Meeting Report

U.S.-China Meeting on Living Marine Resources: Habitat Monitoring, Assessment and Restoration of Reef Systems Project

November 1-3, 2011

The inaugural meeting of the Habitat Monitoring, Assessment and Restoration of Reef Systems Project was convened in Honolulu, Hawaii, USA from 1-3 November 2011. The goals of this meeting were to exchange information and experience associated with monitoring, assessment, and restoration of reef systems (natural and artificial), and identify opportunities for collaborative research. This project falls under the auspices of the larger U.S.-China Living Marine Resources Panel initiative, which last met in June 2011.

Dr. Gerard DiNardo, the United States Chair, and Mr. Wang, Taijian, the Chinese Chair, opened the meeting. Dr. DiNardo welcomed everyone and expressed high hopes for success through the meeting. Mr. Wang thanked the U.S. delegation for hosting the meeting and emphasized the importance of artificial reefs in terms of developing a sustainable marine economy in China. Participants introduced themselves, providing their affiliation, responsibilities and scientific interests **(Appendix 1)**. Mr. Alex Johnston and Dr. Jihong Dai served as lead rapporteurs with overall responsibility of assembling the meeting report. The meeting agenda was reviewed and adopted with minor changes **(Appendix 2)**.

Mr. Keith Chanon, International Science Coordinator in NMFS/ST, provided an overview of the activities of the U.S.-China Living Marine Resources (LMR) Panel. The Panel was established under the "Protocol on Cooperation in the Field of Marine and Fishery Science and Technology" between the Chinese State Oceanic Administration (SOA) and NOAA. The Panel met in June 2011 at NOAA Headquarters in Silver Spring, MD to reinvigorate joint scientific collaboration on the LMR Panel and fisheries. Topics of mutual interest included: aquaculture, climate and ocean acidification, habitat monitoring, assessment and restoration, endangered species and harmful algal blooms. In addition, the delegates shared proposals for sustaining research collaboration through scientific staff exchanges and a Sino-American scientific seminar series. A number of joint project proposals have been shared addressing collaboration on artificial reefs, sea turtles, Western Gray Whales, krill, stock enhancement, stock assessments, shellfish cultivation, habitat monitoring, and response to oil spills. Efforts are underway to develop work plans and advance collaboration on these proposals. The next meeting of the LMR Panel is scheduled for fall 2012 in China.

A discussion about the LMR Panel followed. Concerns were voiced on creating too many proposals, and not enough specific outcomes. It was emphasized that the purpose of the current meeting was to (a) foster communication and contacts (b) outline next steps, and (c) create work plans with specific projects in mind. Possible linkages with other LMR themes, such as stock enhancement, were also pointed out.

Theme 1: Artificial Reefs: Utility and Implementation

Dr. Jim Bohnsack (NMFS/SEFSC) provided an overview of U.S. research on artificial reef utilization and monitoring. The presentation emphasized the importance of artificial reef monitoring for:

1) Identifying and describing spatial and temporal patterns in artificial reef processes.
2) Measuring the reef effectiveness and performance of artificial reef interventions.
3) Testing hypotheses, leading to scientific advice to inform policy and management decisions.

Dr. Bohnsack pointed out previous problems with artificial reefs in the United States, noticeably irresponsible dumping of materials and mistaken theories that fish and other sealife will automatically appear if materials are simply placed in the water.

A brief discussion followed. Questions arose if there had been stock assessments that incorporated artificial reef data in the U.S. It was noted that studies and analyses have been done on Red Snapper in Florida, for example. Results suggested while artificial reefs may encourage species attraction, they do not significantly improve production compared to natural habitat that already exists.

Prof. Chen Pimao (CAFS/SCSFRI) made a presentation entitled: "Sea Ranching Construction Based on Artificial Reef Construction and Stock Enhancement," concerning several artificial reef demonstration areas in Guangdong Province, China. The construction of artificial reefs was divided into three phases: initial stage (1980's to 1990's); starting stage (1990's to 2005) and development stage (2005 to present). The integration of artificial reefs and stock assessments with modern science and technology was the main focus. Results showed the capabilities of sea ranching to significantly restore and improve the marine ecological environment, as well as to proliferate and protect fishery resources.

