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RECENT DEVELOPMENTS IN REMOTE SENSING TECHNOLOGY FOR MARINE RESOURCE DETECTION AND MONITORING

by

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SUMMARY

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In the past ten years many contributions have been made in the rapidly expanding discipline of remote sensing technology. This developing technology of remote sensing instrumentation from aircraft and satellites is providing unique and exciting opportunities to obtain ocean information at such a rapid pace as to be incomprehensible ten years ago. The challenge is to convert this mass of data to information which can be applied to fishery problems.

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INTRODUCTION

The world is looking toward the seas as a source to satisfy the constantly increasing demand for food. Much of this potential source consists of pelagic species located along the coastal shelves. Although largely unexploited at the present time, careful management will be necessary to preserve and maximize yield of these resources in the future. More and better information is required to adequately manage these stocks, and to counteract the problems of rising operational costs and increased demands.

The family of coastal pelagics lends itself to the application of aircraft and satellite remote sensing systems. In the past ten years, several nations have contributed to the rapid expansion of remote sensing technology. This developing technology is providing unique and exciting opportunities to obtain ocean information more rapidly than was comprehensible ten years ago. The challenge is to convert this mass of data to information which can be used to help solve fishery problems.

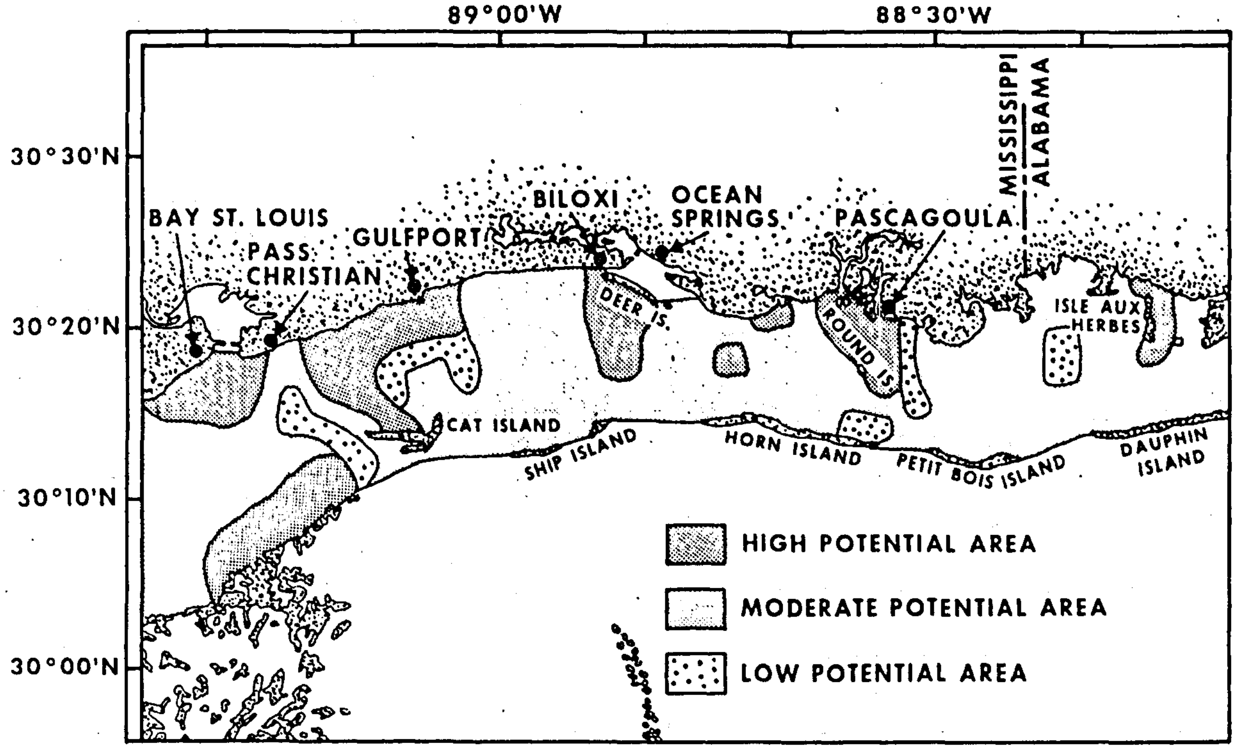
In the United States, the lead agency for developing a capability for applying remote sensing data to fishery problems is the National Oceanic and Atmospheric Administration (NOAA). NOAA is concerned with resource exploration, development, management, and conservation in the oceans. It is also concerned with environmental monitoring, prediction, and modification, including living marine resources; and with developing the capacity to exercise, ultimately, some degree of environmental control. Here, environment means the oceans, the atmosphere, and solid earth.

