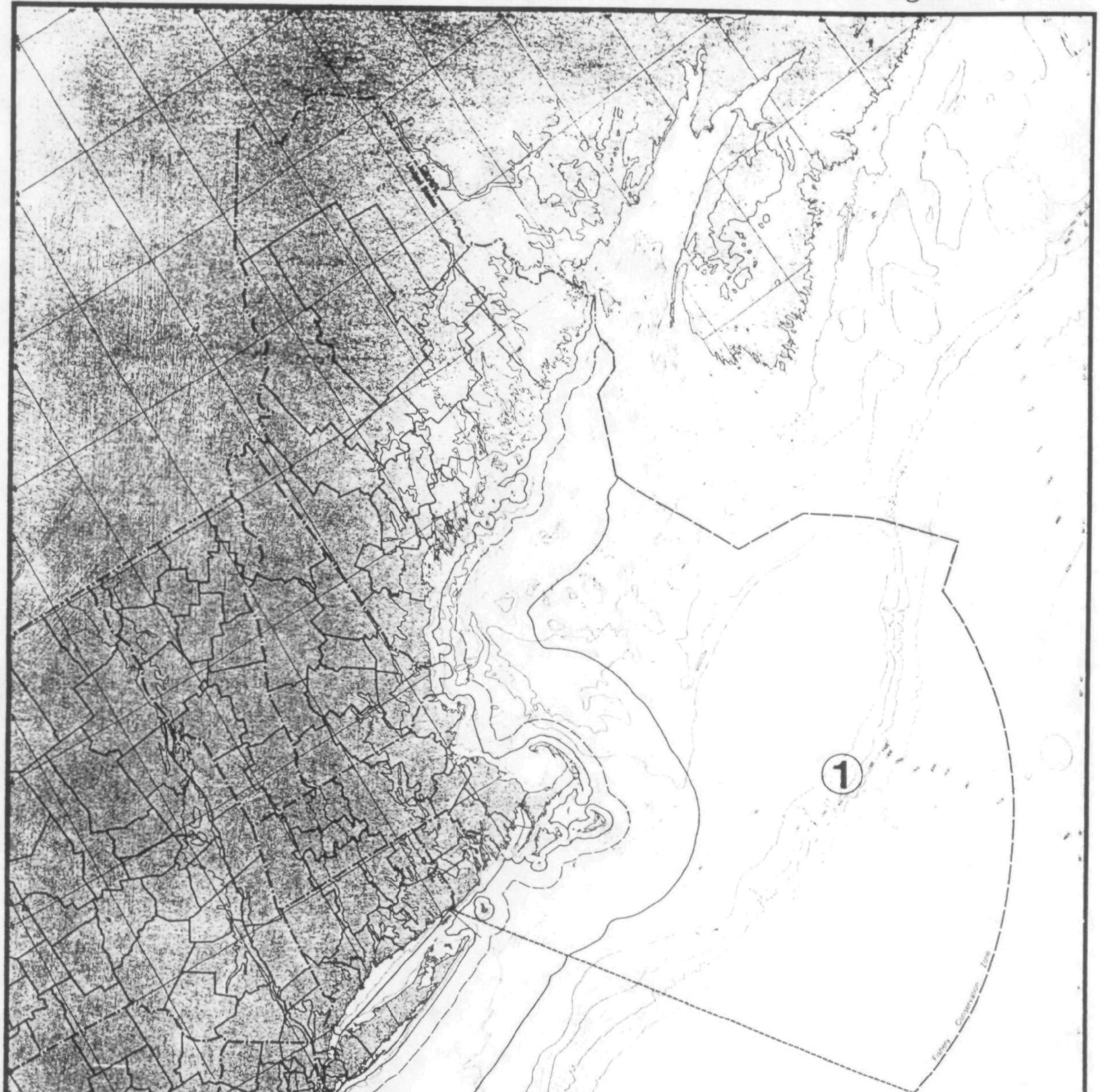
Offshore Boundaries

Offshore Boundaries

The maps of offshore political, maritime and jurisdictional boundaries presented in this section are taken from NOAA's Strategic Assessment Data Atlas Series. They are organized in East/West geographic order from the Northeast through the Gulf of Mexico and up the West Coast to Alaska. These boundaries must be considered when defining offshore analysis areas. The paper which follows the maps presents an early attempt at defining boundaries of offshore coastal areas that are affected by land based sources of pollution. Identifying these areas accurately is an important step towards defining offshore analysis areas. This analysis was originally presented at the Coastal Zone 1980 conference (Coastal Zone '80, Proceedings of the Second Symposium on Coastal and Ocean Management, Vol. IV).

Eastern United States Coastal and Ocean Zones

Council on Environmental Quality and Office of Coastal Zone Management, NOAA



Political Boundaries

- National
- State
- County
- 3-Mile Limit (Territorial Zone)
- 12-Mile Limit (Contiguous Zone)
- 50-Mile Limit (Prohibited Zone or Pollution Zone)
- 200-Mile Limit (Fishery Conservation Zone)
- (1) New England Regional Fishery Management Council
- (2) Mid-Atlantic Regional Fishery Management Council
- (3) South Atlantic Regional Fishery Management Council
- (4) Gulf of Mexico Regional Fishery Management Council
- Fishery Management Council Boundary

Eastern United States Coastal and Ocean Zones

Council on Environmental Quality and Office of Coastal Zone Management, NOAA

Political Boundaries

National	12-Mile Limit (Contiguous Zone)	② Mid-Atlantic Regional Fishery Management Council
State	50-Mile Limit (Prohibited Zone or Pollution Zone)	③ South Atlantic Regional Fishery Management Council
County	200-Mile Limit (Fishery Conservation Zone)	④ Gulf of Mexico Regional Fishery Management Council
3-Mile Limit (Territorial Zone)	① New England Regional Fishery Management Council	Fishery Management Council Boundary

Eastern United States Coastal and Ocean Zones

Council on Environmental Quality and Office of Coastal Zone Management, NOAA

Political Boundaries

National	12-Mile Limit (Contiguous Zone)	(2) Mid-Atlantic Regional Fishery Management Council
State	50-Mile Limit (Prohibited Zone or Pollution Zone)	(3) South Atlantic Regional Fishery Management Council
County	200-Mile Limit (Fishery Conservation Zone)	(4) Gulf of Mexico Regional Fishery Management Council
3-Mile Limit (Territorial Zone)	(1) New England Regional Fishery Management Council	Fishery Management Council Boundary

Eastern United States Coastal and Ocean Zones

Council on Environmental Quality and Office of Coastal Zone Management, NOAA

Political Boundaries

- National
- State
- County
- 3-Mile Limit (Territorial Zone)
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- 200-Mile Limit (Fishery Conservation Zone)
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- ③ South Atlantic Regional Fishery Management Council
- ④ Gulf of Mexico Regional Fishery Management Council
- Fishery Management Council Boundary

Political Boundaries and Maritime Zones: Gulf of Mexico

Description

Political boundaries shown on this map define selected jurisdictions of the Gulf of Mexico These jurisdictions and their importance include

Territorial Sea Coastal waters extending from a coastal baseline seaward within which a nation exercises sovereignty but cannot deny the right of innocent passage to foreign nations Mexico claims a 12 nautical mile (nmi) territorial sea while the USA claims a three nmi territorial sea In the USA the Submerged Land Act of 1953 established the territorial sea for Texas and Florida s Gulf of Mexico coast as three leagues (about nine nmi) and for Alabama Mississippi and Louisiana as three mi This difference exists because the US Congress recognized the seaward claims of these states at the time of their admission to the Union Claims of Florida were established in a new state constitution upon reentry to the Union after the Civil War Claims of Texas were established when it was an independent republic between 1832 and 1845

Contiguous Zone A band of high seas extending 12 nmi from the baseline of the territorial sea established pursuant to the 1958 Geneva Convention on the Territorial Sea and Contiguous Zone Within its contiguous zone a nation can exercise the control necessary to prevent infringement of its customs fiscal immigration or environmental regulations The USA claims a 12 nmi contiguous zone Mexico claims no contiguous zone (Stevens pers comm)

Prohibited Oil Pollution Zone A band of high seas and coastal waters 50 nmi from the nearest land areas established by the 1973 International Convention for the Prevention of Pollution from Ships (MARPOL) Both Mexico and the USA have signed the Convention Oil tankers are prohibited from discharging oil within the zone (see Map 5 23) except under certain conditions specified in the MARPOL regulations Ships other than tankers and greater than 400 gross tons generally are restricted from discharging oil within 12 nmi of the nearest land

Exclusive Economic Zone The Exclusive Economic Zone (EEZ) extends 200 nmi from the baseline of the territorial sea Where the extent of the EEZ s of nations overlap boundaries are determined on the basis of equitable principles The USA proclaimed its EEZ on March 10 1983 Consistent with international law within its EEZ the USA claims (a) sovereign rights for the purpose of exploring exploiting conserving and managing natural resources both living and nonliving of the seabed and subsoil and the superadjacent waters and with regard to other activities for the economic exploitation and exploration of the zone such as the production of energy from water currents and winds and (b) jurisdiction with regard to the establishment and use of artificial islands and installation and structures having economic purposes and the protection and preservation of the marine environment This zone coincides with the US Fishery Conservation Zone where the USA claims exclusive rights to manage fishery resources except for highly migratory species (*Federal Register* March 14 1983) Mexico claims similar rights and jurisdiction over its EEZ

A 1976 maritime boundary agreement between the USA and Mexico established a shared maritime boundary in the Gulf of Mexico It provides that neither country shall claim or exercise sovereign rights or jurisdiction over the waters or seabed and subsoil on the other country s side of the maritime boundary The agreement has not yet entered into force (Smith pers comm)

International Boundary

State Boundary

County Boundary (Municipal Districts in Mexico)

3 Nautical Mile / 3 League Limit (Territorial Zone)

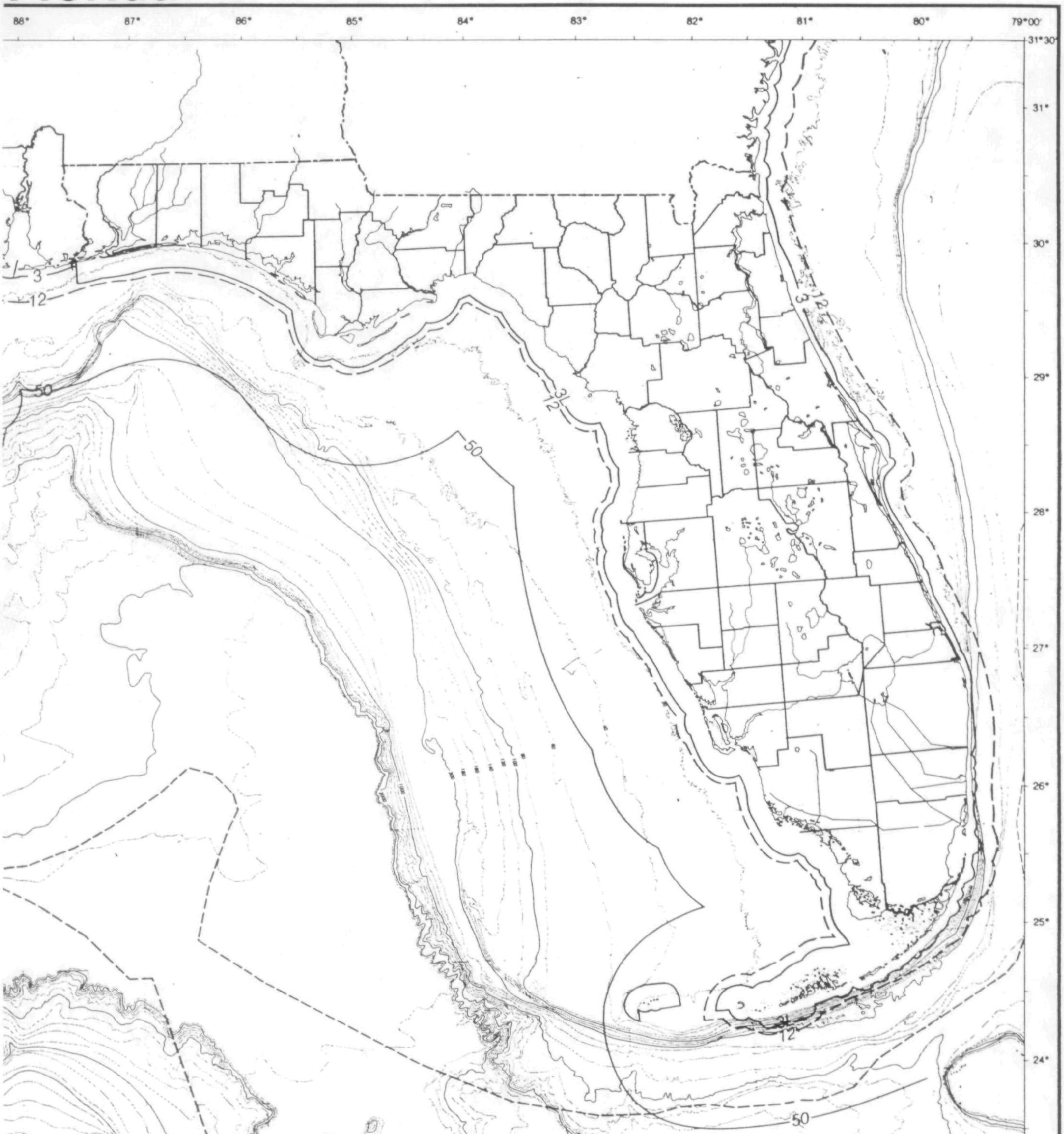
12 Nautical Mile Limit (Contiguous Zone)

