

# FleetLink: Collection & Telemetry of Ocean and Weather Data

*Better Information From U.S. Coastal Waters are Needed by Resource Managers and Regulators, the Ocean Research Community and Commercial Fishermen*

By **Ann Bucklin**

New Hampshire Sea Grant  
Program

University of New Hampshire  
Durham, New Hampshire

**Cliff Goudey**

MIT Sea Grant Program  
Massachusetts Institute of  
Technology

Cambridge, Massachusetts

**Peter H. Wiebe**

Woods Hole Oceanographic  
Institution

Woods Hole, Massachusetts  
and

**W. Gary Williams**

Clearwater Instrumentation Inc.  
Watertown, Massachusetts

Better information from U.S. coastal waters for meteorological and oceanographic conditions and commercial fishing operations are needed by resource managers and regulators, the ocean research community and commercial fishermen. Currently, these data are collected during oceanographic research efforts, National Marine Fisheries Service (NMFS) assessment surveys, operational Navy activities and National Weather Service (NWS) coverage. These activities cannot provide synoptic coverage of large regions and rarely employ near-real-time telemetry. The widespread temporal/spatial distribution of commercial fishing vessels makes them ideal platforms from which to gather basic information for coastal monitoring, modeling and prediction. The use of fishing vessels as platforms has been limited to date by lack of

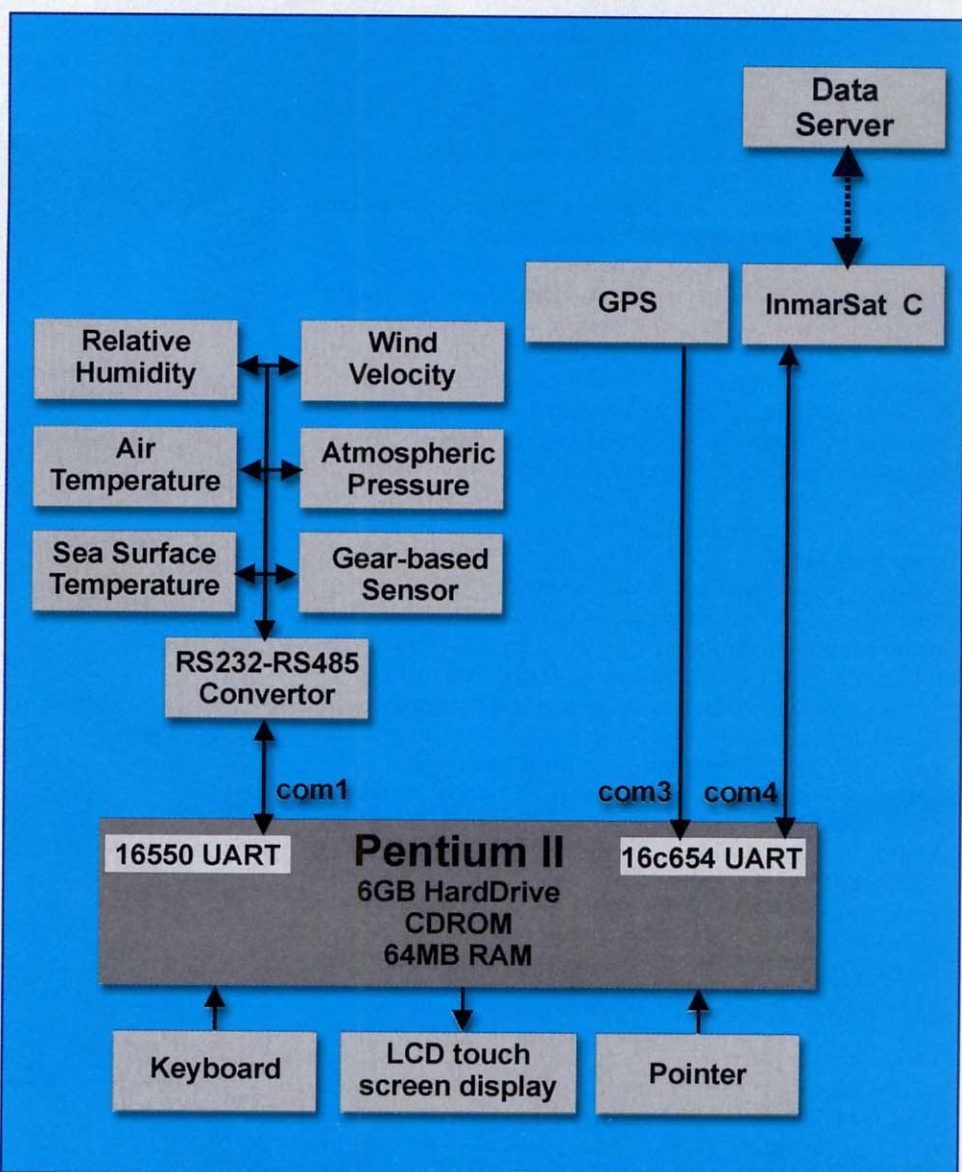


Diagram of the FleetLink sensor system hardware placed on commercial fishing vessels. The system comprises commercial off-the-shelf sensors and one custom-designed gear-based sensor. The sensor data are integrated and stored on a PC in the wheelhouse. The fishermen summarize catch data using the FleetLink program, and can send their hail via email. Every hour, the data are telemetered autonomously via satellite to a shore-based data server.



cooperation between the fishing community, government agencies and the ocean research community.

