ABSTRACT

THE NATIONAL SEA GRANT COLLEGE PROGRAM DEAN JOHN A. KNAUSS MARINE POLICY FELLOWSHIP: A PROFESSIONAL EXPERIENCE WITH NOAA’S CORAL REEF WATCH

by Carl Nim

The National Sea Grant College Program Dean John A. Knauss Marine Policy Fellowship provides graduate students with marine policy experience in the Legislative and Executive branches of government. During 2010 I worked within NOAA’s Coral Reef Watch (CRW) program. CRW utilizes remotely sensed data from satellite platforms to monitor oceanic conditions that influence the health of coral reefs throughout the world. As a liaison between NOAA’s National Environmental Satellite and Data Information Service (NESDIS) and the Coral Reef Conservation Program (CRCP) I coordinated the preliminary development of a Land Based Sources of Pollution (LBSP) remote sensing product. Secondary responsibilities included editing a Technical Report for a workshop held in Lamington, Australia, coordinating the drafting and publishing of a special issue in the journal *Oceanography* on the current status of coral reef remote sensing, drafting international agreements, and assisting in other projects, such as the National Coral Reef Monitoring Plan Working Group and a Reef Resilience and Climate Change workshop in the U.S. Virgin Islands. The Knauss Fellowship provided me with exposure to virtually every level of coral reef conservation from workshops highlighting our ecological understanding of coral reefs to multi-agency U.S. Coral Reef Task Force meetings in Washington D.C.
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**Introduction**

**Background**

After receiving an M.A. in Miami University’s geography program and teaching part time for two years while looking for work, it was suggested that I apply to Miami University’s Institute of Environmental Science (IES) to strengthen my quantitative skills and gain work related experience. During the course work portion of the IES program my advisers suggested that I apply for The National Sea Grant College Program Dean John A. Knauss Marine Policy Fellowship (hereafter referred to as the Knauss Fellowship) in order to gain relevant work experience and fulfill the internship requirement for the M.En. degree. This report documents my experience as a Knauss Fellow in the National Oceanic and Atmospheric Administration (NOAA). The report will explain the overarching organization of NOAA and work down to my host office and the experiences I had during my fellowship.

**National Oceanic and Atmospheric Administration**

NOAA is a federal agency within the U.S. Department of Commerce and its roots are in the first U.S. scientific agency, the Survey of the Coast. NOAA’s purview has broadened substantially since 1807 and its vision today is to contribute to “An informed society that uses a comprehensive understanding of the role of the oceans, coasts, and atmosphere in the global ecosystem to make the best social and economic decisions” ([http://www.noaa.gov/about-noaa.html](http://www.noaa.gov/about-noaa.html)). NOAA’s mission is “To understand and predict changes in Earth’s environment and conserve and manage coastal and marine resources to meet our Nation’s economic, social, and environmental needs”. In order to achieve this, NOAA has six line offices (Figure 1) that address various areas of applied research and planning to provide the public with valuable information and products pertaining to U.S. oceans, coasts, and atmosphere. While NOAA does not have an “organic act” that mandates its existence or purview, like other federal agencies (e.g. The Environmental Protection Agency), there are several acts that legitimate the role of NOAA, such as the Coastal Zone
Management Act, the National Marine Sanctuaries Act and the Coral Reef Conservation Act, to name a few.

Figure 1. NOAA Organizational Chart: [http://www.pco.noaa.gov/org/NOAA_Organization.htm](http://www.pco.noaa.gov/org/NOAA_Organization.htm)
National Sea Grant Office

NOAA’s National Sea Grant Office (NSGO) is an interesting entity conceptualized by Dr. Athelstan Spilhaus in 1963. Inspired by agricultural and mechanical achievements made by land-grant colleges, Spilhaus suggested that existing colleges with an interest in oceanic work adopt a similar partnership with industry and the federal government. In 1966 Congress adopted the National Sea Grant College Act that established a partnership between the federal government, industry and academic institutions. Funding from Sea Grant has since fostered research development in a variety of areas and aided in solving multiple marine environmental problems (http://www.seagrant.noaa.gov/aboutsg/historyofsg.html). Currently the Sea Grant network consists of 32 Sea Grant Programs in all coastal and Great Lakes states (http://www.seagrant.noaa.gov/colleges/index.html) in addition to Puerto Rico, which fund and support hundreds of institutions and thousands of researchers, engineers, and educators.

The Knauss Fellowship

Established in 1979, the Knauss Fellowship provides a paid educational experience to graduate students interested in ocean, coastal, and Great Lakes resources. The fellowship is named after the former NOAA Administrator, John A. Knauss. The purpose of the fellowship is to place highly qualified graduate student fellows in “host offices”, federal agencies and legislative representative offices, where they are introduced to the natural resource policy arena (http://www.seagrant.noaa.gov/knauss/index.html). The program is unique amongst federal agencies in its approach to place trained scientists in policy positions in order to best inform policy makers and policies. This is evidenced by the multiple agencies that recruit NOAA Knauss Fellows, such as the Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (FWS), the National Science Foundation (NSF), Department of the Navy and the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE).

Eligibility and Application

Students enrolled in a graduate program at an accredited university are eligible to apply for the Knauss Fellowship. Students apply through their state Sea Grant office, which selects five applicants a year to submit to the NSGO. If a state does not have a Sea Grant office,
students can apply through a neighboring state’s Sea Grant office. A component of the application process is to express your interest in the program with the state Sea Grant Director. Written endorsement of the applicant is required for the application. I contacted Ohio’s Sea Grant Director, Dr. Jeffrey Reutter, about the fellowship and he agreed to discuss it with me. I had sent my resume, letter of interest, and transcripts in advance and we had a productive discussion about the Knauss Fellowship and what I could contribute to and receive from the experience. Dr. Reutter was extremely helpful in editing my resume and letter of interest to highlight my strengths and improve my application. After the discussion Dr. Reutter agreed to endorse me for the Knauss Fellowship. Once applications are submitted through the state Sea Grant offices, a panel consisting of the Knauss program director, current, and past Knauss Fellows reviews them and selects finalists. A total of 46 Knauss Finalists were chosen in 2010.

