Presentation Abstracts

TAIPEI
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FIFTH INTERNATIONAL FISHERS FORUM

Opening Address

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I would like to begin by thanking the Western Pacific Fishery Management Council and Fisheries Agency, Council of Agriculture, Taiwan for co-hosting this important fifth and final conference in the International Fishers Forum series and for the opportunity to address you during this morning's opening ceremonies.

The activities of these next few days will address two timely and important issues facing not just the tuna fishing industry, but the broader seafood industry as well as many other ocean industry sectors.

A first question I would like to address is how can the Hawaii Longline Association in particular but the broader fishing and seafood industry in general, benefit from initiating or improving coordination with other industries that use and affect marine resources?

Marine Spatial Planning is a relatively new initiative to many participating in this conference. Marine Spatial Planning is simply the planning of uses of marine areas by not just the fisheries sector, both recreational and commercial, but by a wide range of users including transportation, ocean mining, ocean recreation, power generation, and many more users who will increase the complex risks of environmental impacts and potential user conflicts in the use of marine space and resources. Best efforts by a single company or a whole industry sector will not be able to address the cumulative environmental impacts of a wide range of ocean industries or deal with the growing needs for coordination among interactions across a broad range of ocean industries. The recently formed World Ocean Council seeks to provide a mechanism for cross-sectoral coordination and we will see a presentation on this later in the session. Many in the seafood industry will find it difficult in this all encompassing approach to identify short-term and direct or long term and indirect value in this cross coordination. Many of the most important issues in marine capture fisheries do not easily lend themselves to cross sector involvement. Overexploitation, bycatch, allocation and illegal, unregulated, and unreported (IUU) compliance are issues that are most effectively dealt with within the industry. Issues such as changes in marine biodiversity, marine pollution, spread of invasive species and climate change which also have impacts on fisheries lend themselves well to involvement across sector lines.

A second question that will be considered through this conference is how should tuna fisheries be incorporated as a component of marine special planning and management?

The allocation of tuna resources between gear types, and between small scale and industrial fisheries could be achieved through area based planning, for example through the creation of zones for different gear types, area based restrictions on gear designs and restrictions on fishing methods. As an example, the Parties to the Nauru Agreement have established a seasonal restriction on purse seine set on Fish Aggregating Devices to help reduce bycatch rates of small and juvenile tunas. Another example closer to home in Hawaii is a prohibition to longline fishing within the area immediately adjacent to the Main Hawaiian Island not only to avoid conflicts with coastal fisheries, but to increase opportunities for smaller vessels to access the resource. We will hear presentations this week on different perspectives of resource allocation. Some tuna Regional Fisheries Management Organizations and domestic fishery managers employ time area closures. A closure to longline fishing in waters adjacent to the Northwest Hawaiian Islands over concerns about impacts on the endangered Hawaiian Monk seals habitat have the added benefit of setting aside a significant area where no capture fisheries are allowed.

This conference will also review progress to date in the mitigation of bycatch in pelagic longline and purse seine fisheries as well as coastal artisanal fisheries. In the Hawaii longline fishery, you will hear from Eric Gilman about how there has been mixed progress in the development of gear technology solutions to the bycatch of seabirds, marine turtles, sharks and marine mammals in longline fisheries. We will also hear about developments and ongoing work to identify gear technology solutions in tuna purse seine fisheries to reduce their impacts on undesirable take. We will also hear about successful cooperative research that has resulted in the identification of solutions to seabird and sea turtle bycatch in the Hawaii longline fleet. Internationally, improvements are generally needed in the adoption of conservation and management measures by the five tuna Regional Fisheries Management Organizations to employ gear technology best practices, to provide adequate resources for surveillance and enforcement, and to provide sufficient on-board observer coverage so that compliance occurs and effective efficacy of these measures can be validated. The regulatory regime that the Hawaii longline fishery currently operated under meets these mandates and the resulting reductions in the incidental take of protected species is a demonstration that a regulatory regime does not necessarily result in reduced catch of target species. The Hawaii Longline fishery has been twice evaluated against the United Nations Code of Conduct for Responsible Fisheries and has twice achieved a score of over 90%. Yet, the Hawaii fishery operates in an extremely high regulatory environment and continues to be economically viable.

Much progress has been made in bycatch mitigation over the past decade that this conference has taken place. We can be confident that given sufficient investment, we can identify methods to nearly eliminate problematic bycatch and hopefully muster the political will to ensure broad uptake of these effective mitigation measures. On behalf of the Hawaii Longline Association, I am pleased to participate in this International Fishers Forum to advance the tuna fishing industry in the application of marine special planning and to review and establish new priorities for the mitigation of bycatch.

The Role of Marine Spatial Planning in Sustaining Pelagic Fisheries: Transitioning from Managing Sectors to Comprehensive Ecosystem-based Management

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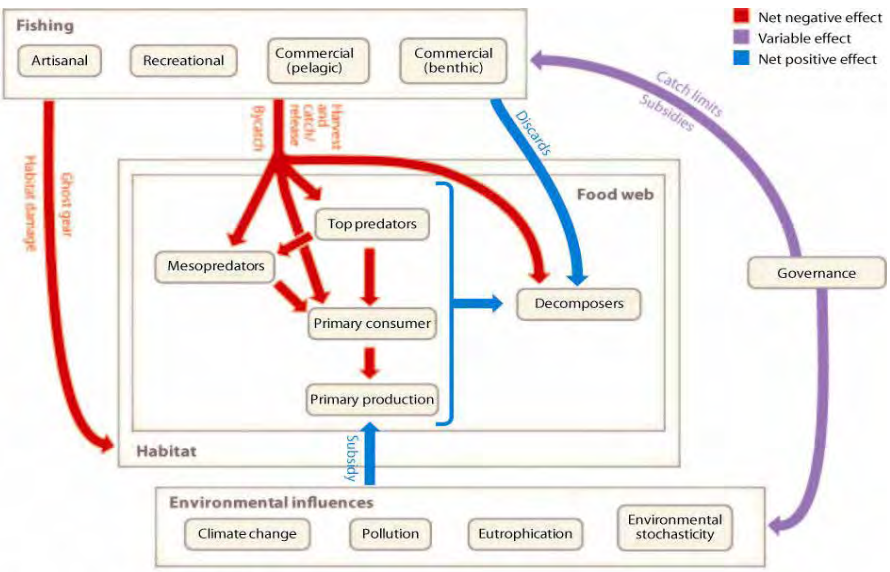
Abstract

Fisheries management is in transition from single species approaches to management toward fully considering the ecosystem context in which these fisheries occur. This trend is often described as ecosystem-based fisheries management. A broader approach to marine ecosystem-based management considers not only the fisheries sector, but other sectors that use ocean resources in one way or the other. National and international assessments urged the adoption of ecosystem-based management over five years ago. In June 2009, President Obama created the Interagency Ocean Policy Task Force in the US to flesh out a new integrative National Ocean Policy and a Framework for Marine Spatial Planning (MSP) to implement ecosystem-based management across ocean sectors. In this talk, I will review the use of MSP around the world in the context of fisheries and in full cross-sectoral mode. I will also extend the idea from demersal and coastal fisheries to off-shore pelagic fisheries. MSP has promise to support economic, environmental, social, and security goals. It has the potential to promote resilient, healthy, functioning ecosystems while also allowing sustainable use of marine space and resources. But transitioning from “business as usual” to this new approach will require active engagement of ocean users and the environmental community in formulating plans that can meet multiple objectives. This approach will be particularly challenging in pelagic systems due to limitations of governance institutions.

1. Introduction

While traditional management of marine fisheries has focused on the widespread declines in targeted species, marine food webs have been significantly altered by overfishing (Jackson et al. 2001). Fishing has a variety of direct and indirect effects on interaction webs in marine ecosystems with complex and potentially cascading effects (Fig. 1). Many fisheries focus on apex predators and are fished at an unsustainable rate, while others fish from the middle of the web removing huge biomasses of forage fishes required by apex predators, including fishes, marine mammals, and seabirds. Fishing not only removes biomass from particular niches in the food web (as one might do in a controlled ecological experiment), but also has indirect effects such as removing non-target species, altering habitat, and providing subsidies to scavengers.

Researchers have pointed to fishing as one of the oldest and largest factors modifying marine ecosystems. Fishing, in concert with other anthropogenic effects, has resulted in a staggering loss of biodiversity (Worm et al. 2006) and may have unforeseen effects that propagate throughout ecosystems. Friedlander and DeMartini (2002) found that the mean biomass of apex predators on the unfished northwest Hawaiian Islands was over 260% greater than on the main Hawaiian Islands, where apex predators and other fishes are heavily exploited. Other research has detected rapid, severe declines in coastal and oceanic shark populations, with declines as high as 99% for some species (Baum et al. 2003). Recognizing the difficulties in identifying and managing for the direct effects of fisheries harvest, much less the indirect effects and potential ecosystem effects, we suggest the food web as the key nexus of interactions (Mangel and Levin 2005).



Crowder LB, et al. 2008.
Annu. Rev. Ecol. Evol. Syst. 39:259–78

Fig. 1. *Direct and indirect effects of fishing on marine ecosystems, with complex and potentially cascading effects (Crowder et al., 2008).*

To understand the ecosystem effects of fishing, it is necessary to examine the surrounding food web and abiotic processes that influence marine systems. Strong interactors shape the resultant food webs through ecological processes such as predation or competition. When impacted by fisheries, these characteristics of strong interactors can amplify the effects throughout the food web. Models have shown that food webs with strong interactions and high specialization (e.g. low omnivory) are most susceptible to fisheries-driven collapse (Bascompte et al. 2005).

2. Fishing, Marine Ecosystems, and the Transition to Ecosystem-based Management

How can we address the cumulative impacts of diverse fisheries in the context of other anthropogenic and naturally-driven variation in marine ecosystems? This calls for a dramatic shift in ocean policy, from management of individual sectoral activities, like fisheries, toward ecosystem-based management

(Crowder et al. 2006). Ecosystem-based management is “an integrated approach to management that considers the entire ecosystem, including humans” (McLeod et al. 2005). Ecosystems are inherently place-based (McLeod et al. 2005, Crowder et al. 2006, Young et al. 2007). Moreover, social, cultural, economic, and political attributes overlay these biophysically-defined places. Thus, approaches that integrate natural and social scientific perspectives on defining and managing places at sea are necessary to overcome uncontrolled, cumulative impacts of fisheries and other anthropogenic effects (Shackeroff et al. 2008).

Analysts are beginning to agree that the escalating crisis in marine ecosystems is in large part a failure of governance (Crowder et al. 2006). Recent assessments have called for a transition from managing sectoral activities, including fisheries, toward ecosystem-based management. The environmental sector has sought to implement marine reserves to maintain the structure and function of marine ecosystems. But this too is a sectoral approach. Traditional single species management has a clearer recovery goal, specifically a certain spawning stock biomass to support future fishing efforts. But it is more difficult to define recovery goals in an ecosystem framework.

Place-based management and marine spatial planning (MSP, Fig. 2) can provide a far more promising approach to implementing ecosystem-based management (Young et al. 2007). Rather than individual sectoral agencies managing their activities everywhere, responsible sectoral authorities could work together to manage all the human activities in a place. These places might align with ecosystem boundaries, socio-economical boundaries, and/or jurisdictional boundaries. In practice, management always occurs in a delimited space, with processes that cross management boundaries.