50 Nautical Mile Limit (Prohibited Zone or Pollution Zone)

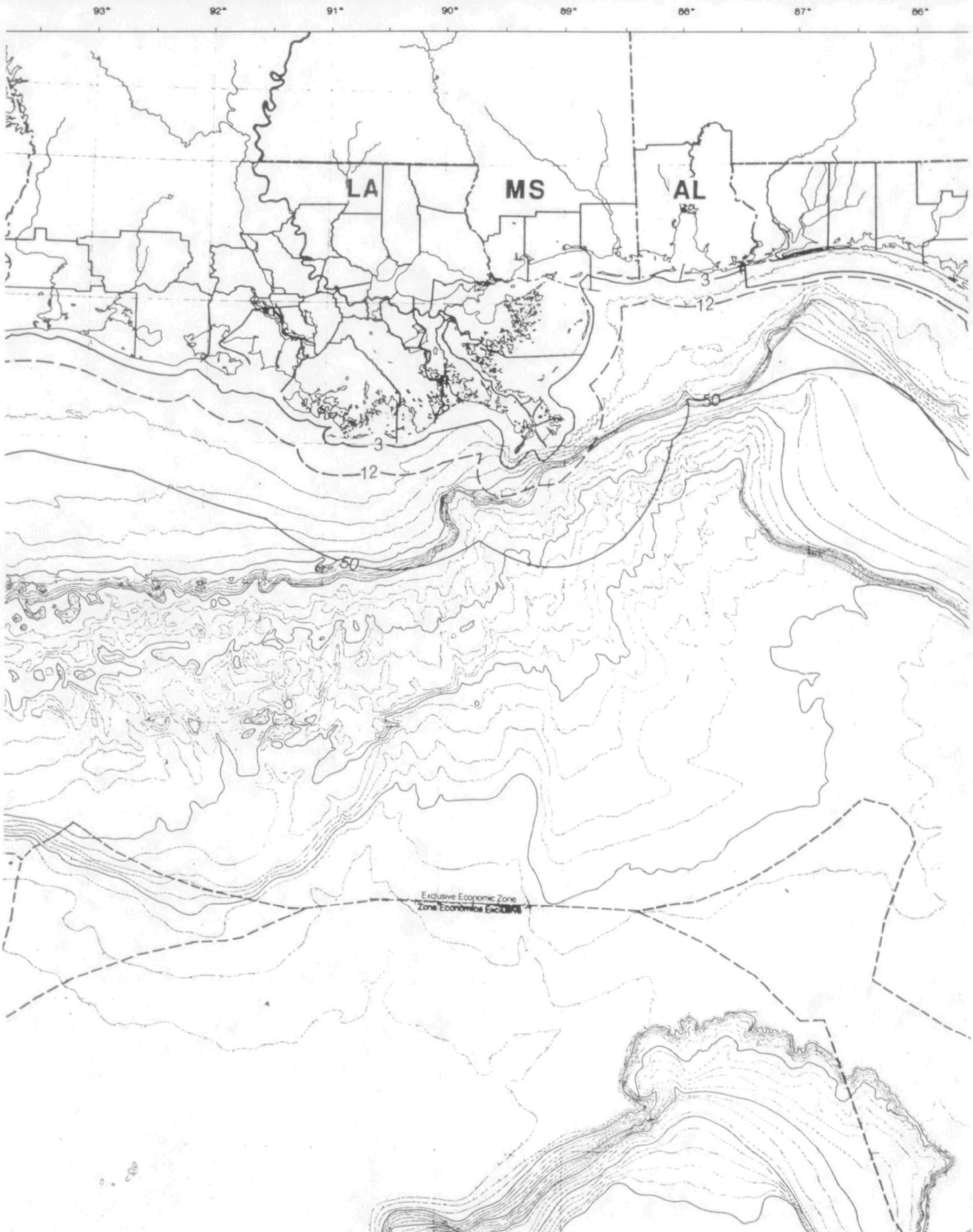
200 Nautical Mile Limit (Exclusive Economic Zone)

Mexican jurisdictional claims illustrated on this map do not imply official recognition of those claims by the United States Government. Territorial Zone is 3 nautical mile offshore limit in Alabama and Mississippi, 3 league limit in Florida and Texas and 12 nautical mile limit in Mexico

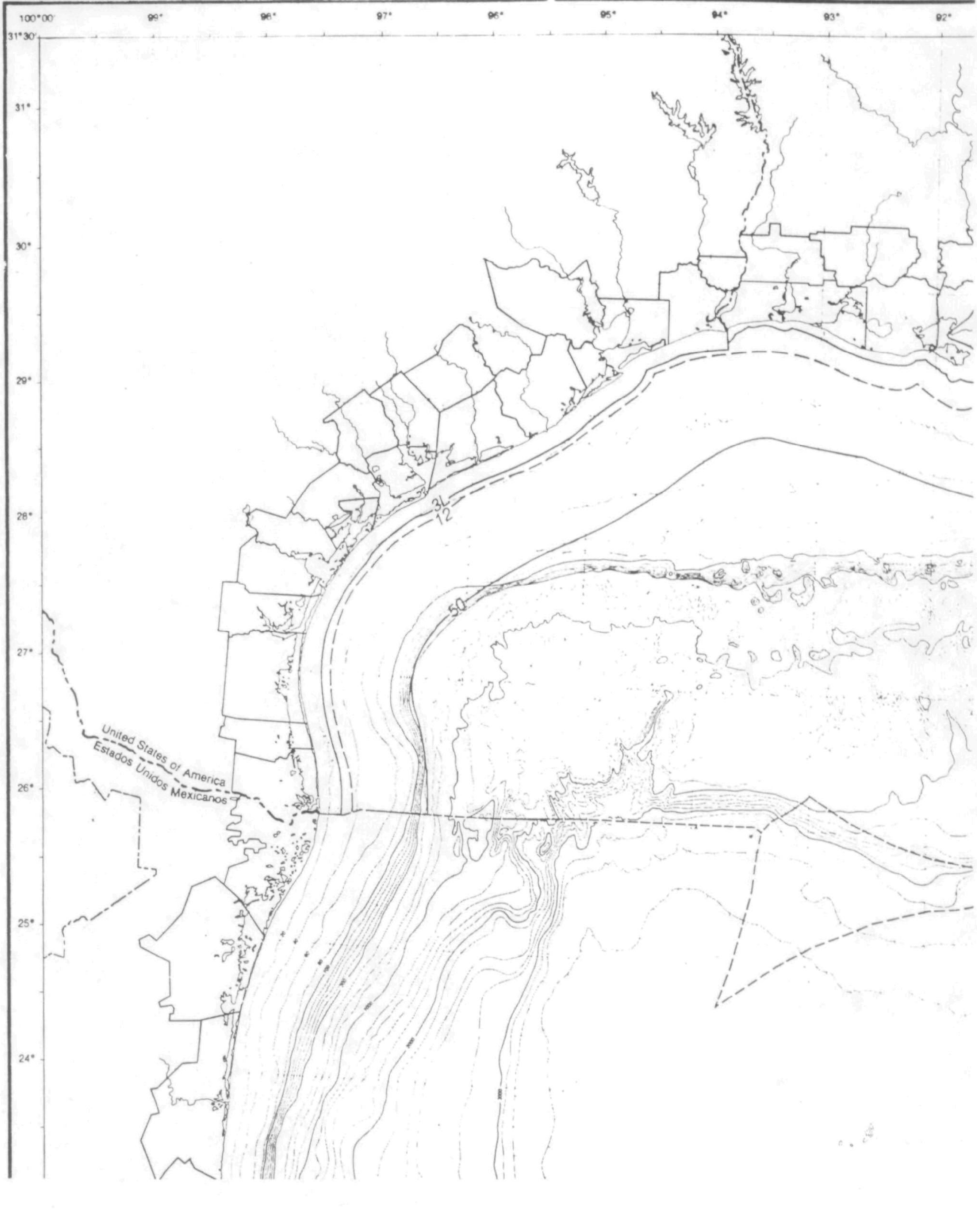
Political Boundaries and Maritime Zones: Florida



Political Boundaries and Maritime Zones: Louisiana, Mississippi, Alabama



Political Boundaries and Maritime Zones: Texas



Federal Agency Regional Boundaries: Gulf of Mexico

Description

Regional boundaries of federal agencies of the USA having marine resource management and environmental quality responsibilities within the Gulf of Mexico region are shown on this map

The Army Corps of Engineers is responsible for the maintenance and improvement of inland waterways rivers and harbors port development flood control projects and all structures or work in or affecting navigable waters and established shipping safety fairways Under Section 404 of the Clean Water Act it grants permits for discharges of dredged or fill materials into navigable waters at specified disposal sites within the 3 nmi territorial sea of the USA (Squires 1983)

The Minerals Management Service US Department of the Interior manages the development of the outer continental shelf (OCS) for oil and gas exploration and production (Maps 4 24–25) The National Park Service of the US Department of the Interior is responsible for the protection and management of designated lands such as national seashores parks and recreation areas

The US Coast Guard is responsible for ensuring the safe and unencumbered passage of marine traffic and monitoring the discharge of oil into navigable waters (Maps 5 23–26) As the principal maritime law enforcement agency in waters subject to US jurisdiction it has the authority to make inspections searches seizures and arrests at sea

The Environmental Protection Agency (EPA) is responsible for implementing federal environmental legislation such as the Clean Water Act (CWA) the Marine Protection Research and Sanctuaries Act (MPRSA) the Toxic Substances Control Act the Resource Conservation and Recovery Act and the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) For example under the CWA EPA provides grants to municipal and state agencies to assist in financing the construction of municipal wastewater treatment facilities EPA administers the National Pollutant Discharge Elimination System (NPDES) which incorporates and applies effluent limitations in individual permits for both municipal and direct industrial dischargers and it conducts monitoring to assure compliance with permit conditions or effluent limits Under Title I of the MPSRA EPA designates recommended sites (Map 4 29) and times for ocean dumping and issues permits for the disposal of municipal and industrial wastes EPA also provides under CERCLA two basic types of hazardous substances response capabilities an emergency response capability for handling major chemical spills (in close cooperation with the US Coast Guard and NOAA) and hazardous substance incidents and a remedial response capability for undertaking the long term cleanup of abandoned hazardous waste sites (Map 4 20)

National Parks Service Regions (NPS)

Environmental Protection Agency Regions (EPA)

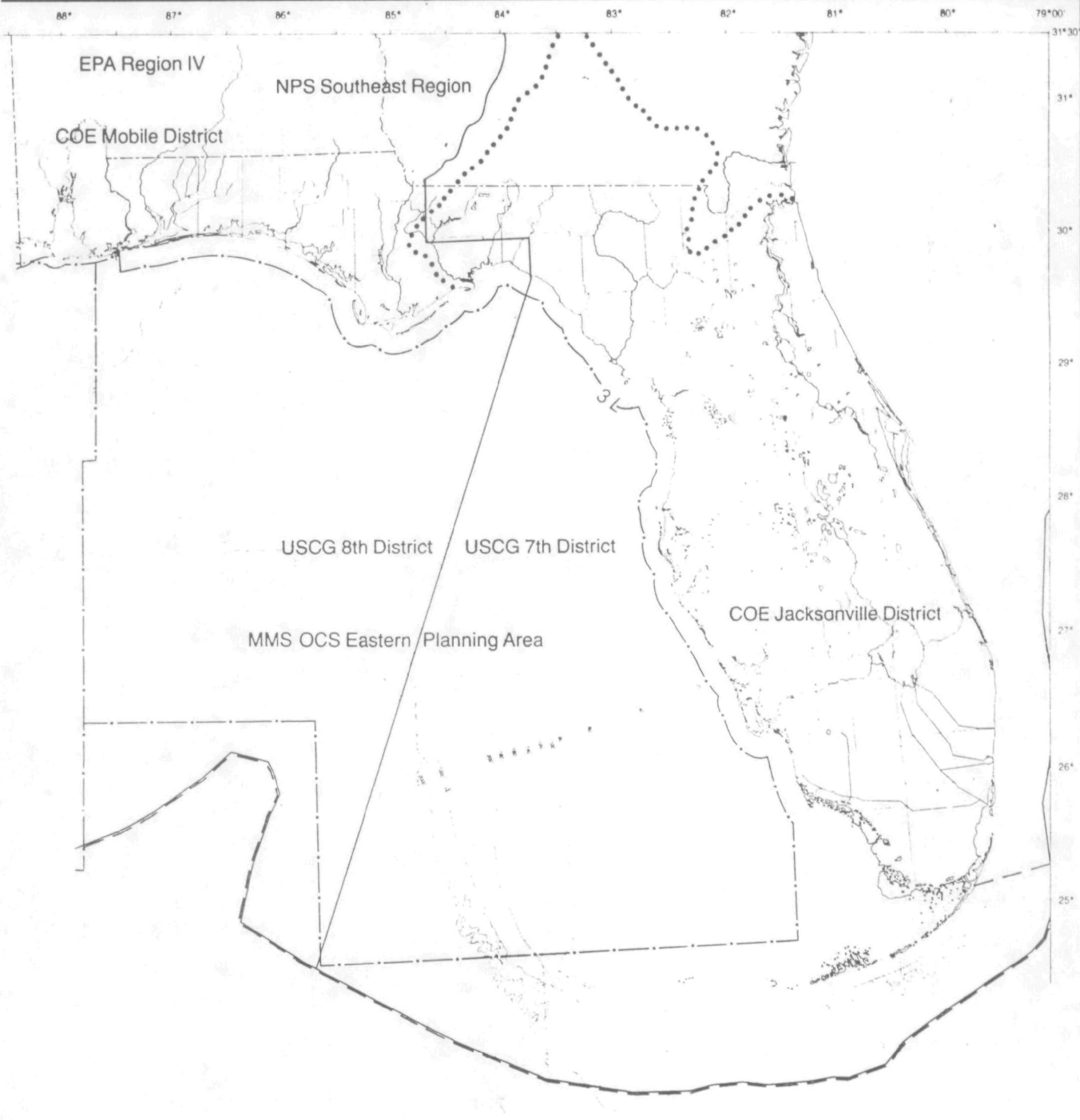
US Coast Guard Districts (USCG)