Placement Week

Once finalists are selected, they are required to attend placement week, a one-week event where finalists are placed in host offices. This usually takes place in November, well ahead of the February start date. During this week, fellows are introduced to one another, acquainted with Sea Grant office members, and are exposed to a variety of other offices. Finalists fly in on a Sunday and meet one another at a group dinner, the first of a series of “meet and greets” that take place throughout the week on a nightly basis to get to know host office representatives and other Knauss Finalists. After Sunday the executive and legislative finalists split into two cohorts. The executive finalists are introduced to the various host offices and spend much of the week interviewing with host offices that meet their interest. Legislative finalists experience a similar situation and have interviews with various state representatives or senators. The remainder of this segment of the report will focus on my experience as an executive finalist as I am not aware of the legislative process for placement week.

On Monday executive finalists attend a daylong introduction to the various host office representatives who provide presentations on their office and what the Knauss Fellows can expect to do in that office. Fifty-seven offices presented and there were forty-six fellows, meaning competition was high amongst host offices because eleven offices may not receive a
fellow. It felt strange being on the opposite side of the hiring process where host offices are competing for you rather than you competing for a job. The day of presentations is helpful because it provides a more detailed explanation of what the fellow would do in the host office in comparison to the brief summary of skills and duties that host offices post to a website prior to placement week. Monday night and Friday morning are two of the most stressful times of placement week. On Monday night you have to decide, based on a limited amount of information, which host office you are going to interview with; and on Friday you have to choose your host office. On Tuesday morning executive finalists sign up for interviews and can interview with 12-20 offices over the course of Tuesday, Wednesday, and Thursday. On Thursday afternoon prior to 5 p.m. it is recommended that the finalists call the offices they are most interested in and notify them of their interest in the office. On Friday morning ranked lists of fellows for each host office are placed on tables. After they have been arranged, finalists survey these to see where they were ranked. Once everyone has had a chance to look over the lists, the top ranking individuals choose the office within which they want to work. Once they choose a host office they cross their name off the other lists to allow other finalists a chance to choose. For example, I was listed as the first finalist on the Coral Reef Watch list and the U.S. Fish and Wildlife Invasive Species Office list. After some thought and persuasion by another fellow who was second on the list and really wanted the U.S. Fish and Wildlife position, I chose the Coral Reef Watch office and crossed my name off the other two lists. After choosing a host office, the finalist visits the host office, signs the agreement forms and becomes a fellow.

**My Host Office: Coral Reef Watch**

Coral Reef Watch (CRW) is an interesting program within NOAA. While many offices and programs sit neatly in one NOAA line office and are primarily funded by that line office, CRW is different. CRW is officially situated in the National Environmental Satellite and Data Information Service (NESDIS), but the CRW program receives a majority of their funding through the Coral Reef Conservation Program (CRCP). In fact 50% of my fellowship funding came from NESDIS, the Center for Satellite Applications and Research (STAR) and the other 50% came from the CRCP. This segment will explain the CRW program and the hierarchical system it is situated in.
As implied by the title, the NOAA line office of National Environmental Satellite and Data Information Service (NESDIS) is overall responsible for NOAA’s satellite and data information systems. NESDIS operates the NOAA National Data Centers, provides near-real-time access to environmental data from satellites, and performs research and official assessments of the environment in order to protect and enhance the Nation’s economy, environment and security, in addition to supporting societal and economic decisions (http://www.nesdis.noaa.gov/AboutNESDIS.html). NESDIS requires the most funding of all the NOAA line offices due to the technical and departmental demands associated with operating satellites and analyzing satellite data. An organizational chart of the departments within NESDIS can be seen in Figure 2.

Figure 2. NESDIS Organizational Chart: http://www.nesdis.noaa.gov/OrganizationalComponents.html
The Center for Satellite Applications and Research (STAR) is a division within NESDIS that uses data obtained from satellites to make products for other NOAA offices that have a scientific or environmental application (http://www.star.nesdis.noaa.gov/star/index.php). Their organizational chart can be seen below in Figure 3. The organizational chart depicts the broad research interests that STAR has and the variety of data and products that they produce. STAR uses a life cycle perspective that includes creating, producing, enhancing, and mastering client requests for satellite hardware, data and products. For instance, many of the products on the CRW website are conceptualized, posted, and maintained on the CRW website by CRW staff, but the data, algorithms, and products are largely developed jointly between CRW and STAR staff.
Coral Reef Watch

The Coral Reef Watch (CRW) mission is to utilize remote sensing and *in situ* tools for near-real-time and long term monitoring, modeling, and reporting of physical environmental conditions of coral reef ecosystems ([http://coralreefwatch.noaa.gov/satellite/index.html](http://coralreefwatch.noaa.gov/satellite/index.html)). In order to accomplish this, the Coral Reef Watch program employs a number of scientists including oceanographers, marine biologists, and information technologies specialists. Most of the CRW team works in Silver Spring, Maryland but there are three scientists who are contractors working in Australia. This allows CRW to obtain data about remote sensing capabilities and coral reefs from around the world and develop products that have applications in a variety of locations throughout the world. It also allows the program to collaborate with leading coral reef research and management entities such as the University of Queensland, the Australian Institute of Marine Science (AIMS), the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Great Barrier Reef Marine Park Authority (GBRMPA). The multidisciplinary combination of scientific research, application, and education and outreach on the part of the Coral Reef Watch program has resulted in the widespread acceptance and use of Coral Reef Watch products throughout the world and for a variety of purposes.
Development of a Land Based Sources of Pollution (LBSP) Product