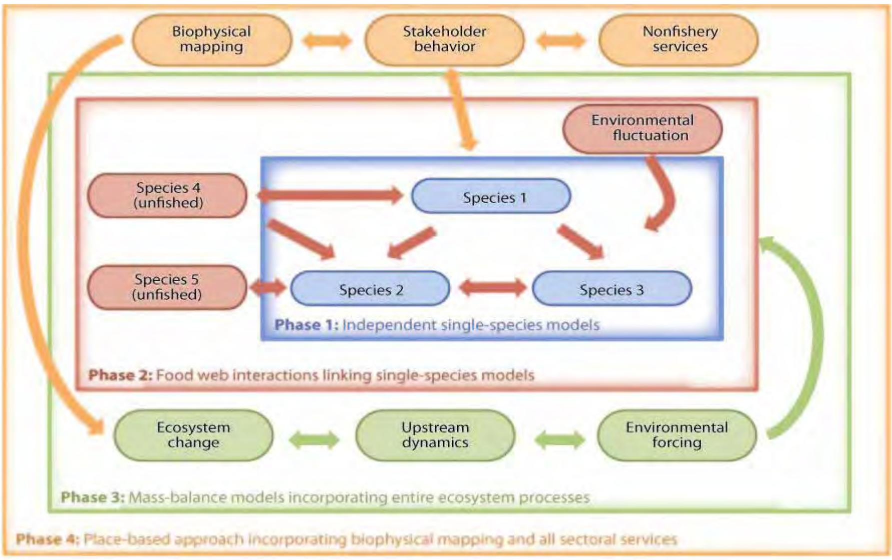


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Fig. 2. *Marine spatial planning (Crowder et al., 2008).*

The biophysical component of marine ecosystems provides the basic template on which all human activities, including fisheries, occur and that various forms of governance regulate. Approaches to MSP and ocean zoning consider basic ecological concepts so that human activities can be conducted in ways that maintain ecosystem functioning, provide sustainable ecosystem services on which people depend, and maintain resilient ecosystems that can respond to environmental change.

Place-based management of marine ecosystems requires a hierarchy of management practices starting at the most general level with the concept of ecosystem-based management and moving toward the development of an integrated approach that accords priority to the maintenance of healthy, biologically diverse, productive, and resilient ecosystems. The key to success in place-based management of marine ecosystems is to design governance systems that align the incentives of stakeholders, in this case fishermen, with the objectives of management. MSP that fully incorporates the underlying ecosystem template and explicitly integrates the socio-economic and governance overlays can form the basis for adequate protection of marine ecosystems and the sound use of marine resources, including fisheries.

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Oceanographic Considerations for Marine Spatial Planning on the High Seas

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Marine spatial planning seeks to minimize detrimental ecological and socio-economic impacts by segregating non-compatible activities temporally and spatially. This approach requires the integration of spatially-explicit information on the extent and magnitude of human activities, the distributions of valuable and protected marine resources, and the degree to which these activities and resources interact with each other in time and space. This presentation addresses the application of marine spatial planning to manage fisheries interactions with protected species and their habitats, with an emphasis on the design of marine reserves for highly-mobile pelagic vertebrates (marine birds, mammals, and turtles).

Marine conservation is advancing rapidly, spurred by technological developments for biodiversity monitoring (e.g., wildlife tracking, remote sensing) and conceptual advances for determining where / when to make the most effective conservation investments (e.g., population structure, demographics). This enhanced understanding is helping resource managers to identify when / where / how to protect oceanic species and habitats. Accordingly, marine reserves are increasingly being advocated and used for protecting pelagic species and their critical foraging and breeding habitats.

Differences in scale and predictability set aside highly dynamic pelagic systems from terrestrial and benthic ecosystems, where wildlife reserves were first implemented. Yet, as in static systems, many pelagic species use predictable habitats to breed and forage. In principle, marine reserves could be designed to protect these foraging and breeding aggregations. Pelagic habitats can be classified according to their dynamics into three broad categories: static, persistent and ephemeral (Hyrenbach et al. 2000). While traditional reserve designs are effective in static habitats, many important pelagic habitats are neither fixed nor predictable. Thus, pelagic reserves will require novel concepts and designs, such as dynamic boundaries and extensive buffers, defined by the extent and location of specific oceanographic features. This presentation illustrates some of these oceanographic features and offers ideas for potential reserve design concepts.

Because marine ecosystems are spatially-explicit environments, marine spatial planning must address the underlying physical and biological heterogeneity in time and space, as well as the dynamic nature of key life-history processes and human impacts. Thus, a critical goal should be to develop spatially explicit conservation targets. To this end, we revisit five key principles guiding the development of these conservation targets (Crowder & Norse 2008), and illustrate their conceptual foundations and practical application for the conservation of pelagic vertebrates: (1) evaluating mis-matches between management and ecological processes, (2) accommodating temporal and spatial variability, (3) preserving webs of ecological interactions, (4) acknowledging the heterogeneity of human activities, and (5) embracing place-based management.

An improved understanding of critical habitats and human impacts will facilitate the integration of conservation needs into the development of comprehensive marine spatial planning for territorial waters and the high-seas. Within this context, knowledge of the physical mechanisms that influence the distributions of commercially-valuable and protected species, and the formation and persistence of dynamic oceanographic habitats will be essential to design and implement spatially-explicit protective measures.

While recent conceptual and technological advances are facilitating the implementation and monitoring of pelagic reserves, effective protected areas should include enforcement, research and monitoring programs to evaluate their effectiveness. Furthermore, these measures should be nested within a larger management context involving broader fisheries management and ecosystem monitoring tools. Marine spatial planning will provide the critical framework for integrating these diverse approaches into a coherent and comprehensive perspective for managing dynamic seascapes.

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Using the Convention on Biological Diversity's Scientific Criteria to Identify Ecologically or Biologically Significant Areas in Need of Protection to Inform Fisheries Management and Marine Spatial Planning

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Abstract

In 2008 the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) adopted scientific criteria for identifying ecologically or biologically significant marine areas (EBSAs) in need of protection. There is now further movement toward the establishment of an inventory of EBSAs. Although the identification of EBSAs is a purely scientific endeavor, the relevance of identifying EBSAs lies largely in their utility to, and incorporation by, organizations with mandates to manage marine resources. By identifying EBSAs we can provide critical information to managers and planners regarding the ecological character of the systems they are acting within. Thus, the identification of EBSAs is crucial to ensuring that our use and management of the marine environment is done in an ecologically relevant and sustainable manner. Here we examine how EBSAs may provide utility to the management of one important anthropogenic stressor (i.e., fisheries), and more generally to marine spatial planning (MSP). Conversely, we also examine how fishery management organizations can contribute to and participate in the process of identifying EBSAs.

1. Introduction

In 2007 an expert workshop was convened by the Convention on Biological Diversity in the Azores, Portugal, to develop, refine and consolidate scientific and ecological criteria for the identification of areas in need of protection. The following year, the Conference of the Parties (COP) to the CBD adopted these scientific criteria for identifying ecologically or biologically significant areas (EBSAs) in need of protection (CBD 2008; Fig. 1). The same decision also urged Parties and invited other Governments and relevant organizations to apply, as appropriate, the Azores scientific criteria. Towards this end, there is now movement toward the establishment of an inventory of EBSAs. As this process moves forward more governments, agencies and organizations are taking note of it, and attempting to understand the role and utility of EBSAs.

Although the identification of EBSAs is a purely scientific endeavor, the relevance of identifying EBSAs lies largely in their utility to, and incorporation by, organizations with mandates to manage marine resources. To date, illustrations of how to implement the CBD EBSA criteria have largely been based on the examination of data pertaining to a specific habitat or species. Undertaken in this manner, the number of EBSAs that could be identified is infinite. For management purposes, it may be more pertinent and efficient to identify EBSAs based on their overlap with, and vulnerability to, specific human activities.

This perspective may, in fact, be inherent in the language adopted by the CBD. The term "ecologically or biologically significant areas" is always followed by "in need of protection". This infers that the site requires protection *from* something. As anthropogenic activities are the main stressor on the marine environment, and the unique focus of any management measure, it is logical that EBSAs "in need of protection" are in need of protection from human impacts. Thus the identification of EBSAs should be related to their vulnerability (one of the EBSA criteria) to such impacts. As mentioned, one efficient method of identifying such areas is to begin by looking at where those activities take place.

CRITERIA	DEFINITION	RATIONALE
Uniqueness or rarity	Area contains either (i) unique (*the only one of its kind"), rare (occurs only in few locations) or endemic species, populationsor communities, and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual algeomorphological or oceanographic features	Irreplaceable loss would mean the probably permanent disappearance of diversity or a feature, or reduction of the diversity at any level
Special importance for life history stages of species	Areas that are required for a population to survive and thrive	Various biotic and abiotic conditions coupled with species-specific physiological constraints and preferences tend to make some parts of marine regions more suitable to particular life-stages and funtions than other parts
Importance for threatened, endangered or declining species and/or habitats	Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species	To ensure the restoration and recovery of such species and habitats
Vulnerability, fragility, sensitivity, or slow recovery	Areas that contain relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery	The criteria indicate the degree of risk that will be incurred if human activities or natural events in the area or component cannot be managed effectively, or are pursued at anunsustainable rate
Biological productivity	Area containing species, populations or communities with comparatively higher natural biological productivity	important role in fueling ecosystem and increasing the growth rates of organisms and their capacity for reproduction
Biological diversity	Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or higher genetic diversity	Important for evolution and maintaining the resilience of marine species and ecosystems. To maintain these areas as reference sites
Naturalness	Area with comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation	To protect as with near natural structure, processes and funtions. To safeguard and enhance ecosystem resilience

Performed in this manner, the identification of EBSAs should still be a solely scientific process based on biological and ecological criteria, but the EBSAs identified will be of more direct use to managers. Here we will examine how EBSAs may provide utility to the management of one important anthropogenic stressor (i.e., fisheries), and more generally to marine spatial planning (MSP). Conversely, we also examine how fisheries management organizations can contribute to and participate in the process of identifying EBSAs.

2. The role of EBSAs in Fisheries Management

The identification of EBSAs is critical to ensuring that our use and management of the marine environment is done in an ecologically relevant and sustainable manner. Marine environments are currently impacted by a wide variety of anthropogenic uses (Halpern *et al.* 2008). Human activities such as agriculture, industrial production, energy exploration/production, coastal development, and shipping & transportation can pollute, contaminate, increase nutrient loads and acidity, and destroy important marine habitats (Bryant 1995, Smith *et al.* 1999, Islam & Tanaka 2004, Orr *et al.* 2005). Fisheries represent another such anthropogenic stressor on marine ecosystems (Dayton *et al.* 1995; Goñi 1998; Jackson *et al.* 2001) and, in many areas, are one of the most if not the most important stressor. Among the ecosystem effects of fishing, the detrimental impact of bycatch has been increasingly documented in recent years (Crowder and Murawski 1998; Hall *et al.* 2000; Lewison et al. 2004; Gilman *et al.* 2005). The role of fisheries in the decline of populations of protected species (Spotila et al. 1996; Brothers et al.1999; Read et al. 2006) has led to the enactment of conservation policies (Moore et al. 2009) and costly management measures (Curtis and Hicks 2000). Gear alterations to mitigate bycatch have also placed economic burdens on fishers and fishing nations (Gilman et al. 2006). Due to these economic and ecological impacts, fisheries are beginning to be more explicitly regulated both for their bycatch and for their spatial extent. As annual catch limits are implemented and bycatch of commercial and protected species becomes more relevant to managers employing ecosystem-based approaches to fisheries management, there is a growing need to increase fishing selectivity (i.e. increase catch/bycatch ratios). As more industries (e.g., mining, shipping, energy) lay claim to marine resources and space, such fisheries management approaches must be implemented within a marine spatial planning context, whereby core areas are reserved for fishing activities and compatible activities. By identifying EBSAs we provide critical information to managers and planners regarding the ecological character of the systems they are acting within.

