Sea Stats

Florida Fish and Wildlife Conservation Commission — Fish and Wildlife Research Institute

GIS and REMOTE SENSING

Marine scientists are among the ranks of researchers who are capitalizing on the technological advancements that have increased our understanding of the world. Some of these advancements—for example, sophisticated computer systems, super-sensitive electronic equipment, and earth-orbiting satellites that supply scientists with detailed pictures—are dramatically expanding scientists' ability to map, monitor, and assess Florida's coastal resources. These technologies enhance the ability of researchers and managers to consider the overall needs of entire natural systems instead of focusing on single components within those systems. This system-wide approach is called ecosystem management.

Two new technologies are being employed by scientists at the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI)—the geographic information system and remote sensing.

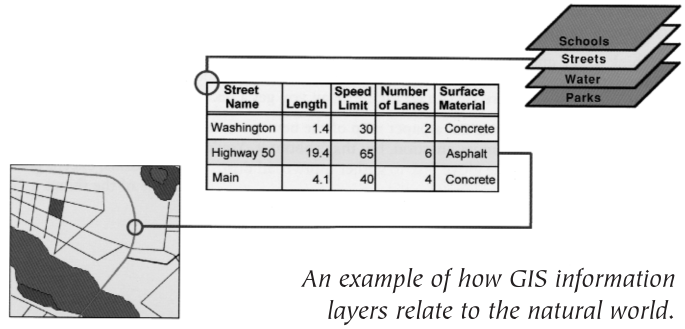
Geographic Information System

A geographic information system (GIS) is a state-of-the-art computer system that can store, integrate, and display a variety of information describing places and activities on the earth's surface. In fact, virtually anything that has geographic coordinates can be entered into the GIS.

A GIS is valuable because it can be used to create simple maps from complex data. One data set or type of data is referred to as a layer. Researchers may superimpose several layers of information on a base map and create a complex portrait of an ecosystem, chart changes in that system over time, and predict what will happen in various scenarios of the future. GIS technology is providing insights into the complicated nature of the natural world, where a change in one component (salinity, for example) may easily affect several other components, such as fish species distribution, vegetation, or algal blooms, in unanticipated ways. Examining these system-wide sets of data effectively is a necessity in successful ecosystem management.

With a GIS, we can develop graphics that provide at-a-glance information about an area. An example of such a product is the popular Boater's Guide series produced by FWRI and other government partners to encourage responsible boating in Florida waterways. Each guide consists of a basic map of the waterway on which natural features, such as major tributaries, water depths, and habitats, are identified, as well as manmade features such as boat ramps, channels, navigation aids, preserve boundaries, and artificial reefs. Boater's guides have been published for several regions of the state including the Upper Keys, Tampa Bay, Charlotte Harbor, and Biscayne Bay.

FWRI used GIS to develop the award-winning



An example of how GIS information layers relate to the natural world.

Fast FACT

More than 100,000 copies of the first **Boater's Guide to Tampa Bay** ***have been distributed since 1992.***

Florida Marine Spill Analysis System. The system is used to prepare maps showing important natural resources along Florida's coast—such as seagrass beds and mangrove forests—that would need priority protection during an oil spill. The system proved its worth during the August 1993 oil spill in Tampa Bay, when GIS specialists at FWRI prepared maps that showed the location and extent of the oil slick and identified natural resources at risk. The maps, updated twice a day, showed the managers directing cleanup crews where the oil slick was moving. When important marshes, mangroves, or seagrass beds were in danger of being contaminated, floating rubber barriers with "skirts" that extended below the surface were put in place around that portion of the slick threatening the important habitat.

An extensive seagrass die-off and a proliferation of microscopic algae generated concern for the long-term health of Florida Bay, a fertile estuary. GIS technology helps scientists investigate the causes of the recent water quality changes in Florida Bay. Biologists use the GIS to study the possible relationships among reduced freshwater flows, seagrass die-offs, and declining fisheries in Florida Bay. GIS-generated maps have documented the seasonal distribution and extent of harmful algal blooms in the Florida Bay system.