SATELLITE APPLICATIONS

The present state of the art has not progressed to the point where fish can be detected directly with satellite sensors; instead, investigators must work with water quality indicators such as water color, temperature, and transparency, which appear to relate to the distribution of some fish and can be measured remotely. This approach was tested by an experiment in 1972 by NOAA in the Gulf of Mexico (Mississippi Sound) where data from the Earth Resources Technology Satellite (ERTS-1) were shown to correlate with locations of fish schools (Figure 1). Additional research is needed to verify the ERTS experimental results, and possibly to extend their application to other areas and to other varieties of fish.

A similar investigation was conducted by NOAA in the Northern Gulf of Mexico in 1973, where the objective was to determine if satellite acquired information could be used to predict the distribution of ocean game fish. The satellite used in this case was Skylab and information on the fishery and oceanographic conditions was provided by a specially organized Game Fish Tournament. This investigation supported the analytical approach used in the ERTS-1 Experiment and demonstrated that correlations between remotely sensed oceanographic data and billfish distribution exist (Figure 2, Prediction Model).

Surprisingly, even though ERTS and Skylab satellites were not oceanographically data oriented, the information acquired by their respective sensor systems were applicable to investigations of living marine resources. Future satellites, such as SeaSat, are expected to carry sensor packages and be programmed for specific oceanographic investigations.



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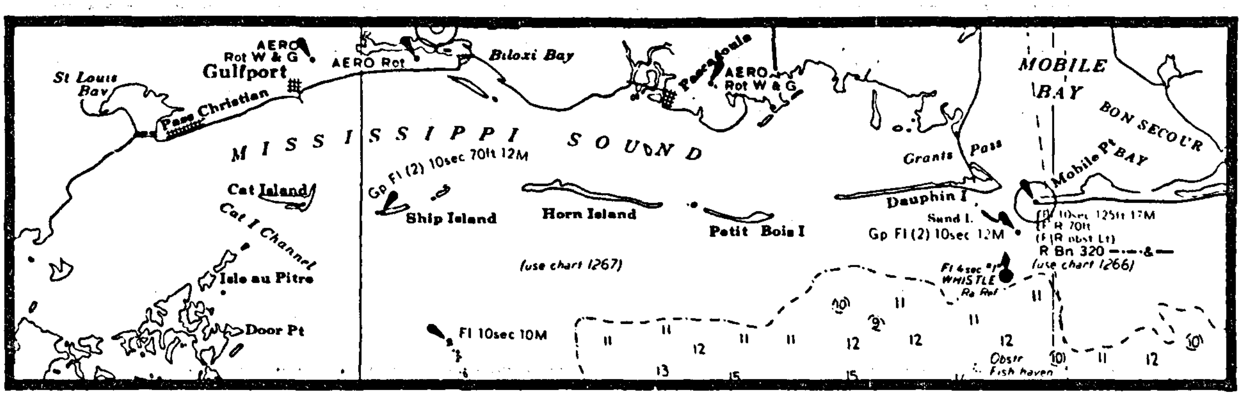

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TEST SITE COORDINATES

	LATITUDE	LONGITUDE
A)	30°27'N	89°30'W
B)	30°27'N	87°45'W
C)	30°00'N	87°45'W
D)	30°00'N	89°30'W

SCALE 1:875,000

N.MI. 10 20

KM. 10 20 30 40

TEST SITE DIMENSIONS

LENGTH: 170 KM.

