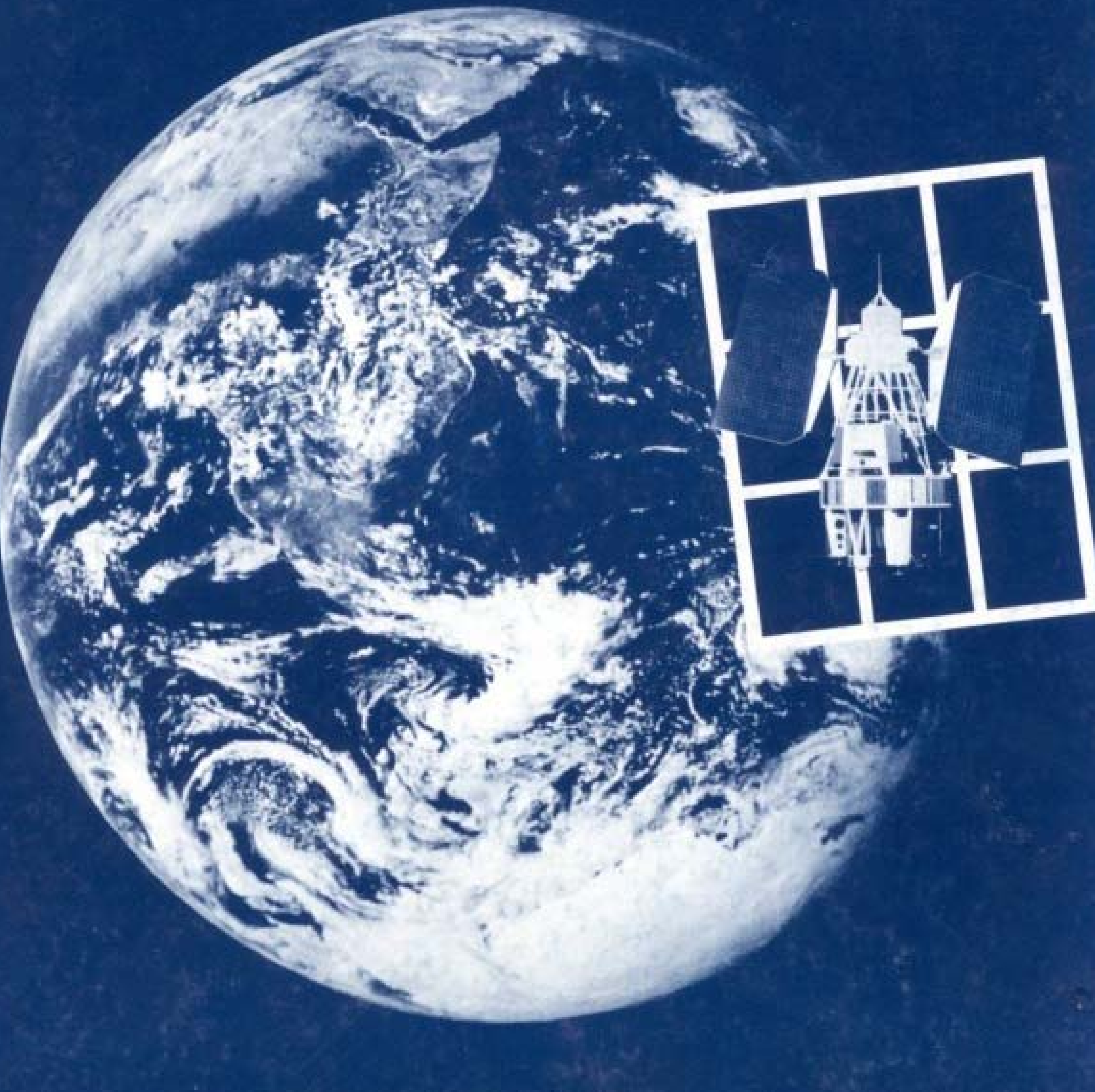
# ERTS-1
# A NEW WINDOW ON OUR PLANET

GEOLOGICAL SURVEY PROFESSIONAL PAPER 929



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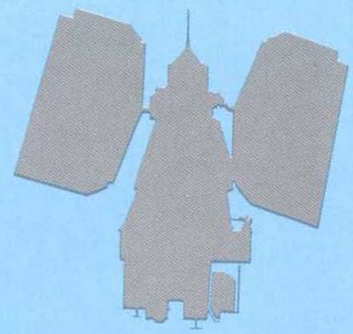

