Appendix C: Discussion Board Notes

Monday, 15 FEB 2010:

"Brainstorming for ideas for new remote sensing products"

Facilitator: William Skirving

- More direct measurement of pH / alkalinity, PCO2.
- Change Detection
    - Hind casting and gap filling of current products
    - Sea level rise at varying spatial and temporal scales.
    - Benthic community identification.
    - Coral bleaching and coral mortality (both cold and warm water).
    - Sea grass beds.
    - Phytoplankton Functional Types (*i.e.,* diatoms *vs.* coccolithophores)
- Identify large sources ("hot spots") of fresh water runoff to reefs.
- Prediction of plume events and use of Synthetic Aperture Radar (SAR) to detect plume events.
- Prediction of roughness and storm damage as a result of hurricanes or cyclones.
- Water movement frontal tracking.
- Compliance product for water quality (turbidity / nutrients) and ship navigation.
- Mapping regional trends and frequency so as to obtain data and baselines for future predictions.

"Integrating *in situ* monitoring with remote sensing to provide tools for management"

Facilitator: Billy Causey

- Tracking of currents and eddies.
    - Velocity, direction, intensity and duration would be useful for multiple management issues such as larval dispersion.
- Methods of obtaining *in situ* data for training and validating water quality remote sensing products in regions with case 2 waters.
    - Ships of Opportunity / Ship based measurement platforms: These can measure numerous biological indicators but hard to match up with satellites.
    - Stationary systems measure fewer biological indicators but have a better match up with satellites.
    - Jetty platforms for collecting numerous samples and linking data with satellites.
    - Marine animals as mobile data loggers.
- Ocean heat product to infer water temperature gradient in water column.

- Using remotely sensed products for targeted monitoring (*i.e.,* river plumes and salinity monitoring / Improved temperature assessment for targeted bleaching response).

Tuesday, 16 FEB 2010:

"How can the use of remote sensing data in models improve coral reef management?"

Facilitator: Scott Heron

- What are the management / ecology implications of model parameterization? For example, what if channels are smaller than model grid size?
- Areas of model enhancement:
    - Coral scientists would like to see more work done with description and verification of light fields in climate models to better understand coral physiology.
    - Managers would like to see enhanced larval distribution models that would add more larval types and include endemic species as vulnerable populations. In addition, identification of coastal sources of water would be helpful.
- Do we have enough biological understanding to use the outcomes of physical models?
    - Models help in pointing out gaps in our knowledge, such as processes that we don't understand yet.
    - Models can be used to design biology data collection programs; they interact and feed both ways.
    - Management decisions need to be made with imperfect knowledge of climate change. Models are necessary so managers can begin adaptive management.
- Model Ideas
    - Use of 3-D radiosity distribution models.
    - Use of 3-D hydrodynamic, biogeochemical models. These, used in part by remotely sensed data, could predict light at the reef surface. Additional components could include pollutants and nutrients, which would then be combined with other data and used to model the ecosystem response.
    - Test sensitivity of ecosystems to various environmental factors then focus research to better constrain models.
    - Use models to interpolate observed water quality data to look for mechanisms, animations, predictions and data reanalysis.
- Communicating Models
    - Model outcomes need to be communicated effectively. Model users must be trained about the assumptions, conditions, boundaries and uncertainties of the models they are interpreting. Given advancements in various fields it is important for turnovers to occur if models are to be used for a different purpose than they were designed.
    - Collaborations are essential: "Crowd Sourcing" allows many perspectives to be taken into account to find an optimal solution in the model development process. Interactions / linkages between managers, citizens and modelers aid

in identifying useful products for managers and verifying intuitive local knowledge of processes affecting citizens.

