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Estuaries

The National Oceanic and Atmospheric Administration's

Estuarine Capabilities

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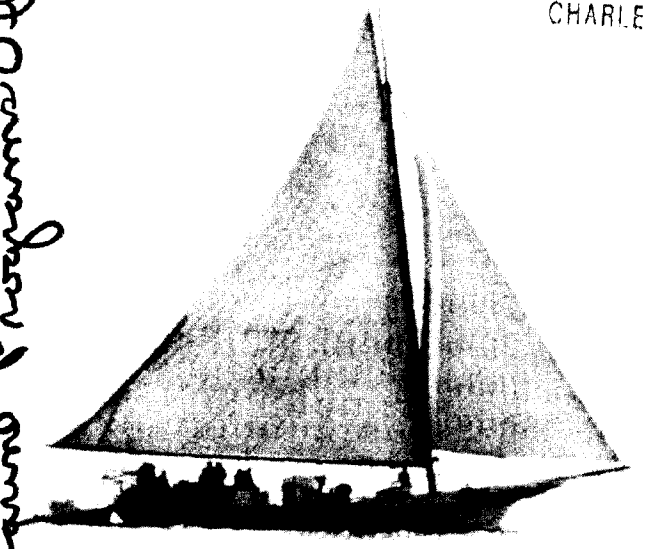

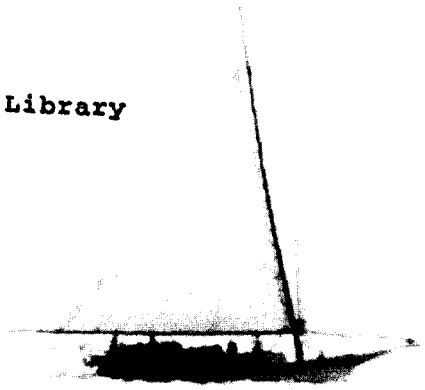

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U.S. DEPARTMENT OF COMMERCE • National Oceanic and Atmospheric Administration

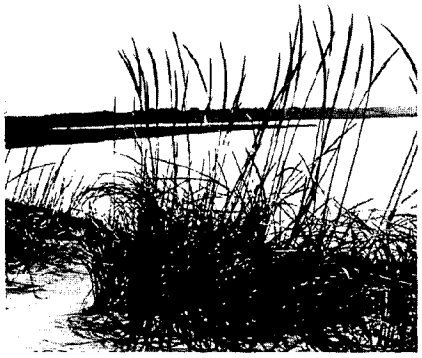
ESTUARIES

ESTUARIES, the most productive of our Nation's coastal environments, are those parts of freshwater rivers or streams that connect with the open sea, where the salt water is diluted with freshwater. Enriched by nutrients from the land, mixed by tides from the seas, and saturated by sunlight, these dynamic environments support a varied ecosytem. The estuarine brew feeds a chain of life from protozoa, plankton, small fish, shrimp, oysters, and larger fish, to the fish-eating mammals, including man. In addition to being important sources of nutrients for fisheries, estuaries provide spawning and nursery grounds for most species of sport and commercial fish. Furthermore, estuaries provide essential breeding grounds and habitat for waterfowl and other wildlife-including a large number of endangered species. Estuarine vegetation also helps protect adjacent waters from upland sediments and waterborne pollutants, by holding, filtering, or eventually breaking down this material before it silts into the open water. Marsh-like vegetation mitigates the erosion of upland areas caused by flood waters, reducing the impact of storm tides and wave surges before they reach the land.

These sheltered bays, inlets, and sounds provide waterways for commerce and pleasure craft, and attract residents to their picturesque shores. In fact, it is projected that by 1990, 75 percent of the U.S. population will live within 50 miles of the coast.

Because the beneficial characteristics of estuaries encourage so many different uses, many of which exclude other uses, and because these uses have increased with human coastal populations, there is a significant decline in the quality of estuarine waters and their resources. It is crucial that these vulnerable, productive coastal ecosystems be managed wisely.

THE National Oceanic and Atmospheric Administration (NOAA), in the U.S. Department of Commerce, is the Nation's lead marine science agency. As such, NOAA is charged with providing information, research, and management services for the Nation's ocean, coastal, and estuarine resources. With 25 coastal and marine research facilities, 17 National Estuarine Research Reserves, and direct ties to 29 universities and colleges through its National Sea Grant College Program, NOAA is uniquely suited to address not only broad scale estuarine issues, but also specific issues affecting individual estuarine systems along the U.S. coastline and in the Great Lakes.



Estuaries are the most productive of our Nation's coastal environments.