There are several criteria that may be used to identify EBSAs of relevance to fisheries management generally and to the reduction of bycatch in particular. For example, the "Importance for threatened, endangered or declining species and/or habitats" (Threatened/endangered), "Special importance for life-history stages of species" (Life history), "Vulnerability, fragility, sensitivity, or slow recovery" (Vulnerability) criteria may all shed light on the dynamics that result in bycatch. EBSAs based on the Threatened/endangered criterion may depict habitat important to endangered species (e.g. Pacific Leatherbacks) that could be avoided by fishermen to reduce bycatch. The Life-history criterion might be used to identify essential spawning aggregations or nursery habitat for commercial species. By-catch data from fisheries management organizations may be used directly to identify EBSAs based on the Vulnerability criterion. In the rationale given for the Vulnerability criterion we are specifically asked to consider "the degree of risk that will be incurred if human activities or natural events in the area or component cannot be managed effectively, or are pursued at an unsustainable rate." If by-catch and discards cannot be "managed effectively" the "degree of risk" to protected species and fish stocks is, in many cases, very high (e.g. Spotila *et al.* 1996; Brothers et al. 1999; Read *et al.* 2006). Dunn et al. (in review) provide a synthesis of methods to identify spatio-temporal patterns in bycatch data. Such patterns could be used to delineate EBSAs based on high bycatch rates or low fishing selectivity, assuming the bycaught animals are "in need of protection". It is important to note that in some circumstances data that might be used to identify EBSAs is already being incorporated into fisheries management (e.g. the voluntary closure of the North Pacific Chlorophyll Transition Front Zone to the Hawaiian pelagic longline fishery; Howell 2008). The identification of such EBSAs and their aggregation in an inventory should be similarly useful in the management of other fisheries.

3. The Role of EBSAs in Marine Spatial Planning

Marine spatial planning offers an integrated framework within which all anthropogenic activities that impact the marine environment can be weighed transparently and equitably dealt with. It affords a means to incorporate multiple objectives and address complex conflicts, to integrate assessments and governance, and to increase investment security for marine resource users and developers (Douvere 2008). If MSP is to assist in reaching sustainability objectives, characteristics of the marine environment must be objectively incorporated into the process. Towards this end, the use of EBSAs within MSP can help managers understand which human uses may or may not be compatible with the ecology of a given area, and avoid user-environment conflicts. The previous integration of sites identified through other programmes and initiatives that also employ suites of criteria to identify areas of ecological or biological importance (e.g., the Ramsar Convention or the Important Bird Area programme of Birdlife International) in marine spatial plans suggests that EBSA may too prove useful to this process (Douvere 2007, Ekebom 2008).

The example above of the use of the Threatened/endangered criterion to identify core use areas of endangered species as EBSAs is also demonstrative of how EBSAs can be used within MSP. Clearly knowledge of such an EBSA would suggest that certain human uses (e.g., fisheries that interact with the endangered species, energy production that produces noise levels harmful to the endangered species, etc.) should be minimized in that area. Conversely the identification of highly productive EBSAs (based on the Biological Productivity criterion) might be important to reserve for fishers to minimize risk and impacts from other human activities (e.g. pollution, certain forms of energy production). Thus, the incorporation of EBSAs in the implementation of MSP, both within and beyond national jurisdiction (see Ardron et al. 2008), is essential to both the environmental sustainability of such planning and the economic viability of individual sectors.

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Marine Spatial Planning in Coastal Zones with Geographic Information System

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Coastal zone environments are usually characterized by abundant fishery resources, beautiful landscapes and rich ecosystems of great importance, which attract human activities such as fishing, aquaculture, tourism, and industrial uses. However, the co-existence of human activities and natural resources often result in conflicts over priority. Marine spatial planning (MSP) in the coastal zone presents an opportunity for the implementation of an overall strategy of conservation, sustainability, and management to maximize future economic profit. However, unlike spatial utilization on land, MSP in coastal zones is more complex due to a relatively larger number of spatial components.

Geographic Information Systems (GIS) is a computer system for capturing, storing, checking, integrating, manipulating, analyzing, and displaying data related to positions on the Earth's surface. GIS is nowadays the principal tool to present and analyze spatial data and the use of GIS would appear to offer a viable solution for supporting the implementation of MSP. There are, especially for coastal uses, many spatial components (e.g. movements and migrations of resources, boundaries of fishing grounds, transportation networks), and many serious issues like habitat loss and environmental degradation have spatial dimensions, so fisheries stakeholder, aquatic resource managers and government decision makers have to address these complex issues. In this regard, GIS is a technology that can help to clarify these issues and lead to solutions by treating many spatial components simultaneously.

Compared to the longstanding practice of land use planning, MSP in coastal areas is subject to a lack of information and comprehensive planning framework. To collect enough information is of course essential; however, to integrate information collected from different systems is yet another problem. The coastal zone covers a dynamic area, including the intertidal zone, which receives less attention on both land and maritime charts. The altitude on land maps are based on the highest tidal level because upland is defined as the area above this water level. Meanwhile, the water depths recorded on maritime charts are usually based on the lowest tidal level, due to a focus on use for navigational safety. The intertidal area therefore is not covered in either terrestrial or marine maps. The two mapping systems can be easily combined using GIS, and all data sources used for the creation of terrestrial and marine maps can be integrated for MSP in the coastal zone.

The collection and digitization of spatial data into a GIS is the first and most difficult phase, requiring the compilation of a tremendous volume of information in different formats. After the integration of data into a GIS, the spatial information can be further processed into a form that is helpful for the process of MSP. Mapping related information on coastal and marine areas in detail allows the opportunity to identify those areas of risk or conflict and to examine in detail how many activities are occurring. It is essential not only to examine environmental impacts of each individual activity but also to research cumulative effects of multiple activities occurring within an area. For example, space conflicts between fishery and non-fishery activities can be highlighted simply through overlaying of maps of different activities, which is helpful for MSP and coastal management. In addition to subjective/top-down decision making, there are many objective/bottom-up decision processes through data analysis using GIS, such as multi-criteria analysis, spatial analysis, biodiversity analysis, landscape analysis, topology analysis, CAD cartography, etc.

Taiwan is surrounded by seas and is blessed with diverse landscapes as well as abundant marine resources, as a result of the convergence of complex current system. Rapid economic development in recent years and the relaxation of controls over coastal activities have resulted in increased marine utilization. However, the lack of comprehensive marine and coastal planning has led to the degradation of the marine environment and terrestrial habitats, threats to public safety, and damage of social security. Fishing is the major use of the coastal zones of Taiwan and occurs in almost all coastal waters around Taiwan. To balance the development of fisheries with other coastal activities, it is necessary to effectively manipulate fishery information, such as target species, catches, seasons, fishing grounds, protection zones, management schemes, etc, and to then understand their relationship with non-fishery information within the same areas.

A study entitled “Fishery multiple use planning in the coastal waters of Taiwan”, sponsored by the Fishery Agency in 2001, is a successful case study of GIS-aided MSP. This study produced ten kinds of zones for fishery use, including three fishing right zones granted by the Fisheries Act, namely the set net fishing right, demarcated fishing right, and exclusive fishing right. Seven other fishery zones were also established, including areas for cage culture, recreational fishery, sea ranching, anchored fish aggregating reefs, fishery resources conservation, marine protection zone, and coastal fishing zones. A web-GIS (http://fgis.ntou.edu.tw) was established after the study to provide authorized users with integrated information on fishery and non-fishery uses in Taiwan’s coastal zone. The GIS was of critical importance during the planning stage, and continues to contribute information to MSP.

Taiwan’s coastal zone is the most prosperous common property for the people. A lack of comprehensive MSP has led to the degradation of the marine environment and upland habitats. Currently, the government is drafting the National Land Act, the National Land Restoration Act, the Coastal Act, and the Administration Zoning Act. In addition to the fishing sector, authorities of other sectors will be involved in coastal zone MSP. Consequently, a more comprehensive perspective will be achieved in the future. MSP in the coastal zone should not only be a political trade-off among interested parties, such as merely balancing interests between fishery and non-fishery sectors. More reliable scientific information and objective analysis should be developed to maximize economical profit while ensuring environment sustainability. GIS will continue to be an important tool to support this MSP process.

Great Barrier Reef Marine Park Authority – Monitoring, Evaluation and Adaptive Marine Spatial Planning and Management

Randall Owens[1]
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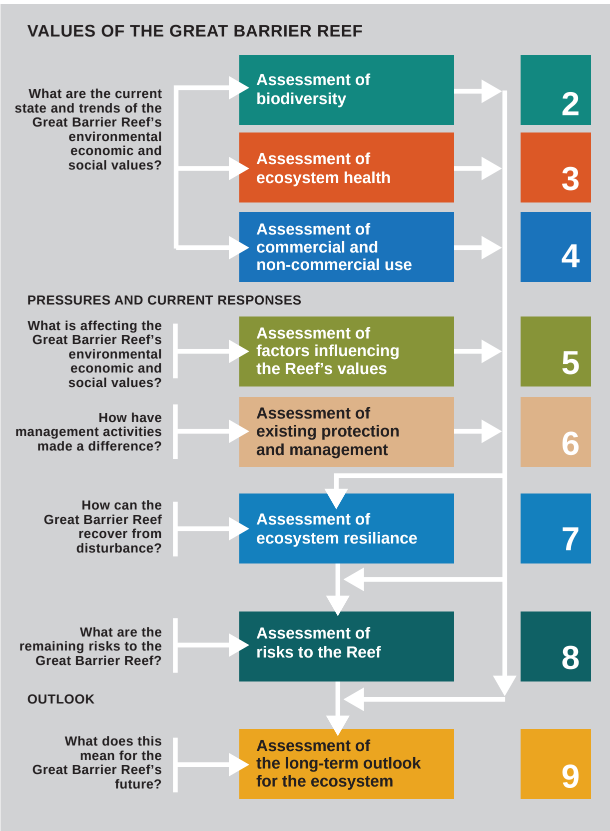
Marine spatial planning (MSP) is unlikely to be successful and maintain long-term stakeholder and political support unless a strategically planned and coordinated process is implemented to ensure that there is effective monitoring and evaluation of the management system in place and equally that there is a clear capacity for adaptation if the evaluation demonstrates that this is necessary. An object of monitoring and evaluation should be to try and forecast or pre-empt change so that it can be prepared for and management settings adjusted to better account for change. When one factors in elements such as climate change adaptive capacity will be a key element of MSP. In an ideal world of single agency management this might be relatively straightforward but in the multi jurisdictional and multi management agency world of MSP the elements of monitoring and particularly evaluation are complex and can be contentious. In 2007 the Great Barrier Reef Marine Park Act 1975 was amended requiring Great Barrier Reef Marine Park Authority (GBRMPA) to prepare an Outlook report for the Great Barrier Reef (GBR) region every five year. The first Outlook report[11] was published in 2009; Fig. 1 is an extract from this report.



The Great Barrier Reef Outlook Report 2009 is structured around the eight assessments specified under Section 54 of the Great Barrier Reef marine Park Act 1975.

***Fig. 1.** The Outlook assessment required by the GBRMP Act.*

It demonstrates the breadth of the areas that need to be monitored and assessed and importantly at 6; management effectiveness has to be assessed. This is not only the effectiveness of GBRMPA but an assessment is required of the effectiveness of other management agencies that have responsibility for activities, such as fishing, that occur in or impact on the Great Barrier Reef Marine Park (GBRMP). The final assessment is a cumulative one; it effectively weighs up the other assessments to derive a judgment of the long-term outlook for the GBR ecosystem. The Outlook report is a public document, a report card if you like, that synthesizes and then sums up the available evidence and although it does not make management recommendations as such it points out and scales the threats and deficiencies and the gaps that exist. The web accessible evidence pages that sit behind Outlook bring together a vast amount of information and Outlook itself provides a new way of looking at this information but it does not provide new information. The value of Outlook is that it indicates what needs to be addressed and it provides clear management priority and a focus for the scientific information needs for the GBRMP.[12]

Russell Reichelt, GBRMPA Chair and CEO, in his preface to the GBR Outlook Report 'In Brief'[13] writes that Outlook *'summarises what is known about the ecosystem, its use, its management and* *the pressures it is facing, and is a window to the future. It identifies climate change, continued declining water quality from catchment runoff, loss of coastal habitats from coastal development and a small number of impacts from fishing as the priority issues reducing the resilience of the Great Barrier Reef'*.