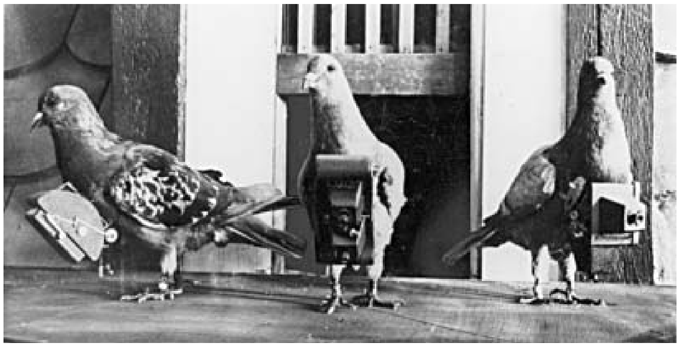
GIS products, such as detailed maps, may be used by fisheries managers in a variety of ways. Managers can identify habitats that are crucial to the state's most important commercial and recreational fishery species and then work to protect them. For example, using GIS maps showing seagrass habitats, which many marine organisms use as nursery areas, fisheries regulators prepared a statewide management plan for the shrimp fishery. The plan protects some of the most critical of these shallow-water nurseries.

An extensive number of variables can be displayed on the computer maps, so biologists may evaluate the effect of many factors acting upon the health of fish stocks and assess the relative importance of each factor at any given time. For instance, biologists can use GIS maps to determine the relationship between water quality and fish distribution, seasonal fluctuations in populations, or critically important nursery areas. The GIS is also a predictive tool; when researchers pose "what if" questions to the computer, the system projects what could happen in various estuaries given certain conditions. Ultimately, scientists hope that the GIS will enable them to detect potential problems in Florida's marine environment and thus prevent their occurrence.

Remote Sensing

Put simply, remote sensing is the art and science of collecting information about an object or phenomenon without coming into contact with that object or phenomenon. Remote sensing is a beneficial methodology because it allows researchers to study a particular component of the environment without harming or interfering with natural processes.

Remote sensing began in the 1840s when balloonists used the newly invented photo-camera to



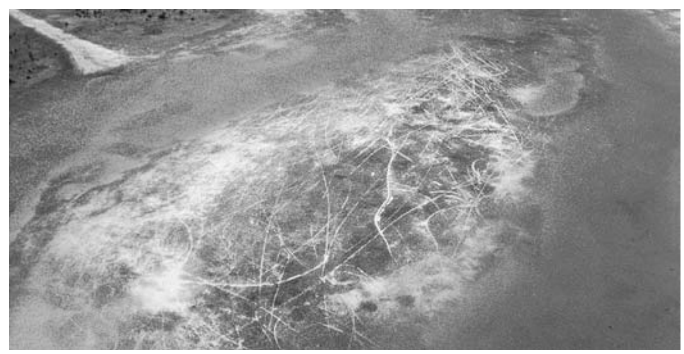
Europe's remote sensing Pigeon Fleet of the late 1800s.

take pictures of the ground. Perhaps the most novel platform was the famed pigeon fleet that operated in Europe at the end of the 1800s. Today, over a hundred remote sensing satellites with a variety of sophisticated equipment are in orbit around the Earth.

Remote sensing tools used by FWRI researchers include aerial photography, aircraft-acquired digital imagery, and satellite imagery. All three provide a bird's-eye perspective of coastal areas that cannot be obtained from field work conducted on the ground or from research vessels. However, as is the case with most research, remote sensing data are usually integrated with other types of information—such as field sampling data or computer-generated analyses—to provide the most comprehensive portrait possible of the research subject. For instance, remote sensing images are often used as backdrops for GIS data layers. The remote sensing imagery used depends on the nature of the research and the level of detail required—as well as on fiscal constraints because the cost of remotely sensed data varies widely.

Aerial photography, aircraft-acquired digital imagery, and satellite imagery are primarily used to map the location and approximate extent of coastal resources such as mangroves, salt marshes, oyster bars, and seagrass beds. Unlike traditional aerial photography, digital and satellite images are captured on magnetic tape that can later be directly entered into the GIS. All three data formats can be interpreted and used to create maps that help environmental managers protect natural resources and identify changes in those resources.