There is also a need for better means of communicating between commercial fishing vessels and their cooperatives, auctions, or homeports. The present system of contacting vessels via VHF, telephone and single side-band is inefficient, time-consuming, problematical (since both parties must be available at the same time) and not secure. More efficient systems reduce costs and increase profits for vessel owners and cooperatives, make reporting easier for the vessel, improve marketing practices for seafood products (perhaps allowing virtual marketing) and create more revenue for less fish.

To meet these needs, a system known as "FleetLink" has been created and has been operating in a test and evaluation phase for more than six months. The FleetLink system is an integrated sensor system and shore-based data management system that is designed to collect, telemeter, manage and distribute high-quality, synoptic environmental (hydrography, meteorology, biology) data from commercial fishing vessels. FleetLink sensor systems are currently installed on three commercial fishing vessels working in the Gulf of Maine. FleetLink ocean and weather data are collected and autonomously telemetered to a shore-based data server and are accessible at <http://www.FleetLink.net>. Proprietary fisheries catch data are collected, and can be distributed to the vessel's cooperative; the data may eventually be incorporated into an open-access catch database for each fishery.

### FleetLink Objectives

The FleetLink partnership began in 1998 with funding from the National Ocean Partnership Program via the Office of Naval Research. Our long-term goal is to provide near real-time biological and physical information on the status and dynamics of the ocean and ocean ecosystems to create new opportunities and new data products for oceanographic researchers, resource managers and commercial fishermen. The specific objectives of the partnership are to:

- Develop a collaboration between commercial fisher-

men, private marine industries, oceanographers and coastal resource managers for the collection, real-time telemetry, analysis, assimilation, distribution and use of environmental and fisheries data from coastal regions off the northeastern U.S.

- Design and produce an integrated sensor system (including navigational, hydrographic and meteorological components) for use onboard commercial fishing vessels; demonstrate all aspects of the prototype systems on the commercial fishing vessels; establish land-based centers for collection, management and Internet-based distribution of data.

### FleetLink Partnership

FleetLink is a partnership between researchers, engineers, entrepreneurs and commercial fishermen. Leadership of FleetLink by New Hampshire Sea Grant ensures the extension of the results to a diverse group of end users. Sea Grant



*FleetLink meteorological sensors (including wind speed and direction, air temperature, relative humidity and pressure) are installed on their own mast on the F/V Susan & Caitlyn (top left). A sea surface temperature sensor is attached to the inside of the vessel's hull. (Photos by Peter Wiebe)*

*The gear-based NetSensor designed by Clearwater Instrumentation, Inc. measures and records temperature and pressure. (A) The sensor unit is designed to be lashed to a head rope on a fishing net and has been designed to withstand the rigors of use in a commercial fishing setting. When the sensor surfaces after a haul, the data are telemetered via a 900 MHz RF link to the DeckMate, which interfaces with the wheelhouse computer via a RS485 bus. (B) The water column temperature data from the NetSensor, like other FleetLink data, can be immediately displayed on the wheelhouse computer (above).*

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extension staff at UNH and MIT are responsible for facilitating communication and coordination between the research and fishing communities. Fishermen’s organizations, particularly the Northwest Atlantic Marine Alliance (NAMA), help build fishermen’s interest in FleetLink and identify vessels for prototype demonstration.

Individual fishermen and fishermen’s cooperatives were drawn into the FleetLink partnership at its inception. Fishermen—representing different gear types, fishing strategies and home ports—contributed to the design of the sensor system and user interface, the selection of types of data to be collected and the identification of possible uses of the environmental and catch data for improvement of fishing practices and product marketing. One FleetLink partner is the Portland Fish Exchange, the first “display auction” in the Northeast U.S. and a progressive, innovative and successful operation. The publicly-owned Portland Fish Exchange currently auctions approximately 22 million pounds of seafood products from 250 vessels.

FleetLink draws on data acquisition, telemetry and management expertise at Woods Hole Oceanographic Institution (WHOI), especially in connection with the U.S. GLOBEC Program Service and Data Management Office. The FleetLink sensor system integration, including software development, was done at MIT and by Clearwater Instrumentation Inc. Clearwater also designed a gear-based sensor; three sensors were built and installed on the commercial fishing vessels.