A discussion followed. Automatic monitoring in China was clarified as monitoring of water quality, automatic imaging, biological monitoring, and using automated biologic imaging devices. Sea ranching in China was clarified as a multi-pronged effort to increase biomass production through practices including stock enhancement, artificial reefs, management measures, and other methods.

Prof. Li, Jilong (CAFS) introduced a national action plan proposed for aquatic resource conservation in China. The implementation of artificial reefs was specifically proposed in this plan to: (a) stabilize and/or increase certain species' populations, particularly high-demand and profitable species, and (b) increase numbers of manageable species.

From 1985 to 2010, China invested a total of 2.29 billion RMB on artificial reefs, of which

about 250 million RMB came from the central government. Local governments and private enterprises contributed about 2.04 billion RMB.

Ongoing issues include: (a) habitat creation for large-scale artificial reefs with balanced organism affiliation, as well as improving deserted sea beds; (b) stock enhancement techniques related to junior fish protection and feed organism cultivation; (c) target species domestication for marine species; (d) long-term monitoring of reef species including the size and number of catchable fish; (e) application of RS (Remote Sensing) and GIS (Geo-spatial Information Systems) techniques for reef site selection; and (f) management capabilities and institutional policy-oriented research.

The following items were highlighted by Prof. Li as important for China:

1) Techniques for deep sea reef construction
2) Techniques for sustainable reefs
3) Studies on carrying capacity for reef area stock enhancement
4) Project phase management with government or enterprises
5) Techniques for spawning ground protection while junior species are present
6) Techniques for regulating upwelling and primary productivity
7) Regulation of reef construction procedures and techniques
8) Improving results monitoring and assessment capabilities
9) Permitting and management of reef protected waters
10) Resource management and procedures to avoid excessive fishing

An open discussion on artificial reef utility (Theme 1) was conducted. China was asked about its sampling data and data availability on artificial reefs. China has data for its publicly-funded artificial reefs, including data on reef construction, materials, and stability. Data are generally not publicly shared for privately-funded reef projects, which are prevalent in China. Clarification was sought on China's monitoring programs, and metrics used to gauge success regarding increased production and diversity on artificial reefs. It was noted that China conducts local studies before and after reef placement in an effort to gauge success. In addition to environmental studies, China places more emphasis on economic impacts, such as catch values and earnings improvements for fishermen. Broader studies comparing different reef sites with each other are lacking. It was emphasized that in China, private enterprises operate a substantial amount of artificial reefs, and therefore tailor their studies towards improving profitability. Often this means determining valuable species to raise, such as sea cucumber. Finally, a question was raised about China's monitoring via fishing and whether monitoring was adjusted for fishing effort. China monitors its publicly-funded reefs, while privately-operated reefs are monitored primarily only for profitable species.

<u>Theme 2: Reef Systems: Assessing Efficacy and Performance</u>

Dr. Jim Bohnsack (NMFS/SEFSC) presented a case study of the U.S. "Rigs to Reefs"

program, first started in 1979. As the number of offshore oil rigs requiring decommissioning peaks, there is growing pressure for the implementation of a "rigs-to-reefs" program in the deep sea, whereby obsolete rigs are converted into artificial reefs. Decommissioned rigs theoretically can enhance biological productivity, improve ecological connectivity, and facilitate conservation and restoration of deep-sea benthos (e.g. cold-water corals) by restricting access to fishing trawlers. Preliminary evidence indicates that decommissioned rigs in shallower waters can also help rebuild declining fish stocks. Potential negative impacts include physical damage to existing benthic habitats within the "drop zone", undesired changes in marine food webs, facilitating the spread of invasive species, and contamination as rigs corrode (*Macreadie et. al., 2011*) [1]. Dr. Bohnsack reiterated the importance of establishing partnerships between scientists and industry to improve the capacity for further research, and emphasized supporting independent research and monitoring programs to evaluate the effectiveness of rigs in fulfilling their intended purpose as artificial reefs in the deep sea. Finally, Dr. Bohnsack emphasized that artificial reefs contribute a miniscule portion to fish production, if anything, when compared with the natural reefs and environments already in place.