WIDTH: 51 KM.

AREA: 8685 SQ.KM.

Figure 1. ERTS-1 Manhaden Experiment

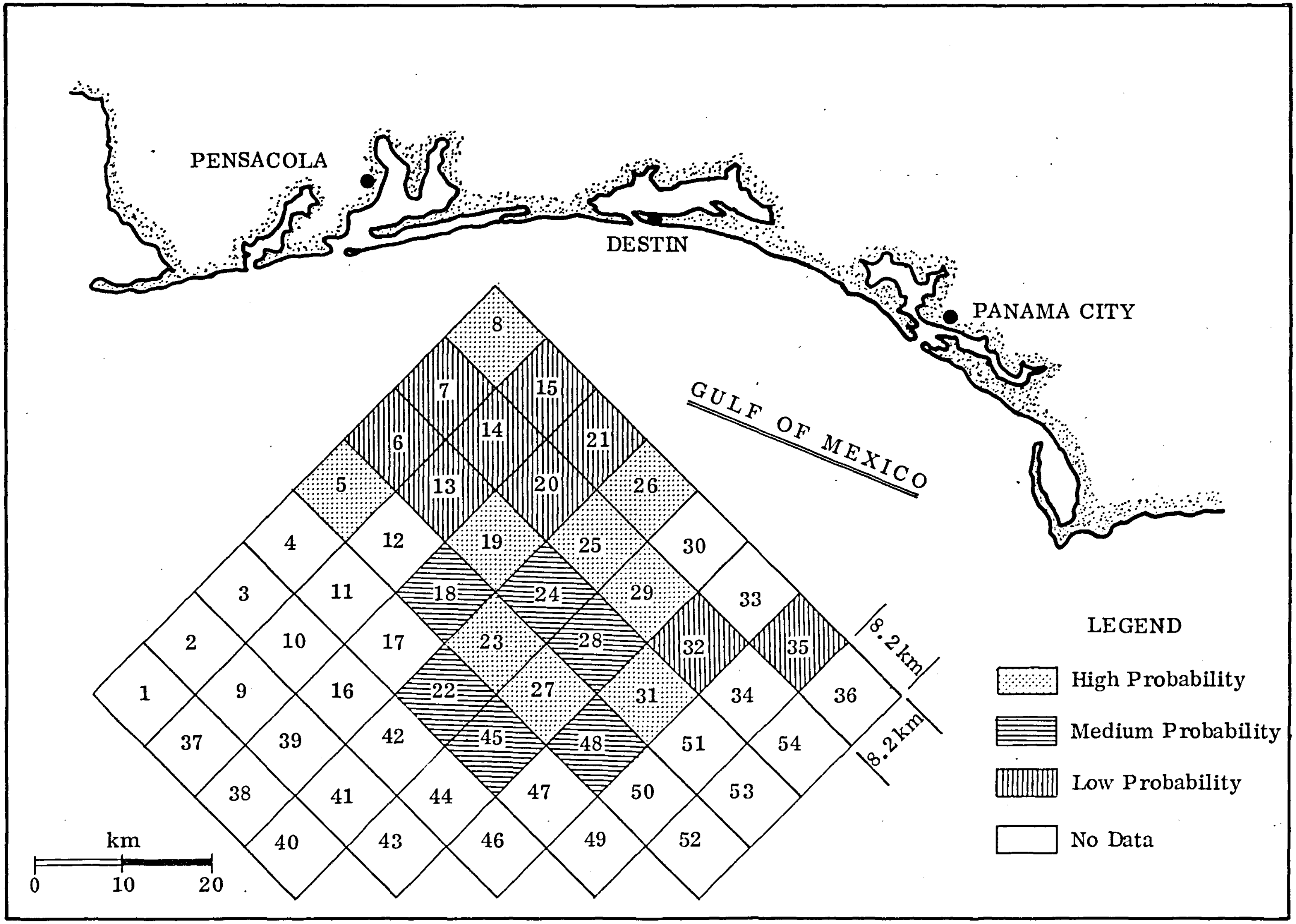

Figure 2. Prediction Results of Skylab Experiment

AIRCRAFT REMOTE SENSING

Today, interpretation of satellite generated visual and thermal imagery lends itself to large scale, gross oceanographic and meteorological phenomena which may be related to fisheries. Satellite acquired data have been used to delineate upwelling areas, major current demarcations, sediment transport, and other large scale surface features. These features can be further explored with the aid of aircraft serving as platforms for remote sensing devices. The aircraft acquired data, if real time and convertible to fishery information, can provide operational information for fishermen's use. These data may provide characteristics of, and relate to, the distribution and abundance of living marine resources.