### **FleetLink System Design**

The FleetLink system consists of an on-board Pentium II based computer with LCD medium resolution screen; serial interfaces connect to oceanographic and meteorological sensors, an Inmarsat satellite C communication transmit/receive unit and a GPS receiver. The FleetLink system provides automatic control, data processing and transmission of data, with a user-friendly interface for fishermen and real-time display of the along-track sensor data. The sensors include wind speed and direction; air temperature, relative humidity and pressure; and sea surface temperature. Each sensor has a RS485 bus interface and is polled by the FleetLink computer at one minute intervals; the data are stored on the computer’s hard disk. A micro-processor controller turns each sensor on and off in response to an addressed control signal, reads the sensor, calibrates the output and returns digital data to the central controller. The system is designed to maximize flexibility and to accommodate expansion and specialization. Sensors can be removed and replaced as necessary for repair or calibration and additional, non-standard sensors may be included for particular applications.

For the FleetLink system, Clearwater Instrumentation developed a rugged gear-based unit, NetSensor, which provides a time series of subsurface water temperature vs. pressure. This sensor begins recording temperature and pressure at one second intervals when it detects rapid pressure changes (i.e., when a fisherman sets the net). Once the sen-

sor resurfaces, the data are automatically transmitted to a receiver unit, the DeckMate, via a RF link. The DeckMate has a RS485 bus interface, just like the other sensors.

MIT’s installation of three operational systems was done in concert with Clearwater Instrumentation, the vessels’ captains and marine electricians retained by the vessel owners. Included in each installation as needed were an uninterruptible power supply and a dedicated power inverter. The project also provided commercial electronic navigation software of the owner’s choice, which was included in the bench testing to ensure compatibility with the primary system functions.

### **Data Acquisition & User Interface**

Data from the FleetLink Sensor System are acquired by a PC-based system mounted in the vessel’s pilothouse. MIT developed this system using commercially-available hardware, standard software modules and a custom-developed software application referred to as “WheelHouse.” The brain of this system is a panel-mount 233 MHz Pentium computer that is integral to a 15-inch color LCD display. Sensor interface is through a serial port, using an RS-232 to RS-485 converter. Other serial ports are used for navigation data input and for telemetry via an Inmarsat transceiver.

The WheelHouse software application is programmed in C++ and incorporates multitasking using several software packages, including Athena (a shipboard sensor interface program developed at WHOI). Data on fishing activity and relevant observations are entered by the captain using custom graphic user interfaces (GUIs) that accept touch screen, mouse and keyboard entries. Control of WheelHouse functions, including GUIs and data displays, is through pull-down menus. Specific GUIs facilitate the gathering of vessel, trip, tow and catch data, as well as comments by the captain on any aspect of the boat or its operation. The display of sensor data is facilitated using a strip chart feature linked to each sensor’s data stream.

The sensors are interrogated every minute, and the data are logged on the system’s 6 GB hard drive. Every hour while underway, the accumulated sensor data—with associated metadata (e.g., date, time, position) and any data that have been entered manually—are transmitted to shore. There is also a provision for sending and receiving e-mail traffic independent of the hourly transmissions. The data and e-mail messages are UU encoded and (to save on transmission costs) GZIP compressed. The hourly telemetry sessions occur automatically, without the need for human interaction.

### **Data Management**

The receiving system is a LINUX-based PC located at WHOI that has three functions: 1) to receive the telemetered data from the vessels as e-mail messages and parse the data into appropriate files; 2) to serve the environmental and fisheries data using standard web-serving software and the JGOFS data management system software; and 3) to store the processed data for serving via the web using the JGOFS software. The data are managed and served from the FleetLink data server located at WHOI and are openly available to any end user at the partnership website <http://www.FleetLink.net>. It is also intended that customized data products will be made widely available for specialized uses. We foresee that these data may be useful for assimilation into prognostic models (e.g., current fields, weather forecasting, surface/subsurface temperature and

salinity charts) of use to fisherman, recreational users of marine waters, managers and oceanographers.

In contrast to the open distribution of environmental data, the fishery catch data are treated as confidential, and their distribution is restricted to the vessel's home port, cooperative, auction or exchange. The FleetLink system can also ensure the appropriate and confidential dissemination of "hails" (i.e., confidential fisheries catch reports) at the captain's discretion.

### Prototype Demonstration

FleetLink sensor systems have been installed on three commercial fishing vessels: F/V *Susan & Caitlyn* (Portland, Maine), F/V *Glenna & Jacob* (Fairhaven, Massachusetts) and F/V *Adventurer* (Portland). Operation of the prototype FleetLink systems was demonstrated during January to March 2001, while all three vessels were engaged in their usual fishing operations. The F/V *Susan & Caitlyn* and F/V *Glenna & Jacob* were shrimping in the Gulf of Maine (working out of Portland) during much of this period, while the F/V *Adventurer* was trawling farther offshore. All three boats telemetered meteorological and ocean data to the FleetLink data server during this period; selected data are posted on the project website, <http://www.FleetLink.net>.