**RICHARD S. WILLIAMS, JR.. and WILLIAM D. CARTER, EDITORS**

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*U.S. Department of the Interior:*
- *Geological Survey*
- *Bureau of land Management*
- *Bureau of Reclamation*
- *Bureau of Mines*
- *Fish and Wildlife Service*
- *National Park Service*

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## ECOLOGICAL MODEL IN FLORIDA

By Aaron L. Higer, A. Eugene Coker, and Edwin H. Cordes,
U.S. Geological Survey

Thousands of years of seasonally fluctuating water supply, punctuated periodically by drought or unseasonally heavy rain. have resulted in a natural balance of plant and animal communities in south Florida. Water fluctuations. together with fires and hurricanes, contributed to the shaping of the ecological communities, that is, the tree islands (composed of woody vegetation) and grassland communities (wet prairies and sawgrass marshes). This natural ecological balance, however, is now influenced by a modified water regime, altered by water control within the Kissimmee-Okeechobee-Everglades watershed for flood control, crop irrigation, and coastal urban use (fig. 96). The Central and Southern Florida Flood Control District manages this watershed that contains more than 22,500 km of canals and levees.

An effect of water deficiencies in Everglades National Park is the failure of wood storks to form rookeries. Wood storks nest in winter at the inner edge of the mangrove belt in the Everglades National Park in south Dade and north Monroe Counties. According to .John Ogden, an ornithologist of the National Park Service (written commun., l973), the wood storks were successful in forming rookeries in 1959,1960, and 1961 but failed for 5 successive years (1962-66), when low rainfall in south Florida resulted in prolonged drought in the park.

The success or failure of wood stork rookeries is a significant index of hydrologic conditions in the park. Wood stork studies in Everglades National Park by the National Park Service suggested a working hypothesis for establishing the water conditions of Shark River Slough, the largest freshwater course in the park, needed for successful formation of these rookeries. An annual prediction of success or failure of the rookeries at the inner edge of the mangrove belt could be made in November, which marks the beginning of the dry season and precedes the height of rookery formation by approximately 2 mo. The prediction can be based on recorded water-level measurements together with a synoptic view of the spatial distribution of surface water. bath available from ERTS data, and on the density of small aquatic animals collected in quantitative traps.

The ecological model is designed to relate the wildlife in the Shark River Slough to the availability of food and water (fig. 97) (Higer and others, 1973). In an on-going study with the National Park Service, more than 50,000 aquatic animals have been captured and tagged. The species numbers and hydrologic data are entered into a digital computer program that provides statistical summaries of species distributions and water depths at point locations in the slough. Time-variant synoptic displays using ERTS imagery taken concurrently with stage and rainfall data presently being collected from DCS (figs. 98. 99) may provide the following information to develop an ecological model (Higer and others, 1974):

1. Knowledge of the quantity of water stored in the slough.
2. Knowledge of the spatial distribution of water in the slough as it relates to available food for the bird rookeries (fig. 100).
3. Quantitative hydrologic data that allow management to know where and when to increase water into the slough from the upstream water storage areas.
4. Ability to predict the number of aquatic animals in the slough and the success or failure of the rookeries, based on conditions of the hydrologic regime.

FIGURE 96. -- Color composite ERTS-I image mosaic of the State of Florida prepared by the General Electric Co.. Beltsville, Md., in cooperation with the US. Geological Survey. Water Resources Division. Miami, Fla., the Central and Southern Florida Flood Control District, and NASA.