Images of a specific area acquired at different times are valuable in determining trends in marine resources such as seagrass beds. For instance, old photographs showing seagrass beds in Charlotte Harbor have been compared to current photos to determine trends in seagrass coverage. Aerial photographs provide an ideal method for assessing propeller damage to seagrass beds because the trenches that propellers carve through the grass beds are easily visible from the air.



Aerial view of a seagrass bed in the Florida Keys that has been severely scarred by boat propellers.

Satellite imagery is playing an increasingly important role in marine research. Images produced by low-orbit satellites provide a wealth of oceanographic information to those skilled in interpreting them. These images can reveal important details of vast areas of the ocean—an essential view when assessing and modeling regional, even global, ecosystems or patterns.

Historical satellite images provide additional clues for researchers investigating the state of Florida's coastal resources. Satellite images of Florida Bay taken in the early 1970s were interpreted to learn whether the harmful algal blooms that re-

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FWRI scientists used extensive aerial photography to map propeller damage to seagrass beds. Results of this research prompted management actions to protect grass beds in heavily impacted areas such as the Florida Keys and Tampa Bay.

cently appeared in the system had occurred before.

Data from satellite images can also be processed to investigate oceanographic conditions such as variations in sea-surface temperature. Researchers use these data to study a variety of subjects from red tide to coral reefs. Some of the most productive areas in the sea are places where nutrient-rich cold water is brought to the surface (upwelling) or where cold and warm water mix. Finding these zones was difficult before satellites were turned to the task. Today, the telltale color patterns that reveal these life-sustaining zones are captured daily by special satellites that orbit the earth; these images are then relayed to researchers around the world.

FWRI can purchase medium-resolution images from a variety of satellites, including the U.S.-operated Landsat satellite as well as satellites deployed by France, India, Japan, and Russia. However, a single image from these satellites can cost several thousand dollars, so images are selectively acquired as they are needed. A partnership between the University of South Florida and FWRI enables FWRI researchers to receive images twice daily from a low-resolution weather satellite operated by the National Oceanic and Atmospheric Administration (NOAA).

The level of spatial detail provided by satellites varies considerably. High-resolution (small pixel size) satellites tend to produce imagery covering smaller areas than low-resolution (large pixel size) satellites do. For example, Space Imaging's Ikonos satellite produces imagery with 1-meter or 4-meter pixel size and an 11-kilometer swath width, whereas NOAA's Advanced Very High Resolution Radiometer produces imagery with 1.1-kilometer pixel size and a 2,399-kilometer swath width. Images produced by the former provide greater detail but for a smaller area, whereas images from the latter provide less detail but cover a much larger area.

The study of baitfish populations provides one example of how FWRI researchers use satellite imagery to manage Florida's fisheries resources. Baitfish—small, schooling fish such as menhaden and sardines—are an important thread in the marine food web and also a lucrative commercial fishery in Florida. Fisheries biologists suspect that areas of cold-water upwelling are a prime habitat for baitfish because of the abundant supply of nutrients these zones generate, but locating these sites by boat is time-consuming and costly. Ocean color satellites, however, may help researchers efficiently verify the relationship between areas of upwelling and baitfish concentrations and predict where baitfish are most likely to congregate. This, in turn, could provide valuable information about a variety of other fish species, such as mackerel and tuna, which feed on baitfish.

Eventually, by using GIS technology, researchers hope to integrate data from these satellite images with data from other sources in order to create statistical models that predict how long-term changes in climate may affect baitfish populations. This information will give fisheries managers a heads-up opportunity to proactively manage these and other irreplaceable resources well into the future.

The Sport Fish Restoration Program

Fishing license revenue and the Federal Aid in Sport Fish Restoration Program are important sources of funding for GIS and Remote Sensing programs at FWRI. The Sport Fish Restoration Program is a "user pays/user benefits" system funded by a tax on sales of recreational fishing equipment and boat fuel. The program supplies three dollars for every one dollar provided by the State of Florida for projects that improve fishing and boating opportunities.

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