NOAA's estuarine programs are best described in terms of its responsibilities in information/assessment, research, and management. First, NOAA's information and assessment programs describe the physical characteristics of estuarine environments using a vast collection of archived and real-time data. This information is used to monitor and predict changes in environmental quality. It is also used to develop estuarine assessments, which provide the basis for analysis of the status, trends, and health of the estuaries on an individual, regional, or national basis.

Second to improve our understanding of estuarine environments and predict the effects of human activities on their ecosystems, NOAA conducts and supports research on estuarine processes. NOAA also conducts research on fishery resources and their habitats. These programs are designed to answer questions such as: How are contaminants dispersed in the ecosystem? What are the effects of waterborne contaminants on fisheries? The results of NOAA's research serve to promote a comparative understanding among estuarine ecosystems but, more importantly, enables us to identify solutions to problems common to many of our estuaries.

Finally, with this scientific and technical support, NOAA encourages wise management of estuarine resources. Coastal resource management laws provide NOAA with the opportunity to design, with the States, approaches to strike a balance among the various and often conflicting coastal uses. Through these laws, NOAA also emphasizes the development of new techniques and information systems that can be used by decision-makers at the State and local level.

ESTUARINE ASSESSMENT

ASSESSMENT entails describing an estuarine system, including the physical environment, water and sediment quality, as well as associated animals and plants. NOAA's programs include collecting, archiving, and synthesizing environmental data. From this data, NOAA develops assessments of the estuarine environment that provide a sound scientific basis for resource managers to make decisions. Furthermore, the review and synthesis of data gathered in the assessment phase helps to identify topics where additional research is needed to support management decisions.

Data Archives

NOAA collects and archives extensive data files for oceanographic, geophysical, climatic, fisheries, and pollution data, much of which are available to the public upon request. NOAA's archives include not only data collected from conventional observations, but also retrospective satellite images from 1960, and raw satellite data on surface temperature, turbidity, and pigment concentrations. These measurements can provide "snapshots" depicting selected characteristics of an entire estuary, and are a valuable tool for monitoring estuarine conditions. For example, using digital satellite imagery, NOAA has developed a computer model that attempts to identify quantitative relationships between marshland and fisheries production in Louisiana.

Oceanographic Data

NOAA maintains the world's largest collection of unclassified historical marine and environmental data on water temperatures and currents, winds and waves, pollution, and marine organisms. These data provide historical records of environmental conditions at particular times and locations, although the amount and type of data vary among the estuaries. These data are being used to develop Coastal Information Systems (CIS) for individual estuaries. A CIS organizes and summarizes voluminous amounts of environmental data applicable to topics such as dumpsites or critical habitat locations. The system allows citizens' groups, port authorities, and State management agencies to easily manipulate large amounts of information. Such systems have been developed for the Hudson/Raritan estuary and the Port of New Orleans. Another is being developed for the Chesapeake Bay.

Climatic Data

NOAA houses all weather records, including data on drought, freezing, precipitation, relative humidity, sea surface temperature, snowfall, visibility, and wind. Coastal engineers routinely use the climatic data in the construction of jetties and breakwaters to improve their resistance to storms and other adverse weather conditions. Other industries have unique construction requirements that also depend on the availability of historic climate data. The oil and gas industry, for example, uses this data in the engineering of on-shore structures, pipelines, and offshore rigs.

Fisheries Statistics Data

NOAA collects data on the U.S. commercial fish and shellfish landings and on recreational catches. *Fisheries of the United States,* an annual publication, provides information on landings by species, region, State, and port, and on employment in fishing and related industries. Such data were crucial in documenting the recent decline of East Coast striped bass and ultimately led to more stringent regional management measures for that species.

NOAA maintains the world's largest collection of marine and environmental data.

Pollution Data

The National Coastal Pollutant Discharge Inventory (NCPDI) is a NOAA data base that identifies pollutant discharges—both point and nonpoint source—into estuarine and coastal waters (except the Great Lakes). Data extend upstream to the head of estuaries and seaward to the boundary of the Exclusive Economic Zone. The NCPDI estimates pollutant discharges from 1980 to 1985, for a variety of contaminants such as nutrients, heavy metals, and sludges. This information is being used to evaluate the relationship between pollutant discharges and their effects on environmental quality.

Data and Information Services

NOAA's library of environmental information can be accessed via computer terminal connected to the national bibliographical data bases and catalogues. NOAA also operates the National Environmental Data Referral Service (NEDRES), a computer catalog of environmental information which has been used to organize data in the Chesapeake Bay Program Computer Center. Accessible by computer terminal over commercial telephone lines, the NEDRES system allows the user to locate these environmental data sets rapidly.

Assessment entails describing water quality parameters.

