CHAPTER 3

National Oceanic and Atmospheric Administration

Agency Approach and Plans for Technology Transfer

The mission of the National Oceanic and Atmospheric Administration (NOAA) is to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet the Nation's economic, social, and environmental needs. This mission will become ever more critical in the 21st century as national needs intensify related to climate change, limited freshwater supply, ecosystem management, and homeland security.

NOAA is one of the nation's premier scientific agencies. NOAA science and technology impact the daily lives of the nation's citizens and have a significant effect on the national economy. About one-third of the U.S. economy (approximately $3 trillion) is weather sensitive. The agriculture, energy, construction, health, travel, and transportation industries are almost entirely weather dependent. Weather data and forecasts play a critical role in these major economic sectors of our economy-- and are transferred to the industry and the public through the media, internet, and NOAA Weather Radio. Federal, State, and local governments and the public use weather warnings to save lives and prevent destruction of property. Television weathercasters, and many weather related firms, use weather data and forecasts in their daily operations. Industry uses NOAA data in home construction and design, crop selection, disease control, and fuel delivery and supply. Weather data have been used for deciding such diverse applications as automobile fuel delivery system design, the best time to market umbrellas, and even for when the conditions would be optimum for the mating of honeybees. Increasingly accurate and longer range weather forecasts depend on an ongoing program of research and development.

Research by NOAA's laboratories is primarily aimed at assisting NOAA's operational components. Recent examples demonstrating the direction of NOAA's research are weather forecasting, solar emission forecasting, estimating fish stocks, predicting water resources, warning of tsunamis, and charting ocean bottom topography. Research results are designed for transfer to NOAA's operational components to improve prediction, management, and other mission activities.

NOAA's web page at www.noaa.gov details the voluminous amount of research and technology made available to the public in the form of information products and services. These include weather and climate forecast data, El Nino prediction and monitoring, tides and currents, satellite imagery, fishery statistics, information on protected species, air quality, state of the coasts, beach temperatures, and nautical charts, as well as extensive databases on climate, oceans, ice, atmosphere, geophysics, and the sun.

NOAA's primary technology transfer mechanism has historically been the open dissemination of scientific and technical information to individuals, industry, government, and universities. This means of transfer is consistent with the agency's mission and scientific tradition and has been found to be more efficient and economical than transfer through patenting and licensing. Even so, NOAA continues to transfer intellectual property where advantageous, through licenses and Cooperative Research and Development Agreements (CRADAs) in order to benefit the competitiveness of U.S. companies.

In FY 2010, NOAA conducted an extensive technology transfer program through applications of meteorological and oceanographic technologies and information, and through open dissemination to individuals, industry, government, and universities. In addition, NOAA provided daily weather forecasts and warnings through the media and NOAA Weather Radio. NOAA technology is also transferred through presentations at scientific meetings, publication in peer-reviewed scientific journals, and through NOAA scientific and technical publications.

NOAA collaborates with other federal research agencies on science and technology development matters of joint interest. For example, NOAA and the Environmental Protection Agency (EPA) team to provide new experimental air quality forecast guidance that enables state and local agencies to issue more accurate and geographically specific air quality warnings to the public. The annual cost of poor air quality to the U.S. from air pollution-related illnesses has been estimated at $150 billion.

Furthermore, to ensure the United States benefits from and fully exploits scientific research and technology developed abroad, NOAA collaborates and shares information with organizations in countries throughout the world. Through these international relationships, technology is transferred into NOAA for the eventual benefit of U.S. industry and public users. For example, the understanding and forecasting of global phenomena that occur in the atmosphere, oceans, and on the sun require worldwide collaboration and information sharing. This is accomplished through formal agreements with individual countries and participation in international organizations, such as the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC), and the International Astronomical Union (IAU). NOAA participates in international scientific programs and shares technology and scientific data, such as in the Global Earth Observation System. This effort involves nearly 50 other countries, the European Commission, and 29 international organizations. NOAA also provides technical assistance and training to individuals from other countries, and participates in an international visiting scientist program. In addition, environmental data are shared through NOAA participation in the World Data Center program.