The Need for a LBSP Product

Coastal development and resultant land based sources of pollution (LBSP) can have negative effects on coral reefs because coral reefs generally require oligotrophic (nutrient free), clear, tropical waters (Sheppard et al., 2009). Nutrients and sediments from coastal agriculture or construction projects can increase the turbidity, pollutants, and primary productivity in the waters that coral reefs occupy (NOAA Coral Reef Conservation Program, 2009). This leads to increased sediment and algal cover of the reefs, which deprive coral’s symbiotic zooxanthellae of sunlight necessary for photosynthesis.

Recent workshops held by CRW have suggested that a LBSP satellite product would be helpful to natural resource managers and coral reef scientists throughout the world. It is through these workshops that the need for an LBSP product was verified. Ocean color remote sensing platforms, such as the moderate resolution imaging spectroradiometer (MODIS) and medium-spectral resolution, imaging spectrometer (MERIS), have the potential to view and estimate the clarity and amount of chlorophyll in the water but technical limitations, which will be discussed later, require research and development.

Coral Reef Conservation Program (CRCP) Goals and Objectives

Research and development for coral reef satellite products is important by itself, but to gain acceptance it is important to base satellite product research and development in policies that the Coral Reef Conservation Program (CRCP) has been charged with. The CRCP was established in 2000 and is a matrix organization within NOAA that draws from a variety of line offices such as the National Marine Fisheries Service (NMFS), the National Ocean Service (NOS), Oceanic and Atmospheric Research (OAR), and NESDIS. The CRCP works with the NOAA line offices in addition to U.S. States and territories “to address strategic coral reef management needs in a targeted, cost-effective and efficient manner” (NOAA Coral Reef Conservation Program, 2009). A recent mandate of the CRCP required that it undergo an external review. One of the recommendations of the external review was to
develop a series of 5-year plans and narrow the goals and objectives of the CRCP. This resulted in the CRCP goals and objectives for 2010-2015. The three primary goals and objectives consist of addressing the impacts of climate change, fishing, and land-based sources of pollution.

Coral Reef Watch currently has a suite of products that address climate change using sea surface temperatures and climatologies. This same data can also be used for fish related products at a large scale as temperature contrasts in oceanic currents often indicate areas of upwelling and nutrients, which feeds phytoplankton and drives trophic interactions in these areas. Therefore, of the three CRCP objectives, LBSP is the only objective that is not monitored by satellites. The following segment will explain why this is and what is being done to develop a LBSP product.

**Technical and Physical Considerations for an LBSP Product**

LBSP events in coral reef waters are difficult to capture using remote sensing, ocean color satellites. A number of technical and physical characteristics make it difficult to obtain accurate retrievals of desired parameters. The technical obstacles primarily consist of the spatial resolution of most environmental satellites used for oceanic applications and the fact that many of the satellites were designed for open ocean settings, not coastal settings. The physical obstacles consist of the characteristic attributes of coastal environments. The atmosphere in coastal areas, due to the interface between land and sea, can distort retrievals of water quality parameter measurements. The other factor is that waters in coastal areas tend to be both shallow and turbid.

*Case 1 and Case 2 Waters*

Within ocean color remote sensing there are two classifications of ocean water types that are monitored. Optically simple, deep, open ocean waters are classified as Case 1 waters and optically complex, shallow, near shore waters are Case 2 waters (IOCCG, 2000). Because coral reefs are largely located in Case 2 waters, ocean color remote sensing scientists have to deal with the technical limitations of the dominant remote sensing platforms and adjust for the confounding effects of the physical environments of coastal areas. The dominant remote sensing platform is the Moderate Resolution Imaging Spectroradiometer or MODIS.
MODIS (Aqua) was designed to capture large-scale events and features over large spaces, such as chlorophyll blooms in Case 1 waters. Pixel resolutions vary depending on the band or channel configuration of the satellite, with the largest pixels on MODIS being 1 square kilometer (km$^2$) in size and the smallest being 250 square meters (m$^2$). These resolutions make it difficult to capture discharge events, let alone coral reefs that are difficult to distinguish with a 30 m$^2$ pixel size.

In addition, atmospheric correction algorithms designed for use in optically simple Case 1 waters are inadequate for coastal applications in Case 2 waters. Remote sensing scientists have recently solved one half of the coastal monitoring puzzle (see figure 3 below from Wang and Shi, 2007) by using a process to combine near infrared and short wave infrared atmospheric correction algorithms to provide more accurate retrievals of water quality parameters in coastal areas (Wang and Shi, 2007; Wang et al., 2009; IOCCG, 2010). The method works by identifying turbid waters with an index and then determining which areas should be analyzed using the near infrared or shortwave infrared atmospheric correction algorithm. By incorporating the shortwave infrared portion of the electromagnetic spectrum into the atmospheric correction process researchers are able to obtain more accurate retrievals of water quality measurements. Prior to this development, retrievals of water quality parameters of chlorophyll amounts and water clarity were overestimated in coastal areas.

