Fisheries Applications

ESE instruments will collect observations of processes occurring within the oceans, lakes, and rivers of the world. Existing applications rely significantly on ship-borne observations for either calibration or validation. ESE data and information will complement these observations made from the sea surface.

Satellite observations characterize environmental factors that affect fish habitat. Environmental parameters that are well measured by data from recent and current orbital instruments include surface temperature, ocean color, wind, and current data. Advantages of satellite-based observation include the ability to image large areas at once, to discreetly observe a range of scales, to repeat observations frequently, and to make observations independent of weather. Remote sensing data are used to derive information about chlorophyll concentration, primary productivity, bio-optical properties of coastal and estuarine regions, and ocean circulation features. For instance, schools of fish commonly correlate with nutrient-rich waters, as well as circulation patterns such as temperature fronts.

Application of remote sensing to fisheries requires previous knowledge of habitat preferences of the fish, biological quality of the waters, oceanography of the area, behavior of a given species at various temperatures, and catch rates occurring under those conditions. The effects of the environment on any given species are location- and season-specific. A long time series of oceanographic and fish population data are then very important in determining the success of satellite oceanography applied to fishery management.

Current and potential uses of satellite remote sensing data for fisheries are listed below. In the Fisheries Applications Matrix, the rows correspond to specific applications, and the columns correspond to individual ESE instruments. The potential use of data from a given ESE instrument to a specific fisheries application is denoted by a check mark in the matrix.

Fisheries Applications Matrix

Application	ESE Instrument								
	MODIS	SeaWiFS	SeaWinds	EOSALT	EOS Models	AMSR	AIRS/ AMSU/ MHS	DFA/ MR	GLAS
Color Mapping of Currents and Circulation Patterns	✓	✓	✓	✓	✓			✓	✓
2 Measuring of Sea Surface Temperature	✓					✓	✓		
Mapping Oceanic Wind Patterns			✓		✓	✓			
4 Observing Ocean, River, and Lake Sediment Concentrations	✓	✓							
Improving Bathymetry		✓							
6 Identifying Chlorophyll and Phytoplankton	✓	✓							
Characterizing and Monitoring Short-term and Long-Term Fish Habitat	✓	✓							
8 Managing Coral Reefs	✓	✓							
Monitoring Pollution	✓	✓							
10 Improving Weather and Storm Prediction			✓		✓	✓	✓		

1 Color Mapping of Currents and Circulation Patterns

Experience with data collected from the Coastal Zone Color Scanner (CZCS) sensor on the Nimbus satellite from 1979 to 1986, demonstrated the utility of ocean color images to distinguish distinctive water masses, currents, and circulation patterns. Subtle changes in the blueness and greenness of water can be dramatically enhanced by instruments specifically tuned to the task, such as SeaWiFS. As natural waters become richer in biomass, they become greener; as they lose biomass, they become bluer. Currents and circulation patterns can be understood through analysis of diagnostic features on these special still photos and through analysis of sequences of images.

Indirect observations of currents and circulation patterns will be made by measuring oceanic wind fields with the SeaWinds instrument because sea surface winds and currents are often coupled and also by measuring ocean height with EOSALT data because currents cause subtle but characteristic changes in sea surface topography. In addition, ESE models will aid in predicting and explaining currents through assimilation of satellite data with numerical simulation of weather patterns.

Early detection of oceanic features can also help avoid unusual gear loss suffered by lobster and crab fishermen primarily caused by ocean currents related to large scale features, such as eddies with diameters between 70 and 270 km and with rotation flows than can reach speeds of over 2 knots.

2 Measuring of Sea Surface Temperature

Maps of sea surface temperature (SST) are directly relevant to fisheries because of the temperature preferences of individual fish species, and maps of SST reflect currents and zones of upwelling or downwelling water. Operational ocean surface temperature maps derived from satellites are routinely used not only by commercial fishing operations but also by sports fisherman to plan outings.