The scope and range of the issues addressed in Outlook also reinforce that in terms of MSP the 344,400 km2 GBRMP is managed as a multiple use area in a within World Heritage Area and that areas outside the direct jurisdictional control of GBRMPA impact on the values of the GBRMP and need to be managed. Water quality, coastal planning, shipping, dredging, fishing and aquaculture all impact on or occur within the GBRMP; the need for strong collaborative management and coordination between various levels of Government is evident and Outlook amplifies this need as it does the need to apply and integrate ecosystem based management (EBM) into the various management systems.

The Outlook approach has provided a way of looking at the totality of the picture and its composite parts. It has provided clarity to objectives (the reasons why we do things) and it has brought the various indicators together so that effectiveness can be assessed holistically and critically, it provides a transparent assessment of management performance to achieve ecosystem based outcomes.

GBRMPA is a well resourced organization with strong links to the research community, including the Australian Institute of Marine Science (AIMS). Various long term monitoring surveys are in place, including reef health at 47 reefs throughout the GBR since 1993. We are also fortunate in that we have long term fish count information for reef associated species and larval transport work in progress by Geoff Jones, Gary Russ and others is providing evidence that GBRMPA's no-take green zones are providing recruitment subsidies beyond their boundaries; this is a key question. However, the effects of zoning for pelagic and migratory species is not settled and we are supporting work in this direction as well as important work to determine species composition in the gill net fishery for tropical sharks as we seek to understand how effective zoning is for mobile apex predators. The Outlook approach is helping to provide an integrated evaluation of the management value and need for the various monitoring programs that are in place within and adjacent to the GBRMP, again with a focus on ecosystem and connectivity.

Having the mandate and negotiated agreement across jurisdictions to look into areas 'adjacent to' is critically important as a marine managed area can basically only be as 'healthy' as its surrounding waters and it is the connectivity that is a critical component of EBM. Outlook has determined that water quality is a key threat to the GBR and that is driving negotiated management response and water quality indicators and improvement targets are now in place. Possibly more challenging is dealing with cumulative impact and the range and scope of coastal development. However, because it has been transparently identified as a key threat it is driving management response and showing where focus needs to be. With respect to fisheries the key threats identified relate to extraction of top predators, incidental catch of species of conservation concern, illegal fishing and discards and fishing unprotected fish spawning aggregations. Outlook has also assessed positive change in fishing with a range of areas that were previously considered high risk now assessed as low risk due to effective management arrangements, for example the spatially managed prawn trawl fishery. Being able to identify and assess levels of risk in a transparent way across a large marine area, as is the case with the GBRMP, clearly points to where the priority actions are and where investment needs to be made. It is also clear for stakeholders and that is an extremely important component of the application of EBM. The evaluation of management effectiveness of fisheries found that *'a lack of information and coordination, plus variable uptake of best practice management, is limiting the effectiveness of fisheries management'.* For the things that we need to improve that statement provides a clear indication of how we need to collaborate and work together and the areas where we should put effort and investment in – it has certainly, along with the need to work towards climate change adaptation strategies, provided a direction to work with both management and industry and it has enabled a genuine partnership approach to be developed and invested in.

Table 1 (from Outlook) illustrates broadly the assessment criteria and the assessment grade and it is a useful summary of issues relevant to MSP

Table 1 *- Broad assessment of the effectiveness of management.*

Assessment criteria	Summary	Assessment Grade			
		Very good	Good	Poor	Very poor
Understanding of context	Understanding of values, threats, national and international influences and stakeholders is strong for all management issues assessed. This reflects a solid information and research base and a very mature understanding of the key values of the Great Barrier Reef in both a national and international context and the actual and potential threats to those values. Understanding of stakeholders is consistently strong across all issues (in fact it shows the strongest performance across the entire range of assessment criteria).	●			
Planning	Planning performance tends to be strongest where there are few organisations or levels of governance involved in the planning process. There are well developed planning systems in place for all issues except for coastal development where the fractured nature of the planning regime causes problems. Lack of consistency across jurisdictions is the weakest aspect of planning.		●		
Financial staffing and information inputs	Planning performance tends to be strongest where there are few organisations or levels of governance involved in the planning process. There are well developed planning systems in place for all issues except for coastal development where the fractured nature of the planning regime causes problems. Lack of consistency across jurisdictions is the weakest aspect of planning.			●	
Management systems and processes	Planning performance tends to be strongest where there are few organisations or levels of governance involved in the planning process. There are well developed planning systems in place for all issues except for coastal development where the fractured nature of the planning regime causes problems. Lack of consistency across jurisdictions is the weakest aspect of planning.		●		
Delivery of outputs	Planning performance tends to be strongest where there are few organisations or levels of governance involved in the planning process. There are well developed planning systems in place for all issues except for coastal development where the fractured nature of the planning regime causes problems. Lack of consistency across jurisdictions is the weakest aspect of planning.		●		
Achievement of outcomes	Planning performance tends to be strongest where there are few organisations or levels of governance involved in the planning process. There are well developed planning systems in place for all issues except for coastal development where the fractured nature of the planning regime causes problems. Lack of consistency across jurisdictions is the weakest aspect of planning.			●	

The beauty of Outlook is that it is predictive and forward looking; it provides reason and substance as to where effort and resources should be invested and it is multi-jurisdictional in that it addresses the factors and the management effectiveness of all areas that impact on the health and resilience of the GBRMP and World Heritage Area.

The GBRMP situation is complex but not as complex as applying MSP in an oceanic and multi-national situation for, in the fisheries sense, a suite of pelagic and/or highly migratory species. However, the GBRMPA experience and our learning's may have application for the way that ecosystem based management evaluation is approached.

Acknowledgements

Thanks to my work colleague Jon Day and former colleague John Tanzer and former colleagues from the Fisheries Department of WA with whom I have had many discussions around these issues. Plus I thank folk from BfN in Germany and WPFMC, Hawaii who enabled me to put the work I do in the GBRMPA in the context of larger international issues and challenges with MSP.

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[10] The views expressed in this abstract are the author’s and do not necessarily reflect the official views or policies of GBRMPA

[11] Available at: http://www.gbrmpa.gov.au/corp_site/about_us/great_barrier_reef_outlook_report

[12] Available at: http://www.gbrmpa.gov.au/corp_site/info_services/science_management/science_information_needs

[13] Available at: http://www.gbrmpa.gov.au/corp_site/about_us/great_barrier_reef_outlook_report

The Role of Marine Spatial Planning in Governance of Climate Change Mitigation Activities in the Oceans beyond National Jurisdiction

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The adverse impacts of anthropogenically induced climate change on the terrestrial and marine environments have been acknowledged by a succession of expert reports commissioned by global and national bodies.[14] This recognition has prompted a variety of marine geo-engineering schemes to mitigate the detrimental effects of climate change on the environment including enhanced schemes to remove carbon dioxide from the atmosphere using the world’s oceans. The ocean is already a major sink for carbon dioxide because of its capacity to readily absorb excess atmospheric carbon and convert it to soluble form. Scientists have estimated that approximately 5.5 billion tonnes (or gigatonnes) of carbon are now released into the atmosphere each year as carbon dioxide from the burning of fossil fuels and that a third of that is taken up by the oceans.[15] While many climate change mitigation activities involving the oceans such as offshore carbon capture are likely to take place in waters under national jurisdiction where environmental protection measures will be mandated under domestic law, there is at least one climate change mitigation activity which has already been trialled in waters beyond national jurisdiction.[16] Augmenting the rate at which the oceans absorb carbon dioxide is the fundamental objective of a process known as ocean fertilisation or ocean nourishment being proposed for iron and other nutrient deficient areas of the ocean many of which are located beyond national jurisdiction. Ocean fertilization seeks to increase the production of organic material in the surface ocean, with a commensurate rise in “marine snow” or organic detritus falling from the upper layers of the water column to the deep ocean. Carbon transported as marine snow into the deep ocean and finally decomposed to inorganic nutrients and dissolved carbon dioxide can remain out of contact with the surface ocean and atmosphere for relatively long time scales associated with ocean currents and circulation.[17]

The long term environmental impacts of ocean fertilization are still uncertain and the regulatory framework for this process is still developing. While climate change mitigation activities such as ocean fertilisation conducted in marine areas within national jurisdiction may be subject to coastal State legislation and policy on environmental impact assessment, strategic environmental assessment and other environmental protection safeguards, the regulatory framework for such activities beyond national jurisdiction is fragmentary and less defined. General obligations to protect the marine environment beyond national jurisdiction are contained in Part XII of the United Nations Convention on the Law of the Sea (‘1982 LOSC’)[18] but these have not been supplemented in the case of marine areas beyond national jurisdiction with international law instruments applying modern environmental protection principles to the conduct of emerging activities such as ocean fertilization by flag States, their nationals and corporations. In the absence of systems to monitor and mitigate the adverse impacts of such activities in marine areas beyond national jurisdiction, there is a real risk of irreversible damage to the marine environment of these areas and its biodiversity.[19]

Marine spatial planning has a role to play in both facilitating and mitigating the adverse impacts of climate change mitigation activities such as ocean fertilization. The International Oceanographic Commission defines marine spatial planning as "a public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that usually have been specified through a political process."[20] The concept of marine spatial planning goes beyond the creation of marine protected areas or ocean zoning, being more in the nature of a comprehensive vision or plan for a marine region which accommodates a variety of objectives including conservation, social and economic development. The process of marine bioregional planning being undertaken in waters under Australian national jurisdiction by the federal Department of Environment is an example of marine spatial planning.

In the oceans beyond national jurisdiction, there are very few examples of comprehensive marine spatial planning although there are some single sector ocean zoning processes such as fisheries closures and limited regional examples of protected areas beyond national jurisdiction binding participating members of OSPAR in the North East Atlantic and parties to the Pelagos sanctuary agreement in the Mediterranean. At the global level there are a number of initiatives taking place which may eventually provide a more established foundation for comprehensive marine spatial planning in waters beyond national jurisdiction. In 2008, the ninth meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 9) adopted the scientific criteria, in its decision IX/20 for identifying ecologically or biologically significant marine areas (EBSAs) in need of protection and the scientific guidance for designing representative networks of marine protected areas. COP 9 also decided to convene an expert workshop to provide scientific guidance on the use and further development of biogeographic classification systems and guidance on the identification of areas beyond national jurisdiction which meet the scientific criteria for EBSAs which met in Ottawa in September 2009. The UN Ad Hoc Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction at its third meeting in Feb 2010, recognized the work of competent international organizations such as the CBD on the use of area based management tools and the importance of establishing marine protected areas consistent with international law and based on scientific information, including representative networks by 2012 as called for in the Johannesburg Plan of implementation (JPOI) of the World Summit on Sustainable Development (WSSD) and called upon States to work through such competent international organizations towards the development of a common methodology for the identification and selection of marine areas that may benefit from protection. This paper will examine the results of these initiatives, some potential options under international law for implementing marine spatial planning in the oceans beyond national jurisdiction and the implications of such marine spatial planning for proposed climate change mitigation activities in the oceans beyond national jurisdiction.

[14] Intergovernmental Panel on Climate Change (IPCC), *Fourth Assessment Report* (2007) ('IPCC Fourth Report') <http:www.ipcc.ch/ipccreports/ar4-syr.htm> accessed 13 May 2010; Nicholas Stern et al, *Stern Review: The Economics of Climate Change* (HM Treasury, London, 2006); BL Preston & RN Jones, *Climate Change Impacts on Australia and the Benefits of Early Action to Reduce Global Greenhouse Gas Emissions. A consultancy report for the Australian Business Roundtable on Climate Change* (CSIRO Canberra, Canberra ACT, 2006).

[15] Tony Koslow, The Silent Deep (UNSW Press, University of New South Wales, Sydney, Australia, 2007) at 156.

[16] Karen N Scott, 'The Day After Tomorrow: Ocean CO2 Sequestration and the Future of Climate Change' (2005) 18 *Georgetown International Environmental Law Review* at 57.

[17] John L. Cullen and Philip W. Boyd, "Predicting and verifying the intended and unintended consequences of large-scale ocean iron fertilization" (2008) 364 *Marine Ecology Progress Series* at 296.