"Improving links between science and management"

Facilitator: Mark Eakin

- In areas with traditional management systems intact, it is important to work with that system in management decisions; in areas where they are not intact, reinstating them can be beneficial.
- Western science should not be used to "validate" traditional management frameworks; instead we need to work together to move forward (furthermore sometimes traditional information can be a good tool to validate the current science).
- Frameworks such as CTI (Coral Triangle Initiative) give us an opportunity to manage multiple areas together. This allows tribes to move through areas that would be managed by different countries in the past.
- As an example from India pointed out, sometimes more information on fish location can lead to a more sustainable and efficient fishery. Catch Shares and Individual Transferable Quotas (ITQ's) are another tool for sustainable and efficient fisheries.
- Managers in the GBR would like to move forward by including more flexibility in management, by incorporating resilience into the management zones and plans, and by doing more adaptive management. Nonetheless, there are challenges to this, such as:
    - The Parliamentary process
    - Limitations in our understanding of the biology
    - Challenge of communication and stakeholder support; importance of involving the stakeholders in the process of decision making, such as zoning with tools like "TRADER."
    - Caution is necessary when closing areas in perpetuity as we do not yet have the science to back this up
- There is a lack of understanding of the scientists on the day-to-day needs for information on the management side.

- In bridging science and management we are two different communities with different goals.
    - Must communicate the goals of each party upfront in order to work together better.
    - Must understand the desired outcomes of each party.

"Use of water quality and light over coral reefs for future management products"

Facilitator: Arnold Dekker

- What temporal and spatial resolutions would be best?

- Can we produce a number of "experimental" products as long as we explain the limitations?
- Ancillary technology and techniques for supporting, calibrating and validating the remote sensing of coral reefs.
    - Models with temporal frequency.
    - Sonar and UAV (Unmanned Aquatic Vehicles) for ground truthing.
    - Stereo 3-D images for resolving ground-truth gaps.
- Novel uses of remote sensing coral reefs.
    - Carbonate balance from coral color and structure.
    - Coral shapes could be retrieved using stereo images but type 2 waters complicate. On water sensors may work the best.
    - Metals and micropollutants detected via proxy relationships.
    - Nutrients could be inferred from indirect relationships but this could include some chance of error.
    - Long-term management products, risk maps, acute events (WQ plumes) compliance products and thresholds.
- Enhancements that could be made to remote sensing platforms.
    - Use of improved geostationary satellites or nanotechnology to achieve more frequent revisit time.
    - Arrays of satellites for constant coverage would benefit coverage but may complicate processing.
    - More use of hyperspectral data for classification and bathymetry.
        - Could aid in calculating percent cover and species estimates of benthic habitats.

<u>Wednesday, 17 FEB 2010:</u>

"What novel uses of any environmental variables can assist management of coral reefs?"

Facilitator: Tyler Christensen

- Important parameters to address in an automated way.
    - Nutrients and Nutrients + Loss of Coral Cover
    - Currents (connectivity, recruitment, *etc.*)
    - Water Movement (waves, tides, currents, and winds) for multiple variables such as temperature and oxygen depletion.
    - Areal Extent of Habitats; and Volumetric (3D/4D – through time) Extent. We can get at many of these with measurements on the ground, but finding automated ways of doing this is import. Are there other parameters that stood out?
    - Water quality/clarity (turbidity) as a result of upwelling and terrestrial input.
    - Rates of change in all of these variables
    - Precipitation as a good precursor for water quality events (LBSP)
    - Prediction of future habitats might be based on different variables

    - Combining variables to create bio-indicators
    - Substrate is important; bathymetry would inform this.
    - Zoox clade algorithm to inform past products
    - Salinity
- Based on the discussion that Scott Woolridge started; there are a lot of complex interactions out there, maybe we can create an overlay of sensitivity based on discerning some of those relationships.
- Is species distribution possible? Coral types might be enough; species composition is key.
- Salinity is difficult to ascertain, however, flood plumes could act as a proxy. Both river plumes and island run off are important but each require different methods of detection.
- Cold water bleaching products?
- Oxygen (not bulk oxygen but more at the reef and in tissues)
    - Combine coupled models and buoys
    - Functional groups will be very important because some corals do better than others due to biophysical characteristics, such as tissue thickness.
- Long term records of wind and direction, air temperature, and wave climatology.
- Upwelling: In the GBR can be indicator of early bleaching
- Concept of Resilience
    - What are the parameters? Water circulation and movement, reef near deeper areas, shading (mountains), areas of natural turbidity/flocculants.
    - Layer resilience parameters on map to get a sense of where their resilient or vulnerable areas are.
- Questions for consideration: What are the temporal scales? What do we need for acute events and what do we need for the long term? Some global parameters can be coarser, some local aspects could be on a finer resolution or in more real-time. Mapping stress or risk is another concept.
- Past thermal history
    - Past bleaching events
    - Past exposure to variable conditions

"Is there too much emphasis on corals and coral health? Do we need to be providing non-coral specific tools to assist management of coral reefs?"