Data Synthesis

Data synthesis entails gathering information from a variety of sources and standardizing it. NOAA's data synthesis activities include building data bases on physical, chemical, and biological factors, as well as on land-use patterns. Much of this information is currently being incorporated into a comprehensive data base, the National Estuarine Inventory.

The National Estuarine Inventory (NEI)

The NEI is the framework in NOAA's efforts to assess the health of the Nation's estuaries. The NEI identifies 92 estuaries within the contiguous United States and compiles data on their important physical, hydrological, biological, and economic characteristics. Data are compiled by estuarine drainage area. The *National Estuarine Inventory Data Atlas* illustrates characteristics of the estuaries identified in the NEI. Additional projects are being incorporated into the NEI framework. These studies are summarized below.

One component of the NEI is a report on the Status of Coastal Wetlands. This project summarizes the distribution of 15 types of wetland habitats by coastal county. Information from the National Wetlands Inventory of the U.S. Fish and Wildlife Service is translated to wetlands maps by using a grid sampling technique. The data can be organized by estuarine drainage area or by county to produce summaries of wetlands acres. Also integrated into the NEI is information from the National Shellfish Register, which classifies 20.6 million acres of shellfish waters according to their ability to support shellfish that are safe for human consumption. In a recent effort to refine the shellfish data, NOAA identified those areas which were classified as unsafe for reasons other than water quality. For example, in 1985, Louisiana converted all its shellfish waters to conditionally approved for management reasons unrelated to water quality. Waters in Louisiana are now sampled monthly and are opened or closed based on immediate conditions. The Living Marine Resources component of the NEI will include information on the distribution and abundance of 150 fish and invertebrates in

those estuaries included in the NEI as well as additional estuaries of biological importance. Finally, the NEI will include information on the distribution and characteristics of public marine recreational activities in the coastal areas of the United States. NOAA has analyzed public expenditures on outdoor recreation and conducted a survey on consumer spending and usage in selected public recreational areas.

Environmental Studies

NOAA prepares regional studies of major estuaries, such as the Chesapeake and San Francisco Bays, and Puget Sound, to assess the effects of weather and oceanographic conditions on three economic sectors: fisheries, recreation, and transportation. For example, synthesis of ice data for the Chesapeake Bay led to projections that icy conditions would prevent the watermen in Maryland from harvesting oysters for an entire fishing season. In response to this information, the State of Maryland extended the oyster season to mitigate the potential hardship.

Environmental Description

A number of NOAA's programs describe the status of estuarine systems, resources, or levels of contaminants, relying on observational and remotely sensed data collection. The data generated are used to predict trends in environmental quality and abundance of living resources.

Nautical Charting

For the maritime industry and the recreational boater, NOAA is the predominant source of navigational information on the Nation's harbors and estuaries. NOAA produces charts for all navigable estuaries depicting boundary limits and other restrictions. In addition, NOAA produces the nine-volume set, *U.S. Coast Pilots,* which contains narrative navigational information.

Fisheries Stock Assessment

NOAA estimates the population sizes and distribution of fisheries that are dependent upon estuarine habitat during portions of their life cycle. For example, accurate prediction of the harvest of Gulf brown shrimp, the Nation's top value seafood, is very important to the seafood industry. To meet this need, NOAA first monitors the influx of post larval shrimp into Galveston Bay, then uses mark and recapture techniques in the Bay's marshes to monitor these resources.

NOAA research vessels ply the Nation's coastal waters.

Finally, NOAA refines predictions of the harvestable stock by analyzing the catch from selected commercial bait shrimp vessels.

Monitoring

NOAA's National Status and Trends Program (NS&T) monitors levels of toxic chemicals in sediments, fish, and shellfish. The program also measures the biological effects of environmental degradation. It is the only national program that collects information on contaminant levels throughout the Nation's coastal and estuarine environments using uniform procedures. The NS&T program has two major sampling components: the National Benthic Surveillance Project and the Mussel Watch Project. For the Benthic Surveillance Project, sediments and bottomfish are sampled and analyzed for contaminants at 50 sites. Data collected in 1984, the first year of sampling for the Benthic Surveillance Project, demonstrate that the Northeast and urban west coast contain elevated levels of most of the contaminants measured. For the Mussel Watch Project, mussels (and other suitable bivalves) and sediments are collected annually from 150 sites to measure contaminant loads. Annual sampling for this Project began in 1976. Data from the NS&T program will help identify priority areas for restoration and protection.

ESTUARINE RESEARCH

IMPROVING the knowledge of the physical and ecological dynamics that drive the estuarine system is a significant thrust of NOAA's estuarine research program. Equally important is research on fisheries and their habitats as well as documenting, the effects of contaminants on food chain organisms, the fish, and their subsequent consumption by humans.