[18] *United Nations Convention on the Law of the Sea* opened for signature on 10 December 1982, 1833 UNTS 3(entered into force 16 November 1994) (*'1982 LOSC'*). The term 'marine areas beyond national jurisdiction' when used in this article refers to all those parts of the sea which are not included in the exclusive economic zone, territorial sea or the internal waters of a State or the archipelagic waters of an archipelagic State and all those parts of the seabed and ocean floor and sub-soil thereof beyond the outer limit of the continental shelf of a State.

[19] Koslow, above n.2 at 159-160; Scott, above n.3 at 58.

[20] UNESCO-International Oceanographic Commission, *Marine Spatial Planning*, http://www.unesco-ioc-marinesp.be/marine_spatial_planning_msp accessed 13 May 2010.

Corporate Role in Marine Spatial Planning and Management

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[1] **World Ocean Council**

Marine spatial planning and management is emerging as a key development in managing marine ecosystems. It is being pursued through a variety of processes and agencies with significant input from NGOs. Marine spatial planning will have major effects on ocean industry access to marine space and resources, e.g. offshore wind energy, wave and tidal energy, oil and gas, shipping, fisheries, aquaculture, etc. Industry must constructively engage with marine spatial management efforts and with the other ocean industry stakeholders to ensure that the process is well informed and balanced. This will increase the potential for newly emerging ocean management to reflect the needs of responsible industry operators. Unfortunately, industry is often not involved in marine spatial planning developments.

Barriers to industry involvement in marine spatial planning and management include: (i) Lack of understanding of the process and players involved; (ii) Limited engagement in the multi-stakeholder process because industry is engaged in sectoral processes; and (iii) Lack of means for engaging the broader ocean business community on marine management and sustainability. There is a need and opportunity for constructive industry leadership and collaboration on marine spatial planning and management, including: (i) Developing an understanding of the issues, stakeholders and process; (ii) Actively engaging in key multi-stakeholder processes; (iii) Building constructive relationships among ocean industries and other stakeholders; and (iv) Creating practical experience by constructively engaging in marine spatial planning and management developments in a specific locations.

Coastal and Marine Spatial Planning and the Northwestern Hawaiian Islands

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Abstract

The Papahanaumokuakea Marine National Monument was created by Presidential Proclamation on June 15, 2006, circumventing the process of designating the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve as a national marine sanctuary. The regulations governing the Monument define zones for specialized activities and all commercial fishing is slated to be phased out on June 15, 2011. The Monument Management Plan and the Monument Science Plan do make provisions for understanding the region's ecosystem and incorporating the information into the Monument's adaptive management strategy. This information will be used in formulating management actions for the activities allowed in the different zones.

1. Introduction

On June 15, 2006, President George W. Bush issued Presidential Proclamation 8031 establishing the Northwestern Hawaiian Islands (NWHI) Marine National Monument under the authority of the Antiquities Act of 1906 (16 U.S.C. 431). At that moment, the monument, which was renamed the Papahanaumokuakea Marine National Monument (PMNM) on March 6, 2007, became the largest fully protected marine reserve in the United States.

The Monument includes a number of existing federal conservation areas: the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, managed by the U.S. Department of Commerce through the National Oceanographic and Atmospheric Administration (NOAA); and the Midway Atoll National Wildlife Refuge, the Hawaiian Islands National Wildlife Refuge, and the Battle of Midway National

Memorial, managed by the U.S. Department of the Interior through the U.S. Fish and Wildlife Service (FWS). It also includes the State of Hawai'i lands and waters, managed by the State through the Department of Land and Natural Resources as the Northwestern Hawaiian Islands Marine Refuge and the State Seabird Sanctuary at Kure Atoll. All of these areas remain in place and are subject to their applicable laws and regulations in addition to those covered by the Proclamation.

The PMNM encompasses 139,797 square miles of the Pacific Ocean and its extensive coral reefs are home to more than 7,000 species (24-35% found nowhere else in the world). It covers the northern 1200 miles of the Hawaiian Archipelago and is the most remote set of islands in the world. Historically, the area provided fishery resources for Native Hawaiians from 500 A.D. and was heavily fished by foreign fishers for monk seals, whales, fish, lobsters, and black lipped pearls. Since 1991, the Longline Protected Species Zone was designated to prevent interactions with endangered species and no pelagic longline fishing within 50 nautical miles of the NWHI was permitted. No crustacean fishery has operated in the NWHI since 2000. Although the bottomfish fishery remained opened to eight vessels with valid permits, the fishery was scheduled for closure on June 15, 2011. By December 2009, all eligible permitees voluntarily accepted compensation for their projected losses and surrendered their permits. All commercial fishing has ceased in the PMNM and coastal and marine spatial planning (CMSP) as it relates to its fishery natural resources is completed. CMSP for other uses in the monument will continue and research to map, monitor, and model the NWHI ecosystem will guide adaptive management of the PNMP.

2. Coastal and Marine Spatial Planning in the Papahanaumokuakea Marine National Monument

The designation of the PMNM was followed by rulemaking that was completed jointly by the FWS and NOAA on August 29, 2006 (71 FR 51134). Monument regulations codified under 50 CFR Part 404, established the scope and purpose, boundary, definitions, prohibitions, marine zones, and regulated activities for managing the Monument (Fig. 1). Entrance into the PMNM is strictly forbidden unless it is for transit, emergency and law enforcement purposes, armed forces activities; all commercial fishing is banned after June 15, 2011. Permitted activities include research, education, Native Hawaiian cultural practice, sustenance fishing in the Midway Atoll Special Management Area, and an activity known only as "special ocean use." The management zones described in Fig. 1 are: Special Preservation Areas, Ecological Reserves, and the Midway Atoll Special Management Area. Each zone addresses protection of habitat and foraging areas of threatened and endangered species; inclusion of a representative range of the diverse array of marine habitats, including shallow coral reef environments, deepwater slopes, banks and seamounts. These zones were recommended through the planning phase and EIS process initiated by the National Marine Sanctuary Program (NMSP) in 2003 and incorporated into 71 FR 51134 to protect the ecological linkages between habitats and minimize the risks associated with activities such as fishing and recreational activities. The NMSP process included six topical fishing discussion groups each of which met two or three times for a total of 18 meetings (Kittinger et al., 2010). A multidisciplinary team of independent researchers were also charged with providing background research on commercial fishing in the NWHI and their report was presented to the fishery discussion groups for feedback and refinement (Wilcox et al., 2003).

Fundamental to the management of these zones is an understanding of the NWHI ecosystem. The PMNM Monument Management Plan indicates that knowledge of the Monument's marine biodiversity, coral reefs, ecosystem dynamics, potential effects of climate change and the social and economic drivers are needed to inform and refine management strategies and activities in their proposed adaptive management process. Inherent in this process is the possibility of redefinition of marine zones should scientific data support change that is consistent with the Monument goals and desired outcomes. Defining the criteria that will guide any change is the key component for this adaptive management.

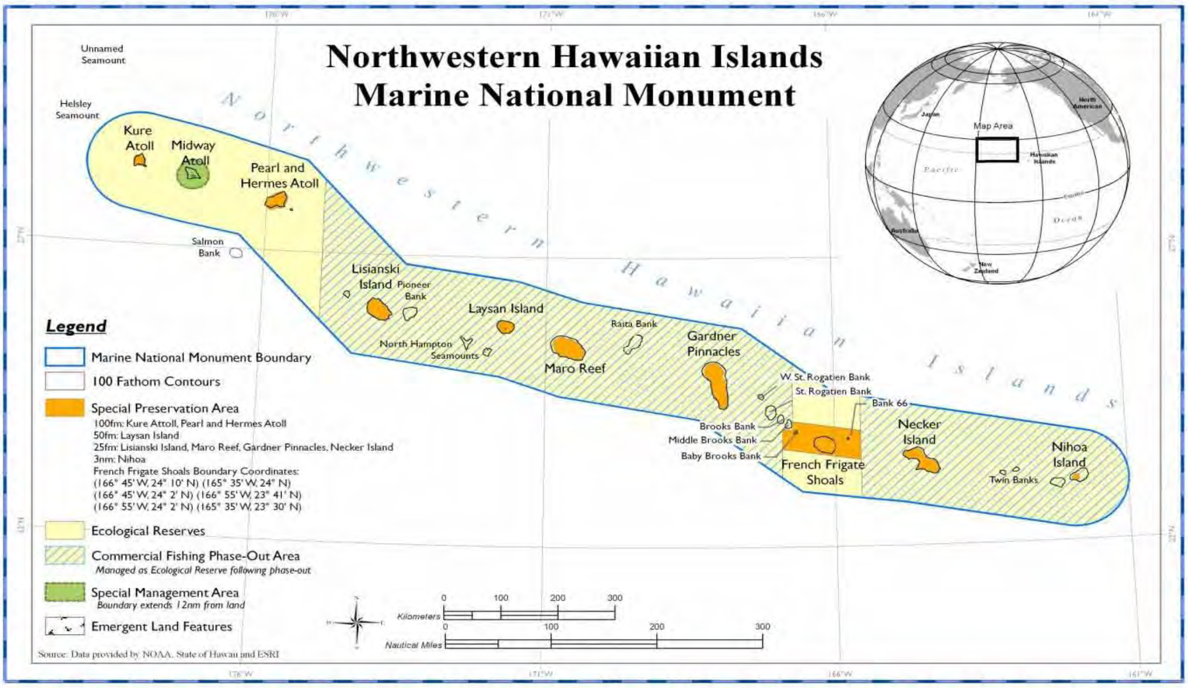

Fig. 1. Northwestern Hawaiian Islands Marine National Monument Zones (2006) (71 FR 51134).

3. Principles and Approach for CMSP in the Papahanaumokuakea Marine National Monument

Spatial management based on an ecosystem approach is now widely accepted as a means to protecting the ecosystem services of a region by separating incompatible uses (Crowder and Norse, 2008). At its core is a firm understanding of the ecological attributes of the system under consideration. These attributes are described in Table 1 derived from Foley et al., 2010. The four ecological principles that have been proposed to guide ecosystem-based CMSP maintain or restore (1) native species diversity, (2) habitat diversity and heterogeneity, (3) key species, and (4) connectivity. In the PMNM, the scientific data supporting these principles are not complete and scientific studies continue to add to this data resource.

Table 1. Ecological principles for ecosystem-based CMSP.

Principle	Important feature	Ecosystem function(s) supported
Maintain native species diversity	Species diversity and composition Genetic diversity Functional redundancy	Productivity Resilience (resistance & recovery)
Maintain habitat diversity and heterogeneity	Habitat representation	Maintenance of species diversity
Maintain populations of key species	Keystone Foundations Basal prey Top predators	Species diversity Food web stability Resilience Ecosystem engineering
Maintain connectivity	Populations and species persistence Flow of subsidies	Species diversity Metapopulation & metacommunity dynamics

Modified from Foley et al., 2010.

4. Ocean Policy Task Force Coastal and Marine Spatial Planning – Pacific Islands

An ecosystem approach to CMSP is an integral component of President Barack Obama's Ocean Policy Task Force response to the call for recommendations for a national policy for our coastal and oceanic resources (June 12, 2009 Presidential memorandum). On December 9, 2009, the Inter-agency Ocean Policy Task Force issued an interim framework for effective CSMP and this document provides the principles and approach for Ecosystem based management of the PMNM (Interagency Ocean Policy Task Force, Dec. 12, 2009, Interim Framework for Effective Coastal and Marine Spatial Planning).

CMSP is defined as a comprehensive, adaptive, integrated, ecosystem-based and transparent spatial planning process, based on sound science, for analyzing current and anticipated uses of ocean, coastal, and Great Lakes areas. CMSP identifies areas most suitable for various types or classes of activities in order to reduce conflicts among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives.