While advancements in atmospheric algorithms have improved, the shallow depth of coastal areas continues to make accurate retrievals of water quality difficult to ascertain due to the backscattering of the benthic substrate (coral reefs), which also provides inaccurate retrieval values. Numerous researchers are interested in solving this problem because it would allow more accurate water quality parameter estimates over coral reefs. One proposed concept to solve this problem is to develop a spectral “climatology” that would provide an average of backscattering values for particular locations. Once this average is determined, it would be possible to subtract this value from the reflectance value of subsequent data with
Figure 3. Comparisons of atmospheric correction techniques in coastal areas of the Chesapeake Bay, U.S. and the east coast of China from Wang and Shi (2007).
backscattering present and then analyze the reflectance values of water quality parameters of interest. One recent project proposal has involved researchers from NOAA, Mississippi State University, the University of Queensland, and CSIRO, but funding proposals for research and development have not been approved.

**Fostering Collaborations for an LBSP Product**

Collaborations for research efforts between governmental and public sector researchers can be implemented in a number of ways. These can include verbal agreements, data sharing arrangements, and in some cases financial support. A number of contractual mechanisms can be used when developing research collaborations between governmental and public sector research entities. Some examples consist of Memorandums of Agreement or Understanding (MOA and MOU), and Implementing Arrangements (IA). These can foster collaborations between agencies or smaller programs or offices within agencies. A recent MOU between NOAA and Australia’s CSIRO was developed to coordinate research efforts between the two agencies in the areas of oceanic and atmospheric research as well as climate change impacts. With this overarching MOU in place, CRW decided that it would be useful to coordinate an Implementing Arrangement between NOAA/STAR and CSIRO in the area of ocean color remote sensing for the development of products for measuring water quality over reefs. Part of this effort required coordinating efforts among researchers to determine topics they would like to focus on, what kinds of products would be developed, and what contributions they would provide.

After attending workshops and meeting with researchers we had determined that it would be useful to pursue an Implementing Arrangement and a NOAA/STAR Satellite Product and Services Review Board (SPSRB) request to foster the development of these products both within NOAA and amongst NOAA and CSIRO. In my efforts to draft an Implementing Arrangement I met with NOAA/NESDIS lawyers to discuss options and obtain drafts of previous Implementing Arrangements that I could use to model the draft for CRW. Having identified researchers best suited for working on the project, I worked to promote a dialogue between them to investigate the possibility of collaborative efforts. I asked researchers to draft a list of items for the Implementing Arrangement that they would contribute to the collaboration but I did not receive any input. By this time a conference for Ocean Color in
Hong Kong was about to happen and many of the collaborators would be there. A member of CRW planned to go and so I asked him if he would arrange for a meeting between the researchers most interested in this area. The meeting resulted in a verbal agreement between NOAA and CSIRO researchers to exchange and share data that would promote the development of this product. The SPSRB request is a formal request of STAR to develop a satellite product for a particular NOAA purpose. These requests, when authorized, commit time and money of remote sensing scientists to develop a product. The efforts on the part of research funding for the backscattering issue and both the Implementing Arrangement and SPSRB request are ongoing. Although the issue of backscattering over reefs is still unresolved, collaborations and contacts have been forged between key researchers. With the aid of funding and continued collaborations it may be possible to derive accurate estimates for parameters of water quality over coral reefs in the near future.
Coral Reef Watch: Conservation Education and Outreach

Education and Outreach Workshops

While coral related, remote sensing products for natural resource managers are the mainstay for CRW, there is also a substantial amount of efforts directed towards outreach and education. Coral Reef Watch regularly holds workshops with coral reef resource managers and scientists from a number of disciplines with an interest in coral reef conservation. The first type of workshop consists of regional training workshops for coral reef managers of an area (e.g. Caribbean) on topics such as reef resilience and climate change. These workshops are often joint efforts between NOAA and The Nature Conservancy. The second type are research and development workshops held with collaborators from a variety of locations such as the University of Queensland, CSIRO, AIMS, GBRMPA amongst many other collaborators. The purpose of these workshops is to explain the current knowledge of coral reef biology, remote sensing technology, and issues that coral reef managers are facing to determine what products would be of use to these researchers. The following segment will describe two of the workshops I attended as a NOAA Knauss fellow in the office of Coral Reef Watch.

Lamington, Australia and St. Thomas, U.S. Virgin Islands

The first workshop I attended was entitled Satellite Monitoring of Reef Vulnerability in a Changing Climate and was held from the 15\textsuperscript{th} – 18\textsuperscript{th} of February 2010 in Australia. The workshop took place in Lamington, Queensland but prior to the workshop the members of CRW met for their biennial retreat in Townsville, Queensland. During the retreat members participated in team building exercises, discussed CRW projects, mission statements, goals, and enjoyed snorkeling and hiking trips on Magnetic Island. This week also allowed for the U.S. CRW members to visit with cooperating institutions, such as AIMS and GBRMPA to discuss collaborations. After these events in Townsville, everyone flew to Brisbane, Queensland and travelled by bus to Lamington. Lamington was chosen due to its seclusion (it is located on top of a ridge in the McPherson mountain range and is surrounded by rain forest). Coral reef natural resource managers and researchers from public and private
institutions around the world attended the four-day conference. The workshop consisted of a mix of presentations by experts in the fields of coral reef biology, ecology, remote sensing, and management. Presentations were broken up by a series of discussions that focused on the benefits, problems, and future research areas for coral reef remote sensing products. The three broad categories of the workshop consisted of biological, technical, and managerial considerations. My first task was to document the workshop, with the assistance of additional participants. After the workshop I wrote and edited a technical report that captured the content and ideas discussed in the presentations and discussions held during the workshop. A link to the Technical Report of the workshop can be found in Appendix A of this internship report.