US Department of the Interior, Minerals Management Service Outer Continental Shelf Planning Areas (MMS OCS)

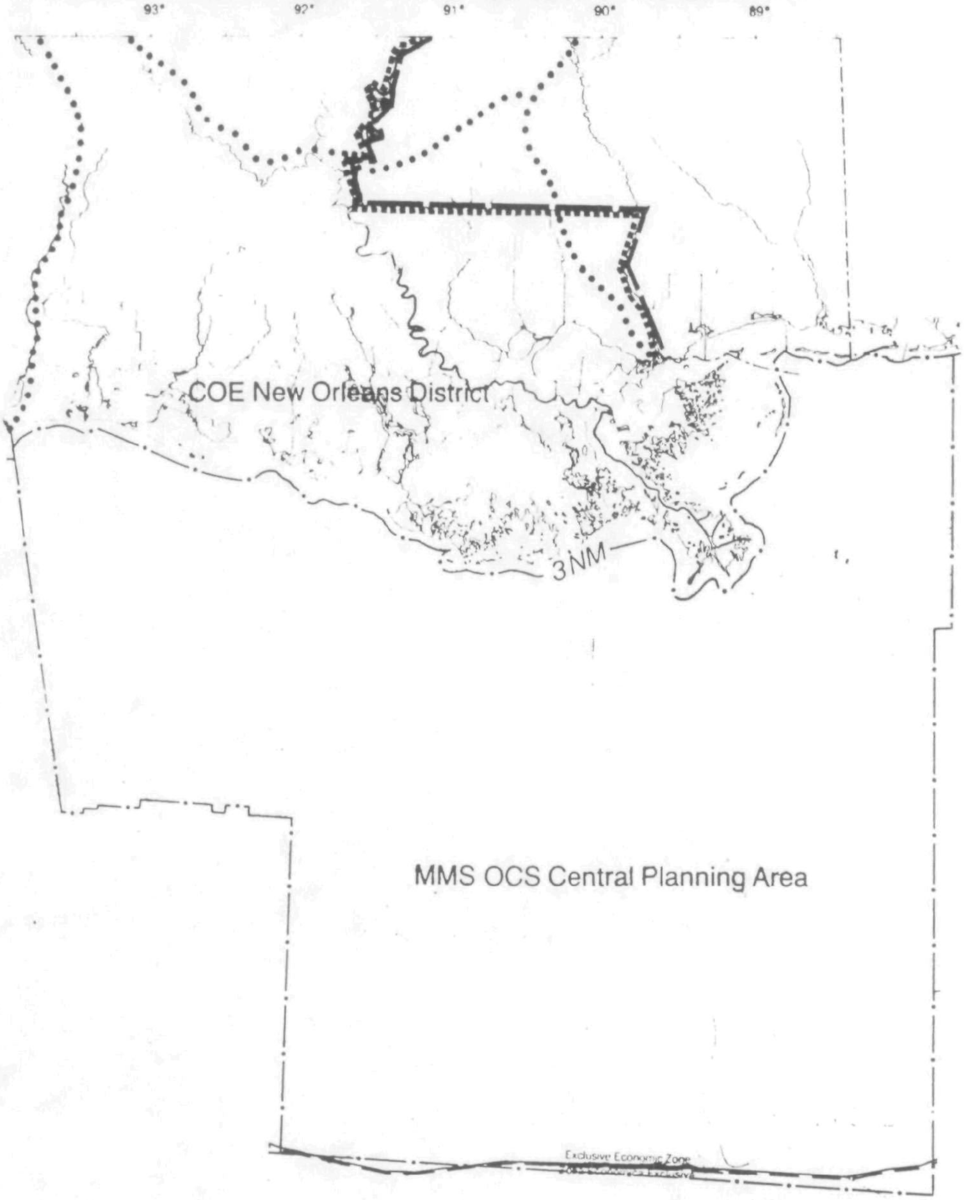
US Army Corps of Engineers Civil Works Districts (COE)

Gulf of Mexico Regional Fishery Management Council

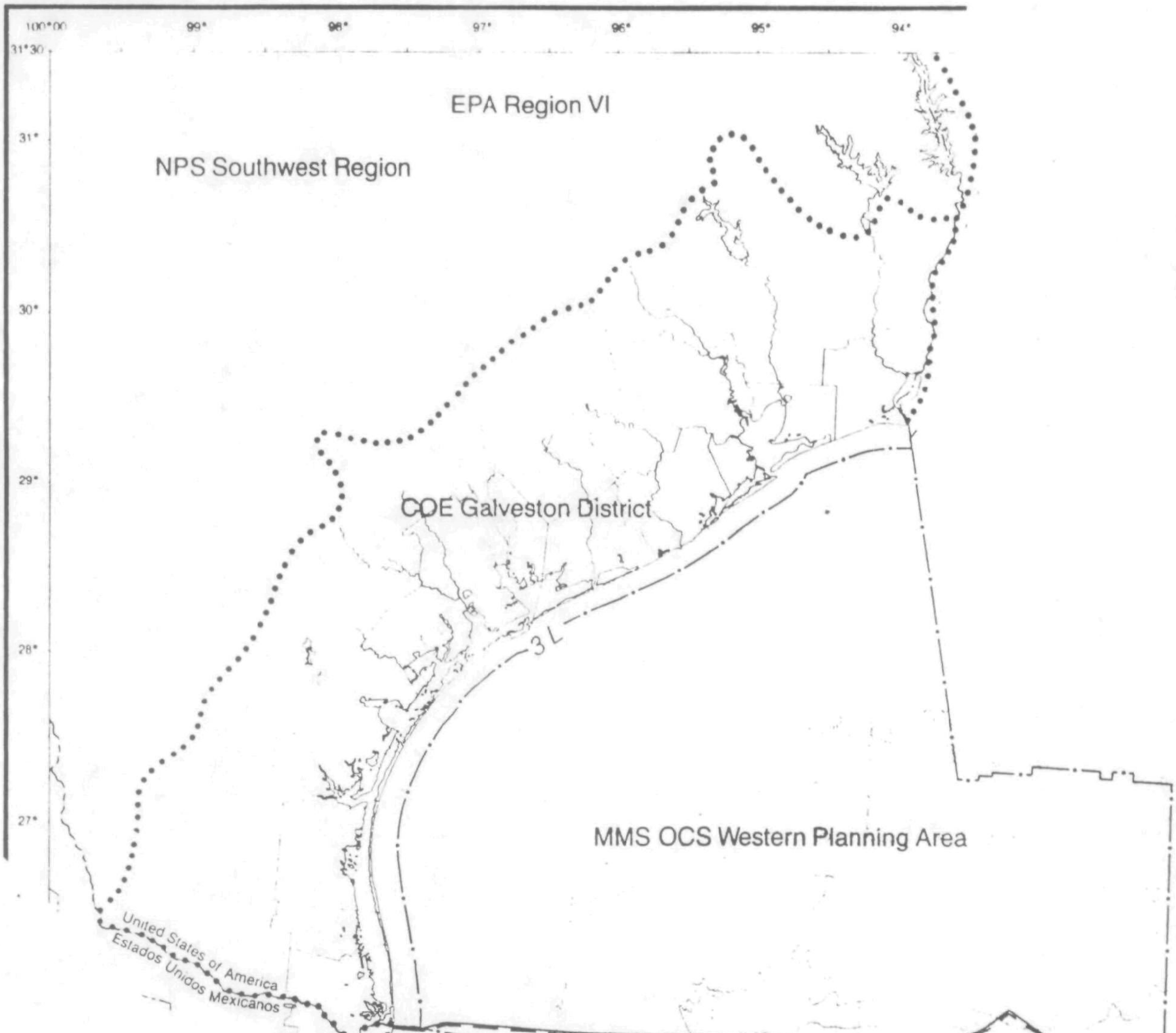
Federal Agency Regional Boundaries: Alabama, Florida

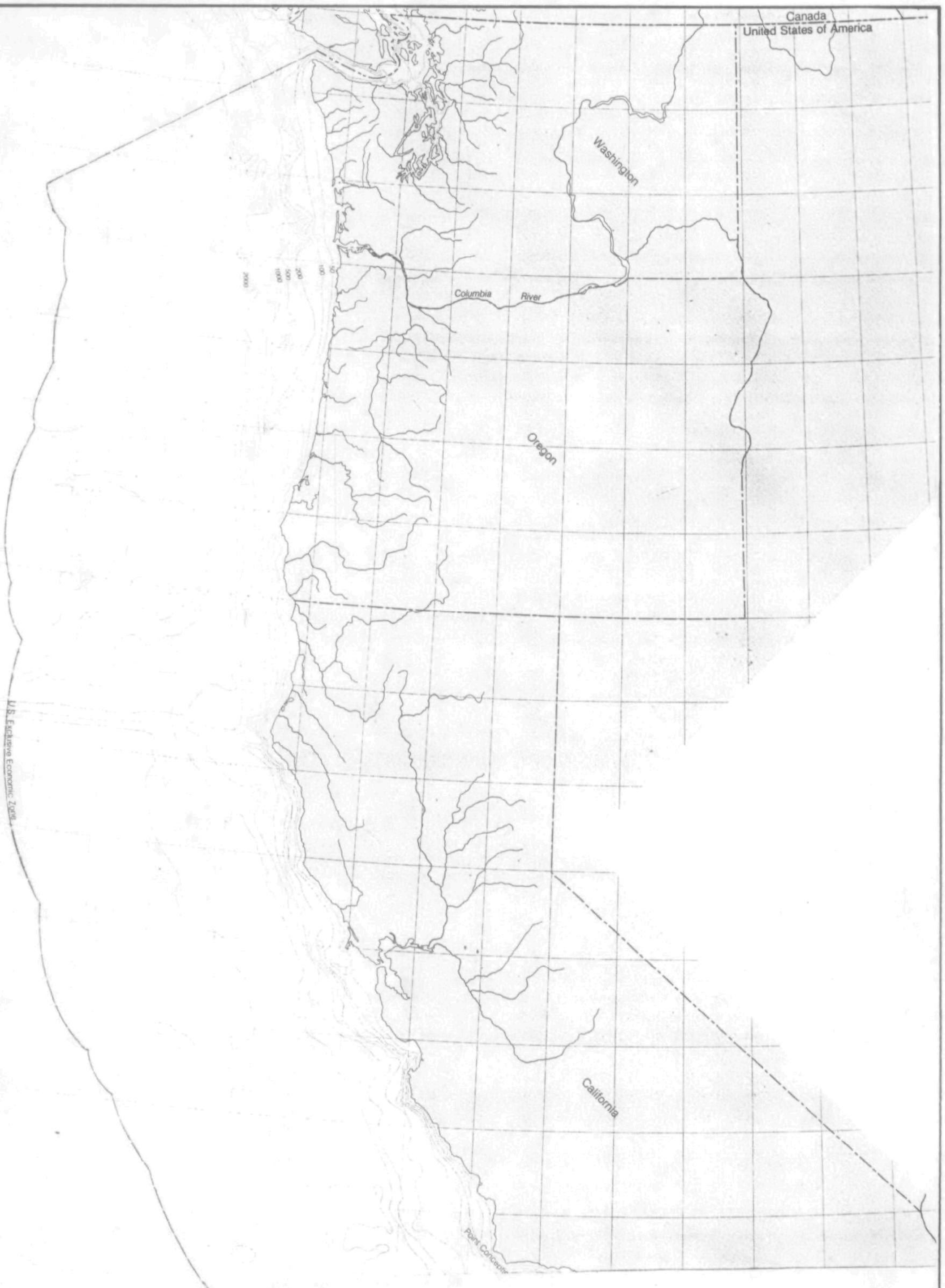


Federal Agency Regional Boundaries: Louisiana, Mississippi



Federal Agency Regional Boundaries: Texas



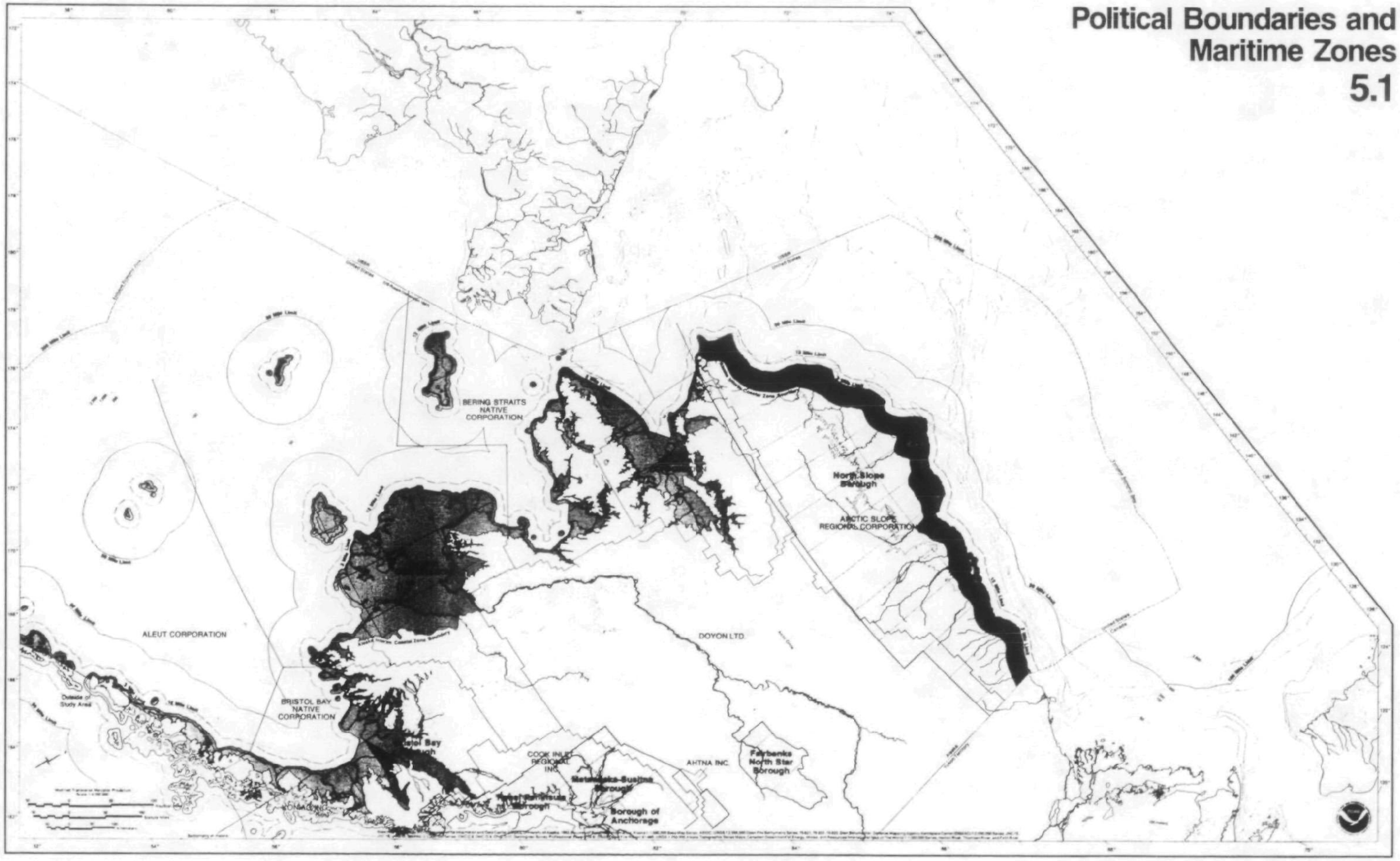


WEST COAST

Maps portraying political and federal agencies' boundaries will be available in the West Coast of North America Data Atlas Preliminary edition (November)