Primary application of aircraft remote sensing instrumentation to direct use of the fishery most likely will come from the location and identification of harvestable stocks. Such information will be attained by direct sensing from aircraft and inferences from satellite oceanographic data.

The most promising techniques under development in the United States are aerial photography, low light level image intensification, and laser instrumentation systems. To use these systems, it will be necessary to understand species behavioral characteristics, or at least the family behavior patterns, to transfer effectively the sensing data to fishery information and to fish stock use.

Aerial photography is probably the most utilized remote sensing system. The current system has been field tested against a number of aircraft resources with some success. Techniques involve film type, altitude, filters, etc. Two limitations of the system are lack of real time data for analysis and the number of photographic light hours available for surveys.

The Low Light Level Image Intensifier System has the potential for locating and detecting fish at night through the use of an airborne low light magnification sensor which detects luminescent plankton halos around fish schools. The operation provides rapid detection of schooling fish as a direct aid to commercial fishermen and marine resource managers.

The Prototype System uses a camera mounted in an inverted position facing the rear of the aircraft (Figure 3). A mirror is used to reflect and reverse the area imaged through a hole in the bottom of the aircraft. The camera is coupled to a video monitor, enabling the system operator to view the data on a real time basis, and to a video tape recorder to facilitate future evaluation and analysis. The system is flown at 1,000 meters altitude in its survey mode.

A prototype system has been developed and tested, and airborne demonstrations are continuing over fishing areas to provide for correlations with sea truth data. Various automatic data processing techniques, suitable for analyzing video tape information, are under evaluation.

The Laser System (Figure 4) has the potential of providing a day and night detection capability, and acquiring data from depths of ten meters. Detection, identification, and quantification of fish schools at various depths are the nominal objectives of the development effort.

Previous attempts to use an airborne remote sensing laser system for resource assessment have been generally unsuccessful. The predominant reason for past failures was that laser systems were not sufficiently reliable for airborne operations; however, recent developments in laser technology have increased the probability of developing a suitable laser survey system.