Facilitator: Mark Eakin

- Coral and "the Other" - Benthic composition of entire ecosystem is needed:
    - Algorithms for seagrass would be useful for detecting changes to coral reef ecosystems over time.
    - Mapping of crustose coralline algae to identify important areas of coral recruitment.
    - Difficulty in determining which components to monitor.
- Can calcification rates of coral be determined to determine volumetric change over time?
- Would an algorithm for benthic micro-algae be useful?

- More work is needed for determining thresholds and bioindicators or keystone species of coral reef organisms, although the process of determining these is likely to be contentious.
- Calcification rates of corals in reefs versus non-reefs are comparable. There are tools that we have which can be repackaged to determine calcification such as SST and Sea Grass.
- Spatial considerations – Latitudinal gradients need to be considered for coral and crustose coralline algae. For instance, how does ocean acidification affect high latitude reefs?
- Alternative sources of information: Could data that Bioprospectors have be useful in understanding environmental stressors / conditions of coral reef organisms, namely sponges.
- ESA will produce high-resolution products for coral reefs soon.

Thursday, 18 FEB 2010:

"From a management perspective, what are examples of good product delivery?"

Facilitator: Randy Kosaki

- History of the organization, communication, and economic funding of the CRW workshops.
    - Initial Funding: World Bank
    - Initial Organization: Al Strong and Peter Mumby
    - Communication Networks: Coral-List and ReefBase
- Discussion of how close we are to being able to analyze other parameters that confound the impacts on coral health such as water quality and light.
    - Should we develop products that synthesize and /or separate both of these new components?
    - Thresholds – are these known or do we need more research?
- Process of product development
    - When to release operational and experimental products?
    - Use of a Beta testing group of scientists and managers to receive feedback on products.
    - Product outreach when experimental products are released
    - Lessons learned include the following issues.
        - Disagreement between CRW Bleaching Outlook and the BoM POAMA model outlook release for GBRMPA.
        - The potential for contrast of communication between locations, for example, hot spot blips in the Caribbean and the NWHI Monument.
- Important items for products.
    - Predictive or change related products.
    - Simplicity and Accessibility is key for use by managers.
    - Not just data product but product that can inform management – tie parameter to reef impact

- Better to have new / experimental false starts with products and explain the problematic features than to have no starts at all.

"Management questions with limited information"

Facilitator: William Skirving

- Florida Cold Snap – How much seagrass has died off as a result of this?
  - How to reference this against a baseline given difficulties with the determination of baselines and the shifting boundaries highly fluctuating habitats, such as seagrass beds.

- Vessel groundings and associated problems like cargo spills and scar recovery remediation.
  - Use of high resolution remote sensing like Landsat and SAR to track and report illegal vessels.
  - MODIS if the spill is large.
- Aerial photos or satellite based information to document illegal navigation outside of channels that damage seagrass beds.
- Forensic oceanography to track drugs and bodies.
- Crown of Thorns Starfish (COTS) outbreak detection and patterns of it. Difficulty in detection due to limited temporal visibility.
- Closure events such as coral diseases and outbreaks.
- Usage patterns of locations people use the most.

"What other variables, tools, and information would be useful for managing coral reefs?"

Facilitator: Roberto Iglesias-Prieto

- Tools
  - Public relations media products such as animations, films and pictures taken from the field that document, in real-time or past events, stressors to coral reefs.
  - Database and network structure for facilitating a citizen science framework for gathering data, information and photos.
  - Ocean acidification hot spots for planning purposes.
  - Disease Algorithm
  - Coastal Runoff
- Variables and Information
  - Wind data from *in situ* instruments and satellite derived data.
  - Tidal component to estimate water flow.
  - Coral spawning information such as directional prediction and tracking.
  - More *in situ* Ocean Acidification data. Need for Rio Tinto.
  - Need a method to illustrate to policy makers that ocean acidification is occurring.