Physical Processes

The semi-enclosed nature of estuaries and the continuous mixing of river and ocean water create unique circulation patterns. These tides and currents, and the accompanying chemical and biological processes, are important in determining the fate of contaminants introduced into an estuary. Therefore, NOAA's research programs include studies on circulation dynamics and contaminant transport.

Circulation Dynamics

NOAA is dramatically improving its ability to describe and predict water levels and estuarine circulation. Using real-time data on currents, water levels, and winds, NOAA is incorporating this information into numerical circulation models. These models assist ships to navigate safely over a longer portion of the tidal cycle with greater cargo loads. These models were used to produce NOAA's first tidal circulation and water level forecast atlas and will be coupled with a water quality model for Long Island Sound. In another effort, NOAA-sponsored research is demonstrating that physical oceanographic factors during the summer months are critical in determining annual recruitment of the blue crab larvae into the Chesapeake Bay.

Transport of Contaminants

Contaminants in estuarine systems can be transported as materials bound to particles, as substances dissolved in the water, or by disturbances in the bottom sediments. Better understanding of these transport mechanisms is necessary to determine the exposure of fishery resources to contaminants. Several years of NOAA research on contaminant transport in Puget Sound has revealed that this estuary traps dissolved as well as particle-borne pollutants, and that circulation plays a dominant role in this accumulation. In fact, research results indicate that over 90 percent of lead and copper entering Puget Sound are retained in the sediments. Activities of bottom-dwelling invertebrates also may affect the release of contaminants into the water. To examine the invertebrate's role in re-suspending and transporting polychlorinated biphenyl (PCB) laden sediments, NOAA is funding research at the New Bedford Harbor, Massachusetts Superfund site.

Ecosystem and Nutrient Dynamics

Estuaries are among the most productive ecosystems on Earth, due in part to the stimulation of biological growth by nutrients. Much is still unknown, however, about how nutrient dynamics, primary production, and decomposition combine to create a constantly varying environment. To better understand these relationships, NOAA researchers are investigating the dynamics of estuarine food webs and the role of nutrients and physical conditions affecting productivity.

Plant Productivity

Microscopic plants are important components of the estuarine and marine food chains. Understanding the processes governing their growth, including the effects of human activities, is critical. Because plants require nutrients to grow, NOAA is conducting studies of nutrient cycling and the effects of excess nutrients on production. NOAA also is developing models to integrate the relationships among nutrients, plants, and animals in both the water and the sediments. These evolving models will help predict potential effects of changes in nutrient inputs.

Eutrophication

Excessive nutrients can lead to rapid growth of algae. Nuisance algae can clog waterways and create noxious odors. As algae die, oxygen levels may be reduced, harming finfish and shellfish. Excessive nutrients also reduce the penetration of light into the water column, which can lead to massive reduction of submerged aquatic vegetation, a critical fishery habitat. NOAA is exploring the causes and extent of low oxygen levels along the Atlantic and Gulf coasts and is investigating the links between anoxia, nutrient inputs, meteorology, and physical conditions. Results of these studies will help managers regulate the volume of nutrients released into estuaries.

Living Resources

To understand natural and human-induced factors affecting the productivity of our estuarine fishery resources, NOAA investigates the life history and disease patterns of a number of species. NOAA also conducts aquaculture research by artificially creating environments that can support valuable living resources.

Life History

NOAA provides information to fishermen and managers to help them predict the size of fishery populations. As part of this effort, NOAA is determining the requirements that economically important fish need to survive during various life stages. In the Everglades National Park, NOAA research has revealed that larval gray snapper and spotted sea trout settle from the water column into seagrass beds and mangroves where they remain during early developmental stages. The link between seagrasses and life history will assist in habitat management.

Diseases

NOAA is studying the health of our fisheries. After finding cancer and other diseases in finfish and shellfish from contaminated estuarine regions, NOAA has increased its research into the causes of these diseases and their effects on fisheries. Recent projects have demonstrated that blood sarcomas in soft clams of several Northeast estuaries have resulted in extensive population losses. In conjunction with these efforts, NOAA is determining how disease limits the marketability and economic value of fishery products and is assisting government officials in identifying severity of the diseases.

Aquaculture

As natural stocks of fish and shellfish decline, aquaculture of seafood species is becoming increasingly important for enhancing wild stocks. To assist the infant aquaculture industry, NOAA is developing technology to culture species such as salmon, striped bass, and shrimp. These programs provide technology for rearing animals in ways that are economically feasible and to find solutions to diseases that can plague aquaculture projects. Recently, NOAA has taken the lead in developing aquaculture technology for estuarine and Great Lakes species. NOAA's Sea Grant Aquaculture Plan has provided guidance for future research programs on topics such as genetics and breeding, nutrition, disease/parasites, and economics.