A brief discussion followed, in which the group agreed to postpone discussion and decision-making on combining themes of stock enhancement and artificial reefs until further presentations had been made.

Dr. Matthew Parry (NMFS/PIFSC) gave a presentation on the case studies of artificial reefs conducted jointly by PIFSC and the State of Hawaii. The purpose of Hawaii's artificial reef program is to increase fishing opportunities. The State's first artificial reef was created in 1961 at Maunalua Bay, off Kahala, Oahu. In 1963, two more artificial reefs were created off Keawakapu, Maui and Waianae, Oahu. A fourth artificial reef was created in 1972 off Kualoa, Oahu. The Ewa Deepwater artificial reef was built in 1986. Unlike the other four artificial reefs, which were built in water depths of 60-120 feet, the Ewa deepwater artificial reef was built in 50-70 fathoms (300-420 feet) of water for bottomfish habitat and is 31 acres in size. The two most popular types of artificial reef modules used since the 1970s include "Z-modules" and "Belt Transect". There are issues such as limited bottom time due to depth and the haphazard nature in which modules are deployed. Since 2007, a new SPC method has been considered and is still being fine tuned.

A discussion followed Dr. Parry's presentation. Questions were raised about Z-modules' construction, configurations, and stability once deployed. As Z-modules are deployed in groupings, some become buried, while others remain above the ocean floor. Studies have shown that Z-modules, by virtue of their size, weight, deployment depths, and deployment styles, are stable and not affected by ocean currents or inclement weather. Recreational

[1]Macreadie, P.I., A.M. Fowler, and D.J. Booth. 2011. Rigs-to-reefs: will the deep sea benefit from artificial habitat? Fron. Ecol. Environ. 9(8): 455-461.

divers have also reported no structural problems or risks. The State of Hawaii determines reef sites according to permit availability and funding levels. By contrast, Florida's artificial reef program uses considerable input from the recreational fishing sector to decide on artificial reef sites.

Dr. Rusty Brainard (NMFS/PIFSC) gave a presentation entitled "Autonomous Reef Monitoring Structures (ARMS): A Systematic Tool to Assess Spatial Patterns and Temporal Trends in Cryptobiota Diversity." Marine resource management is undergoing a fundamental transformation from the management of individual stocks or species to ecosystem-based management. For coral reef ecosystems, which are considered to be the most biologically diverse marine ecosystems, this transition has challenged policy makers, resource managers, and the scientific community since most of this biodiversity is poorly known and understood. Assessment and monitoring of biodiversity has been hampered by resource limitations, shortages of trained taxonomists, subjectivity biases, and inconsistencies of methods and observers. Since 2006, the Census of Marine Life's Census of Coral Reef Ecosystems (CReefs) project and NOAA's ARMS have provided systematic sampling tools to comparatively assess spatial patterns and to monitor temporal trends in the diversity of poorly-known cryptobiota on coral reefs worldwide. Over 650 ARMS have been deployed in shallow (12 to 15 m) forereef coral habitats across biogeographic, oceanographic, and human impact gradients in the Pacific, Atlantic, and Indian Oceans. ARMS could provide a useful tool to assess the performance of various designs of artificial reefs in supporting biodiversity and the associated ecosystem goods and services.

An open discussion on reef systems (Theme 2) was conducted. Questions regarding the specifics of ARMS deployment were asked. The U.S. relies heavily on GPS for successful placement and retrieval of ARMS; China's GPS capabilities are not as strong. Further questions were raised about artificial reefs and what types of species are attracted. U.S. studies have shown that artificial reefs rapidly attract smaller, mostly herbivore species first, followed later by larger predatory species. Often artificial reefs attract more species to a specific location; however, they do not increase biomass of smaller-scale fundamental nutrition (i.e. plankton). As a result, fish move to the reef for shelter, but they tend to feed away from it.