In the future, NOAA will continue to direct its technology transfer and international collaboration activities toward four mission goals:

1. protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management;
2. understand climate variability and change to enhance society's ability to plan and respond;
3. serve society's needs for weather and water information; and
4. support the Nation's commerce with information for safe, efficient, and environmentally-sound transportation.

Performance in FY 2010: Activities and Achievements

■ Collaborative Relationships for Research & Development

	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
● **CRADAs,** total active in the fiscal year (1)	6	5	4	5	6
- New, executed in the fiscal year	0	0	1	2*	2
▪ Traditional CRADAs,(2) total active in the fiscal year	6	5	4	5	6
- New, executed in the fiscal year	0	0	0	0	0
▪ Non-traditional CRADAs,(3) total active in the fiscal year	0	0	0	0	0
- New, executed in the fiscal year	0	0	0	0	0
● **Other types of collaborative R&D relationships**	0	0	0	0	0

CRADA = Cooperative Research and Development Agreement.

(1) "Active" = legally in force at any time during the fiscal year. "Total active" is comprehensive of all agreements executed under CRADA authority (15 USC 3710a).
(2) CRADAs involving collaborative research and development by a Federal laboratory and non-Federal partners.
(3) CRADAs used for special purposes, such as material transfer or technical assistance that may result in protected information.
(4) *FY 2009: Correction made to "newly executed" CRADAs; there were two not one as previously reported.

■ Invention Disclosure and Patenting

	FY 2006	FY 2007(3)	FY 2008	FY 2009	FY 2010
● New inventions disclosed in the fiscal year (1)	4	3	0	4	1
● Patent applications filed in the fiscal year (2)	0	2	3	1	1
● Patents issued in the fiscal year	0	0	1	0	2

(1) Inventions arising at the Federal laboratory.
(2) Includes U.S. patent applications, foreign patent applications filed on cases for which no U.S. application was filed, divisional applications, and continuation-in-part applications. Excludes provisional, continuation, duplicate foreign, and PCT applications.
(3) Correction made to FY 2007 on number of patent applications and patents issued. The patent for the DART (Deep-ocean Assessment and Reporting of Tsunamis) system was expected to be issued in September 2007 but was not issued until October 30, 2007.

■ Licensing

Profile of Active Licenses

	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
● **All licenses**, number total active in the FY [1]	5	6	6	7	6
▫ New, executed in the FY	1	3	0	1*	0
▪ **Invention licenses**, total active in the FY	5	6	6	7	6
▫ New, executed in the FY	1	3	0	0	0
- Patent licenses,[2] total active in FY	5	6	6	7	0
▫ New, executed in the FY	1	3	0	0	0
- Material transfer licenses (inventions), total active	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
- Other invention licenses, total active in the FY	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
▪ **Other IP licenses**, total active in the FY	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
- Copyright licenses (fee bearing)					
▫ New, executed in the FY					
- Material transfer licenses (non-inventions), total active					
▫ New, executed in the FY					
- Other, total active in the FY					
▫ New, executed in the FY					

Multiple inventions in a single license are counted as one license. Licenses that include both patents and copyrights (hybrid licenses) are reported as patent licenses and are not included in the count of copyright licenses.
(1) “Active” = legally in force at any time during the FY.
(2) Patent license tally includes patent applications which are licensed.
* One-Time License only with one-time flat fee royalty

Licensing Management

	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
● **Elapsed execution time**,(1) licenses granted in the FY					
▪ **Invention licenses** ▫ Average, months ▫ Minimum ▫ Maximum	7.0	5.0 6.0 7.0	*	7.0	7.0
- Patent licenses (2) ▫ Average, months ▫ Minimum ▫ Maximum	7.0	5.0 6.0 7.0	*	7.0	7.0
● **Licenses terminated for cause**, number in the FY					
▪ Invention licenses	0	0	0	0	0
- Patent licenses (2)	0	0	0	0	0

Data included in this table (intentionally) addresses only invention licenses, with patent licenses distinguished as a sub-class.
* No new licenses were executed in FY 2004, FY 2005, 2008.
(1) Date of license application to the date of license execution. (Date of license application is the date the lab formally acknowledges the written request for a license from a prospective licensee and agrees to enter into negotiations.)
(2) Patent license tally includes patent applications which are licensed.