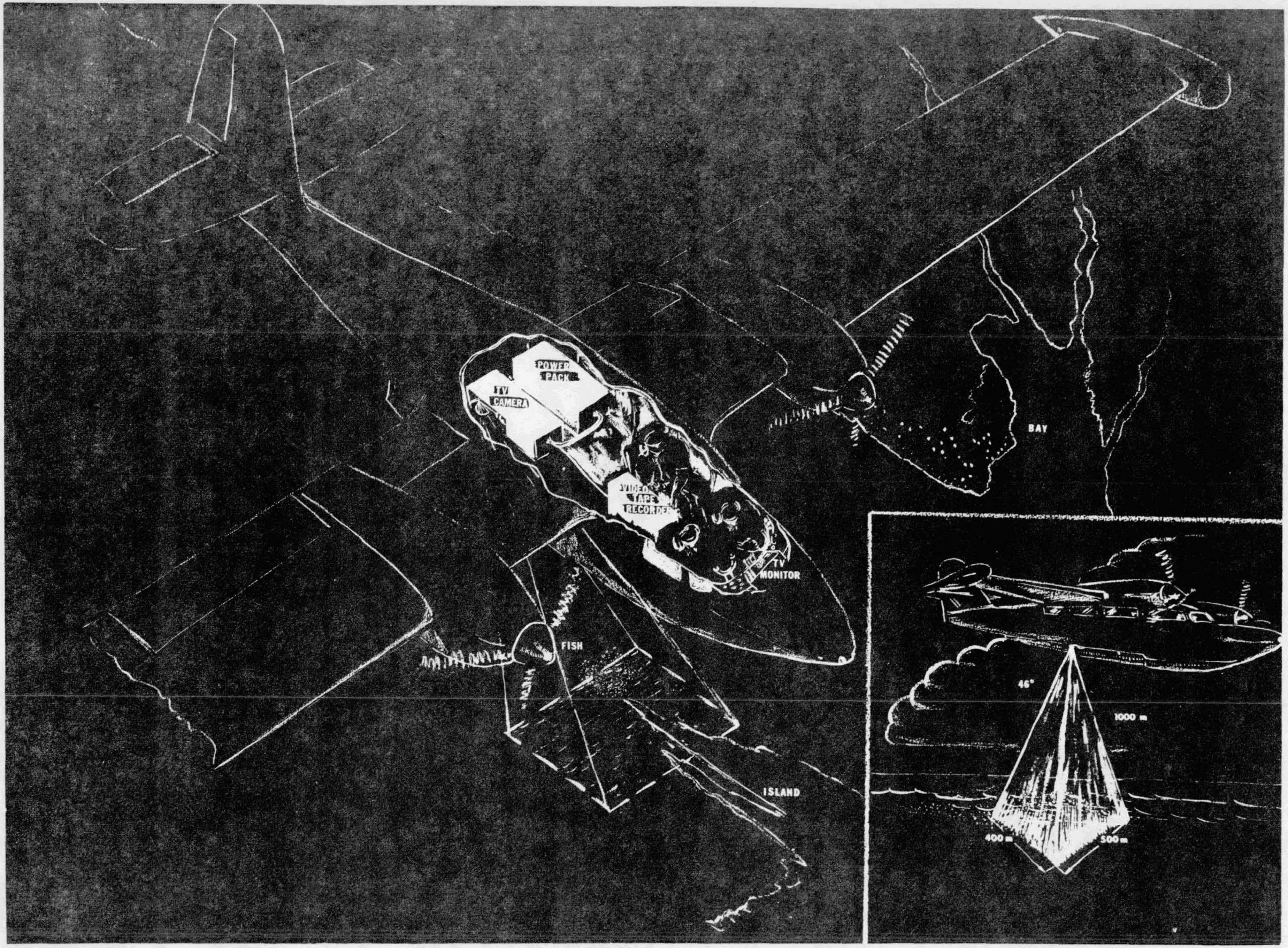

Figure 3. Low-Light-Level Image Intensifier System Components and Operating Concept