Theme 3: Incorporating Habitat Data and Production Data from Ecosystem Enhancements into Living Marine Resource Assessments

A presentation entitled "Incorporating Habitat Data into LMR Assessments" was given by Dr. Ben Richards (NMFS/PIFSC). In the U.S., coral reef fisheries management is transitioning from single-species towards ecosystem-based strategies. Monitoring programs are essential to collect habitat data along with data on fish assemblages. Additionally, artificial reefs with different habitat parameters (i.e. structure type, size, size and number of holes in the reef structure) and in different areas help to empirically test hypotheses regarding fish environments and habitat diversity. Models can be used to highlight the importance of

particular habitat parameters, to create habitat-based maps predicting distributions of fish, and to design MPA's (Marine Protected Areas).

Dr. Jon Brodziak (NMFS/PIFSC) gave a presentation on living marine resources assessment. In the U.S., stock assessments of living marine resources are conducted to answer management questions, such as: are fish stocks currently experiencing overfishing? In general, stock assessments need to estimate stock abundance and mortality. Stock assessments may also project the probability of future fishery yields and stock conditions under alternative harvest scenarios. Few stock assessments currently have enough quantitative information to explicitly incorporate ecosystem and habitat factors in the modeling process.

Dr. Tang Zhenzhao (CAFS/SCSFRI) presented his research findings from six surveys conducted in the Yangmeikeng artificial reef area from 2007-2009. Surveys indicated that biomass in the reef area increased noticeably after the reef was constructed. The reef area appeared to partially regulate and control its neighboring natural sea environment.

Dr. Ken Leber (Mote Marine Laboratory) gave a presentation entitled "Stock Enhancement Background: Perspectives on Marine Fisheries Enhancement." Marine fisheries enhancement is a set of management approaches involving the release of cultured organisms to enhance or restore fisheries. While some initiatives have been successful in conservation, rebuilding of depleted or threatened populations, mitigating habitat loss or negative effects of fishing, or helping to create new fisheries in restored habitats, taking a broad and integrated view of the role of enhancements within fisheries management systems was emphasized. It was pointed out that all stakeholders should participate in a scientifically informed, accountable planning process in order to assess the potential contributions of enhancement and other measures in providing economic and social benefits. Progress in fisheries assessment methods is key for practical implementation of the updated approach.

Prof. Chen, Pimao (CAFS/SCSFRI) presented his research entitled "Effects and Assessment of Fishery Stock Enhancement in Guangdong Coastal Waters". Shrimp and fish larvae were released (in 2010) throughout 21 locations along the coastal waters of Guangdong Province, and research and growth assessments were conducted based on: (a) time series studies of the enhancement species, (b) fish market surveys, (c) fishing log surveys, and (d) gill net field surveys. Results showed significantly increased fish production, output value and economic returns to these areas. Surviving adult shrimp and fish showed dramatically increased numbers up to 2 and 3 years later. Recruitment stocks, through breeding, showed potential for reaching sustainable development levels. Stock enhancement in Guangdong Coastal waters took place after the annual fishing moratorium on the South China Sea. To improve economic and ecological results, enhancement and optimal recapture assessments should be species-specific.

An open discussion regarding habitat data, ecosystem data, and living marine resource

assessments (Theme 3) was conducted. China's assessment methodology was further clarified. China's artificial reefs were established primarily for enterprise, industrial, and habitat restoration purposes in the past. Recently they have also begun to be used for environmental protection. China's natural reefs were reported to be healthy, but artificial reefs can help relieve pressures (i.e. climate change, over-fishing, bleaching, and excessive trawling). Clarification regarding attraction versus production was raised: it was noted that artificial reefs risk leading to population crashes by aggregating too much biomass in one place, which can then be easily extracted, severely reducing fish numbers.