Estuarine Habitats

Estuarine habitats, vital to commercial and recreational fisheries, are threatened by disposal of sewage and industrial wastes, dredging, filling, freshwater diversions, damming, and channelization. Through its research programs, NOAA is determining the effects of habitat loss on fishery resources and the potential benefits of habitat restoration, enhancement, and mitigation.

Fisheries-Habitat Interactions

Estuarine habitats provide food and shelter for a variety of economically important species. In the Southeast, for example, NOAA estimates that as much as 90 percent of these fishery resources depend on estuarine habitat during part of their life cycle. However, matching the needs of individual species with specific habitat types is difficult. This difficulty stems not only from identifying the habitat requirements of adults, but also of juveniles and larvae. NOAA, therefore, is evaluating the importance of marshes and seagrass beds to the growth and survival of fishery resources throughout their life cycle. Research results are used in deciding whether to grant permits for development projects which effect habitats. The U.S. Army Corps of Engineers recently relied on NOAA research to impose seasonal restrictions on dredge and fill permits in New Jersey estuaries that serve as critical habitat for winter flounder.

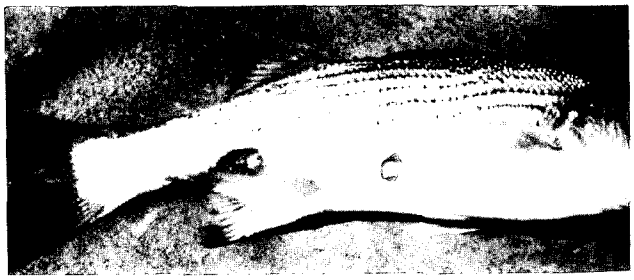
Habitat Alterations

Complementing its program in fisheries-habitat interactions, NOAA is assessing the effects of physical habitat losses and alterations on fisheries. For example, research has begun to link changes in freshwater inflow in Pamlico Sound, North Carolina, to shifts from economically important species (such as oysters) to less valuable species (such as catfish). In addition, NOAA is using life history data to develop models to predict the cumulative effects of habitat alterations. These models will show whether alterations can be detected within the natural variation of fishery populations.

Habitat Enhancement

NOAA is developing techniques to restore damaged habitats and to generate high quality habitat. NOAA has developed population growth models for the four major seagrass species of North America based on data from over 85,000 transplants in different climate zones around the country. Studies in Beaufort, North Carolina, the Florida Keys, California National Estuarine Research Reserves at Elkhorn Slough, Tijuana River, and San Francisco Bay have demonstrated that damaged habitats can be restored in a cost-effective manner. To meet requests for guidance from State agencies and the public, NOAA has developed marsh and seagrass transplant handbooks.

It may take years for grasses in restored habitats to catch up with the level of growth of grasses in a natural habitat. During this lag time, the restored habitat has a much smaller



NOAA scientists are studying the prevalence of diseases in fish from contaminated waters.

capacity to sustain fishery resources. Even after growth has peaked in restored habitat, it is questionable whether this habitat can sustain the same level of productivity as natural habitat. NOAA, therefore, is comparing the ability of restored habitat to sustain fisheries with undamaged habitat. These studies will help managers assess the utility of mitigation procedures.

Contaminant Effects

NOAA draws from a pool of research experts and facilities to examine the biological effects of pollutants such as synthetic organics (e.g. pesticides and PCBs), toxic metals, petroleum hydrocarbons, and excessive nutrients on living resources. NOAA examines not only the effects of contaminants on edible fish and shellfish, but also on food chain organisms.

Living Resource Effects

NOAA is documenting the uptake by fish and shellfish of chemicals from contaminated sediments, water, and food. NOAA is assessing how these pollutants affect behavior, survival, and reproduction of fish and shellfish. In one project, NOAA scientists are exposing hard clams to clean and contaminated waters from Long Island Sound to examine the effects of various levels of contaminants on egg viability and production and sperm mortality.

Pollutants also effect food organisms that support many fish species. As part of NOAA's efforts to examine this relationship, the Agency is funding a project to identify the effects that ocean discharges of industrial wastes have on copepods; a critical link in fisheries food chains. Results show that copepods exposed to these discharges experience a decline in reproductive capability. Future discharge limitations, therefore, should incorporate criteria that protect not only the fish, but also their food sources.