FIGURE 96.—Color composite ERTS–1 image mosaic of the State of Florida prepared by the General Electric Co., Beltsville, Md., in cooperation with the U.S. Geological Survey, Water Resources Division, Miami, Fla., the Central and Southern Florida Flood Control District, and NASA.

Sufficient water must be maintained in the Shark River Slough of the Everglades National Park to preserve the aquatic community and the several bird and mammal species that feed primarily on fish. The amount and time of water releases to the park are a resource-management decision based on very limited information on the water storage that may be available to the north of the park Small-scale thematic maps of water levels provide an accurate evaluation of water distribution. A gradual reduction of water levels before the birds start nesting would result in the concentration of fish in the Shark River Slough that may ensure adequate food for successful hatches of several rare and endangered bird species.

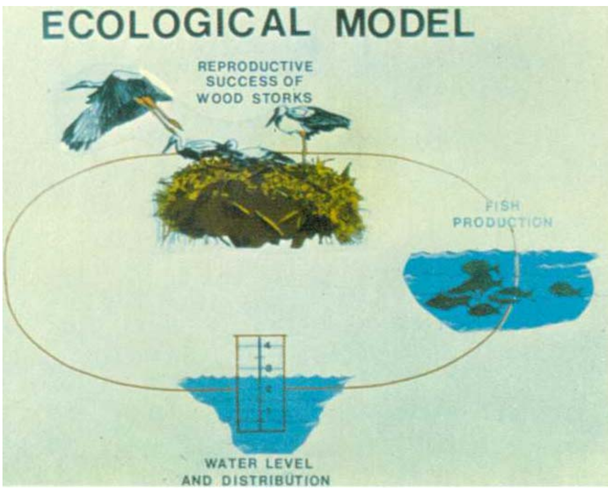


FIGURE 97.-Wildlife ecological model of the Shark River Slough, Fla.

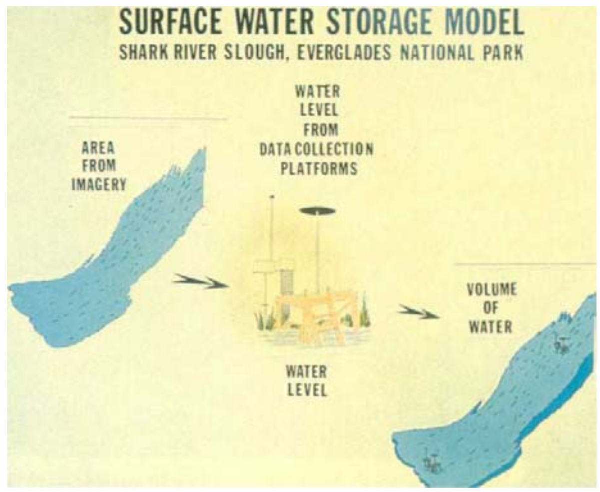


FIGURE 99.-Surface-water storage model of the Shark River Slough, Fla.

FIGURE 98.-Data collection platform in the Everglades National Park in south Florida used in the ecological model study.

FIGURE 100.-Wood storks nesting in the Everglades National Park, south Florida.

# WATER-MANAGEMENT MODEL OF THE FLORIDA EVERGLADES

By Aaron L. Higer, Edwin H. Cordes, and A. Eugene Coker,
U.S. Geological Survey

The water supply for southeast Florida, which has a population of 2.5 million, depends upon the retention of water in four major impoundment areas in the Everglades water basin (figs. 112, 113) : (1) Lake Okeechobee, (2) Conservation Area No. 1, (3) Conservation Area No. 2, and (4) Conservation Area No. 3. Shark River Slough, an important source of water for the Everglades National Park, at the downstream end of these interconnected water bodies, also depends upon overland flow from adjoining Conservation Area No. 3. An accurate accounting of the amount of water in surface storage is difficult because land-surface profiles are not available. The shallow water depths of 0.3 to 1.0 m, the flat terrain, the abundant vegetation, and the vast area of 3,600 $km^2$ of the Everglades preclude the feasibility of determining accurate volumes by conventional methods. In the conservation areas and the Shark River Slough, the water does not pond in the usual manner but slowly flows over the gently sloping land surface.