Theme 4: Ecosystem Services of Natural and Artificial Reefs in a Changing Climate

A presentation entitled "Ecosystem Goods and Services of Natural and Artificial Reefs in a Changing Climate" was given by Dr. Rusty Brainard (NMFS/PIFSC). Though uncertainties exist regarding the details of climate change and ocean acidification, it is certain that climate change and ocean acidification are occurring and that the ecosystem impacts will likely continue to accelerate over the coming decades. As such, when discussing natural reef systems and artificial reefs, it is important to consider them both in the context of changing climate conditions. Ecosystem impacts of ocean warming include habitat damage (coral bleaching), increased vertical stratification and associated decreases in mixing of nutrients to surface layers, resulting in decreased productivity, and likely population shifts. Questions to be addressed include:

1) Can artificial reefs be used to mitigate some of the impacts of climate change and ocean acidification by providing key ecosystem goods and services that might otherwise be lost?
2) Can artificial reefs be used to increase or sustain fisheries/economic production in the face of climate change?
3) Can artificial reefs mitigate ecological services and provide enhanced resilience or coastal protection?

The presentation outlined potential areas for China-U.S. collaboration:

1) Climate change, ocean acidification, thermal structure and other observations and monitoring to support Ecosystem Approaches to Fisheries Management (EAFM).
2) Climate change vulnerability assessments for EAFM.
3) Ecosystem modeling with climate change, such as the Atlantis Ecosystem Model.

A discussion followed. One suggestion was to add spatial components in stock enhancement models for artificial reefs. Models incorporating basic environmental parameters, such as temperature, salinity, etc. can then be compared with on-site results. Simulations and on-site research should be done together, providing feedback for models. On-site sampling can also point towards using additional model parameters. Prior to being deployed, artificial reefs can be modeled to see how they may impact fish growth and

survival. A point was made that relying on models alone can result in meaningless results, further encouraging the practice of simulation and modeling to be done hand-in-hand with observation and monitoring.

Prof. Li submitted a presentation entitled "Evaluation of Stock Enhancement (Shrimp, Crabs and Jellyfish) in the Bohai Sea" for inclusion in the meeting materials. In this presentation, recent stock enhancement efforts in the Bohai Sea are introduced. Issues covered include: (a) resource and ecologic environment conditions, (b) number of larvae/young released, (c) recapture rates, and (d) economic benefits.

Theme 5: Enhancing reef habitat and ecological function

This topic was led by Dr. Jim Bohnsack (NMFS/SEFSC). His presentation entitled "Coral Reef Fisheries – Restoring Ecosystem Function" emphasized the impacts of human activities on environmental ecosystems. Marine ecosystem models indicate that ecosystem goods and services are based on ecosystem structure and functionality, composed of a biotic dimension, a physical dimension and a human dimension. Ecosystem conservation is a state of harmony between humans, land, and sea. Humans have the responsibility of understanding this and creating conditions for ecosystem self-renewal. The establishment of Marine Protected Areas (MPA's) along with the species protection acts, such as the Endangered Species Act and the Marine Mammal Protection Act, is essential for protecting fish and habitat from human interference, and has been widely used in the United States as a conservation tool.

A discussion followed. Historical data's significance was emphasized; it is vital in order to establish baselines, and to show stakeholders the capacities and limitations of reefs and reef systems. There was consensus that a holistic management process is preferable when dealing with ecosystems, including artificial reefs. Commercial fishing, recreational fishing, climate change, MPA's non-fishing uses, and many more factors should be considered when managing the marine environment.

Dr. Chen Haigang (CAFS) gave a presentation of his research entitled "Analysis of Environmental Variables and Fouling Organisms on an Experimental Artificial Reef Area of Daya Bay." Key results showed:

1) Artificial reefs affected the environmental variables to different extents among different study designs. Salinity, nutrients and chlorophyll seemed to be most affected by the artificial reef.
2) Fouling organisms attached on steel reefs and concrete reefs formed quickly, and numbered more than 70 species after one month. The results of canonical correspondence analysis (CCA) further indicated that depth, transparence and dissolved oxygen were the dominant factors in the distribution of attaching organisms.