Contaminants in Fish Products

The public health significance of contaminants in fish and shellfish must not be overlooked. To support this need, NOAA is assessing the kinds and levels of contaminants in tissues of fishery products. Congress requested NOAA, for example, to coordinate a study describing PCBs in bluefish along the East Coast. The two-year survey, conducted with the Environmental Protection Agency and the Food and Drug Administration, yielded data that identified the health risks. Based on a preliminary examination of this data, FDA has concluded that the level of PCBs in commercially available bluefish does not present a health concern for the public. Levels of pesticides measured in conjunction with the analyses for PCBs were not significant enough to require regulatory action.

Chemical Interactions

Mercury is widely distributed in the marine environment. Trace amounts of methylmercury, a toxic form of the metal, can be found in edible tissues of fish. Based on consumer health concerns, FDA established guidelines for mercury concentrations. These guidelines, however, do not take into account the role that selenium, an essential trace element for humans and also found in seafood, can play in reducing the toxicity of methylmercury. NOAA is examining how methylmercury and selenium interact to decrease the potential health risk to the consumer. The results of the research will assist FDA in evaluating its mercury guidelines.

Contamination of Shellfish

Virus contamination of shellfish has led to numerous cases of illness among consumers. Many of these viruses are sewage-related, but their presence and spread are not easily monitored. NOAA research is developing new ways to extract and assay viruses from oysters and clams. In addition, NOAA scientists are examining pathogens in the estuarine environment and monitoring the ability of selected shellfish to purify themselves of pathogens. Knowledge of the time required for shellfish to cleanse themselves before they are consumed is critical for protecting human health.

ESTUARINE MANAGEMENT

MANDATED to encourage wise management of our estuarine resources, NOAA administers programs for managing the Nation's marine fisheries, protecting valuable marine and estuarine habitats, and balancing coastal development and conservation activities. Additionally, NOAA provides expertise to Federal and State agencies that have management responsibility in coastal areas.

Living Resources

NOAA is mandated to manage the Nation's living marine resources. These mandates extend to both finfish and shellfish as well as to endangered species and marine mammals. Through its fishery conservation and grant programs, NOAA supports the management of estuarine living resources.

Federal Fisheries Management

The Magnuson Fishery Conservation and Management Act of 1976 is designed to assure that fishing harvests are kept within sound biological and economic limits. The law authorizes the Federal Government, in cooperation with fishermen and other interested citizens, to manage most fishing within a conservation zone between 3 and 200 miles off our coasts. (The coastal States are responsible for resource management within 3 miles offshore.) Because a majority of species for which NOAA has management responsibility spend portions of their life cycle within estuaries, NOAA provides information and expertise to the States to assist them in their management programs.

Interstate Fisheries Grants and Management

Through the Commercial Fisheries Research and Development Act and the Anadromous Fisheries Conservation Act, NOAA provides grants to States, universities, and other organizations to characterize estuarine fisheries. These funds enables States to improve their fishery statistics programs and thereby enhance their stock assessment capabilities. In addition, NOAA is a member on each of the Interstate Fishery Management Commissions assisting the States identify research priorities and estuarine species needing management measures.

Protected Species Management

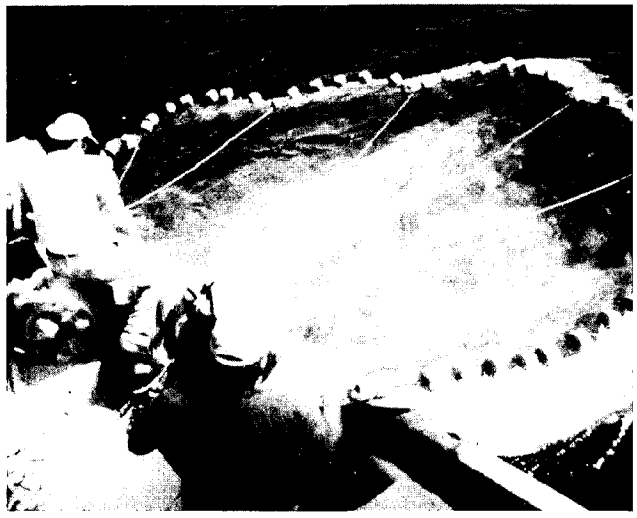
The Endangered Species Act and the Marine Mammal Protection Act give NOAA the responsibility to conserve and protect marine mammals and endangered or threatened species. NOAA's regulations limit collection of such species to research and public display purposes. Even the number of animals caught incidental to fishing are restricted. Estuarine species of principal concern are the short-nose sturgeon, sea turtles, seals, and sea lions.

Habitat Resources

NOAA recommends modifications to proposed Federal projects to ensure that their effects on living marine resources and their habitats are minimized. NOAA also provides similar advice to the States. The Habitat Conservation Policy provides a focus for NOAA's habitat conservation activities and integrates these activities throughout the Agency.