For CMSP purposes, the planning scale for initiating CMSP is at the large marine ecosystem (LME) scale. In the case of the Pacific Islands, this includes the entire Hawaiian Archipelago, the Commonwealth of the Northern Mariana Islands, American Samoa, and Guam. The process involves the following:

1. Identification of members of the Regional Planning Body: Federal, State, tribal authorities, and indigenous community representatives with jurisdictional responsibilities or other interests.
2. Partners execute a CMSP Development Agreement which would provide a process for resolving conflicts and a process to develop a formal regional work plan.
3. Partners develop a regional work plan that establishes key milestones, identifies resources, specific time frames, and addresses the essential elements for the planning process:

a. Identify regional objectives
b. Identify existing efforts that should help shape the plan throughout the process
c. Engage stakeholders and the public in key points throughout the process
d. Consult scientists and technical and other experts
e. Analyze data, uses, services, and impacts
f. Develop and evaluate alternative future use scenarios and tradeoffs
g. Prepare and release a draft CMS plan for supporting environmental impact analysis
h. Create a final CMS plan and submit for National Ocean Council (NOC) Review. (The NOC's functions and duties are described in the Interim report of the Ocean Policy Task Force.)

It is unclear at this moment how these principles and approaches will impact the Monument Management Plan and the draft PMNM natural resources science plan.

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Great Barrier Reef Marine Park Authority Lessons Learned in Marine Spatial Planning, including Sustainable Marine Fisheries[21]

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In preparing this abstract for the Forum an assumption has been made that readers have familiarity with the concepts of marine spatial planning (MSP) and have some knowledge of the Representative Areas Program (RAP) and the consequent 2004 rezoning of the multiple use 344,400 km2 Great Barrier Reef Marine Park (GBRMP) where, among other things, an increase in no take area protection from 4.5% to ~34% was achieved

Underpinning this substantial biodiversity conservation achievement and with respect to fisheries and MSP initiatives that are increasingly being implemented (and refined) by various jurisdictions it is apparent that the allocation and conservation of fish resources is occurring within an increasingly complex marine and socio-political environment, an environment in which perhaps the most challenging allocation of all is the determination of an ecologically effective and socially just balance between the ecosystem and extraction. Marine Protected Areas (MPAs), with a goal of biodiversity protection, are an important part of the allocation conundrum. However, perceived allocation and socio-cultural deficiencies in MPA planning processes and their apparent lack of regard for fisheries management processes and objectives and vice versa are problems.

The lessons learned, from the Great Barrier Reef Marine Park Authority (GBRMPA) experience, relate to the preceding paragraph. One thing we have learned is that the GBRMP is large enough and representative enough of an entire ecosystem to allow GBRMPA to achieve (or at least approach), but not on its own, ecosystem based management (EBM). Critically, and an important distinction from many smaller MPAs, is that the EBM approach GBRMPA has taken occurs in a multiple use context. The object is to manage the impact of use, on an ecosystem scale, not simply exclude it.

Fig. 1. *The GBRMP extends through 14° of latitude (10°41'S to 24°30' S). It is roughly the size of the Baltic Sea or West Coast USA, but it is only bordered by one State*

Key points from the GBRMPA experience are that we have[22] :

- A sound governance framework, including specific legislation for the GBRMP and World Heritage Area, combined with comprehensive Federal environmental legislation, and complementary legislation for the adjoining State waters (It is appreciated that the GBRMP situation is fortunate, it does not have the jurisdictional and legal difficulties that are MSP realities in international and 'high seas' environments).
- A strong legal mandate to be consistent with ecosystem-based management[23] and the principles of ecologically sustainable use.
- Management influence over a wider context than just the Federal GBRMP with consideration of connectivity issues including the adjoining catchments, offshore waters and the islands; hence consideration of the widest possible aspects of 'the ecosystem'.
- A comprehensive management system including a statutory zoning plan which provides a multiple-use zoning network, statutory plans of management, site-specific management plans, a permitting regime and a strategic plan for the entire area.
- Well developed/integrated management with all relevant Federal & State agencies, including formal and informal arrangements with the state of Queensland as the responsible jurisdiction for the adjacent tidal waters and most islands.
- Widespread stakeholder involvement through a variety of advisory committees and community engagement processes in both planning and ongoing management.
- Strong cooperative partnerships and/or formal agreements with other agencies, commercial (including fishing) and recreational industries, Traditional Owners, research institutions and universities.
- Strong (though at times feisty) political support at all levels (Federal, State and Local Government levels).
- An adaptive management approach based on monitoring and a range of assessments including management effectiveness, and continuous improvement.
- National consensus and international recognition that the GBR is 'iconic' and worth conserving, with many industries who depend upon its health, recognising its values and the need for protection.
- Effective research & monitoring programs, prioritised to provide information on changes to assist management.

This background, along with our primary legislation, the GBRMPA Act, gives GBRMPA strength in what it does and gives it purpose.

It is also important to note that zoning, including highly protected zones, is a critical management tool to achieve our objectives, including EBM in the GBR but it must be supported by other spatial and temporal management 'tools'. These other tools are necessary to control and mitigate the broad range of impacts associated with human use of the GBR and the impacts stemming from activities occurring outside of the GBRMP. In the GBRMP, these other management tools include: permits (normally tied to defined areas or specific zones); plans of management (developed particularly to regulate tourism and high use areas); site management plans; special management areas (eg. Dugong Protection Areas) and other legislated spatial restrictions (eg. Defence Training Areas, Designated Shipping areas, agreements with Traditional Owners); best environmental practices; industry Codes of Practice and partnerships with industry. These various management tools overlay the zoning and may have their own objectives or legislative mandates.

There are also various other management programs, including the Reef Water Quality Protection Plan, (a negotiated partnership with Queensland directed at catchment management), fisheries management arrangements (GBRMPA influences but does not have responsibility for or manage fisheries), a Climate Change Action Plan, strategically designed collaborative compliance and enforcement programs and comprehensive monitoring programs, are all essential to maintain the health of the GBR as a critical global resource.

The preceding summary sounds well, but the 'devil' as usual is in the detail. In the confines of this abstract there is space only to summarise, not elucidate, detail. Consequently, as someone who was intimately involved in the RAP and subsequent outcomes, I will only highlight areas of importance and difficulty, particularly with respect to fisheries. Our experience does not translate directly to high seas and open ocean pelagic governance and environmental issues. However, there are lessons that can be learned and there are commonalities that exist when one considers what spatial management can achieve (and what it might cost) with respect to ensuring the resilience and long term productivity of marine ecosystems.

The rezoning of the GBRMP was driven by the RAP which was, among other things, a process of clear objective setting based on best available scientific knowledge and advice about what was required to achieve, via a network of no-take areas, a satisfactory level of protection for the biodiversity of the GBRMP to ensure, as far as possible, that the health and resilience of the GBR ecosystem would be adequately protected into the future.

RAP utilised the best collective contemporary scientific knowledge of the GBR ecosystem to, through a collaboration of scientific and stakeholder expertise (including fishers), identify and map 30 reef and 40 non-reef bioregions of the GBR ecosystem. The process of RAP recognised from the outset that it was not just a science decision and that for it to be politically and socially acceptable socioeconomic considerations and implications had to be effectively taken into account and principles had to be established.

The Cornerstones of RAP

First among these were the bioregions[24]. This approach was foreshadowed by Lubchenko et al in 1991 in 'The Sustainable Biosphere Initiative' where they recognised that 'current research efforts are inadequate for dealing with sustainable systems that involve multiple resources, multiple ecosystems, and large spatial scales. They emphasised the need to understand and describe the 'underlying ecological processes that affect the sustainability of natural and managed systems'.

The second major cornerstone was the development of the eleven 'Biophysical Operational Principles' (BOPs) as recommended by a Scientific Steering Committee. Supporting the scientific BOPs was a set of four 'social, economic, cultural and management feasibility operational principles (SecBOPs).

Table 1. Operating principles (Summarized).

Biophysical Operating Principles

1. Minimum size 20km across if possible
2. The larger, the better
3. Replicate no-take areas within bioregions to reduce risk
4. Don't 'split-zone' reefs if possible
5. (reef) & 6. (non-reef). Minimum of at least 20% per bioregion
7. Consider cross-shelf & latitudinal diversity
8. Include examples of all community types & physical environments
9. Consider connectivity
10. Consider special & unique sites/locations
11. Consider adjacent uses

Social, Economic, Cultural & Management Feasibility Operating Principles

1. Maximise complementarity with adjacent areas
2. Recognise social benefits / costs
3. Complement existing & future management
4. Maximise public understanding & enforceability

Achieving the BOPs drove the placement of the no-take areas. The BOPs were interdependent and needed to 'be considered as a 'package' and not in isolation' (Day et al 2003). This Consideration was not easy, the socioeconomic principles were subject to the scientific BOPs and, trying to meet the objectives of both to achieve least socioeconomic cost in the ultimate placement of no-take areas represented a major challenge and exposed weaknesses in the ability to obtain all relevant data. The integrity and transparency of the RAP process, and ultimately the retrospective political and social justification of the basis for zoning, depended on the ability to successfully meet both sets of principles.

The application of the BOPs provided a starting point and a reference for what needed to be achieved. Over the scale of the GBRMP there were literally thousands of candidate area options. These were then redefined many times over and multiple solutions were generated because of stakeholder input, including the comprehensive analysis of some 31,500 submissions from two formal public participations phases.

In our experience in MSP it is clear that objectives and operational principles need to be established upfront. They need to be anchored in the best available science, and what they are setting out to achieve, and why, needs to be documented and publicly available and the whole process needs to be transparent and invite participation. The 'problem' needs to be defined and clarified and the 'proposed' scale of the solution justified. It is also essential to have staff relating to the community who understand the implications of what is proposed at a personal level.

In essence the operational steps are (adapted from Fernandes et al.2004):

- Discussion and clarification of the problem;
- Decisions on objectives;
- Engagement of relevant and independent experts;
- Description of the biodiversity, for example through bioregions;
- Definition of the operational principles that will achieve the objectives;
- Invite substantive community input into all of the above;
- Gather and layer data in round-table discussions (and have the appropriate balance of participants including people who know and understand the uses of the area);
- For each alternative map of a no or restricted take area generated, report the degree of achievement of the principles; and
- Have a strategy in place to effectively address negative socioeconomic impacts.

The remaining hurdles 'will be political and legal and unique to each situation'.

In any of these steps consensus on all points and full agreement with the 'certainty' of the science is unlikely to be gained. The level of protection that is sought needs to be defensible within both a political and regional context and if 'multiple use' as a concept is to be a purpose and intent of MSP then the protection requirements will need to be balanced against the constituents of wise and reasonable use of the area(s) in question. Finally, the result is worthless, if it is a 'paper park'. The resources to implement and effectively manage the area to achieve a satisfactory level of compliance are critical elements of success; elements that will be enhanced considerably if the ground work has been done to engender and maintain broad 'area user' support; basically the work will need to have been done to maximise voluntary compliance.

The Fisheries Issues

The final development of the Zoning Plan was an iterative task-force-led process. Candidate areas were examined and re-examined in light of submissions, and other information and data available. For this process to be effective, it was critical that staff, who had a balanced knowledge-based appreciation of various stakeholder positions, were on hand during the round table decision-making. The processes were difficult and stressful. As a change was made in one place to accommodate legitimate considerations, it upset the degree of achievement with the BOPs in another. From a fisheries perspective it was, at times, very difficult as it became obvious (to those who understood and realised the effects on particular fishers or groups of fishers) that some candidate area placements would impact very heavily on those fishers to the extent that their economic viability would be severely compromised.