### Potential Data Users/Customers

FleetLink partners are working to expand our partnerships with federal and state coastal resource managers by targeting potential participants and data customers. We have sought advice from representatives of several organizations to ensure that FleetLink data are useful for diverse purposes, telemetered at appropriate intervals, integrated into an accessible data management system, etc. Targeted users and customers of FleetLink data include:

- National Marine Fisheries Service: The use of vessel monitoring systems (VMS) or "black boxes" as a NMFS enforcement tool is expected to eventually encompass much of the commercial fishing industry. The data collection aspects of the VMS program may be integrated with other monitoring efforts for state and federal programs and other users. We are working to coordinate and share data between the VMS program and the FleetLink effort. For example, environmental data collected from fishing vessels and archived in the FleetLink database may contribute to the NMFS environmental monitoring, fisheries research and stock assessment activities.

- National Weather Service: The need for high-resolution meteorological data has resulted in current efforts by NOAA and the NWS to involve ships of opportunity in data collection using installed improved meteorological (IMET) sensors, as part of the volunteer observing ships program (VOS). *In situ* data from IMET sensors are now making it possible to test the accuracy of numerical weather prediction models and remote sensing systems. One can envision a time when the sensors could be queried on demand, allowing NWS and other users to obtain data whenever needed (e.g. as in cases of severe weather), rather than waiting for routine data reports. FleetLink would provide a means to include commercial fishing vessels in this volunteer fleet.

- Department of Transportation and U.S. Coast Guard: FleetLink environmental and fisheries data could be integrated with the U.S. Coast Guard's New England Early Warning System for Right Whales. Currently, upon sighting a right whale, the captain of the fishing boat reports the

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time, position, behavior and the number of whales to NMFS via Inmarsat. A summary report is then distributed by NMFS via fax, VHF, written report and NOAA weather radio. The broadcasts and reports could be made more timely with the use of telemetered information.

- Department of Defense and U.S. Navy: Operational Navy programs occasionally require and use real-time environmental data from the coastal ocean. We expect that the Naval Oceanographic Office may potentially be able to use the high-quality near-real-time information from coastal waters off the Northeastern U.S. obtained from commercial fishing vessels.

- Ocean Research Community: The incorporation of near-real-time data from commercial fishing vessels may contribute to improving coupled physical-biological models, such as those developed during the U.S. GLOBEC Northwest Atlantic program, and model predictions (see Wiebe et al., 1996). This approach may eventually lead to the development of modeling products intended for direct use by the fishing community.

- Fish Cooperatives, Auctions and Exchanges: Fisheries catch data are currently collected in person and by word of mouth. Thus, many commercial fishermen—even those on coastal vessels—are unaware of market action and may fish without regard for daily market fluctuations. We expect that it will be possible to predict and respond to market dynamics more accurately and effectively using telemetered catch data.

### Future Plans

The FleetLink partnership envisions the installation of FleetLink sensor systems on 100 commercial fishing vessels working in the Gulf of Maine and Georges Bank. The FleetLink sensor system offers researchers, resource managers and environmental consultants a highly diversified, customizable instrumentation package, which can collect and telemeter high-quality low-cost data. A sufficient number of vessels equipped with the FleetLink sensor system will produce synoptic and high-resolution weather and ocean data for diverse customers and applications. The ocean temperature data can be used by researchers as indices of ecosystem health and climate variability. The meteorological data can improve marine forecasts - especially in offshore regions. The subsurface temperature measurements can improve environmental monitoring by the NMFS. And importantly, the confidential, real-time transmission of fish catch and market data can be used by fishing cooperatives and auctions to improve fishing practices and optimize market strategies. /st/

### Acknowledgments

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*Ann Bucklin is a biological oceanographer and professor of Zoology at the University of New Hampshire, where she is affiliated with the Institute for the Study of Earth, Oceans and Space. Since 1993, she has been director of New Hampshire Sea Grant.*

*Cliff Goudey is extension leader for the Massachusetts Institute of Technology Sea Grant Program and project director of the Center for Fisheries Engineering Research at MIT. His professional interests include fisheries, fisheries management and open ocean aquaculture.*

*Peter Wiebe is a senior scientist at the WHOI. A zooplankton biologist, his long-term focus has been fostering collaborative oceanographic research programs. He now serves as chair of the Executive Committee for the U.S. GLOBEC NW Atlantic Georges Bank Study.*

*W. Gary Williams is president of Clearwater Instrumentation Inc., in Watertown, Massachusetts. Trained as a physical oceanographer, he has extensive experience in instrumentation development for oceanographic research applications.*