A discussion followed that mainly elaborated on materials used in China's artificial reefs. Wood-concrete mixtures, shells and shell-concrete mixtures, and concrete were discussed. China has conducted numerous studies on the stability and placement of artificial reefs. Studies have found only small amounts of pollutants emanating from artificial reefs. The relatively new practice of establishing marine reserves and MPA's in China was also discussed. Experiences were compared with those in the U.S., especially regarding the U.S. goal of protecting 20% or more of its coral reefs. Common challenges in both countries include funding and competing uses from other sectors, such as recreation, transportation, tourism, etc.

Next Steps

Mr. Keith Chanon and Dr. Gerard DiNardo summarized the next steps for advancing collaboration under the LMR Panel:

1. Scientific Exchange Program
    a. CAFS South China Sea Fisheries Institute will send two scientists to NOAA's Pacific Island Fisheries Science Center in Honolulu for up to two months each. The CAFS scientists will work with PIFSC on Autonomous Reef Monitoring Structures (ARMS) and on stock assessment methodologies. Drs. Rusty Brainard and Gerard DiNardo will provide a "Scope of Work" detailing the preferred timing and scope of research for each project by November 30th.

2. CAFS Forum on Fishery Science and Technology
    a. CAFS will schedule the next meeting of the LMR Panel in conjunction with the Forum (either before or after). The follow-up meeting on artificial reefs will also be scheduled in conjunction with the Forum and LMR Panel meetings. This will help facilitate the participation of NOAA staff in the Forum.
    b. CAFS will provide additional information about the Forum (topics, dates, registration procedures, etc.)

3. Emergency Plans for Oil Spills and Impacts on Fisheries
    a. NOAA will send information materials to CAFS. Plans for a workshop will be discussed in Fiscal Year 2013 (October 2012-September 2013).

4. Fishery Resources Enhancement
    a. CAFS will provide to NOAA additional information regarding this project proposal (e.g., target species, types of environmental surveys, etc.). Professor Li identified salmon and flounder as key species and an interest in tagging and environmental surveys. Professor Li suggested the possibility of a CAFS scientist working with Dr. Ken Leber from the Mote Marine Lab.
    b. In follow-up discussions with Dr. Ken Leber, he indicated that discussions are underway to develop a memorandum of understanding with the Yellow Sea Fisheries Research Institute (Dr. Wang) to enable scientific exchanges of Chinese students to spend 1-year at Mote Marine Labs.

5. Research on Shellfish Cultivation
    a. CAFS will confirm its ability to provide travel and living expenses for a NOAA scientist (Chris Brown) to work with the Resource and Environment Research Center.

6. Monitoring of Habitats in Estuarine Nature Reserves and its Dynamics
    a. Professor Li clarified that CAFS is seeking support in using remote sensing techniques for monitoring habitat in protected areas. Keith Chanon will identify appropriate project leads for NOAA.

7. Coordination with Shanghai Ocean University
    a. Professor Li agreed that NOAA's Pacific Islands Fisheries Science Center's activities with the Shanghai Ocean University (SOU) could be linked to the LMR Panel. Prof. Li will follow-up with SOU to explore collaboration in this area and how CAFS can help support a China-U.S. LMR symposium in March/April 2012 in Shanghai.

Mr. Chanon (NOAA, U.S.) and Dr. Li (CAFS, China) were designated as official Points of Contact for the action items.

Mr. Wang recognized the difficulties in funding staff exchanges and encouraged the U.S. to support scientist staff exchanges to China.

Adjournment

The meeting was adjourned on 3 November 2011. Mr. Wang and Dr. DiNardo expressed their appreciation to all participants for their contributions and cooperation in completing a successful meeting.