Political Boundaries and Maritime Zones

5.1



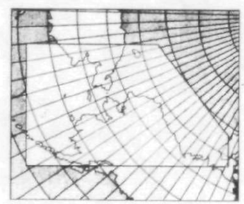
Legend

- International Boundaries
- 200-Mile Limit (Exclusive Economic Zone)
- 50-Mile Limit 100-Mile Limit in Canada (Prohibited or Pollution Zone)
- 12-Mile Limit (Contiguous Zone)
- 3-Mile Limit (Territorial Sea)
- Alaska Interim Coastal Zone
- Corporation Boundaries
- Borough Boundaries
- Boroughs

The 3-mile limit is also the seaward boundary of the Alaska Interim Coastal Zone.

Map References

Bureau of Land Management, 1974; U.S. Department of State, 1977; National Foreign Assessment Center, 1978; Alaska Coastal Policy Council, 1979; Alaska Office of Coastal Management, 1979; National Advisory Committee on Oceans and Atmospheres, 1984.



EAST COAST STRATEGIC ASSESSMENT PROJECT

ORCA

The Use of Coastal Zone Color Scanner Imagery to Identify Nearshore Ocean Areas Affected by Land-Based Pollutants

Thomas F. LaPointe and Daniel J. Basta

January 1981

Office of Ocean Resources Coordination and Assessment
Office of Coastal Zone Management
National Oceanic and Atmospheric Administration
Washington, D.C. 20235

ORCA's Mission

The Office of Ocean Resources Coordination and Assessment (ORCA) is one of four major line office of the National Oceanic and Atmospheric Administration's Office of Coastal Zone Management. ORCA has the responsibility for the coordination and development of overall NOAA policy positions in two important ocean use areas -- outer continental shelf oil and gas exploration and development and marine transportation -- both ocean uses which may have significant effects on the management of other ocean and coastal resources that fall under the responsibilities of NOAA. To complement its evaluation of individual ocean use proposals, ORCA has initiated a series of "strategic assessments" of the Nation's coastal and ocean regions. This document descirbes a study undertaken as part of a strategic assessment of the East Coast of the United States.

Introduction

This paper describes an analysis undertaken by the Office of Ocean Resources Coordination and Assessment (ORCA) as one part of its Eastern United States Coastal and Ocean Zones Strategic Assessment Project.[1] The East Coast project is the first of five regional assessments initiated by ORCA which focus on large coastal and ocean regions of the U.S. These assessments will cover the entire "coastal zone" of the U.S. (excluding the Great Lakes), extending seaward to the 200-mile limit of the fishery conservation zone and including all of the outer continental shelf as defined by the 200-meter isobath. Their purpose is to identify ocean resource use conflicts before they occur, so that resources can be developed or conserved in an effective manner and environmental damages minimized. The assessments are described as being "strategic" because they are carried out from a comprehensive planning perspective intended to complement, not replace, the detailed "tactical" analysis of coastal and ocean use proposals.

The objective of this analysis was to utilize remotely sensed satellite imagery to determine the spatial boundaries of nearshore areas or zones likely to be affected by pollutants from land-based sources, so that data collected on the presence or absence of living marine resources could be combined with information on land-based pollutant discharges in a preliminary and relative assessment of potential risk. These areas have been termed "ocean zones of impact". The actual size and shapes of these zones vary, depending upon: (1) type and quantity of pollutant discharge; (2) local meteorologic conditions; and (3) oceanographic/hydrodynamic conditions.

Ocean zones of impact related to east coast estuaries and embayments were approximated using reflectance patterns from data transmitted from the Coastal Zone Color Scanner (CZCS) instrument mounted on the NASA Nimbus-7 satellite. Data were transformed from numerical measures of radiance to photographic images suitable for identifying and mapping ocean impact zones through a simple enhancement technique.

Many similar applications of remote sensing imagery exist in the literature. These applications are based on the property of waters high in organic and inorganic particulates and dissolved matter to alter the way in which sunlight is reflected. For example, waters high in suspended solids scatter incident light of certain wavelengths increasing reflectance relative to surrounding clearer waters. Remote sensing instruments, like the CZCS, can detect this higher reflectance. The assumption is that the spatial distribution of waters of high reflectance which can be related to a point of discharge, e.g. the mouth of a river, is indicative of the dispersion of pollutants discharged at that point.[2]

The authors gratefully acknowledge Dr. Warren A. Hovis and Mr. Lee D. Johnson, Office of Research, National Earth Satellite Service, without whose expert guidance and assistance this project could not have been undertaken.

Only a preliminary identification of ocean impact zones along the east coast was attempted in this study, and those developed were used primarily in an illustrative manner in the East Coast Project. The analyses required to make a detailed assessment of the changing boundaries of these zones (over time) were beyond the scope, objectives, and resources of the overall project.

Methodology

Estimating the boundaries of east coast coastal and ocean zones affected by land-based sources of pollutants involved four steps. First, a determination had to be made as to which remote sensing instrument would best capture the phenomenon of interest. Second, the study area had to be divided into subregions that associated pollutants generated by sources located in specific land areas with the points at which these pollutants entered coastal waters, e.g., the mouths of rivers and outlets of embayments. Third, large amounts of remotely sensed data had to be screened, processed, and then analyzed for each subregion, including the selection of data from preliminary images ("quick looks"), the translation of numerical data into visual images, and the enhancement of those images, and their analysis. Fourth, individual images taken at different times were combined for each subregion to arrive at an estimate of the maximum observed boundaries of ocean zones that could be affected by pollutants entering coastal waters.

Choosing a Remote Sensing Instrument: Two remote sensing instruments instruments were investigated: the Coastal Zone Color Scanner (CZCS) and the Landsat 1 and 2 Multispectral Scanner (MSS). The CZCS was designed to monitor changes in ocean turbidity and chlorophyll concentrations. It is mounted on the Nimbus-7 satellite launched on October 23, 1978. The MSS was designed to discriminate among land masses and land uses, but has also been used with considerable success in identifying turbid conditions in coastal and ocean waters. The MSS has been in orbit for more than a decade. Table 1 compares the specifications of each instrument.

Although either instrument could have been used to approximate ocean impact zones, the CZCS was superior for this purpose. The capability of the CZCS to detect low radiance values (the measure of reflectance) is an order of magnitude greater than that for the MSS. This is an important feature for analyzing ocean areas which have low reflectance compared to land areas. Radiance resolution as measured by the number of intervals in the light intensity range of interest is many times greater for the CZCS (Hovis, 1979; Hovis, 1980). In addition, the larger spatial coverage of the CZCS (800m resolution vs 80m for the MSS) was more appropriate to the scale of the study area. Finally, while it was obvious that the MSS data base was more extensive than that for the CZCS (the MSS has been in orbit five times longer), an initial screening of the CZCS scenes that had been processed to date

Table 1. Comparison of Specifications of Nimbus-7 Coastal Zone Color Scanner and Landsat Multispectral Scanner

CHARACTERISTIC	COASTAL ZONE COLOR SCANNER		MULTISPECTRAL SCANNER	
	Wavelength Range (nm)	Saturation Radiance[a,b]	Wavelength Range (nm)	Saturation Padiance
Spectral Bands	433-453	5.41-11.46		
	510-530	3.50-7.64	500-600	24.8
	540-560	2.86-6.21		
	660-680	1.34-2.88	600-700	20.0
	700-800	23.9	700-800	17.6
			800-1100	15.3
Radiance Intervals	256		64	
Spatial Resolution at Nadir	825 meters		80 meters	
Swath Width	1600 km		186 km	
Processed Scene Size	1600 km by 800 km		186 km by 186 km	

a. Units in mW/cm^2 ster um
b. Bands 1 through 4 programmable in four steps for varying solar elevation angles

indicated adequate CZCS data was available to achieve the limited objectives of this analysis.

Three CZCS bands (ranges of wavelengths) were chosen for the analysis: band 2(510 nm to 530 nm); band 3(540 nm to 560 nm); and band 4(660 nm to 680 nm). These three bands, in the blue-green, green, and red portions of the visible spectrum respectively, are also contained within the wider MSS bands 4 (500 nm to 600 nm) and 5 (600 nm to 700 nm). Their selection was based upon a review of similar applications utilizing the MSS, which strongly suggested that the best discrimination of ocean turbidity is obtained in the 500 nm to 700 nm range (Pirie, 1973; Moore, 1974; Polcyn and Sattinger, 1979; Klemas, 1973 and; Bowker and Witte, 1977), with the best resolution in the 600 nm and 700 nm range. Measurements taken in bands on either side of this range often contain considerable interference caused by algae containing cholorophyll, which strongly absorbs light in the lower blue region and reflects light with wavelengths above 700 nm (Hovis and Leung, 1977; Bowker and Witte, 1977). The three CZCS bands differ in the extent to which they penetrate clear water and their sensitivity to atmospheric reflectance (backscatter). For example, Band 2 (blue-green) is deeply penetrating (about 30 meters in clear water) and quite sensitive to atmospheric conditions, while at the other extreme band 4 (red) penetrates only the upper few meters of the water column with lesser atmospheric interference (Moore, 1974).

Identifying Subregions for Analysis: Three considerations helped to define subregions of the east coast. First, the subregions had to be of sufficient size to be commensurate with the strategic focus of the East Coast Project and completely cover the entire study area. Second, their size had to be compatible with the spatial resolution of the CZCS. Third, and most important, the subregions had to relate areas containing land-based pollutant sources with the points at which their pollutants enter coastal waters, i.e., through the mouths of rivers and outlets from embayments.

These considerations resulted in the division of the study area into sixteen subregions defined by the commonly accepted hydrological boundaries of major east coast river basins, as established by the Water Resources Council (Water Resources Council, 1978). Figure 1 shows the subregions and identifies the number of major rivers in each. In general, pollutants which are discharged into these rivers eventually reach coastal waters after a specified time and after undergoing various physical and chemical degradation, deposition, and transformation processes. The outlets of these rivers or embayments, e.g., the mouth of Delaware Bay at Cape May, are the primary points at which land-based pollutants enter coastal waters. They serve as the coastal reference points to identify ocean impact zones.

Analyzing CZCS Data: At the time of this analysis (August-September 1980), approximately 150 CZCS scenes had been processed onto computer tapes suitable for analysis.[3] Each scene represents a portion of a single pass of the Nimbus-7 satellite over a specified area. Twenty of these scenes which contained data on some portion of the east coast, were screened to the extent to which cloud cover or thinner atmospheric formations, i.e., aerosols, obscured observation. Scenes which did not show the coastal portion of at least one entire subregion free of cloud cover or aerosols were excluded from the analysis. The original set of twenty scenes was reduced to ten. These are listed in Table 2, and the subregions to which they apply are identified.