Several water-budget studies for the conservation areas arc underway by the U.S. Army Corps of Engineers and the Central and Southern Florida Flood Control District. Elements that need more accurate definition in the existing water-budget studies are rainfall, evapotranspiration, seepage losses, and surface storage.

The ERTS water-management model uses the DCS to provide quantitative in-situ data on the elevation of the water surface and MSS data to provide information on the areal extent of the water surface (Higer and others, 1973). Knowing the relation between the surface-water area and surface elevation for the range of water levels, the storage can then be calculated (figs. 114, 115). In addition, knowing the change in storage and the surface inflow and outflow (input and output) from the system, it is possible to calculate evapotranspiration and seepage (Higer and others, 1974).

At present the DCS data are transmitted from the Everglades stations to the satellite and relayed via two ground tracking stations to the Goddard Space Flight Center, Greenbelt, Md. The data are then transmitted by teletype to the Miami office of the US. Geological Survey. The perforated teletype tape is then processed daily through a minicomputer to convert the data to engineering units and place it into the format requested by the Corps of Engineers. The data are then transmitted to the Corps of Engineers, Jacksonville, Fla., by telecopier. The time required for the transmission of the data from the Everglades via the satellite, the NASA tracking stations, and the US. Geological Survey to the Corps of Engineers is less than 2 h.

The importance of the space-relayed data can be shown by a comparison of the accuracy and frequency of those data received through the Miami teletype with data from the existing remote radio-transmission systems in southern Florida. The great line-of-sight distances involved in the radio-transmission systems often provide “rare” and garbled data messages. The frequent meteorologic disturbances in southern Florida prevent the transmission of the accurate synoptic information on rainfall and water stage that is essential for managing the water for optimum conservation. ERTS-1 provides the U.S. Geological Survey with five transmissions per day of these parameters and warns when any DCP recorder becomes faulty, so that it can be repaired within 24 h. This enhances the opportunity for a constant flow of information and makes it possible for the Corps of Engineers to make daily decisions to optimize its water-control policy to conserve a greater proportion of the seasonally deficient water resource.