Of the two sets of principles that had to be met, the socioeconomic principles were the more difficult to achieve; internally and externally they elicited the most controversy. Difficulties arise when, working with imperfect data sets, one attempts to analyse then comparatively evaluate social costs and benefits, including social resilience. The difficulty compounds when there is widely differing opinion on the human, economic and intrinsic values of ecosystem services and the way that they are used by society (Costanza & Daly 1992; McManus 1996, Lubchenko et al 1991). However, when resources are being reallocated from generating a private benefit such as fishing, to a broader public good such as biodiversity conservation[25] then this evaluation must be made. The costs are real and they are personal. Evaluation decisions made affect people's livelihoods and despite possible compensation or other remedial actions they may affect a person's perception of his or her standing in society and in so doing affect the social fabric of a community. This 'perception of personal standing' may not be an important issue for communities or people distant from the area(s) under consideration but it is real, and socially significant, for people living in communities near, or adjacent to the area(s) affected. It is also politically painful and can divide communities.

In the GBRMP a particular difficulty related to both the range and the interpretation of data sources used to develop robust spatially based estimates of the gross value of production (GVP) of various fishery activities. Compounding the difficulty was the knowledge, held by staff with fisheries expertise, of the unreliability of logbook data. These staff, through their collective knowledge of respective fisheries and involvement with the State fisheries management processes on management advisory committees and working groups, knew that logbook data for a number of fisheries were inaccurate enough, if taken at face value, to distort spatially-based GVP estimates. Although some fisheries spatially reported at 6x6 minute (6nm2) grid sites, the bulk of data was at the coarser scale of 30x30 minutes (30nm2) grids. Fishing effort is not spread universally over an area, some areas are far more productive than others and fishers apply unique sets of knowledge and fishing strategies to maximise productivity from any given area. Compounding this further is the fact that some fishers work 'in patches known to them' well away from others. On a pure, spatially based GVP estimate their catch may not be significant, but at the single boat level, a particular area may represent a substantial portion of their expected income.

Engagement with fisheries managers and fishers was problematic. Not only because it was difficult as it obviously is when an object of the consultation or negotiation is to find suitable areas to close to extractive activity. Firstly, it was difficult because there were legal and jurisdictional policy barriers to obtaining all relevant data to support decision-making at the types of spatial scale that is necessary when one is legitimately trying to minimise the socioeconomic costs of locating a no-take area. Secondly, to achieve the RAP biodiversity protection objectives it became apparent that required decisions would result in resource reallocation and a serious and probably unsustainable displacement of effort in some cases that, if not ameliorated, would be a threat to the sustainability of fish stocks.

These factors made any consideration of who should be compensated, by whom, both political and problematic and that problem remains. Latency concerns in a number of fisheries were a major issue. If, at a spatial level, which is the case with zoning, one is reallocating fishery resources to another sector, and if compensation is being considered, then real effort applicable to the area(s) under consideration must be removed or little is achieved. In terms of achieving equitable outcomes, it is important that compensation goes to those who deserve it and who can prove that their effort in, and reliance on, a fishery is real.

The application, in fisheries management, of an EBM approach designed to preserve the resilience and essential ecological character and connectedness of marine ecosystems requires an interpretive change in some of the assumptions that have underpinned fisheries management. While multiple target and non-target stock structures and predator-prey and other ecological and habitat relationships will need to be examined and accounted for in an integrated way a primary focus will also need to be on the way that fisheries resources are allocated. Recognition that the ecosystem itself requires an allocation changes the way that the purpose of resource allocation is viewed and it fundamentally changes how a share of a resource might be apportioned. This change of 'share' has both an economic and an ecological consequence and it changes the way that the optimal and efficient use of a resource might be considered.

Despite arguments and misgiving by sections of the fishing industry it is imperative that fishery management agencies strategically plan to most effectively utilise the biodiversity protection processes and strategies encompassed within MPAs to ensure that resource reallocation, when it occurs, is equitable.

Marine environmental agencies possess and accumulate considerable data, knowledge, and skills, as do fishery management agencies. In the fenceless marine environment both sets of skills are required to conceptually manage ESD on an ecosystem basis. Fisheries agencies are the repository of data and knowledge about the respective fishery activities in their jurisdictions. They need to develop policy positions whereby they can proactively assist in designing MPAs for biodiversity protection. In so doing they need to contribute and exercise control over information and fine scale data about resource usage so that appropriate and knowledge-informed decisions can be made about minimising the socioeconomic costs of locating no or restricted take areas. The legal issues and jurisdictional conventions pertinent to fisheries data sharing and confidentiality protection need to be re-examined. In large part, when the conventions and rules were formulated resource reallocation shifts from a private benefit such as fishing to a broader public good such as biodiversity protection were not normally matters that had to be contended with.

The objectives of fisheries and marine environmental management agencies, though different, should not be mutually exclusive. Both management streams need to weave their objectives together in a more cohesive manner and they need to collaboratively optimise the use of data and knowledge resources. Extractive activities are a fact in the marine environment and there is not a convenient set of fences or natural boundaries to separate activities and their impacts and the way that they can be managed. Current administrative and jurisdictional boundaries coupled with 'philosophical mindsets' that are often ideology or politically driven, are impairing the bringing together of knowledge that could reshape marine resource management and the optimal use of marine resources to achieve ecologically sustainable development across large tracts of the exclusive economic zones of nations. Importantly, for the community, the demarcation lines that polarise discussion, and create angst in coastal communities, need to be drawn together in order to fully operationalise and give ownership to the meaning of ecologically sustainable development. Put simply, the camps need to come together.

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Footnotes:

[21]The views expressed in this abstract are the author's and do not necessarily reflect the official views or policies of GBRMPA.

[22]Adapted from a 2010 internal GBRMPA assessment by Jon Day and Peter McGinnity

[23]The GBRMP Act defines EBM as " *...an integrated approach to managing an ecosystem and matters affecting that ecosystem, with the main object being to maintain ecological processes, biodiversity and functioning biological communities*"

[24]Bioregion boundaries are rarely hard-edged, they are indicative or fuzzy, but they assist greatly in categorizing the biodiversity requiring protection (Day et al 2003).

[25]Australian Government, January 2004 'Marine Protected Areas and Displaced Fishing: A Policy Statement'

New England Area Rotation of Scallop Beds

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Abstract

Area rotation is a form of marine spatial planning that has been used in scallop management in New England since 1998. While it began somewhat as an accident, it is now one of the most successful examples of how marine spatial planning can be used to increase biomass and improve overall management of fishery resources. During the 1990s the scallop fishery was experiencing overfishing and landings were relatively low. In 1998 areas with high concentrations of small scallops were closed to the fishery for three years. After these areas reopened, biomass and catch rates increased, and scallops were larger leading to higher prices for vessels and lower fishing costs. These things in turn resulted in higher profits for the fleet. This program was expanded in 2004 under Amendment 10 to the Scallop Fishery Management Plan (FMP). Minor adjustments are continually made to further improve the program and make it more effective. The primary benefit of area rotation is reduced fishing time, which has positive impacts on the resource, bycatch, and ocean bottom, as well as lower fishing costs. In addition, closing areas allows scallops to grow and maximize yield per recruit. This has beneficial impacts for the fishery because larger scallops have a high price premium in the market. Area rotation does require high-quality, timely data on the size and location of the resource, effective enforcement of closed areas, a relatively rapid and flexible management system, and strong support from the industry because closing prime scallop fishing grounds can be very controversial. Overall area rotation has been a very successful example of marine spatial planning for New England because it has helped optimize yield in the scallop fishery and help prevent overfishing.

Background

The Atlantic sea scallop, Placopecten magellanicus (Gmelin), is a bivalve mollusk found in the Northwest Atlantic from North Carolina to the Gulf of St. Lawrence typically found in sand and gravel habitat (Hart and Chute, 2004). Scallops recruit to the fishery at a shell height of about 90-105 mm, but smaller scallops have been landed in the past (NEFSC, 2007). There are currently about 350 limited access permits that harvest scallops, primarily with a New Bedford-style dredge from vessels generally between 70 and 90 feet in length. The primary measures in place to control mortality in this fleet are limits on the number of days a vessel can fish, maximum number of trips a vessel can take in rotational access areas, limits on number of crew, and gear restrictions. A ‘general category’ fleet made up of smaller vessels also harvests scallops, and it lands less than ten percent of the total catch (NEFMC, 2007). This permit category was open access until recently, but now general category vessels fish under an individual fishing quota (IFQ) program based on catch history and number of years in the fishery.

The US scallop fishery began in the early 1900s with peaks in landings around 1960, 1978, 1990, and 2004 (NEFSC, 2007), and low landings during the 1990s as the stock became overfished. In 1994 large areas on Georges Bank were closed to reduce impacts on overfished groundfish species. Coincidently, these same areas overlapped with portions of scallop fishing grounds, and during the closure scallop abundance increased dramatically. The fishery was granted limited access in 1999 and 2000 in portions of these areas that were expected to have high scallop catch rates and low groundfish bycatch. At the same time, two areas in the Mid-Atlantic were closed to scallop fishing in order to protect small scallops that were found there in high concentrations (Hart, 2003).

Since the late 1990s scallop biomass has increased dramatically due to area closures, reduced effort, changes in fishery selectivity, and strong recruitment. The stock is not overfished and overfishing is no longer occurring. Annual catch has been about 55-60 million pounds since 2003. Total revenue for the fishery has increased dramatically. Total revenue for the fishery has been $350-400 million dollars a year since 2005 compared to less than $100 million a year in the 1990s, primarily because the average meat count of landed scallops is larger than in the past. Fig. 1 depicts commercial landings by meat weight category from 1998 through 2006; the larger scallops (< u20) are just a fraction of the total catch in 1998, compared to the majority of the catch in 2006.

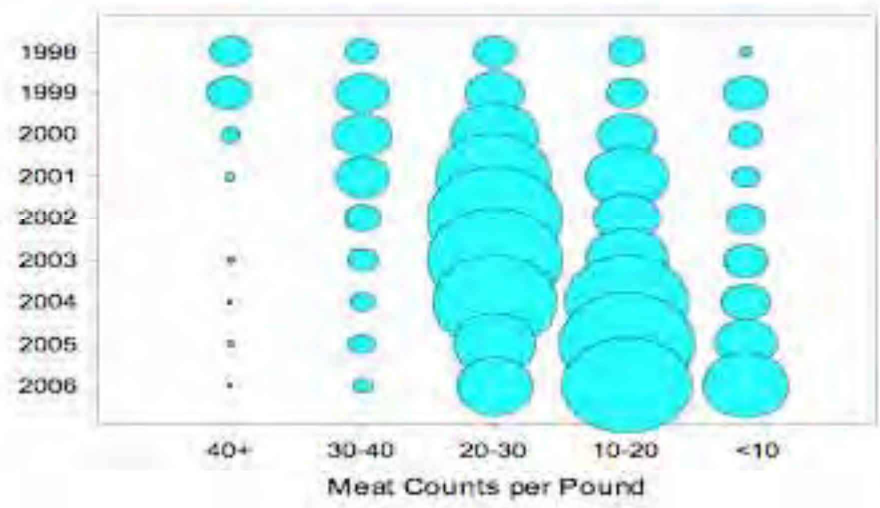

Fig. 1. Commercial landings by meat count category, 1998-2006 (Source NEFSC, 2007).

Area Rotation Today

Today there are six scallop rotational areas along the east coast of the United States; three within pre-existing groundfish mortality closed areas on Georges Bank, and three more that were identified exclusively to protect small scallops in the Mid-Atlantic region (Fig. 2). Typically, several areas are open per year on a rotating basis. It is not always possible to have the same number of areas open each year, but the management program strives to maintain consistent catch levels. Area rotation has helped stabilize landings and prevent the “boom and bust” cycles that were evident in this fishery in the 1900s. As the area rotation program has expanded the percentage of total catch from access areas has increased. For example, in 1998 there was only one area open and catch from that area was on a very limited basis very limited at 5,000 mt or about 20% of total catch. On the other hand, in 2007 and 2008 over 60% of total catch came from access areas (NEFMC, 2010).