Characteristics of Licenses Bearing Income

	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
● **All income bearing licenses**, total number	5	4	4	5	4
▫ Exclusive ▫ Partially exclusive ▫ Non-exclusive	1 0 4	0 0 4	0 0 4	0 0 5	0 0 4
▪ **Invention licenses**, income bearing	5	4	4	5	4
▫ Exclusive ▫ Partially exclusive ▫ Non-exclusive	1 0 4	0 0 4	0 0 4	0 0 5	0 0 4
- Patent licenses,(1) income bearing	5	4	4	5	4
▫ Exclusive ▫ Partially exclusive ▫ Non-exclusive	1 0 4	0 0 4	0 0 4	0 0 5	0 0 4
▪ **Other IP licenses**, income bearing	0	0	0	0	0

	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
▫ Exclusive ▫ Partially exclusive ▫ Non-exclusive					
- Copyright licenses (fee bearing)					
▫ Exclusive ▫ Partially exclusive ▫ Non-exclusive					
● **All royalty bearing licenses**,[2] total number	5	4	4	5	4
▪ **Invention licenses**, royalty bearing	5	4	4	5	4
- Patent licenses,[1] royalty bearing	5	4	4	5	4
▪ **Other IP licenses**, royalty bearing	0	0	0	0	0
- Copyright licenses (fee bearing)	5	4	4	5	4

In general, license income can result from various sources: license issue fees, earned royalties, minimum annual royalties, paid-up license fees, and reimbursement for full-cost recovery of goods and services provided by the lab to the licensee including patent costs.
(1) Patent license tally includes patent applications which are licensed.
(2) Note that royalties are one component of total license income.

Income from Licenses

	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
● **Total income**, all licenses active in the FY [1]	$13,100	$22,000	$69,007	$138,444[4]	$35,043
▪ **Invention licenses**	$13,100	$22,000	$69,007	$138,444	$35,043
- Patent licenses [2]	$13,100	$22,000	$69,007	$138,444	$35,043
▪ **Other IP licenses**, total active in the FY	0				
- Copyright licenses					
● **Total Earned Royalty Income** (ERI) [3]	$13,100	$22,000	$69,007	$138,444	$35,044
▫ Median ERI	$1,000	$4,000	$9,007	$19,000	$5,000
▫ Minimum ERI	$100	$1,000	$1,000	$1,000	$1,000
▫ Maximum ERI	$5,000	$9,000	$25,000	$75,000	$17,044
▫ ERI from top 1% of licenses	$5,000	$9,000	$25,000	$75,000	$17,044
▫ ERI from top 5% of licenses	$5,000	$9,000	$25,000	$75,000	$17,044
▫ ERI from top 20% of licenses	$5,000	$9,000	$25,000	$75,000	$17,044
▪ **Invention licenses**	$13,100	$22,000	$69,007	$138,444	$35,044
▫ Median ERI	$1,000	$4,000	$9,007	$19,000	$5,000
▫ Minimum ERI	$100	$1,000	$1,000	$1,000	$1,000
▫ Maximum ERI	$5,000	$9,000	$25,000	$75,000	$17,044
▫ ERI from top 1% of licenses	$5,000	$9,000	$25,000	$75,000	$17,044