The second workshop I attended was the Reef Resilience and Climate Change: A Workshop for Coral Reef Managers. This workshop was held in St. Thomas, U.S. Virgin Islands from May 10-14th, 2010. The event is a joint training workshop between NOAA/CRW and the Nature Conservancy. The objective of this workshop is to share reef resilience and climate change information with stakeholders from a specific region. This workshop invited researchers, managers, and government officials from Puerto Rico, the U.S. Virgin Islands, and the British Virgin Islands and focused on issues within the Caribbean. Regional experts serve as trainers during the workshop and provide presentations on a variety of related topics to inform workshop participants. Additional activities include planning exercises and snorkeling trips, in this case Botany Bay, that train managers to identify areas of coral reef resilience to lessen the impacts of climate change and conserve coral reef resources. Participants are also informed of resources, such as CRW satellite products, so they have more tools to make informed decisions. The agenda and modules of the workshop can be seen in Appendix B of this internship report.

Both of the workshops were incredible learning opportunities that exposed me to a variety of perspectives, resources, and information about coral reefs and the threats to which they are subjected. In addition, it gave me the opportunity to become familiarized with the international institutions, managerial needs, and concerns of various coral reef regions. Having the chance to receive input from regional experts at a single location over the course
of a week serves as an exceptional educational and crowd sourcing opportunity that I learned a great deal from.

**CRW Products and Publications**

*CRW Suite of Products*

CRW provides a number of different operational and experimental products (Table 1), which can be accessed at [http://coralreefwatch.noaa.gov/satellite/product_overview.html](http://coralreefwatch.noaa.gov/satellite/product_overview.html). As coral biology research advances, researchers are becoming more aware of the multiple ways environmental stressors affect coral reefs. For example, there is now ample evidence that bleaching is not just associated with climate change through increased sea surface temperatures (SST); but that bleaching is often the result of increased SST and light stress (Lesser and Farrell, 2004; Hoogenboom et al., 2006). Light stress increases the potential for photoinhibition of the coral (Iglesias-Pietro, 1997; Dunne and Brown, 2001) and some reports from the field have found that coral colonies in mangroves that were shaded survived bleaching events while exposed coral colonies subjected to the same water temperatures bleached (Tihansky and Rogers, 2010). Unfortunately, bleaching is only the first stress related to corals; more research has indicated that thermal stress is a causal factor in disease outbreaks (Bruno et al., 2007; Heron et al., 2010). Thermal and light stresses are not the only climate change related threats to coral reefs. Another study by Analauf et al (2010) found that increased thermal stress, when coupled with ocean acidification, could have multiplicative detrimental effects on the growth of juvenile coral. Finally, wind (Mass et al., 2010) and water quality parameters (Wooldridge and Done, 2009) have also been cited as potential bleaching variables. CRW either has, or is in the process of, developing products for all of these stressors. While bleaching products are the primary operational products for CRW, research and development into additional, experimental products is ongoing. The CRW website [http://coralreefwatch.noaa.gov/satellite/index.html](http://coralreefwatch.noaa.gov/satellite/index.html) has an abundant amount of information on the suite of products the program produces. Data and information include:

Operational near-real-time data products  
Datasets in Hierarchical Data Formats (HDF) or Google Earth:
http://coralreefwatch.noaa.gov/satellite/hdf/index.html
http://coralreefwatch.noaa.gov/satellite/ge/index.html

Table 1: Summary of Operational (O) and Experimental (E) Coral Reef Watch Products:
http://coralreefwatch.noaa.gov/satellite/product_overview.html

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<tr>
<th>Operational Product Suite</th>
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<th>Current Conditions</th>
<th>Image Archive</th>
<th>Animations</th>
<th>Google Earth</th>
<th>HDF Data Archive</th>
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Enhanced 50km Products: near-real-time, better coastal coverage & climatologies

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<th>E50 Alert Areas</th>
<th>Status</th>
<th>Current Conditions</th>
<th>Image Archive</th>
<th>Animations</th>
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191 Virtual Stations
Experimental sites

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<th>Status:</th>
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<td>O = Operational; stable product with 24/7 support</td>
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<td>E = Experimental; product under evaluation; changes are possible</td>
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<td>R&amp;D = Research &amp; Development; future improvements are planned</td>
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While at first appearance it may seem that many of the products that CRW uses are coral specific, I am aware of several applications of the products that transcend coral reef applications. These include use in determining productive areas for fishing as well as tracking El Niño and La Niña events to study climate/sea interactions with typhoons. In the first example a company named Roffer’s Ocean Fishing Forecasting Service (http://www.roffs.com/) uses satellite data to detect parameters such as sea surface temperature differentials and chlorophyll concentrations that indicate upwelling. Areas of upwelling transport nutrients to the surface, drive phytoplankton growth, lead to higher level trophic interactions and ultimately attract fish. As these examples illustrate, because temperature and productivity drive so many oceanographic processes there are a wide amount of applications. This wide utility has led not only to numerous collaborations but also publications.

**CRW Publications**

There are a number of ongoing research and publication projects that CRW members are involved with as a result of their many interests and collaborations. These consist of “grey” papers (papers written and published by NOAA) and “white” papers that are written by NOAA employees and then published in peer reviewed journals. There are also other publications such as education and outreach materials. Numerous publications are released each year that have had some kind of CRW involvement. During my fellowship I contributed to the publication of both white and grey papers. The “grey” paper I edited, “Satellite Monitoring of Reef Vulnerability in a Changing Climate”, was discussed earlier and can be found using the link in Appendix A. The “white” paper I coordinated came as a surprise during my fellowship. Another NOAA author on the article was initially asked to write the piece for a special issue of Oceanography magazine, but they did not have enough
time to complete it. The author asked my supervisor, Mark Eakin, if he had the time to do it. Mark approached me about coordinating the effort and pulling it all together and I accepted. The topic of the special Oceanography edition was entitled “The Future of Oceanography from Space”. Our paper focused on ways remote sensing is used to monitor coral reefs. From April to December of 2010 I coordinated the drafting of several segments, compiling of sections, organization of the article, preliminary editing, and submission of the article to journal reviewers and editors. By the time of publication in December 2010, 14 authors from a variety of backgrounds contributed to the publication, which included multiple remote sensing platforms and a variety of biological and environmental applications. The final article, entitled “Monitoring Coral Reefs From Space”, was a fantastic coordination experience that allowed me to gain experience drawing together unfamiliar and new information into a cogent and cohesive article that is accessible to non-scientific audiences. A link to the article can be found in Appendix C.
Conclusion