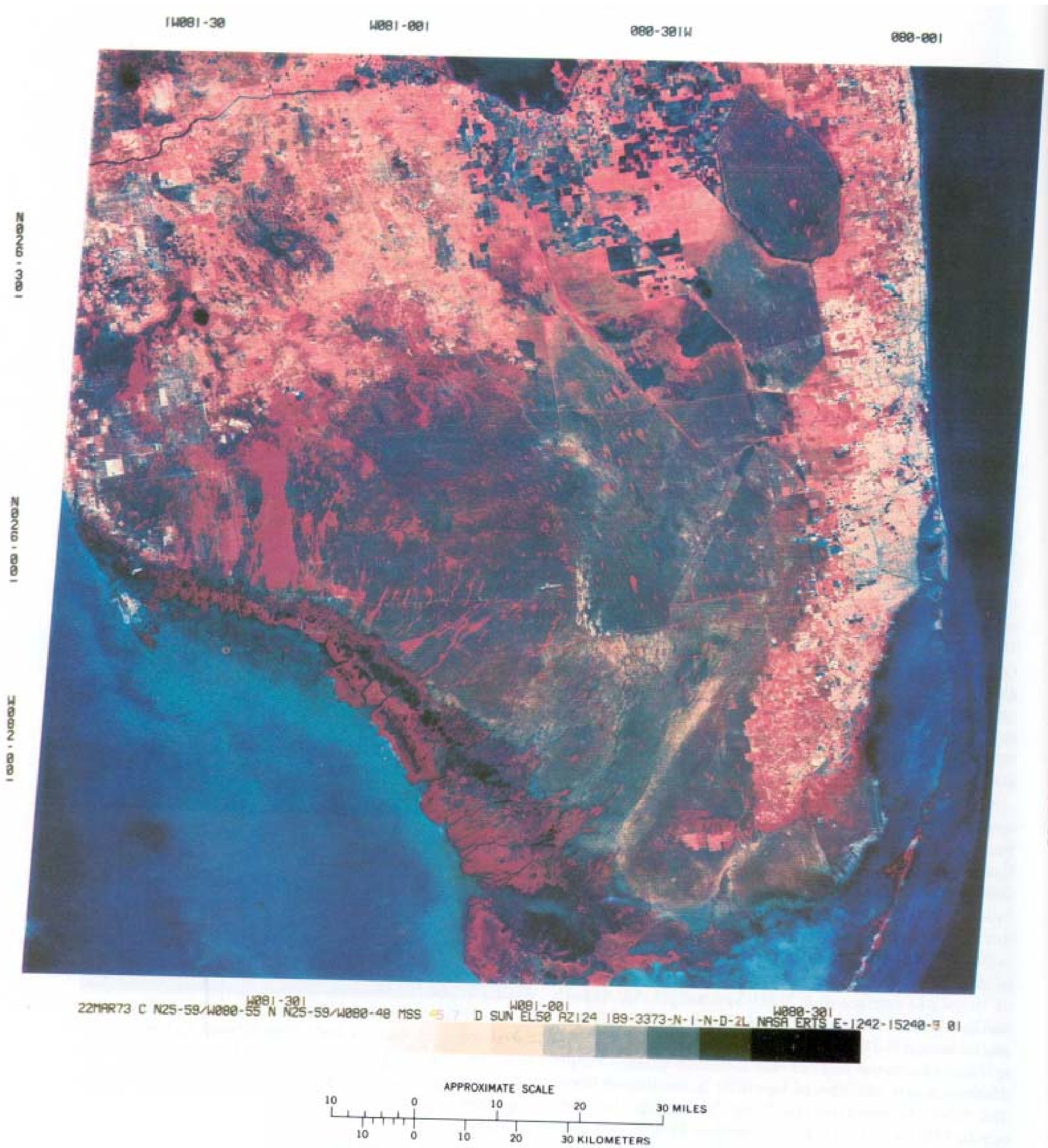


FIGURE 112. -- Color composite ERTS-1 image of the Everglades National Park area of Florida (1242-15240).