	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
▫ ERI from top 5% of licenses	$5,000	$9,000	$25,000	$75,000	$17,044
▫ ERI from top 20% of licenses	$5,000	$9,000	$25,000	$75,000	$17,044
- Patent licenses (2)	$13,100	$22,000	$69,007	$138,444	$35,044
▫ Median ERI	$1,000	$4,000	$9,007	$19,000	$5,000
▫ Minimum ERI	$100	$1,000	$1,000	$1,000	$1,000
▫ Maximum ERI	$5,000	$9,000	$25,000	$75,000	$17,044
▫ ERI from top 1% of licenses	$5,000	$9,000	$25,000	$75,000	$17,044
▫ ERI from top 5% of licenses	$5,000	$9,000	$25,000	$75,000	$17,044
▫ ERI from top 20% of licenses	$5,000	$9,000	$25,000	$75,000	$17,044
▪ **Other IP licenses**, total active in the FY	0	0	0	0	0
▫ Median ERI					
▫ Minimum ERI					
▫ Maximum ERI					
▫ ERI from top 1% of licenses					
▫ ERI from top 5% of licenses					
▫ ERI from top 20% of licenses					
- Copyright licenses					
▫ Median ERI					
▫ Minimum ERI					
▫ Maximum ERI					
▫ ERI from top 1% of licenses					
▫ ERI from top 5% of licenses					
▫ ERI from top 20% of licenses					

(1) Total income includes license issue fees, earned royalties, minimum annual royalties, paid-up license fees, and reimbursement for full-cost recovery of goods & services provided by the lab to the licensee including patent costs.
(2) Patent license tally includes patent applications which are licensed.
(3) "Earned royalty" = royalty based upon use of a licensed invention (usually, a percentage of sales or of units sold). Not a license issue fee or a minimum royalty.
(4) Increase is due to a license with Walt Disney for NOAA's Science on a Sphere for a one-time royalty of $75,000.

Disposition of License Income

	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
● **Income distributed** (1)					
▪ **Invention licenses**, total distributed	$13,100	$22,000	$69,007	$138,444	$35,044
- To inventor(s)	$7,500 (57%)	$12,200 (55%)	$21,802 (32%)	$45,153 (33%)	$14,514 (41%)
- To other	$5,600 (43%)	$9,800 (45%)	$46,205 (68%)	$93,291 (67%)	$20,530 (59%)
- Patent licenses, (2) total distributed	$13,100	$22,000	$69,007	$138,444	$35,044

	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
- To inventor(s)	$7,500 (57%)	$12,200 (55%)	$21,802 (32%)	$45,153 (33%)	$14,514 (41%)
-To other	$5,600 (43%)	$9,800 (45%)	$46,205 (68%)	$93,291 (67%)	$20,530 (59%)

Invention licenses are the chief policy interest regarding disposition of income; content of table reflects this focus.
(1) Income includes royalties and other payments received during the FY.
(2) Patent license tally includes patent applications which are licensed.

■Other Performance Measures Deemed Important by the Agency

	FY 2006	FY 2007*	FY 2008*	FY 2009*	FY 2010
Journal articles published	444	909	838	789	709
Technical reports published	148	284	258	186	158

*Publication counts have been recently updated by the NOAA Laboratories for FY 2007, FY 2008 and FY 2009.

GREAT LAKES ENVIRONMENTAL RESEARCH LABORATORY	FY 2007	FY 2008	FY 2009	FY 2010
Website hits (HTML pages) (M)	2,244,420	3,086,605	2,790,351	2,941,319
Website downloads (PDF pages)—brochures, research papers, technical memos, etc.	65,740	110,880	93,400	95,137

*Update made for FY2007 and FY 2008 on number of articles published and reports published.

	FY 2009	FY 2010
NOAA Inventors on Patents filed “by Others”	**1***	**0**

*NOAA’s PMEL Scientist on Cortland Patent

Other Performance Measures Deemed Important by the Agency

Prestigious Awards for NOAA’s Scientific Technology received in FY 2010

● NOAA Technology Transfer Award:

Harold Barnet from NOAA’s National Marine Fisheries Service – In recognition for development and commercialization of a process to transform fish processing wastes into high quality fish meal and oil aquaculture feeds.