The IES Experience

My experience with the Institute of Environmental Sciences (IES) has shaped my abilities and skills in ways I never could have expected. The combination of coursework, field activities, cohort camaraderie, and faculty guidance are experiences that I will fondly reflect upon in the future. This segment will expand on these experiences and explain how they prepared me for my fellowship experience.

Coursework and Field Courses

From our cohort’s first orientation field trip I could tell that the IES program would have something for everyone who had a desire to make the world a better place. The required coursework provided opportunities to learn, improve, or reaffirm a broad range of environmental assessment methods such as general surveying skills, the use of spatial technology, biological assessments, and data and statistical analyses. The core courses allowed the cohort to be both teacher and student and drew from the entire class’ expertise. Whether learning occurred in the classroom or in the field, it was always informative, fun, and relevant to real world environmental applications and problems. I took a variety of courses over a year and a half that allowed me to pursue areas of interest that I thought would enable me to build on my previous skills and take me in the direction I wanted my career to go. These included courses such as GIScience in Landscape Ecology, Limnology, and Environmental Statistics, which allowed me to build on my natural science and quantitative analytical skills. Most importantly, however, the required coursework emphasized not only the basic components of the scientific process, but the broader implications that science has on the society that utilizes it through the use of the Willeke Wheel problem solving process. This process facilitates the dissection of seemingly overwhelming environmental problems into manageable and resolvable tasks. While numerous IES courses invoked the use of the Willeke Wheel, few emphasized its utility as much as the field courses I took in the summer of 2009.
Tropical Marine Ecology and Coral Reef Ecology are two great interests of mine. Until I took these courses I had a longstanding appreciation of these research areas but no formal training. These courses put the pieces of my understanding of tropical marine ecosystems that I had developed over the years together and gave me the knowledge to participate in discussions about the study, concerns, and management issues associated with these ecosystems. These courses also provided an excellent intellectual foundation to work from when I was exposed to more in-depth material during my fellowship. Through experiential learning techniques, Dr. Cummins and Dr. Boardman facilitated an insight driven learning process that allowed students to choose their own learning topics and use the Professors as a resource. As a trained educator I genuinely admired their teaching philosophies. In these courses I was exposed to mangrove, seagrass, benthic, and fish identification, geomorphological and oceanographic forces on coral reefs, as well as applied and innovative characterization and monitoring methods of coral reefs. Additional topics included invasive species, freshwater management in southern Florida, and coral reef management techniques. The courses were both informative and entertaining and there is no doubt that they were essential for my success in adjusting to the steep learning curve I encountered when I began my fellowship.

Public Service Project and Graduate Assistantship

Additional IES experiences that prepared me for this fellowship were the public service project (PSP) portion of the IES curriculum and my duties as a graduate assistant. In my public service project I worked as part of a team to help answer the problem of why a decline in school student attendance to the Cincinnati Zoo and Botanical Gardens (CZBG) was occurring. The PSP allowed me to branch out to other disciplines and gain professional experience by working as a consultant for the CZBG and delivering needed information to the client. With the help of three other students our group held meetings with CZBG educational staff, conducted focus groups, interviews, and surveys of regional teachers, principals and educators, and provided presentations and reports of our findings. Ultimately we determined that the reason for the decline in school attendance to the CZBG was due to the decline in students in Cincinnati schools, which was likely the result of people moving out of Cincinnati and into adjacent suburbs. Trend lines for declines in attendance at the CZBG and student enrollment in area schools mirrored one another.
The other IES experience that prepared me for the fellowship was my graduate assistantship. During my time as a graduate assistant I had two jobs. For the fall semester of 2008 I had the chance to edit a public service project, which was conducted by an earlier class on the burgeoning deer population in Oxford, Ohio. This opportunity gave me additional editing experience through formatting and fact checking, and bolstered my research skills by expanding my biological knowledge of deer and population management strategies associated with them.

For the next year I would serve as a team member and outfall coordinator for IES and the Butler County Storm Water District. This work served to fulfill part of Butler County, Ohio’s requirements for the National Pollutant Discharge Elimination System (NPDES) regulations. In order for Butler County, Ohio to discharge wastewater into streams and rivers, Butler County must take steps to curb non-point source pollution by monitoring streams in the county for illegal discharges. The outfall project had the responsibility of monitoring 400 outfall sites to check for illegal discharges, and to sample 200 locations for water quality parameters within the course of a year.

The job was both challenging and rewarding in a number of areas. It was challenging because the protocol of the monitoring needed revisions or clarification by the Butler County Stormwater District and they were not particularly concerned with revising it during my term. The job also required long periods of field time, which I enjoyed, with the exception of hacking my way through Amur honeysuckle (Lonicera maackii) infested stream beds, catching poison ivy over the entirety of the back of my right leg when sliding over a fallen tree, and being told by local residents that “they had guns and they weren’t afraid of using them”. The job also required long periods of lab time conducting water quality analyses of samples taken in the field. The benefits of the job were that I became capable of collecting and analyzing water samples and analyzing them in a lab for a suite of water quality parameters.