Numerical data for each scene (radiance measurements) were next transformed into photographic images on a minicomputer/viewscreen system developed and maintained by the Office of Research of NOAA's National Earth Satellite Service. The system was also used to magnify those portions of each scene corresponding to the coastal areas of each subregion. Each magnified image was then manually enhanced to accent the "reflectance structure" of coastal waters.[4]

Magnified images were enhanced by reducing the effective radiance range and range center. This technique effectively blacks out areas at the lower end of the reflectance scale (e.g., areas of deep clear ocean where most

SUBREGION				COASTAL COUNTIES		SUBREGION: Water Resources		
	Name	Area (sq.mi.)	1972 Population (x1,000)	Area (sq.mi.)	Population (x1,000)	No. of Major Rivers	Surface Storage (sq.mi.)	Mean Discharge (cfs)
1	Northern Maine	31,110	667	5,907	161	4	375	37,900
2	Saco-Merrimack	6,527	921	2,947	513	1	84	9,870
3	Massachusetts-Rhode Island	6,608	6,153	3,745	3,811	2	23	4,590
4	Housatonic-Connecticut	17,214	4,379	2,269	1,883	3	111	17,180
5	Hudson-New Jersey	20,177	19,167	8,946	15,961	3	83	15,600 a/
6	Delaware	15,569	7,982	5,057	4,593	1	27	15,700
7	Susquehanna-Potomac	20,629	6,460	8,294	3,109	2	P 14	S/P 33,290 b/
8	York-James	19,973	2,326	6,374	1,747	3	UC, LC 23 c/	UC, LC 14,600
9	Chowan-Roanoke	6,395	10,525	3,644	136	2	192 (9–11)	25,900 (9–11)
10	Pamlico	18,708	1,259	3,012	145	2		
11	Cape Fear	14,161	8,215	2,677	228	1		
12	Pee Dee-Santee	17,348	1,920	2,901	138	2	495 (12–13)	28,000 (12–13)
13	Cooper-Edisto	24,975	3,019	4,329	394	2		
14	Savannah	35,595	1,973	2,893	281	5	472	25,500
15	St. John's	10,079	1,598	5,303	1,032	1	31	11,700 d/
16	South Florida e/	19,708	3,486	13,267	1,858	0	1,083	7,310

a/ Discharge value includes only the lower Hudson River to avoid double counting the flow value from the upper Hudson region.
b/ Discharge value includes flow from the Susquehanna River.
c/ The Upper and Lower Chesapeake (UC and LC) cannot be broken down further for surface storage and mean discharge categories.
d/ A USGS estimate for flow into the Atlantic.
e/ This subregion includes counties which drain into the Gulf of Mexico. A USGS estimate for for discharge into the Atlantic from this area is 7,700 cfs.

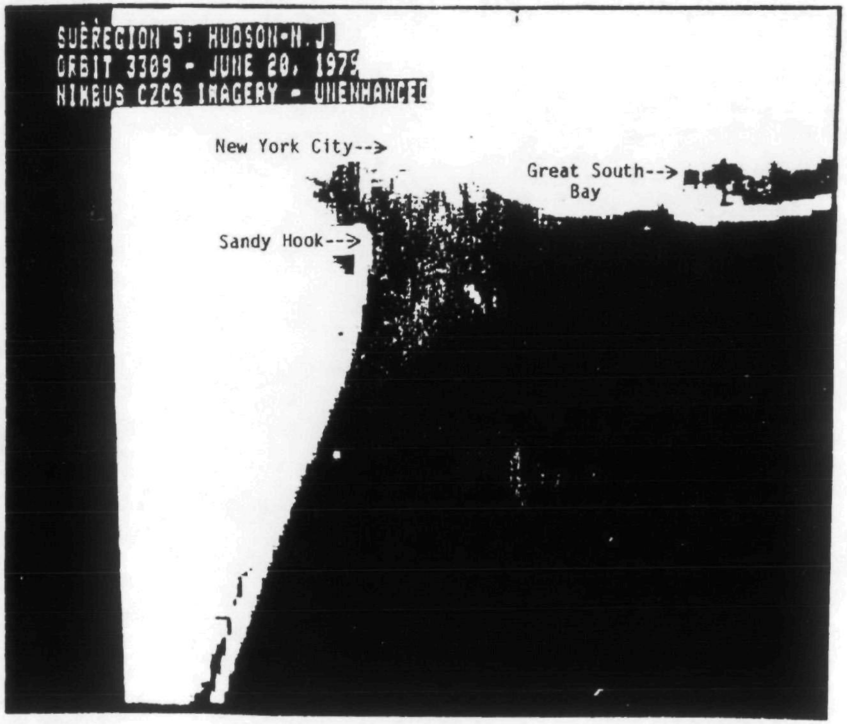
Figure 1. Analysis Subregions and Estuarine Boundaries

Table 2. CZCS Scenes Used to Define Ocean Impact Zones

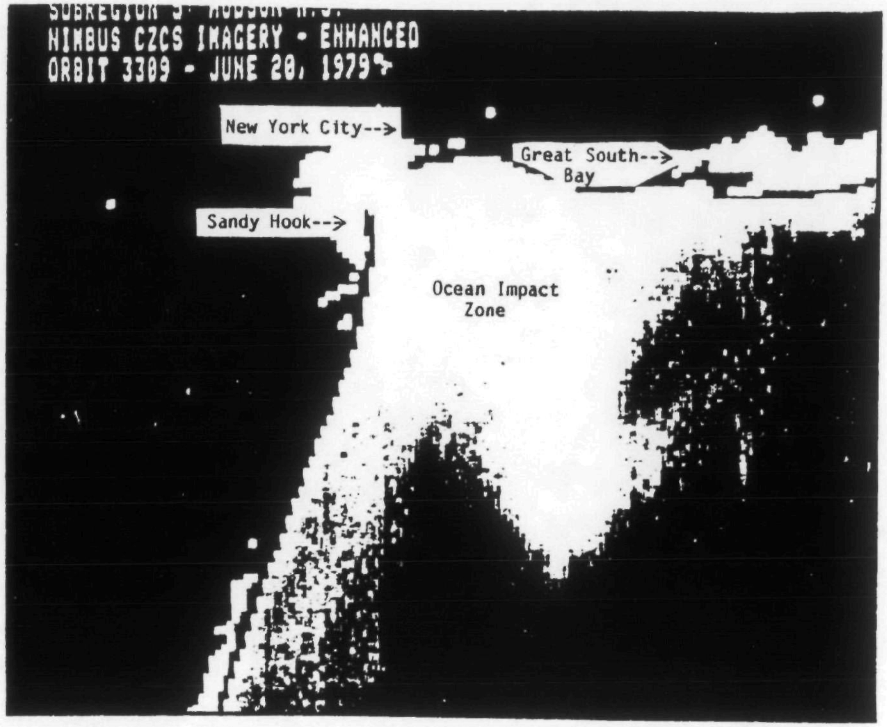
ORBIT NUMBER OF CZCS SCENE	DATE OF ORBIT	CLOCK TIME (EST)	ANALYSIS SUBREGIONS IN SCENE
130	Nov. 2, 1978	12:11	15,16
268	Nov. 12, 1978	11:36	13,14,15,16
2715	May 8, 1979	11:13	1,2,3,4
3226	June 14, 1979	10:39	1,2,3,4,5,6,7,8,
3240	June 15, 1979	10:57	1,2,3,4,5,6
3309	June 20, 1979	11:38	2,3,4,5,6,7,8,9,11
3351	June 23, 1979	11:38	9,10,11,12,13,14,15,16
4180	Aug. 22, 1979	11:28	4,6,7
4235	Aug. 26, 1979	11:00	8,9,10,12,13
4249	Aug. 27, 1979	11:19	8

of the observed reflectance is due to the atmosphere) and those on the very high end (e.g., land masses). The procedure was performed separately for each of the three spectral bands used, resulting in three single-band enhanced images. These images were then superimposed to form a single, three-color composite enhanced image. No single set of rules was established to perform the enhancements. Each enhancement was guided solely by the discrimination in the reflectance structure in coastal waters which could be visually perceived on the viewscreen.[5] Figure 2 illustrates the results of this procedure for a magnified image of Subregion 5, Hudson-New Jersey. This procedure is primarily a qualitative correction for Rayleigh scattering, i.e., light backscattered to the CZCS instrument by the atmosphere. Rayleigh scattering can account for 50 to 90% of the radiant energy signal on each of the three CZCS bands used. The effect of Rayleigh scattering is to give the images an overall brightness that obscures the reflectance structure in coastal and ocean areas.

<u>Defining Ocean Zones of Impact</u>: Ocean zones of impact for each subregion were defined by projecting color photographic slides of both the three-color composite enhanced and unenhanced magnified images onto a map of the east coast (scale = 1:2,000,000 or 1 inch = approximately 32 miles). The outlines of areas of high reflectance shown on each enhanced image were then transferred directly onto the map. Although the projected slides did not always match perfectly with the map because of differences between the projection of the map (Lambert conformal conic) and the surface as observed by the satellite, these distortions were slight and easy to correct. Unenhanced images were



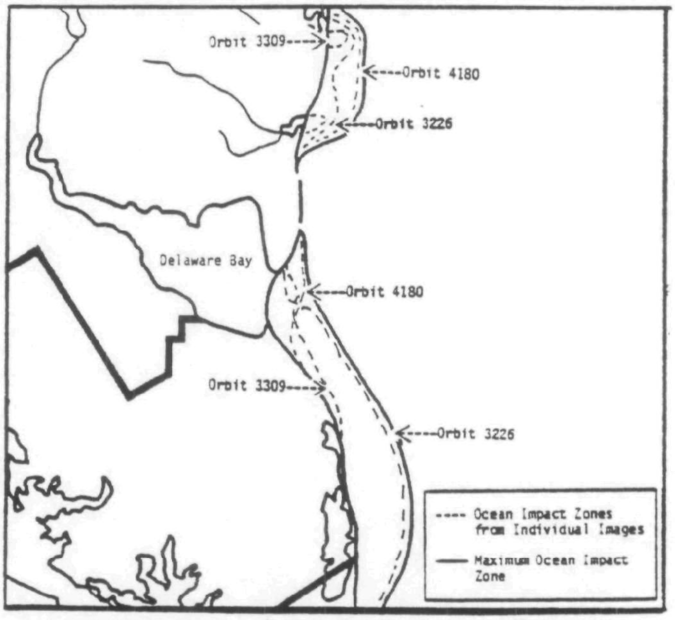
2a. Unenhanced Image



2b. Enhanced Image

Figure 2. Comparison of Unenhanced and Enhanced Images of Subregion 5, Hudson-New Jersey (Orbit 3309, June 20, 1979)

Figure 3. Individual and Maximum Ocean Impact Zones Observed for Subregion 6, Delaware



used to check the orientation of each image with coastline features shown on the map; coastline features on enhanced images were often distorted when the images were enhanced. Figure 3 illustrates how impact zones defined by individual images were combined to approximate a maximum ocean impact zone[6] for Subregion 6, Delaware. Figure 4 shows the maximum ocean zones of impact defined for each subregion.

The ocean zones of impact identified in Figure 4 cover about 90% of the coastline of the East Coast. The zones generally extend about 10 to 30 miles offshore, with the exception of zones in northern Maine (a special case), and overlap among subregions in several cases. In most cases (Subregion 3, Massachusetts-Rhode Island, through Subregion 14, Savannah), the enhanced images clearly show ocean zones of impact emanating from the mouths of major rivers and/or the outlets of major embayments. In these zones high reflectance indicates the existence of areas of relatively high turbidity directly related to sediment and pollutant discharges entering nearshore ocean waters. However, in some cases (Subregions 1 and 2, Northern Maine and Saco-Merrimack, and Subregions 15 and 16, St. Johns and South Florida), ocean impact zones could not be directly related to specific discharge points and, therefore, to pollutant discharges. In these areas the observed ocean zones are relatively large and are assumed to be the result of coastal processes such as the upwelling of nutrient rich bottom waters (Appolonio, 1979). The assumption is that although these zones are not the result of pollutant discharges, they are general nearshore "mixing zones" within which pollutant discharges from land-based sources are relatively confined and concentrated and, therefore, were reasonable ocean impact zones for the purpose of the East Coast Project.

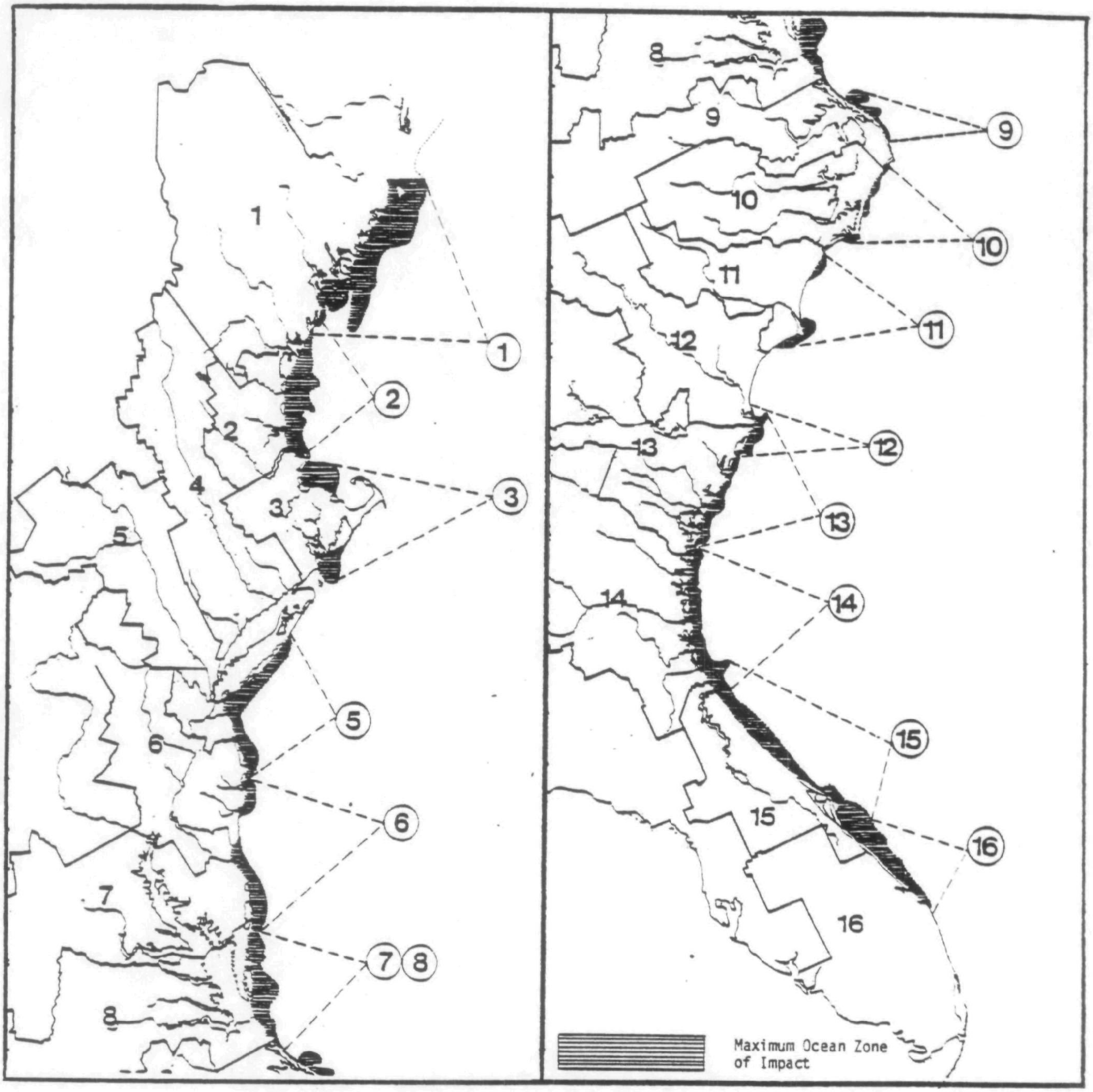


Figure 4. Maximum Ocean Zones of Impact Observed for Analysis Subregions

Evaluation and Interpretation

Each of the ocean impact zones identified in Figure 4 were evaluated and interpreted by investigating the individual images comprising each maximum impact zone in relation to: (1) the extent to which areas of reflectance, assumed to be turbidity resulting from land-based sources of pollutants, could be due to other factors; and (2) whether or not these areas made reasonable sense based on climatic conditions, e.g., precipitation, known to exist immediately preceding and at the time at which an image was recorded.