Dusan Zrnic from NOAA’s Office of Ocean and Atmospheric Research for developing a novel way to measure linear orthogonal polarimetric variables without a switch that was patented and transferred to the private sector producing significant savings in the implementation of commercial dual polarization radars.

- **NOAA Silver Medal Award:**

Alan Leonardi, Deputy Director, NOAA/OAR/AOML
For exemplary leadership in building a first-of its-kind partnership with Google to disseminate NOAA ocean data and information through Google Earth.

Alan had a productive and fascinating assignment in 2009 – a detail in California with Google. His efforts helped incorporate NOAA's vast ocean data into Google Earth, to include NOAA (& worldwide) Bathymetry Data, NOAA Content for Google's "Explore the Ocean Layer," and NOAA Data in the Google Earth Observations Layer. This unique partnership between NOAA and Google is another opportunity to make publicly-owned data more available and put it in a form that people can easily use. The CRADA between NOAA and Google was signed January 6, 2010.

Example Outcomes from NOAA Technology Transfer

For this year's report, the cases described below are provided as examples of downstream outcomes being achieved by NOAA technology transfer efforts.

- **Tsunami Training**

NOAA's Pacific Marine Environmental Laboratory (PMEL) Center for Tsunami Research (NCTR) has developed multiple training curricula to assist states and cooperating nations to improve tsunami readiness for their citizens. Training includes instruction in the development and implementation of tsunami forecast systems and in providing "train the trainer" classes for improving tsunami readiness at the local level.

Tsunami Awareness Training

The NCTR, in conjunction with the Natural Disaster Preparedness Training Center (NDPTC) at the University of Hawaii, has developed a training course for emergency management officials. The course focuses on tsunami mitigation, risk analysis, preparedness, and recovery. Three courses were presented in 2010, in Honolulu, HI, Pago Pago, AS, and Camp Murray, WA. A total of 125 students were trained in the three courses.

ComMIT Training

A Community Model Interface for Tsunami (ComMIT) is a major avenue to transfer modeling expertise and capabilities from NOAA to and between the Indian Ocean (and other) countries. The community model provides tools for the construction of tsunami inundation maps under different scenarios and for real-time tsunami forecast applications and thus is a critical tool for building tsunami-resilient communities. The United Nations Educational Scientific and Cultural Organization and the United States Agency for International Development funded PMEL/NOAA to develop such a tool which allows nations access to modeling tools with an internet-enabled interface. ComMIT enables government agencies and others in the region to run tsunami models, using data from local or remote databases. This approach allows nations without a significant cadre of trained modelers to build tsunami modeling capability for forecast and hazard assessment, allows nations with restrictions on sharing geo-spatial data to input that data locally and not share it with other web-based model users, and, most significantly, the internet-based approach creates a virtual regional and global community of modelers using the same tools and approaches to understand tsunami threats, all able to share information and insights among themselves. In 2010, ComMIT training was provided in Daejeon, Republic of Korea in October, 2009 to 17 scientists.

Tsunami "Train the Trainer" Training

The Washington State Train-the-Trainer program aims to develop an educational curriculum to train qualified Tsunami Public Education Instructors. The Train-the-Trainer program is a joint effort of the NOAA Center for Tsunami Research (NCTR) and the Washington state Emergency Management Division (WA EMD). On 3 June 2010, WA EMD hosted the 2nd Annual Train-the-Trainer Workshop in Port Angeles, Washington. The workshop objective was to conduct a Trainer program taught by the NCTR in collaboration with WA EMD to graduate qualified Tsunami Public Education Instructors as identified by WA EMD. This objective is a critical component essential to the National Tsunami Hazard Mitigation Program (NTHMP) Educational Plan. The Workshop was a joint effort of the WA EMD and the NCTR. A total of 20 participants from various coastal Washington jurisdictions took part in the Workshop. Attendees included personnel from county and community organizations such as Emergency Management and Community Emergency Response Team.