Habitat Advisory Services

To reduce damage to habitat, NOAA recommends innovative techniques or modifications in project design to Federally constructed or regulated projects. NOAA is often asked to bring this expertise to bear in court. In a 1985 court case, NOAA testified that landfill from New York's proposed



NOAA encourages wise management of our estuarine resources.

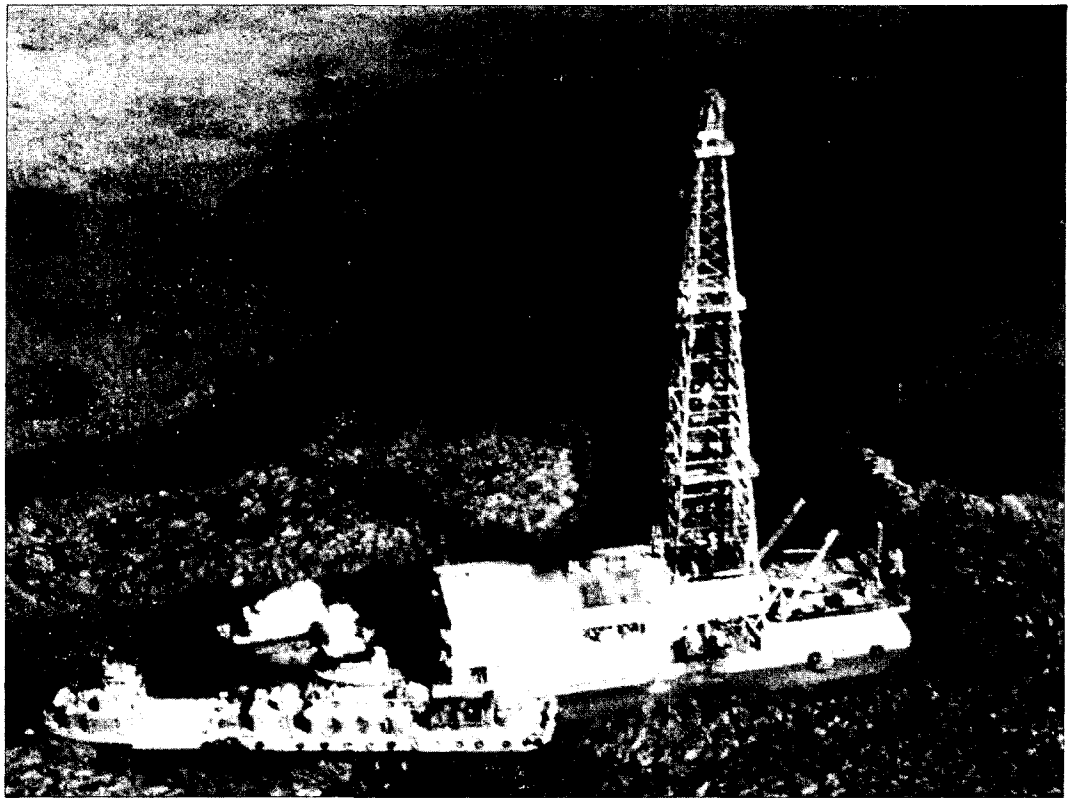
Westway Highway Project would severely affect striped bass in the Hudson River. This testimony, based on 10 years of NOAA studies, was instrumental in the court's decision to reject the project's Environmental Impact Statement for insufficiently considering the effects on striped bass. In the Southwest, NOAA staff participated in the Trinity River Task Force, which recommended a 10-year program to rehabilitate fish and wildlife populations, including artificial production of salmon, restoration of salmon spawning areas, and appropriate fishery management measures.

Habitat Resource Planning

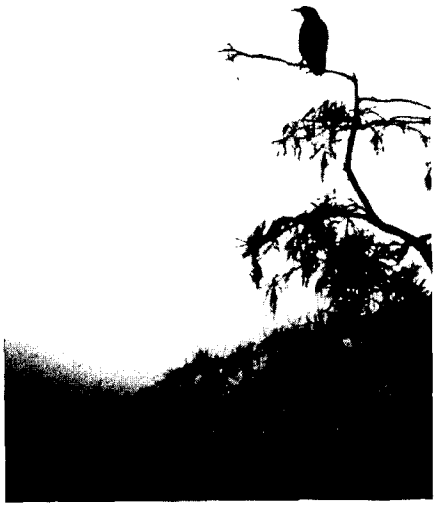
NOAA's Habitat Conservation Policy encourages greater participation by the Regional Fishery Management Councils and State fishery agencies in habitat conservation. The Policy contains a dozen implementation strategies that include assisting (1) the States in managing anadromous fishery habitats; (2) developers in pre-permit application planning; (3) and the public in communicating habitat conservation information to constituents. Pre-application has accelerated the permit process by exposing potential habitat impacts early. NOAA staff also recommend modifications in the project design that will reduce adverse impacts and therefore save the applicant time and money. Recently, the process enabled the U.S. Army Corps of Engineers to expedite a permit to the State of New Jersey for work in man-made lagoons, piers, and breakwaters by stipulating design details that minimized adverse environmental effects.