Two possible causes of reflectance in coastal waters other than turbidity were assessed -- bottom reflectance in shallow waters and reflectance due to aerosol formations. Bottom reflectance was assessed by assuming that if an area of reflectance was due solely to shallow waters, this area would appear the same in each image containing the area. Conversely, if at least one image which contained the areas showed no reflectance emanating from it, it was assumed that no or very little bottom reflectance affected the image. In addition, examination of bathymetry showed that only in one case was an area of consistently high reflectance in very shallow waters (less than six to ten meters). This area, the Nantucket shoals in Subregion 3, was therefore, not considered an ocean impact zone. Aerosols were, for the most part, easily identified in the unenhanced and/or enhanced images. Remaining uncertainties were resolved by case-by-case judgements comparing the locations of possible sources of turbid water, i.e., the mouths of major rivers, bays and estuaries to nearby, more obvious atmospheric formations.

Four climatic conditions known to affect the extent and movement of turbidity in coastal waters were investigated: seasonal currents (Pirie, 1973); precipitation (Rouse and Coleman, 1976); wind intensity and direction; and tidal stage (Hunter, 1973). Data were obtained from the East Coast Data Atlas (surface currents), NOAA Daily Weather Maps (precipitation and wind data), and the National Ocean Survey (tidal stages). Data on these conditions were used to qualitatively assess the sizes and shapes of the observed ocean impact zones. In most cases, the ocean impact zones appeared reasonable based on seasonal currents, precipitation, and prevailing wind conditions. However, this was generally not the case with respect to tidal stage. For example, in those subregions in which ocean impact zones were most obviously due to discharges from river mouths and embayments, the images showed major differences in both the extent and direction of the zones. These differences were generally consistent with what would be expected from precipitation and prevailing wind conditions, but often counter to what would be anticipated based on tidal stage (i.e., the largest zones observed during incoming or high tide). This discrepancy may simply be due to the limited number of images of each subregion, or may have a physical basis, e.g. the relative influence of tides as compared to wind or streamflow.

Table 3 identifies the specific locations at which the data used to assess each image were collected, reports relevant information on each climatic

Table 3. Summary of CZCS Images of Individual Subregions and Associated Climatic Data

ORBIT NUMBER OF CZCS SCENE	DESCRIPTION OF AREAS OF HIGH REFLECTANCE EXTENDING BEYOND ESTUARIES WHICH ARE ATTRIBUTED TO OCEAN COLOR	ATMOSPHERIC INTERFERENCE[a]		CLIMATIC CONDITIONS[b]		
		Clouds	Aerosols	Rainfall for Previous 4 Days[c] (Week)	Wind Direction	Tidal Stage[d]
Subregion 1				Portland, ME	Portland, ME	Portland, ME
2715	none	low	low	T(T)	calm	HL
3226*	large area extending southward from Bay of Fundy	none	none	T(T)	W	LH
3240	none	moderate	moderate	T(T)	SW	LH
4235	none	low	moderate	T(H)	W	LH
Subregion 2				Portland, ME	Portland, ME	Portland, ME
2715	none	none	moderate	T(T)	calm	HL
3226*	large faint area along entire coast	none	none	T(T)	calm	LH
3240	small area in Casco Bay	low	moderate	T(T)	SW	LH
4235	very small plume from minor river	low	moderate	T(H)	W	LH
Subregion 3				Boston, MA/ Nantucket, MA	Boston, MA/ Nantucket, MA	Boston, MA/ Nantucket, MA
2715	very small plume from Charles River	none	none	T(L)	ENE/WSW	HL/HL
3226*	large plumes from Charles River and southern bays	none	none	M(M)	WNW/N	LH/LH
3240	small plume from Charles River	low	low	M(M)	WSW/WSW	LH/L
3309	small plume from Charles River	none	none	L(L)	NW/N	HL/HL
Subregion 4				Hartford, CN/ Albany, NY		New L'don, CN/
2715	confined to Long Island Sound	none	none	T(L)	no station	L
3226	confined to Long Island Sound	none	none	H(H)	no station	H
3240	confined to Long Island Sound	none	none	H(H)	no station	LH
3309	confined to Long Island Sound	none	none	L(L)	no station	L
4180	confined to Long Island Sound	none	none	M(M)	no station	LH
Subregion 5				Albany, NY/ New York, NY	New York, NY	Sandy Hook, NY
3226	none in cloud free area	moderate	none	H(H)	N	H
3240*	large plume from Hudson River extending along Long Island coast	none	none	H(H)	WSW	H
3309*	large faint plume extending along New Jersey coast	none	none	L(L)	NNW	L
Subregion 6				Phil'phia, PA/ Salisbury, MD		At'tic City, NJ
3226*	small plumes from minor N.J. rivers; large southerly plume from Delaware Estuary	none	none	H(H)	no station	H
3240	small plumes from minor N.J. rivers; large southerly plume from Delaware Estuary	none	none	H(H)	no station	H
3309	small faint plumes from minor N.J. rivers	none	none	M(M)	no station	LH
4180*	large plumes from minor N.J. rivers; small faint plume from Delaware Estuary	none	none	VH(VH)	no station	L
Subregions 7/8				Salisbury, MD/	Norfolk, VA	Hamp'n Rds, VA
3226*	small plume from Chesapeake Bay extending along coast	none	none	H(H)	ENE	H
3309	none	none	none	M(M)	NE	L
4235	large easterly plume from Chesapeake	none	moderate	M(VH)	WSW	H
4249*	very large northeasterly plume from Chesapeake Bay	none	none	M(VH)	SW	H

(continued on next page)

ORBIT NUMBER OF CZCS SCENE	DESCRIPTION OF AREAS OF HIGH REFLECTANCE EXTENDING BEYOND ESTUARIES WHICH ARE ATTRIBUTED TO OCEAN COLOR	ATMOSPHERIC INTERFERENCE[a]		CLIMATIC CONDITIONS[b]		
		Clouds	Aerosols	Rainfall for Previous 4 Days[c] (Week)	Wind Direction	Tidal Stage[d]
Subregion 9				Hatteras, NC	Hatteras, NC	Hamp'n Rds, VA
3309*	small nearshore plume from inlet to sound	moderate	none	L(L)	ENE	L
3351*	large easterly plume from inlet to sound	none	none	L(M)	WSW	HL
4235	small faint plume from inlet to sound	moderate	none	T(M)	SSE	HL
Subregion 10				Hatteras, NC/ Raleigh, NC	Hatteras, NC	
3351*	small plume from inlet to sound	low	moderate	M(VH)	WSW	no station
4235*	small plume from southern tip of Pamlico Sound	low	low	T(H)	NE	no station
Subregion 11				Wilmington, NC	Wilmington, NC	Myrtle Bch, SC
3309	none	moderate	moderate	VH(VH)	N	L
3351*	small plume from minor river; small plume from Cape Fear River	moderate	moderate	T(VH)	WSW	L
Subregion 12				Wilm'gton, NC/ Charleston, SC	Charleston, SC	Charleston, SC
3351	none	high	moderate	L(VH)	SW	L
4235*	small faint plume from Pee Dee River	low	moderate	L(VH)	NE	HL
Subregion 13				Charleston, SC	Charleston, SC	Charleston, SC
268*	large very distinct areas from coastal embayments	low	low	T(T)	ENE	L
3351*	small distinct areas along entire coast	none	low	L(L)	SW	L
4235*	single plume fron northern embayment	moderate	moderate	L(L)	NE	HL
Subregion 14				Savannah, GA	Savannah, GA	Edisto, GA
268*	large very distinct areas from coastal embayments	low	low	T(L)	calm	L
3351	faint areas along coast	low	moderate	L(H)	WSW	L
Subregion 15				J'sonville, FL	J'sonville, FL	D'tona Bch, FL
130*	large area along southern coast	moderate	none	L(M)	calm	HL
268*	large area along entire coast	low	low	T(T)	calm	L
3351	narrow faint band along coast	moderate	moderate	T(T)	calm	L
Subregion 16				Miami, FL	Miami, FL	Miami, FL
130*	large area along northern coast	moderate	none	L(VH)	NNW	HL
268*	large area along northern coast	low	none	VH(VH)	NNE	L
3351	none	low	none	T(VH)	NE	L

* image used to define all or a portion of seaward boundary of maximum ocean impact zone

a. A qualitative indication of interference over coastal and nearshore waters by simple inspection of image

b. First station/second station as listed

c. Highest rainfall in period at any single station

Legend:
- T - trace amount or less
- L - trace to 0.3 in.
- M - 0.3 to 0.8 in.
- H - 0.8 to 1.3 in.
- VH - greater than 1.3 in.

d. Legend:
- L - low tide +/- 1.5 hours
- LH - incoming tide, 1.5 to 4.5 hours after low tide
- H - high tide +/- 1.5 hours
- HL - outgoing tide, 1.5 to 4.5 hours after high tide

condition at the time the image was recorded, and describes the size, shape, and intensity of the ocean impact zones identified by each image. The table also summarizes the extent of atmospheric interference visible in each image. An evaluation and interpretation of the ocean impact zones defined for each subregion follows.

Subregions 1 and 2, Northern Maine and Saco-Merrimac: Three of the four scenes utilized for these subregions showed little or no reflectance structure beyond the estuarine areas and bay mouths which comprise most of the coastline. The fourth scene, however, indicated a large area of high turbidity extending southward from the Bay of Fundy (see Figure 5). In this scene the structure of the high reflectance is very well defined along the entire coast of Subregion 1, but becomes much fainter and less distinct south of Casco Bay in Subregion 2.

The general southerly orientation of the zone is consistent with reported current regimes (NOAA/CEQ, 1980). However, minimal precipitation during the preceding week would tend to rule out any significant contribution to reflectance in this zone from the major land-based pollutant sources in the region -- sediments from agricultural and silvicultural sources. The zone of high turbidity is likely due to high concentrations of algae associated with a upwelling of nutrient rich bottom waters. This existence of such an upwelling along the coast of Maine has been reported by Appolonio (1979). The shape of nutrient concentration contour lines reported by Appolinio is very similar to the reflectance structure shown in Figure 5.

Subregions 3, 4, and 5 (Massachusetts-Rhode Island, Housatonic- Connecticut, and Hudson-New Jersey: Two distinct ocean impact zones were identified in Subregion 3 -- the plume of the Charles River draining the Boston area, and a zone emanating from Narragansett Bay and Buzzard Bay to the south (see Figure 6). The impact zone defined by the large plume from the Charles River derives from scene 3226[7] which was recorded two days after 0.4 inches of precipitation fell in the Boston area, and during and a westerly prevailing wind. Considerably smaller plumes were observed in the other three scenes containing this subregion, when climatic conditions were less strong.

The maximum zone of impact emanating from Narragansett Bay and Buzzard Bay was also defined by scene 3226. The general southwestly direction of this impact zone agrees with the direction of coastal currents and mean wind (due north) on the day the scene was recorded. Precipitation occured only preceding scenes 3226 and 3240. No precipitation occured during the week prior to the other scene for this region. Scene 3240, taken one day after scene 3226, is the only other one which shows an ocean impact zone, although much smaller than that shown by scene 3226. The smaller zone shown in this scene might be due to the prevailing wind direction on this day (west-southwest), which would tend to push surface waters into the bay mouth.