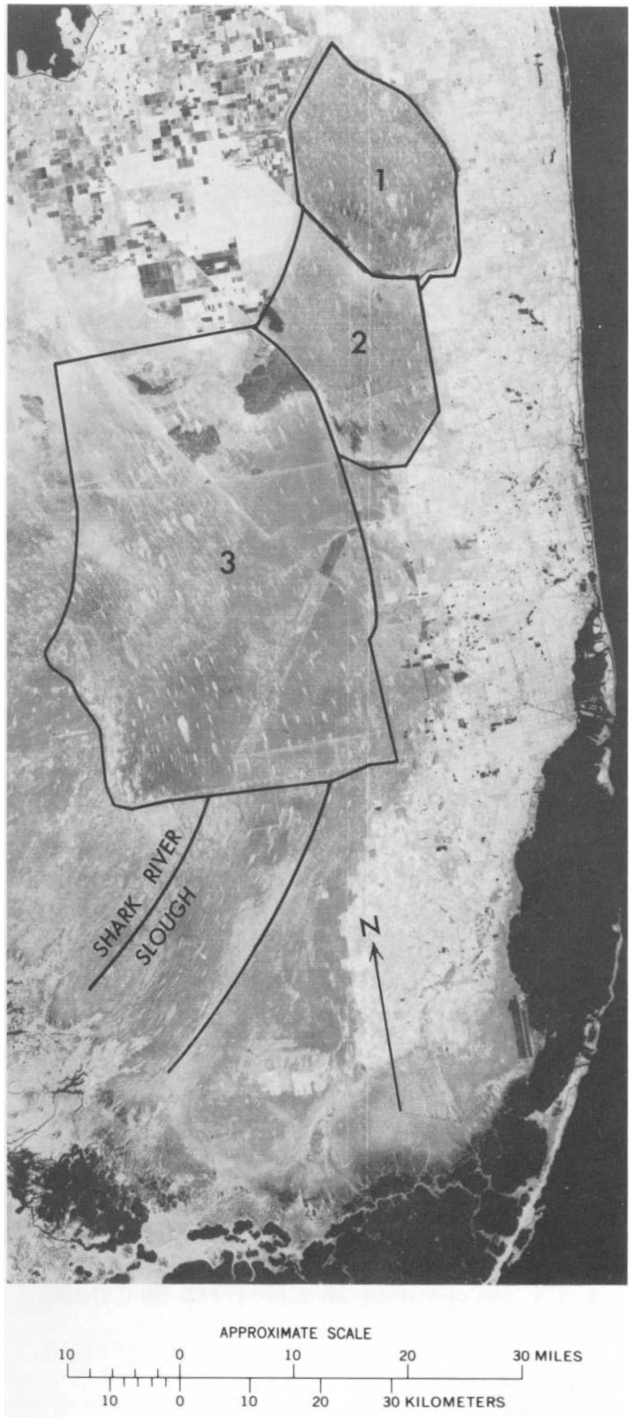


FIGURE 113.--Annotated ERTS-1 image showing water-management conservation areas in the Everglades National Park area of Florida (1242-15240, band 6).

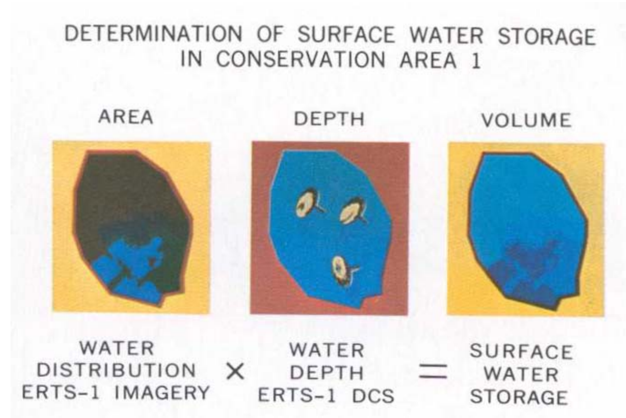


FIGURE 114.-Determination of surface-water storage in Conservation Area No. 1. Schematic diagram of the use of space-relayed data to calculate surface-water storage. ERTS data from three successive passes on Feb. 14, Mar. 4, and Mar. 22, 1973, of Conservation Area No. 1 are used to demonstrate the feasibility of determining surface-water storage.

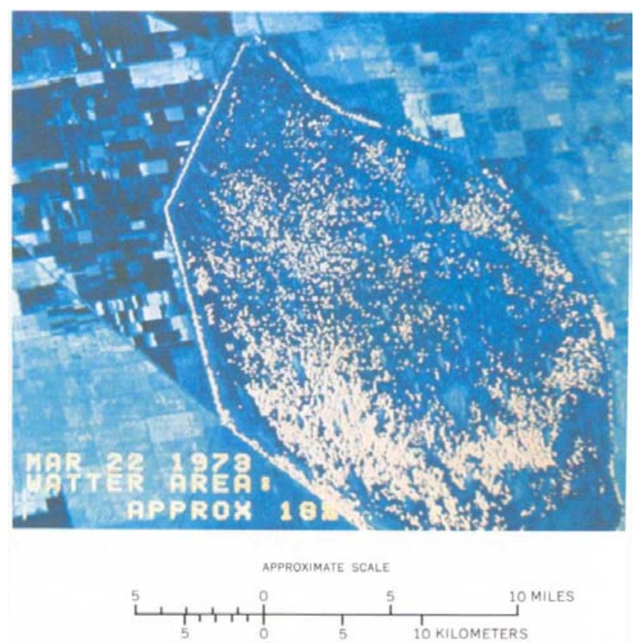


FIGURE 115.--Electronically processed part of ERTS-1 image 1242-15240 of Conservation Area No. 1. Each dot represents 4 ha of surface water.

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