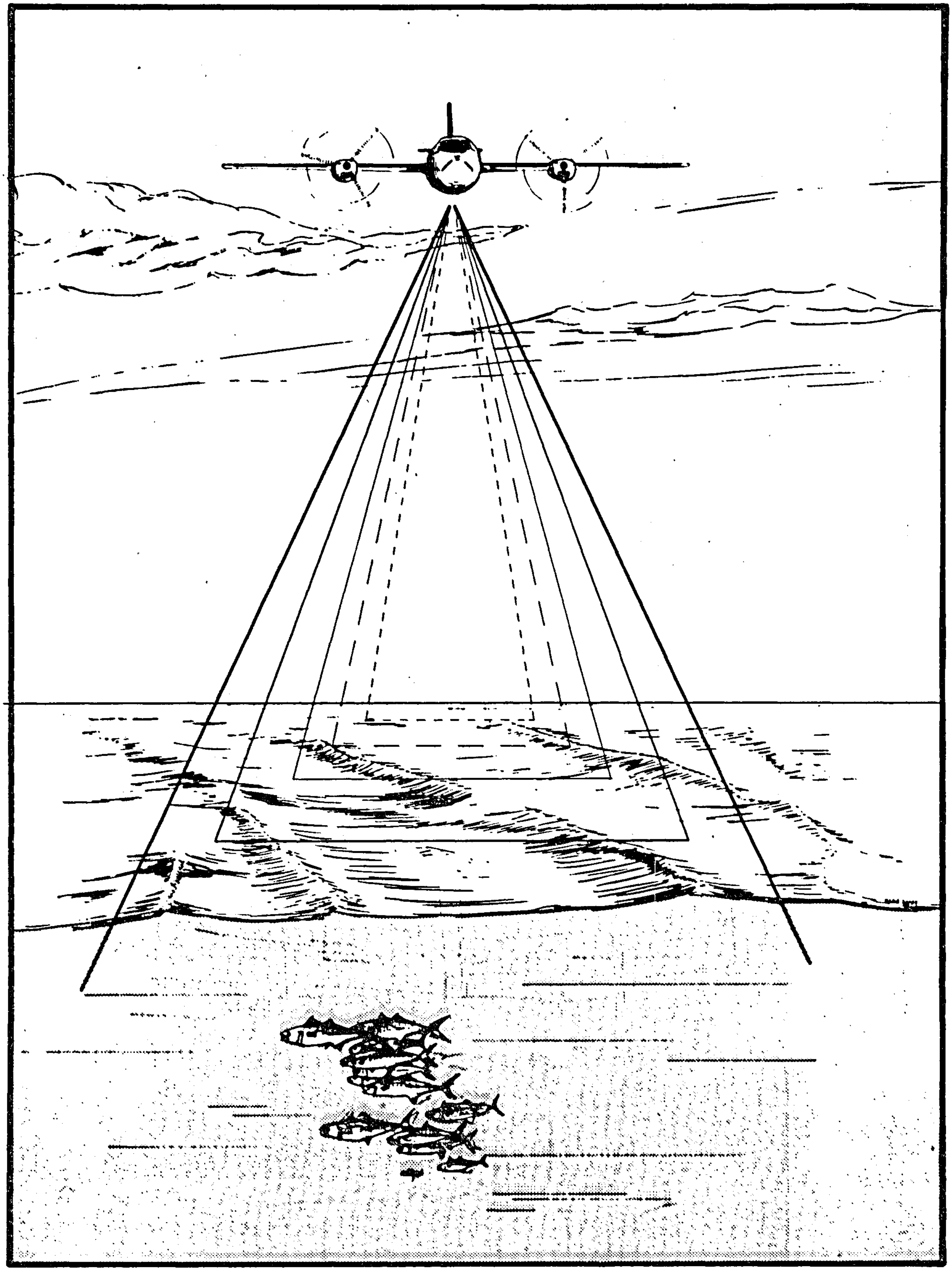

Figure 4. Laser System Survey Pattern

Laser data will be acquired and processed to provide information on the location, identification, and abundance of fish in the survey area. The physical parameters which may be detected have not been completely ascertained; however, as a minimum, location, depth, and lateral measurements of fish schools will be determined. Tests will be performed to determine the quality of data obtained at greater depths when the power output of the laser is increased to obtain greater penetration.

A feasibility study has been conducted to identify the developmental approach and initial system and hardware requirements. Components have to be acquired, a prototype system fabricated, and tests performed to determine operational characteristics of the laser based fish surveillance system. Testing in the natural environment will later demonstrate the system's operational capability.

FUTURE REQUIREMENTS

The application of aircraft remote sensing to the problems confronting world fisheries requires a multidisciplinary approach. Instrumentation and data management engineers, oceanographers, fishery scientists, and fishery experts, working as a team, are required to convert remote sensing data to applicable information. Extensive efforts by the advanced nations will be necessary throughout the development of these systems to ensure the validity of the conclusions.

There is a real need to train people everywhere to apply the techniques developed for converting remote sensing information to fishery use. A basic system of training should be planned and be ready for implementation as techniques and procedures are made available. Through this medium, all countries will have an opportunity to use remote sensing data for rational management and development of fishery resources within their areas of interest.

Through aircraft and satellite acquired information about the oceans, we can look forward to a significant advancement in our knowledge about the ocean and its fishery resources. Remote Sensing complements the classical approaches to understanding living marine resources. The task today is to establish plans for the future that will allow these technological advances to be used effectively for the benefit of mankind.

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