Subregion 4, had the largest number of applicable scenes (five), covering a considerable range of climatic conditions, e.g., from low to high precipitaiton

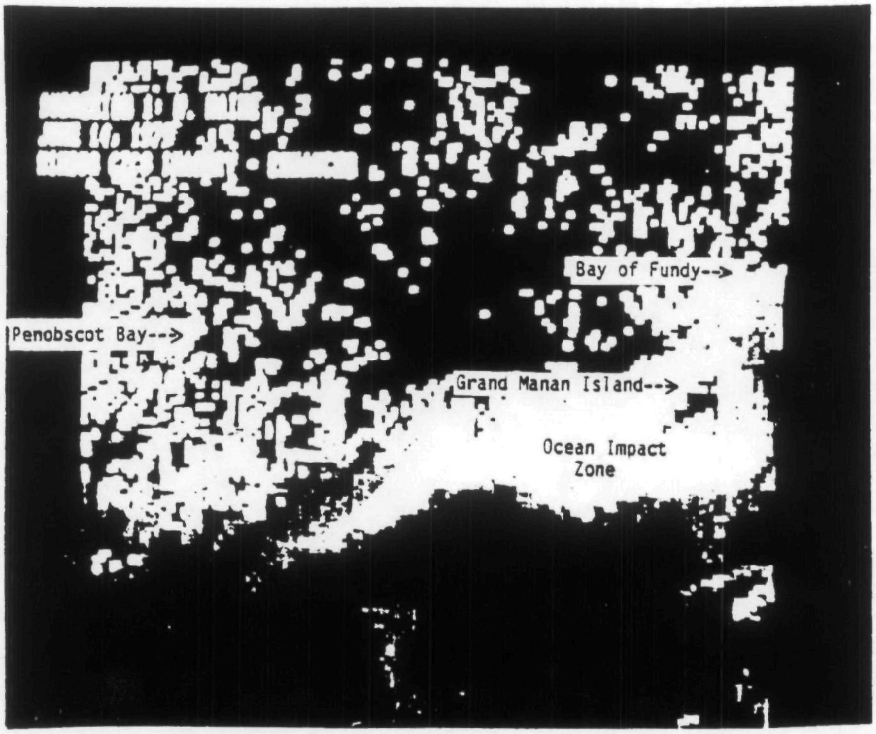


Figure 5. Enhanced Image of Subregion 1, North Maine (Orbit 3226, June 14, 1979)

Figure 6. Enhanced Image of Subregion 3, Massachusetts-Rhode Island Coastal (Orbit 3226, June 14, 1979)

and low to near high tide.[8] The principal conclusion is that the very high turbidity observed inside Long Island Sound does not extend beyond the mouth of the Sound -- at least at the surface (see Figure 7). For example, scenes 3226 and 3240 taken two and three days after moderate to heavy precipitation over western Massachusetts and Connecticut showed very high reflectance over most of the water surface inside the Sound, with the strongest structure located between the most likely sources of suspended sediment, the Connecticut and Housatonic rivers. However, neither in these nor the three scenes of lesser reflectance, did the structure extend beyond the mouth of Long Island Sound into ocean waters.

For subregion 5, the New York Bight, three scenes were available, one of which was partially obscured by cloud cover. An ocean impact zone extending easterly along Long Island (scene 3240) and south along the New Jersey coast (scene 3309) was identified (see Figure 2b and Figure 7). The area of reflectance shown in scene 3240 is considerably more distinct than in scene 3309. Scene 3240 was preceded by 1.2 inches of precipitation in the Hudson River drainage basin, while scene 3309 was preceded by relatively little precipitation. The orientation of the reflectance structure in the two scenes is in agreement with the respective westerly and northerly directions of the prevailing winds. No impact zone was observed in scene 3226 because of cloud cover. These results are generally supported by other remote sensing and field sampling studies of the New York Bight (Hovis and Leung, 1977; Polcyn and Sattinger, 1979).

Subregions 6, 7, and 8, Delaware, Susquehanna-Potomac, and York-James: Two separate impact zones were identified in Subregion 6, a small zone defined by several small rivers and estuaries which discharge directly into the ocean along the New Jersey coast, and a large zone, produced by the Delaware estuary (see Figure 8). For the small zone all scenes showed small, but distinct, plumes from the Great Egg and Wading Rivers, plumes similar to those observed with Landsat imagery (Klemas, et al, 1973). The largest of these plumes were observed in scene 4180, taken on the day of a very heavy, localized storm. The ocean zone of impact emanating from the Delaware estuary was constructed from two scenes taken within a few days of a high precipitation in the Delaware River drainage basin. The largest part of the zone, directed southward, was taken from scene 3226. In the second scene (4180), partially obscured by aerosol, a much smaller zone was visible along the northern tip of the estuary mouth.

Ocean impact zones related to the Delaware Estuary have been extensively studied with Landsat MSS imagery, through research conducted at the University of Delaware (Klemas, 1980; Klemas et al., 1973). Results have demonstrated a pattern of reflectance implying a southerly flushing of the bay along the Delaware and Maryland coast with a much smaller zone directed northward along the New Jersey coast. These findings generally support the ocean impact zones defined above.

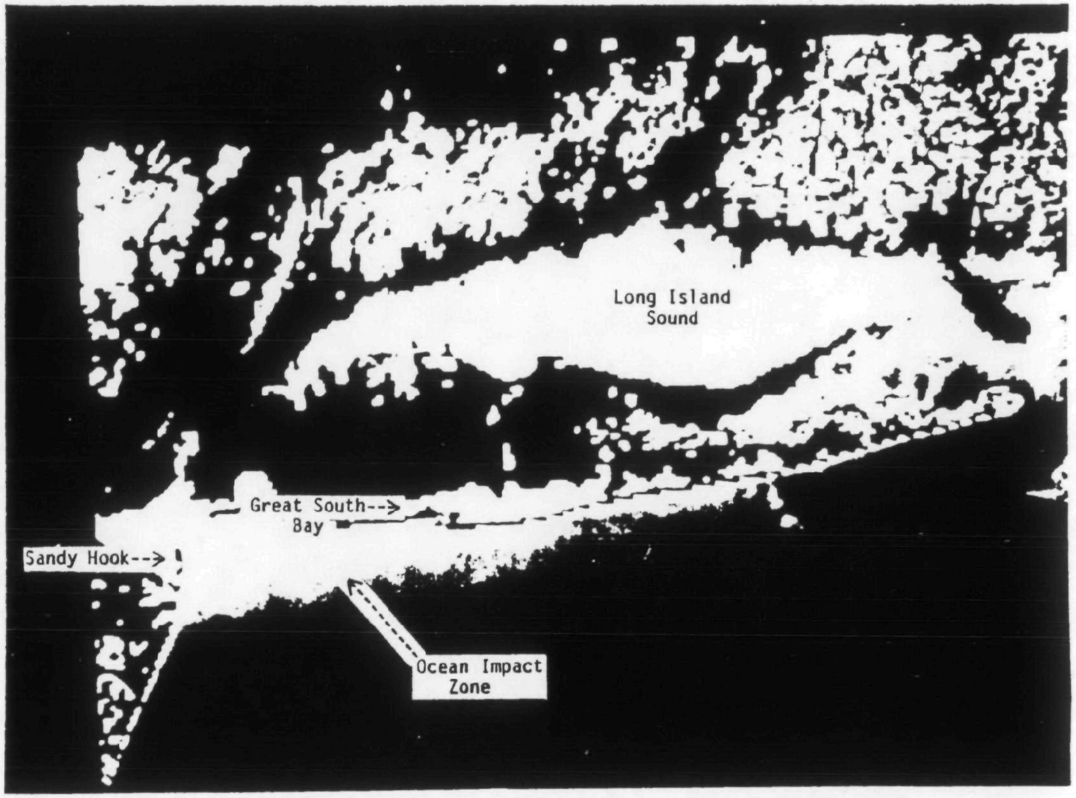


Figure 7. Enhanced Image of Subregions 4 and 5, Housatonic-Connecticut and Hudson-New Jersey (Orbit 3240, June 15, 1979)

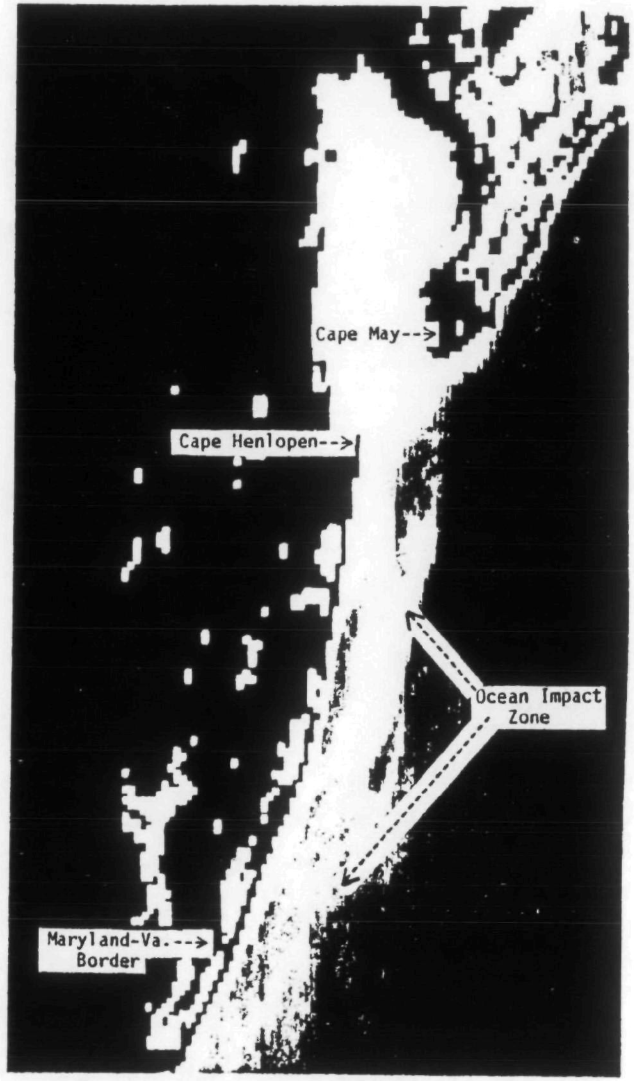


Figure 8. Enhanced Image of Subregion 6, Delaware (Orbit 3240, June 15, 1979)

Subregions 7 and 8 were combined into a single large area, the entire Chesapeake Bay drainage system. The largest portion of coastline for both these subregions is along the Chesapeake Bay which receives the overwhelming mass of pollutants. However, discharge into nearshore ocean waters takes place only at the mouth of the Bay in Subregion 8. No scene could clearly distinguish any reflectance structure along the ocean shores of Maryland and Delaware (Subregion 7) from the high reflectance emanating from the bay mouth.

During the summer months currents along this stretch of coast have two directions: southerly along the coast and northwesterly from the ocean into the coast (NOAA/CEQ, 1980). A southerly flushing of the bay similar to that of the Delaware estuary was evidenced during two recent sampling surveys of the Chesapeake Bay plume (National Marine Fisheries Service, 1980).

The maximum impact zone for these subregions was defined by scenes 3226 and 4249. In scene 4249 the ocean zone is strikingly defined by a northeasterly directed plume of turbid waters flushing from the bay. While the structure of high reflectance continues northward along the entire coast of Subregion 7, it is uncertain whether and to what extent this is directly caused by Bay waters. Scene 4235 taken the previous day and partially obscured by aerosols, indicated an almost identical plume in size and direction. In both images, the orientation of the impact zone is consistent with the direction of prevailing winds, coming from the southwest in scene 4229, and west-southwest in scene 4235.

In scene 3226 wind direction was reversed (i.e., east-northeast). Instead of an expansive plume, the impact zone has a flat seaward boundary stretching from the northern tip of the bay to the North Carolina-Virginia border. It should be noted that all of these scenes were recorded at or near high tide. The single scene recorded near low tide (3309), when some flushing of the bay would be expected, showed no ocean zone of impact.

<u>Subregions 9, 10, 11, and 12, Chowan-Roanoke, Pamlico, Cape Fear, and Pee Dee-Santee</u>: Data for these subregions consisted of only two scenes, each of which contained some interference from nearshore clouds and aerosols. In subregions 9 and 10, ocean impact zones were defined by small plumes at the major outlets of the Albemarle and Pamlico Sounds, the dominant coastal features of the North Carolina coast (see Figure 10). No other areas of high reflectance were observed along most of the coast of Subregions 11 and 12. Except for the southern tip of Florida, this is the largest stretch of coast without an observable ocean impact zone. While the data for these subregions is admittedly thin, the absence of impact zones is not surprising. This stretch of coast has only two major river discharges -- the mouth of the Cape Fear River in Subregion 11 and the Pee Dee/Santee Rivers at the extreme southern tip of Subregion 12. These subregions contain no large bays or estuaries, and a only minimal network of smaller rivers. The impact zones of the two rivers (both taken from scene 3351) appeared as a dense "yellow" color on the unenhanced image, a visual aspect very similar to the extremely high reflectance and color tone observed in unenhanced images in scenes of Subregions 13 and 14.