I also had a chance to become intimately familiar with the southwest Ohio landscape, which can be quite beautiful. And the position enabled me to keep the rust off my GIS skills by creating new data layers of the outfall points I had monitored and gave me database entry
skills when uploading water quality measurements. Although the job was frustrating in some ways it was also very rewarding and I would do it all over again if given the chance. It provided me with a great understanding of water quality concerns, how to measure and analyze these, and how to coordinate sampling, analysis, and public outreach events.

The Knauss Fellowship Experience

My experience with the Knauss Fellowship took the skills, training, and knowledge I had gained through my time in IES and expanded it. Through travel and educational opportunities, special events and opportunities for professional development, I was able to strengthen and broaden my professional experience in the areas of remote sensing, coral reef ecology, and tropical marine coastal management. The combination of my IES and Knauss fellowship experiences have provided me with the skills and experience to begin a career in the area of coastal management, something I have always wanted to do. This section will address the ways the Knauss fellowship experience has enabled me to begin the next chapter in my career development.

Travel and Education Opportunities

After a week of starting my fellowship I was on a plane for Australia to take part in a CRW Retreat and assist with the documentation of a CRW workshop in Lamington, Queensland. The retreat provided me with the opportunity to get to know the entire CRW staff, become familiarized with the suite of CRW products, see who was working on which projects, and meet Australian collaborators. I arrived a couple of days early in order to see Townsville, Queensland and dive on the Great Barrier Reef. The week was informative in so many ways. In a week I saw a snapshot of the diversity of Pacific coral and reef fish species on a dive trip to Walker’s Reef in the Great Barrier Reef. I also visited the GBRMPA headquarters and aquarium, and the AIMS aquaculture facility, labs, and machine shop for building oceanographic equipment. The following week was just as incredible when we flew to Brisbane and took a bus to the workshop in Lamington, Queensland. At the workshop I was exposed to numerous presentations on a variety of biological, technical, and managerial aspects of coral reefs. Although much of my time was spent taking notes and documenting the workshop, during time when someone else was taking notes it was like I had a free
lecture from a leading coral reef researcher. My travel experience in Australia was one of two incredible travel and learning opportunities.

My second travel and learning opportunity was to assist with workshop logistics for a workshop in St. Thomas, U.S. Virgin Islands. Again, I had to go a few days early in order to reacquaint myself with the resources I was working for. During the workshop regional experts provided a wealth of information on the various issues affecting their coral reefs and how they were working to address these. Over the course of four days I had the chance to understand the various issues facing coral reef researchers and managers in the Caribbean, participate in a field snorkeling exercise that introduces participants to ways they can identify resilient reef areas, and visited the University of the Virgin Islands research facility. This travel and education opportunity allowed me to reinforce previous concepts I had learned in Australia, as well as become more familiar with the various issues affecting coral reefs in the Caribbean.

Educational opportunities during my fellowship largely consisted of courses offered through NOAA’s Coastal Services Center (CSC): http://www.csc.noaa.gov/. The CSC provides a number of services to NOAA facilities and one of the major services is training http://www.csc.noaa.gov/training/. There are a variety of courses offered and the three courses I took were GIS Tools for Strategic Conservation Planning, Public Issues and Conflict Management, and Project Design and Evaluation. The courses varied in time from four days to three, but they all provided valuable information. The GIS Tools for Strategic Conservation Planning course provided an excellent framework for using spatial analysis tools in conjunction with conservation planning methodologies to perform a number of coastal analyses. The course used ArcGIS tools, such as spatial analyst and model builder, which refreshed my skills with these tools. The course also provided me with an understanding of a variety of new tools I could use.

The Public Issues and Conflict Management course trained participants in the scenarios and personalities that a communication representative is likely to encounter in a variety of meetings. Through numerous presentations, in class exercises, and role-playing exercises I was exposed to methods that both prepare for and defuse confrontational scenarios. The last
CSC course I took was Project Design and Evaluation. In this course we had the opportunity to learn about the ways to tackle projects of varying sizes by conceptualizing goals and objectives and then operationalizing these using a variety of methods. The course drew upon information from material and philosophies I had learned in my undergraduate educational coursework as well as the problem solving skills and planning methods I learned in IES. My work related travel and educational experiences during my fellowship heavily drew on my IES training.

Special Events and Professional Development

Throughout the course of the Fellowship there were a variety of special events and opportunities for professional development. The special events largely consisted of tours to various Washington D.C. landmarks including the White House, the U.S. Capitol Building the Library of Congress, and the U.S. Naval Observatory. The tours were arranged and scheduled by fellows in both the executive and legislative branches who had connections with tour operators in these landmarks. Most of the tours are open to the general public and for some, like the tour of the White House; it took over six months to arrange for the tour. Most of the tours were well worth the wait and provided excellent insights to the history and intrigue of Washington D.C. Other special events included happy hours, where current and past NOAA Knauss Fellows had the chance to network and get to know one another. The informal class trip, as these are no longer funded by the fellowship, consisted of a trip to a Farm in the Shenandoah Valley during the fall. All of these opportunities allowed for the Fellows to relax, have fun with one another, network, and form friendships with colleagues.

Opportunities for professional development were also available. Our Knauss class was offered a Sea Grant Career workshop, and I attended an International Coral Reef Task Force Meeting and a Nature Conservancy Marine Protected Areas (MPA) Symposium. Our career workshop was very helpful and a number of NOAA contractor companies sent representatives to discuss the hiring process, protocols, and tips for applying to jobs within NOAA. The workshop was very helpful and it provided a bit of needed reassurance that our time as Knauss Fellows would be a valuable commodity. The International Coral Reef Task Force Meeting was a great opportunity to see high-level U.S. agency interactions as they pertain to coral reef resources. The meeting provided an opportunity to meet and network
with people who have an interest in coral reefs from around the U.S. and territories. Another similar, but smaller and more focused event that allowed for professional development was the Nature Conservancy’s Kathryn D. Fuller Symposium on Marine Protected Areas (MPA). In this symposium a number of researchers presented and discussed the numerous issues associated with MPAs, their design, and their management. A number of other NOAA employees and fellows attended in addition to a wide variety of stakeholders.