Because temperature and currents are related, SST maps help refine understanding of currents and circulation described above. An example is the identification of ocean circulation features such as cold / warm-core rings. In a warm-core ring, warm water species of fish such as shark and swordfish congregate; they find more food along the rotating perimeter of a warm eddy. These data also indirectly aid fishermen and fisheries managers because SST is directly related to weather and climate.

SST can be obtained directly from satellite remote sensing. The longwave (thermal infrared) radiation emitted by an object is mathematically related to the temperature of that object. MODIS includes several bands sensitive to the thermal infrared, allowing precise, daily measurement of SST over the world’s oceans.

3 Mapping Oceanic Wind Patterns

Knowledge of surface winds benefits fishermen by aiding ship navigation, voyage planning, and anticipation of sea state. The SeaWinds sensor is designed to provide direct measurement of surface wind fields over water by pulsing radar signals and measuring the backscattered return. The strength of the return signal is primarily controlled by surface roughness of the water, and hence, local wind speed. In addition, atmospheric models using ESE data will offer more accurate local predictions of surface wind fields.

4 Observing Ocean, River, and Lake Sediment Concentrations

Water containing suspended sediment exhibits a characteristic increase in Visible and Near-Infrared (VNIR) reflectance. The high spectral resolution of MODIS and SeaWiFS in the VNIR spectral region makes these instruments ideally suited to gather these data and detect subtle changes in sediment concentration that are undetectable by the human eye.

5 Improving Bathymetry

On a local scale, near-shore marine bathymetry in relatively clear water can be seen directly by visible and near-infrared instruments. Maps derived from these measurements made over the last 20 years have been used for many specific fisheries applications.

6 Identifying Chlorophyll and Phytoplankton

Phytoplankton thrive on organic carbon in sea water and utilize chlorophyll to power their digestion of carbon. The MODIS and SeaWiFS instruments have individual bands tuned to the reflectance patterns of chlorophyll and chlorophyll fluorescence, allowing improved species identification and biomass estimate.

Phytoplankton also thrive in nutrient-rich upwelling regions that are well identified by their color, temperature, and current. Cold, nutrient-rich water results in high phytoplankton densities, which attracts an aggregation of fish populations. For example, the aggregation of salmon off the southwest coast of Vancouver Island is tied to prevailing circulation patterns and areas of upwelling.

7 Characterizing and Monitoring Short-term and Long-Term Fish Habitat

Short-term fish habitat characterization is based on a combined understanding of currents, circulation patterns, winds, sediment concentrations, water temperature, and nutrients. SeaWiFS and MODIS can routinely provide direct information on all these parameters. Long-term monitoring of habitat health and variability is one of the principal ESE program goals.

8 Managing Coral Reefs

Coral reefs host some of the greatest biodiversity within the ocean. They provide rich habitat for large numbers of fish species that are either commercially important or critical components of the fish food chain. Intelligent management requires accurate mapping of these shallow water features. Because coral reefs only form in relatively shallow and clear water, they are well imaged in the visible and near infrared. Repeat mapping will aid the early identification of physical changes to the reefs that could occur in response to either natural or human factors. In addition, sediment loading and pollution represent major threats to coral reefs, and these factors can also be monitored directly from space.

9 Monitoring Pollution

Pollution of oceans, rivers, and lakes is one of the principal threats to fisheries worldwide. Point-source pollution can often be directly seen on visible and near-infrared satellite images such as those from MODIS and SeaWiFS without substantial image processing. Hydrocarbons (e.g., oil) are particularly well detected by remote sensing. The contrast in emmissivity between an oil slick and the surrounding water causes distinct anomalies in the thermal-infrared part of the spectrum, which can be readily detected with MODIS data.

10 Improving Weather and Storm Prediction

Better weather and storm prediction provides direct benefits to fishermen, allowing improved navigation and logistical planning, minimizing cost by enhancing storm preparation, and minimizing storm damage. ESE instruments can help provide improved weather prediction both directly by tracking of wind fields via SeaWinds and indirectly with improved performance of numerical weather models using by ESE data.