- **Cooperative Agreement between NOAA and the University of New Hampshire:**

NOAA's Center for Coastal and Ocean Mapping (CCOM)/ Joint Hydrographic Center (JHC) is a University of New Hampshire program aimed at creating a national center for expertise in ocean mapping and hydrographic sciences. Guided by a Memorandum of Understanding, with funding from the National Oceanic and Atmospheric Administration (NOAA) under a CRADA, the JHC operates in partnership with NOAA's National Ocean Service. The CCOM is a University center that expands the scope of interaction and cooperation with the private sector, universities and other government agencies including the US Geological Survey, the Office of Naval Research, the Naval Research Lab, Defense Advanced Research Projects Agency and National Science Foundation. The centers focus their activities on two major tasks, an educational task, aimed at creating a learning center that will promote and foster the education of a new generation of hydrographers and ocean mapping scientists, and a research task aimed at developing and evaluating a wide range of state-of-the-art hydrographic and ocean mapping technologies and applications.

Below are a few examples of the work that's being done under this Cooperative Agreement:

The Combined Uncertainty and Bathymetric Editor (CUBE) multibeam sonar data processing algorithm, developed by UNH is licensed to several major hydrographic software firms and is widely used in their commercial packages. This algorithm is rapidly becoming the standard for processing multibeam sonar data worldwide. There were no CUBE licenses issued in 2010 but to date, CUBE has been licensed to 11 companies. The JHC also has licensed software for the conversion of CUBE Bathymetry Format encoded data to Generic Sensor Data format (CBF2GSF) to Science Applications International Corporation (SAIC).

In parallel with CUBE the Navigation Surface algorithm developed by NOAA for managing multibeam data, processed by CUBE, has been adopted by many similar software packages. This technology is now open-source and managed world-wide through an "open navigation surface working group" made up of representatives from government, academia, and industry. Geocoder software for seafloor character mapping and acoustic sediment size determination is similarly licensed to several sonar and software companies and is widely used by the private sector and governments worldwide. To date there are 6 companies licensing Geocoder with several more being negotiated.

This past year the JHC and the New Hampshire Innovation Research Center, successfully transferred technology for processing and visualization of mid-water targets from single and multibeam sonar data. This software has seen wide use in the Gulf of Mexico at the Deepwater Horizon spill site, where it was used to map gas seeps, search for deep oil plumes, and monitor the wellhead for leaks.

- **NOAA's National Marine Fisheries Service Partners with Private Industry to Transform Fish Wastes into Useful Products**

Scientists at NOAA's Northwest Fisheries Science Center (NWFSC) partnered with the State of Alaska's Industrial Development and Export Authority (AIDEA) and a private sector fish processing plant in Sitka, to develop a process to economically transform fish processing wastes into high quality fish meal and oil for aquaculture feeds. Uniquely combining a double drum dryer process in use by other, non fisheries, industries and a plant design used in previous (NWFSC) research, the process was successfully piloted at the Center and demonstrated to industry.

This new technological breakthrough lies in three areas: 1.) it creates a method to stabilize the waste enabling managers to "bank" the material when it is either in excess or under the amount needed for efficient processing, 2.) it uses a mobile plant to handle multiple fisheries and operate more days per year, and 3.) it uses drum dryers to gently dehydrate the meal and preserve quality. The process produces high quality fishmeal, oil, gelatin, and bone meals that perform well in fish feeds and pet food.

The ability of this process to be used in a variety of remote and seasonal fisheries that cannot use existing waste refining technology, promises to reduce coastal nutrient pollution from seafood processing plants worldwide while providing an environmentally sound source of fishmeal and oil for aquaculture and the animal feed industries. With funding from AIDEA , several seafood processors in Sitka, Alaska plan to build a plant that will transform the industries' 17 million pounds of waste annually dumped into Sitka harbor into useful products with an estimated annual value of at least $3.5 million.