The combination of my experience with the IES program and the Knauss Fellowship facilitated experiences that allowed me to advance in the direction I wanted my career to go. The two experiences gave me a great background in tropical marine and coral reef ecology and I have had the chance to see aspects of the science behind these fields as well as the policy and management of these natural resources. I have had the chance to meet experts in these fields from around the world and collaborate on interesting and multifaceted jobs. I have no doubt that the skills I have learned will provide me with the ability to be successful in a variety of future pursuits and think that both experiences have made me more connected to the people and institutions that are working in these fields.
References


Appendices

Appendix A: Lamington Workshop Technical Report
http://coris.noaa.gov/activities/sm_reef_vulnerability/
Appendix B: Reef Resilience and Climate Change Workshop Agenda

Reef Resilience and Climate Change Workshop
May 10 – 14, 2010
Frenchman’s Reef and Morning Star Marriott Beach Resort
St. Thomas, US Virgin Islands

Day 1: Monday May 10th

1:00-1:45   Introductions, Logistics, Agenda, and Overview of the Activities – Local Host and Britt Parker (45 minutes)

1:45-2:45   Module 1: Climate Change Basics and Discussion – Tyler Smith (1 hour)

2:45-3:00   Coffee Break (15 min)

3:00-3:45   Module 1: Mass Coral Bleaching & Bleaching Physiology and Discussion – Tyler Smith (45 min)

3:45-4:00   Module 1: Ocean Acidification – Tyler Smith (15 min)

4:00-5:00   Participant Introductions (1 hr)

1 slide per participant, or group if coming from the same agency, and 2-3 minutes.
Day 2: Tuesday May 11th

8:15-8:30  Announcements, Discussions and Reactions
8:30-9:30  Module 1: Climate Change and Coral Disease – Marilyn Brandt (1 hour)
9:30-10:00 Supplemental Activity: Name that Disease! – Marilyn Brandt (30 min)
10:00-10:15 Coffee Break
10:15-11:30 Module 2: Bleaching Early Warning Systems – Britt Parker (1hr 15min)
11:30-12:00 Activity 1: You Make the Call – Britt Parker & Carl Nim (30 min)
12:00-1:00 Group Lunch
1:00-2:30  Module 3: Principles and Components of Resilience – Nancy Woodfield-Pascoe (1hr 30min)
2:30-2:45  Coffee Break
2:45-4:15  Module 4: Resilient MPAs and MPA Networks – Nancy Woodfield-Pascoe (1hr 30min)
4:15-5:00  Case Study: British Virgin Islands - Nancy Woodfield-Pascoe (45 min)

**Remember to fill out course evaluations for Modules 1, 2, 3 and 4 and Activity 1.**
**Day 3: Wednesday May 12th**

8:00-8:15  Announcements, Discussions and Reactions
8:15-8:45  Activity 2A: MPA Reef Classification (30 min)
8:45-9:45  Activity 2B: MPA Design & Zoning (1hr)
9:45-10:15 Group Presentations of Activity 2 Results (30min)
10:15-10:30 Coffee Break
10:30-11:15 Module 5: Monitoring Mass Bleaching Events – Tyler Smith (45 min)
11:15-12:00 Module 5: Monitoring for Resilience Factors – Tyler Smith (45 min)
12:00-1:00 Lunch
1:00-5:00  Field Trip Introduction – Tyler Smith and Kemit Lewis
          Activity 4: Field Trip
          Field Trip Debriefing
TBD       TNC Sponsored Reception

**Remember to fill out course evaluations for Module 5 and Activities 2 and 4**
Day 4: Thursday May 13th

8:15-8:30  Announcements, Discussions and Reactions
8:30-9:30  Module 5: Assessing Social and Economic Impacts – Christy Loper (30 min)
9:00-10:15 Social Science Case Studies: Environmental Awareness and Social Resilience – Chris Setter and Christy Loper (1 hr 15 min)
10:15-10:30 Coffee Break
10:30-11:15 Facilitated Discussion: Setting Social Science Research Priorities for Climate Change – Christy Loper (15 min)
11:15-12:00 Module 6: Incorporating Resilience into Management Discussion – Paige Rothenberger (45 min)
12:00-1:00 Lunch
1:00-1:45  Module 6: Incorporating Resilience into Management Discussion – Paige Rothenberger (45 min)
1:45-2:45  Module 7: Communications – Kemit-Amon Lewis (1 hr)
2:45-3:15  Communications Examples and Discussion (30 min)
3:15-3:30  Coffee Break
3:30-4:00  Module 8: Introduction to Bleaching Response Plans – Britt Parker (30 min)

**Remember to fill out course evaluations for Module 5, 6 and 7**
Day 5: Friday May 14th

8:15-8:30  Announcements, Discussions and Reactions
8:30-10:15 Activity 5: Drafting your Bleaching Response Plan (1hr 45min)
10:15-10:30 Coffee Break
10:30-11:15 Group Presentations of Bleaching Response Plan Activity 5 (45 min)
11:15-12:00 Workshop Wrap Up Discussion: Challenges and Next Steps

**Remember to fill out course evaluations for Activity 5**
Appendix C: Monitoring Coral Reefs From Space