Gerard DiNardo, Ph.D.
U.S. Chair

Wang, Taijian
Chinese Chair

Appendix 1

Meeting Participants

United States Delegation:

National Oceanic & Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) (http://www.nmfs.noaa.gov/)

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Appendix 2

Meeting Agenda

U.S.-China Meeting on Living Marine Resources: Habitat Monitoring, Assessment and Restoration of Reef Systems

November 1-3, 2011 --- Honolulu, HI

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Goal: Exchange information and experience associated with monitoring, assessment, and restoration of reef systems (natural and artificial), and identification of opportunities for collaborative research

Tuesday, November 1

7:00am Chinese delegation arrives in Honolulu, HI

1:00pm Opening Statements
- U.S Chair – Mr. Gerard DiNardo, NMFS/PIFSC
- China Chair – Mr. Taijian Wang, CAFS

1:30pm Introductions

1:45pm Adoption of the Agenda & Assignment of Rapporteurs

2:00pm Overview of the U.S. – China LMR Panel and Collaborative Research Activities, Keith Chanon, NMFS/OST

2:25pm Theme 1: Artificial Reefs: Utility and Implementation
(Leaders - Jim Bohnsack, NMFS/SEFSC; Jilong, Li, CAFS)

Topics to be discussed:
a. Divergent goals and objectives (e.g., increasing productivity)
b. Structure and design characteristics
c. Other

3:40pm Coffee Break

4:00pm Open Discussion - Artificial Reefs: Utility and Implementation

5:00pm Adjourn for the Day

Ice Breaker & Dinner – Hotel

Wednesday, November 2

9:00am Theme 2: Reef Systems: Assessing Efficacy and Performance
(Leaders - Jim Bohnsack, NMFS/SEFSC; Chen, Pimao, CAFS)

Topics to be discussed:

a. Objective (framing the question-hypothesis testing or monitoring)
a. Performance metrics
b. Monitoring methodologies

Case Studies:

a. State of Hawaii
b. Rigs to Reefs Program
c. Experiences in China

10:15am Open Discussion - Reef Systems: Assessing Efficacy and Performance

10:40am Coffee Break

11:00am Theme 3: Incorporating Habitat Data and Production Data from Ecosystem Enhancements into Living Marine Resource Assessments
(Leaders - Gerard DiNardo, NMFS/PIFSC; Chen,Pimao, CAFS)

Guest Speaker – Ken Lieber, Motte Marine Laboratory

Topics to be discussed

a. Evaluating CPUE metrics across natural and artificial habitats
b. Incorporating habitat data in assessments
c. Ecosystem approaches to fisheries management

12:30pm Lunch

2:00pm Open Discussion - Incorporating Habitat Data and Production Data from Ecosystem Enhancements into Living Marine Resource Assessments

2:30pm Theme 4: Ecosystem Services of Natural and Artificial Reefs in a Changing Climate
(Leader - Rusty Brainard, NMFS/PIFSC; Chen, Pimao, CAFS)

3:45pm Coffee service

4:00pm Open Discussion - Ecosystem Services of Natural and Artificial Reefs in a Changing Climate

5:00pm Adjourn for the Day

Thursday, November 3

8:30am Theme 5: Enhancing Habitat and Ecological Function
(Jim Bohnsack, NMFS/SEFSC; Chen, Haigang, CAFS)

Topics to be discussed:

a. Shore-based habitat restoration
   i. Wetland protection/enhancement/creation
   ii. Reducing land based sources of pollution
   - Sediment
   - Nutrients
   - Contaminants

b. In-water habitat restoration
   i. Response to physical Impacts (groundings, storms, anchor damage)
   ii. Enhancement of coral stocks and genetic diversity through propagation
   iii. Shellfish restoration
   iv. Sea Grass Restoration

9:15am Open Discussion –Enhancing Habitat and Ecological Function

9:40am Potential Activities and Collaborative Research Projects pursuant to the Artificial Reef Project

a. Possibility of joint assessments of the stock population in habitat restoration areas
b. Mechanisms of sharing data and information in artificial reef and habitat evaluations

10:45am Coffee break

11:00am Next Steps

a. Identification of joint research projects and activities
b. Joint presentations and updates at U.S.-China events (e.g., U.S.-China Fisheries Symposium, U.S. – China LMR meeting, and U.S. –China Protocol on Marine and Fisheries Science and Technology Workshops)

12:00pm Closing

6:00pm Chinese Delegation departs to Airport