- **Collaboration and Training: Improve Modeling of Circulation in the Nearshore Zones of Lakes**

NOAA's Great Lakes Environmental Research Laboratory (GLERL) hosted a visiting scientist from the Budapest University of Technology and Economics, Hungary, from February through September 2010. Collaboration involved developing a one-dimensional wind model to improve the modeling of circulation in the nearshore zones of lakes. The model accounts for sudden change of surface temperature and roughness at the shoreline and atmospheric boundary layer that develops along the fetch in response, providing a non-uniform wind shear stress input to hydrodynamic lake models. GLERL's Lakes Huron to Erie Connecting Waterways Forecasting System for shallow, medium-sized Lake St. Clair was used as a target for the new wind model. It was found that nearshore circulation is very sensitive to the non-uniformity of the wind forcing: occasionally a reversal is observed in the modeled flow, with a clearly important consequence on the propagation of pollutants and sediments. Currents are being measured close to the main public beach in Detroit, Michigan to validate the approach. Upon returning to Hungary, the visiting scientist will be applying the hydrodynamic modeling and forecasting techniques he has experienced while at GLERL, to his work on European lakes and rivers.

- **ReCON Bouy Array - Observation Systems Supporting Early Warning of Hypoxia and Internal Waves**

The NOAA GLERL's Real-time Environmental Coastal Observations Network (RECON) bouy array brings together a team of NOAA and Great Lakes institutes to construct experimental, integrated environmental observing systems. The integrated environmental observatory provides real-time observations of chemical, biological, and physical parameters. Observations from the ReCON bouy array have supported the Cleveland Water Department in early warning of hypoxia and internal waves at water supply intakes.

The Cleveland Water Department (CWD) provides drinking water to approximately 1.5 million people in 72 communities in Northeast Ohio. The water system gets its source water from the Lake Erie Central Basin through four water intakes covering approximately 27 miles of shoreline in the greater Cleveland area. Water treatment plants can be exposed to hypoxic waters from Lake Erie compromising water quality in the system. When hypolimnetic waters reach CWD intakes, pre-treatment operations are disrupted and corrosion control strategies are affected by changes in temperature and pH. In addition, dissolved manganese from the hypolimnion enters the distribution system resulting in numerous customer complaints about discolored water. Hypoxic waters are low in pH and temperature negatively impacting water treatment and subsequently drinking water quality. Low oxygen conditions also result in an increase in anaerobic bacteria that contribute high levels of manganese to the hypolimnion leading to drinking water taste and odor problems. Real-time information is distributed to project researchers and CWD drinking water processing managers providing hourly updates of decreasing dissolved oxygen and internal wave status. Real-time access to this information gives managers time to prepare alternate processing methods in the event that low temperature and low pH hypolimnetic waters are transported to water intakes by internal waves. Real-time observations of meteorology and water temperature profiles allow early detection of cyclical central basin internal waves.

- **NOAA's National Centers for Coastal Ocean Science (NCCOS) Seagrass Restoration**

In January 2010, the Qatar Ministry of Environment invited NOAA's NCCOS staff to participate in a week-long workshop to assist in preparing a conservation and restoration protocol for seagrasses. Qatari government staff, university scientists, United Nations Environmental Program advisors, and regional contractors were briefed on conservation and restoration tools developed by NCCOS scientists. The workshop program included an evaluation of potential seagrass restoration sites among Qatar's rich and diverse coastal marine resources at two locations where seagrasses were impacted by dredging and filling operations. Following the workshop, NCCOS staff prepared a seagrass restoration guidelines document for the Ministry of Environment.

- **NOAA's National Centers for Coastal Ocean Science (NCCOS) Domoic Acid Detection Kit**

At the request of the French government, NOAA scientists trained researchers from the French Research Institute for Exploitation of the Sea (IFREMER) on how to incorporate the domoic acid detection kit developed by NOAA scientists into the French national shellfish monitoring system. Domoic acid is a potent neurotoxin produced by bloom-forming microalgae which accumulates in shellfish causing amnesic shellfish poisoning. It is a major problem in both the United States and France. The detection kit developed by NOAA and commercialized by Mercury Science provides a rapid, accurate, cost-effective way to monitor for this toxin.