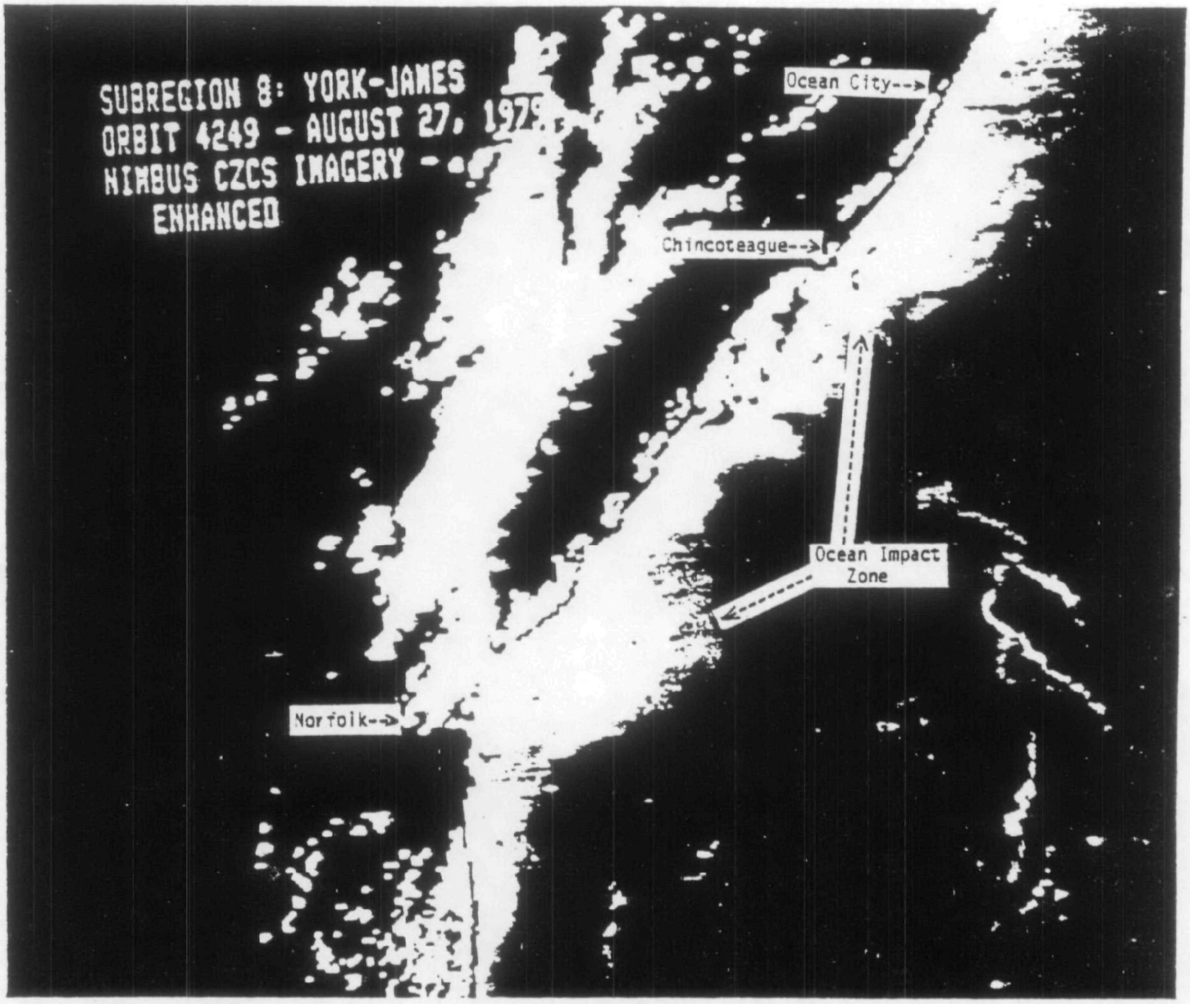


Figure 9. Enhanced Image of Subregions 7 and 8, Susquehana-Potomac and York-James (Orbit 4249, August 27, 1979)

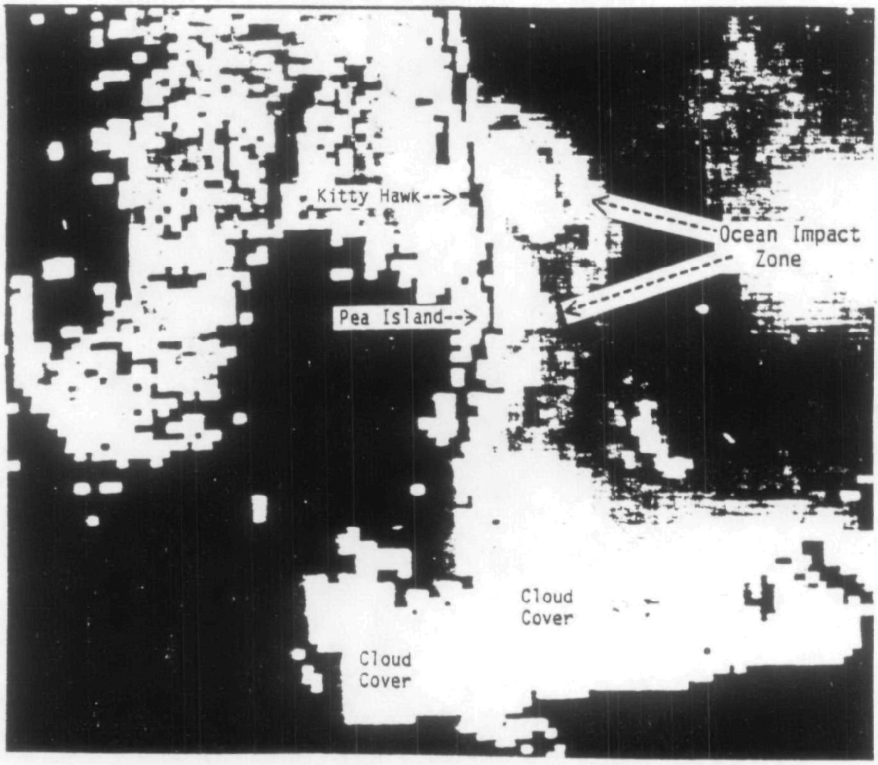


Figure 10. Enhanced Image of Subregion 9, Chowan-Roanoke (Orbit 3351, June 23, 1979)

Figure 11. Unenhanced Image of Subregions 13 and 14, Pee Dee-Santee and Cooper Edisto (Orbit 268, November 12, 1978)

Subreigons 13 and 14, Cooper-Edisto and Savannah: The results for Subregions 13 and 14 were unexpected. The entire coast of these two subregions exhibited an extremely well defined reflectance structure in offshore waters in two of the three scenes available. The structure appeared as a deep yellow - orange in the unenhanced image. Close inspection suggested that this reflectance is the result of discharges from many rivers and small bays rather than a coastal process. In several areas the deep yellow color could be traced "upriver" for a considerable distance, in others, distinct plumes from individual rivers and bays could be identified. The lack of a single reflectance structure covering a large area raises doubts about the influence of coastal processes. However, these observations should not rule out the possibility that coastal processes are also affecting the reflectance. For example, the strongest reflectance structure was observed in the image of Orbit 268 (see Figure 11). On the date of this orbit both previous precipitation and wind direction would suggest a minimal offshore influence from land-based pollutants.

Subregions 15 and 16, St. John's and South Florida: The large ocean impact zones for these two subregions are taken from two CZCS November orbits (130 and 268). As illustrated in Figure 12, a very distinct continuous band of high reflectance exists along the entire coast of Subregions 15 and the northern portion of Subregion 16, following very closely the 20 meter isobath. Similar observations have been made by others using more advanced image-processing techniques to analyze these scenes. Both scenes are part of the CZCS "benchmark" series of the Nimbus Experiment Team (Hovis, 1979).

Evaluation of these scenes indicated that the reflectance did not originate from the ocean floor, i.e., bottom reflectance. Scene 3351 showed little reflectance off the Florida coast. Neither previous precipitation nor pollutant discharges offered explanations. Precipitation in Subregion 15 was light in the week preceding the three scenes. Land-based discharges in the two subregions are characterized by only a few major rivers some of which could be clearly observed. Although the greatest pollutant discharges are in the more developed southernmost counties of Subregion 16 (NOAA/CEQ, 1980), little nearshore reflectance was observed in this area. Thus, there was no evidence which suggested that the ocean impact zones for these subregions were the result of land-based pollutant discharges. As was the case for Subregions 1 and 2, the zones more likely result from coastal processes, such as tidal mixing of bottom sediments (Lee, 1980).

Concluding Comments

This paper has presented a limited application of satellite imagery in the context of a large-scale strategic assessment of the east coast. The completeness of geographic coverage of satellite data makes them especially well suited for studying areas as large as the entire east coast. The CZCS images provided a single set of data which encompassed the entire study area. Obtaining comparable information from other sources, e.g., from published sampling surveys, would have been a considerably more complex

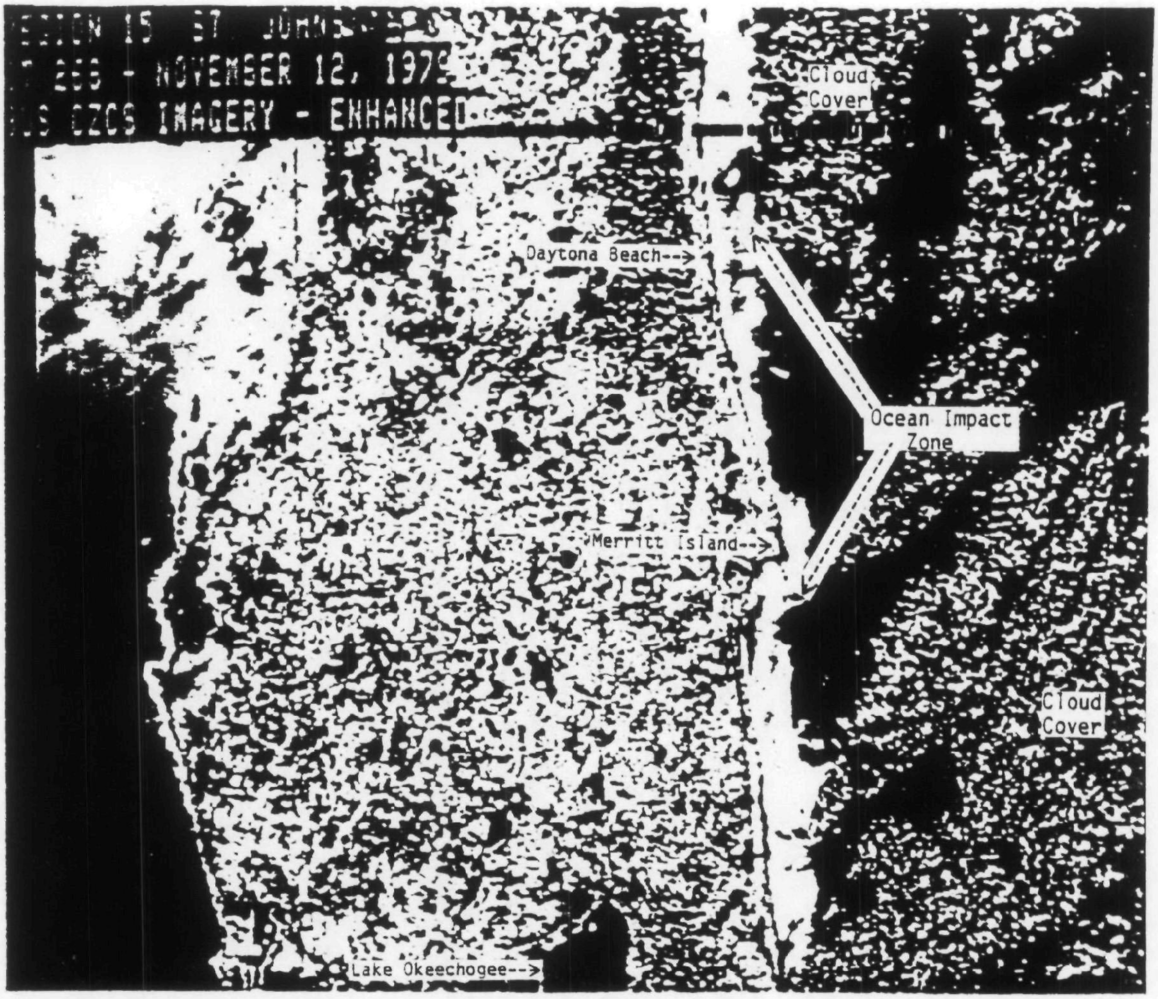


Figure 12. Enhanced Image of Subregions 15 and 16, St. John's and South Florida (Orbit 268, November 12, 1978)

task, and results would have lacked both consistency and geographic coverage.

This application of enhanced CZCS imagery to estimate the spatial extent of the persistance of land-based pollutants in nearshore ocean waters was limited by: (1) the extraordinary complexity of the phenonmena it attempted to capture; (2) inherent limitations of remote sensing; and (3) limited availability of data at the time of the study. For example, one inherent limitation of remote sensing is that it primarily monitors only surface phenomena. Reflectance measurements in turbid waters are dominated by radiation emanating from only the upper few meters of the water column. They will not capture the movement of material at greater depths or along the ocean floor. Therefore, the ocean impact zones defined for subregions in which subsurface transport is dramatically different from that observed on the surface will not be accurate. Also, in most cases ocean impact zones will be underestimated. This is because satellite observations based upon the light scattering of suspended particles cannot infer the presence of dissolved pollutants, which are not subject to settling and disperse at a greater rate than suspended matter.

Nevertherless, the results have been useful. In combination with data on the presence or absence of marine species and pollutant discharges from land-based sources, these data are being used to make a preliminary assessment of the potential risks to living marine resources among areas along the east coast. For example, potential risks to a species (e.g., a particular fish or invertebrate) from land-based pollutants will be generally greater within estuaries than nearshore ocean impact zones and greater in nearshore impact zones than other ocean waters, depending on the types and quantities of pollutants present and the life-history function the species is undergoing at the time (e.g., spawning or nursing).

Considerable improvement in the type and quality of information presented here will be possible in the near future, as more and more CZCS data are made available. As indicated above, only a small number of CZCS scenes had been processed at the time of this study. Recently processing of CZCS data has gone into accelerated production. This expanded data set will enable a much more complete identification and analysis of nearshore ocean impact zones, particularly under different climatic conditions and over time.

Footnotes

1. For a complete discussion of the East Coast project and its use of satellite imagery see Ehler, et al, 1980.

2. Although the scatter of light by suspended particles is only one of many processes which determine ocean color, it is the principal phenomenon of interest in the spectral bands selected for analysis.

3. All of these plus additional recently processed scenes are now being made available to the public through the Environmental Data and Information Service, NOAA.

4. It is important to note that magnifying the image reduces the field of view and thereby reduces the variation in atmospheric thickness across the image. This improves the quality of the subsequent enhancement.

5. For most of the images the enhancement was achieved with a band width of 60 to 100 counts with a midpoint between 130 and 190 counts (as opposed to a full range of 256 counts and a 128 count midpoint).

6. The term "maximum ocean zone of impact" refers to the total area of high reflectance observed from all of the images of a subregion.

7. Note that for ease of exposition scenes are identified by orbit numbers. For example, in Subregion 3 the image developed from orbit 3226 is referred to as scene 3226.

8. Tidal stages referred to in discussion correspond with definitions in Table 3:

   low tide - observed low tide +/- 1.5 hours
   incoming tide - 1.5 to 4.5 hours after observed low tide
   high tide - observed high tide +/- 1.5 hours
   outgoing tide - 1.5 to 4.5 hours after observed high tide

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