Coastal Resources

The Coastal Zone Management Act (CZMA) authorized the first national program to promote the wise use and protec-



Alterations of critical wetlands habitat is a focus of NOAA's habitat advisory services



We can predict with certainty that pressure on the estuaries will continue to rise.

tion of coastal land and water resources. This Act, administered by NOAA, provides funds, policy guidance, and technical assistance to coastal States to help them establish and maintain coastal zone management programs and National Estuarine Research Reserves that meet Federal objectives.

Coastal Resources Programs

Under the CZMA, NOAA makes grants to coastal States to implement programs to manage the coastal zone. Grants are available to preserve areas that contain significant coastal resources, redevelop deteriorating urban waterfronts, and provide access to public beaches. Coastal States can acquire critical estuarine wetlands and conduct estuarine research through the grant program. States also are provided grants to coordinate coastal planning for areas adjacent to more than one State. In the Chesapeake Bay, for example, Maryland, Virginia, and Pennsylvania used interstate grants to acquire computer hardware and conduct studies on striped bass, oysters, and seagrasses. The funds also enabled the States to standardize data bases used to analyze the Bay's resources and to implement clean-up programs.

National Estuarine Research Reserves

In conjunction with the States, NOAA operates a National Estuarine Research Reserve System, which is a network of land and water areas that are managed as natural laboratories for scientists and the public. Each reserve has an on-site manager and many have laboratories, boats, or public education facilities. At Elkhorn Slough, for example, a visitor center was recently opened complete with an audio-visual area and educational displays. The Reserves System yields not only long-term, comparative data sets for a network of sites, but also protects vital habitats for estuarine-dependent and endangered species. To date, NOAA has designated 17 Estuarine Research Reserves nationwide, representing distinct biogeographic regions and estuarine types.

Public Outreach

Communication is an integral component of NOAA. The National Sea Grant Program funds universities and institutions to develop products for the public that communicate scientific, legal, and policy-related findings. In 1985, Sea Grant produced a film, "The Chesapeake Bay—A Twilight Estuary," to educate the public regarding the stresses on the Chesapeake system and the role that research played in identifying the stresses. Publications providing technical advice to mariners and fishermen also are part of the program.

Marine Advisory Service

Marine advisory programs assist all who use the water, whether in fishing, marine recreation, or marine trades. The Mississippi-Alabama Sea Grant Marine Advisory Service, for example, frequently assists the local commercial fishing communities with problems such as recovering damages for nets snagged on unmarked submerged cables, and communicating unwritten "rules of the road" to Vietnamese fishermen in the area.

Estuarine Education

Under the National Sea Grant College Program, NOAA provides educational opportunities, including fellowship and internship programs, to the public. Most institutions funded by the program support graduate and undergraduate students in marine related disciplines, and expand conventional curricula with marine and social science materials. Some institutions have teacher training programs in marine and estuarine sciences in public school districts.

PLANNING FOR THE FUTURE

WHAT lies in store for the future? We can predict with certainty that pressures on the estuaries will continue to rise. Our attraction to the coast will inevitably lead to more development, and with that development, an array of stresses—more human and industrial wastes to be disposed of, higher volumes of runoff with sediments and contaminants to be controlled, more alteration of fish and wildlife habitat.

To anticipate and manage these stresses, Federal and State agencies must work with the public to develop innovative strategies. It is a time for cooperation, introspection, and careful planning. NOAA, therefore, is evaluating its programs to ensure that they meet the future's estuarine needs. NOAA has already taken the first step in this introspective process by establishing a separate office - the Estuarine Programs Office to coordinate NOAA's diverse estuarine activities both internally and with other organizations. This Office is pursuing the second step, which is to develop a comprehensive estuarine plan for the Agency. The plan will be complete in 1987 and will guide NOAA's estuarine assessment, research, and management activities well into the 1990s. With the estuarine plan as a blueprint, NOAA will be equipped with a list of priorities for the future and a pathway for implementation.

We must plan for the future to maintain the bounty of our bays.

For more information a ns, contact the NOAA Estuarine Programs Office, 1825 ington, D.C. 20235.

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