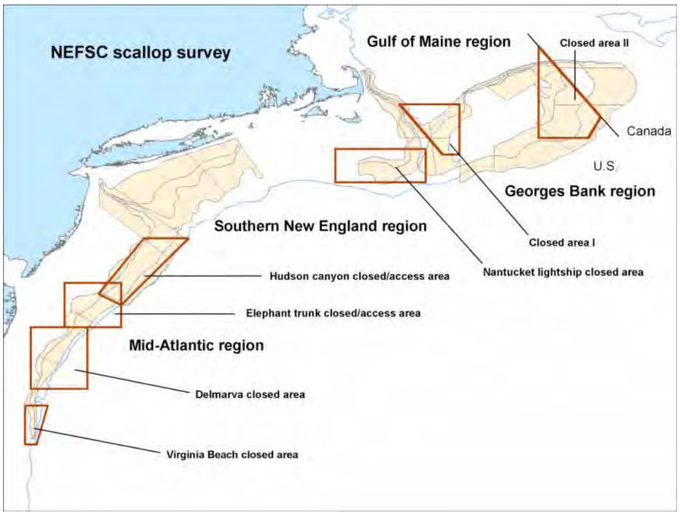

Fig. 2. *Map of scallop access areas and regions (shaded areas are strata from the NEFSC dredge survey) (Source NEFSC, 2007).*

Benefits

The primary benefit of area rotation is reduced fishing time, which has benefits on the resource, bycatch, and ocean bottom. The less time scallop fishing gear is in water, the less it catches bycatch such as flounders and skates. In addition, less fishing time translates into fewer potential interactions with protected resources such as sea turtles. Lastly, if the gear is in contact with the ocean floor less there are beneficial impacts on benthic ecosystems and habitats. Reduced fishing time also has benefits for the vessels because costs are reduced. In the past it could take two weeks to land 18,000 pounds of scallops, the equivalent of one access area trip. In some cases, trips are now as short as five or six days for the same 18,000 pounds. That represents a huge cost savings for vessels. In addition, by closing areas scallops can grow larger to maximize yield per recruit, which has beneficial impacts for both the stock and the fishery because larger scallops have higher fecundity and have a high price premium in the market. Now that there is a steady supply of larger scallops from US fishing grounds, the industry has been able to compete in new markets around the world. Lastly, there is some evidence that closing areas may allow for “spillover,” in the form of increased scallop recruitment in adjacent areas.

Challenges

There are some challenges that accompany area rotation. Because it requires detailed surveying of the areas, it is expensive. The federal government supports a dredge survey that has evaluated the scallop resource in the same manner annually since 1979. The management program has solved some of the cost issues associated with area rotation by setting aside two percent of the projected catch each year to fund scallop research. A portion of that catch is used to assess the resource for setting allowable catch levels and identifying new scallop access areas. In addition to survey costs, adjusting the scallop area rotation program takes a considerable amount of resources for data processing, analysis, and monitoring. Accurate enforcement is a critical component to the success of area rotation. Vessels are now required to have a vessel monitoring system (VMS) onboard that informs NMFS of their location 24 hours a day to help enforce access area closures. Adjustments to the overall program have been made based on concerns voiced to the Council. For example, there have been safety and fairness issues related to allocating trips that are far from particular ports. Luckily the system is flexible enough that modifications can be made relatively easily and quickly. Finally, area rotation cannot be the only tool to control mortality. Other measures are necessary to reduce impacts on scallops and prevent overfishing such as limits on crew size, minimum ring size on gear, and DAS limits to control fishing effort in open areas.

Probably the largest challenge for area rotation in New England is that scallop management is not the only issue facing the Council. Other management programs such as the Groundfish Plan and the Essential Fish Habitat Plan are imposing restrictions on the scallop fishery that prevent area rotation from working as effectively as it could. For example, additional closed areas can be imposed outside of the Scallop plan that may overlap with future scallop access areas. However, that is a major challenge of the Magnuson Stevens Fishery and Management Act – the Council must continually weigh the costs and benefits of each action and identify the strategy that minimizes the impacts and maximizes the benefits on the ecosystem overall.

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Taiwan's Experience with Marine Protected Areas

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In 1992, the Fourth World Congress on National Parks and Protected Areas, held in Caracas, Venezuela, explicitly defined "Protected Area" as "…an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means," (IUCN, 1994). For the purpose of protected areas management, the International Union for the Conservation of Nature (IUCN) has defined a suite of six protected area management categories, based on primary management objective:

1. Strict Nature Reserve/ Wilderness Area
2. National Park
3. Natural Monument
4. Habitat/Species Management Area
5. Protected Landscape / Seascape
6. Managed Resource Protected Area

Of these, the category Managed Resource Protected Area has the most flexibility, with a management target of sustainable use of natural resources. This category of protected area contains predominantly unmodified natural systems, and is managed to ensure long term protection and maintenance of biological diversity, while providing, at the same time, a sustainable flow of natural products and services to meet community needs. Marine protected areas (MPAs) have become a popular tool and have been established by many countries globally, with goals of both conserving marine the marine environment and ensuring the sustainable use of natural resources within the marine protected area.

Taiwan is an island country surrounded by the sea in the subtropics, between 120 and 122°E° longitude and 22 and 25°N latitude. The west coast of Taiwan is predominantly a flat coastal plane, with an extensive continental shelf and well-developed sand banks, wetlands and tidal flats. Taiwan's east coast is predominantly steep cliffs with a narrow continental shelf, with numerous bluffs, sea caves, and reefs. Taiwan's north coast is adjacent to the East Sea adjacent to China, while the southern coastal area abuts the Bashi Channel. Taiwan's coastal and nearshore marine ecosystems are highly productive. Taiwan has a high diversity of marine ecosystems, including rocky shores, estuaries, sand flats, coral reefs and nearshore and pelagic ecosystem, with high marine species diversity.

Over the past several decades, global fisheries have become increasingly industrialized. As a result, 90% of large fish stocks are now overexploited and 75% of commercial fish stocks are depleted. As a result of the pollution of coastal habitats, the diversity of marine species has dramatically declines and many fishery resources are severely depleted. There is a growing body of empirical evidence from global research that marine protected areas offer an effective and economically viable approach to conserve marine resources. Marine protected areas have been adopted by numerous countries globally and the establishment of marine protected areas has been a common objective of several countries.

Management of marine areas in Taiwan is conducted by several authorities, including for fisheries, wildlife conservation, tourism, environmental protection, national parks and cultural resources. For the maintenance of marine ecological diversity, each authority, in accordance with their function and objectives, establish conservation area zones, which are types of marine protected areas. These include fisheries resource conservation areas, wildlife protected areas, wildlife important habitat environments, nature reserves, national designated scenic areas, coastal protected areas and national parks. In addition, the National Council for Sustainable Development, Executive Yuan, modified the Taiwan Sustainable Development Indicators on December 31st, 2009, which includes marine protected areas as one of the indicators. Currently, marine protected areas in Taiwan cover an area of about 233,000 hectares (excluding Dongsha Atoll National Park), comprising 9.28% of Taiwan's territorial waters (2,511 hectares). Marine national parks are planned near the area of Green Island, Penghu Archipelago and the Three Northern Islands.

Marine protected areas usually overlap commercial or traditional fishing grounds and recreational areas, and impose certain restriction on these activities. Therefore, during the planning process, local fishers and residents usually express opposition to the establishment of marine protected areas. After their establishment, some protected areas are managed by local governments. However, due their limited budget, staffing and resources for enforcement such as patrol boats, the protected areas sometimes do not fulfill their objectives.

Taiwan is surrounded by the sea. The marine environment is critical to economic development in Taiwan. Therefore, conserving the marine ecosystem and ensuring the sustainable use of fishery resources are both fundamental tasks for the Taiwan Government. While we can expect opposition to the establishment of marine protected areas, they are a critical tool in preventing the continued decline of the health of marine ecosystems and fishery resources. In the future, the Taiwan government will expand the fleet of enforcement vessels in protected areas, and will enlarge the coverage of marine protected areas, with a goal of 20% coverage of the Taiwan territorial waters by 2012.

Incipient Implementation of Marine Spatial Planning in Puget Sound

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Puget Sound (including the Straits of Juan de Fuca) located in Northwest United States is a major estuarine body of water that provides many benefits to residents and visitors to the area Fig. 1. Commercial and recreational fisheries, marine transportation, shellfish aquaculture, beaches as well as habitat for marine mammals, seabirds and other living marine resources as well as aesthetic and other values make it a major contributor to quality of life in the region. Over time, many of these qualities have been diminished as a result of complex interactions between overfishing, marine pollution, habitat alteration, etc. Significant efforts to reduce the impacts of society on Puget Sound have not succeeded in reversing many of the negative trends. Recently, serious efforts to restore Puget Sound to a healthier condition have been started.

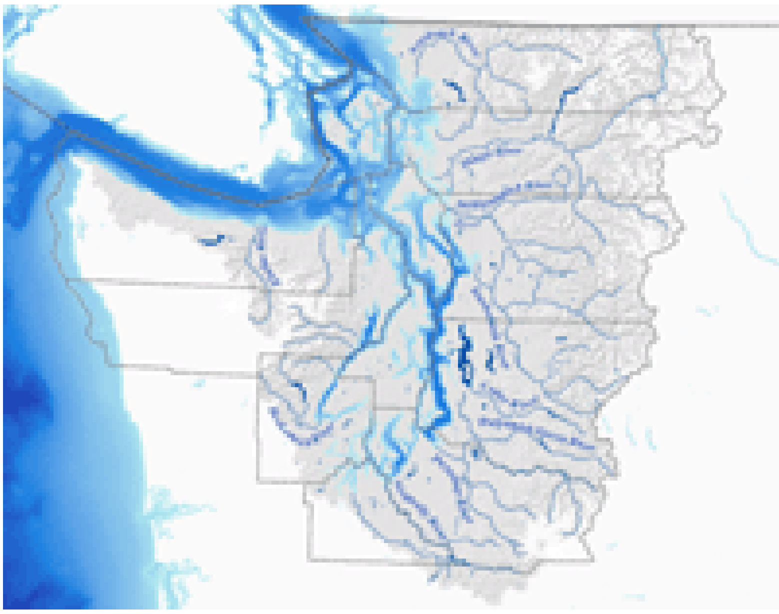

Fig. 2. *Puget Sound and Adjacent Watersheds*

Building off of efforts in the 1970's and 1980's the Washington State legislature created the Puget Sound Partnership as a science-policy governance structure that is charged with developing action plans to cause ecosystem-wide restoration. This Partnership combines efforts to control marine pollution and habitat degradation as well as a Shared Salmon Strategy that evolved to solve the problems associated with salmon and other Puget Sound species listed as Endangered or Threatened under the US Endangered Species Act. Salmon especially are iconic of the life cycle linkages between watersheds, the Puget Sound estuary and the oceans.

The hallmark of this Partnership is a science-based integrated ecosystem assessment planned and implemented on a basin wide scale. The Partnership's action plan is in early stages of implementation however the stepwise program to make progress is clearly spelled out. First, the Partnership has articulated the objectives for and scale of management. Second, the Partnership is in the midst of developing ecosystem indicators and thresholds. Third, through modeling and scenario building ecosystem-scale risk analysis is being performed to identify priorities. Fourth, while management changes are being made, monitoring and management strategy evaluation is being incorporated to inform adaptation and choice of improved management strategies. Finally, the cumulative effect of these steps is implementation of selected management strategies.

Tough management choices have to be made about tradeoffs between management strategies and ecosystem based goals are intended to discipline and make explicitly those policy choices. This holistic management approach is being implemented at the local, basin and ecosystem level through efforts to inform and create incentives for restoration of Puget Sound. Already, it appears that promising aspects are appearing. However, there is a long way to go to not only maintain but restore a healthy Puget Sound in light of increased population and other obstacles.

Socioeconomic Effects on Commercial Fisheries from Spatial Planning by the US Papahānaumokuākea Marine National Monument

Timm Timoney[1]
[1] **Northwestern Hawaiian Islands Bottomfish Fisher**

As bottomfish fishermen made their last trips to the Northwestern Hawaiian Islands (NWHI) in the fall of 2009, the fishing chapter in the long history of these remarkable Islands was brought to a sad close. Over the years, a variety of fisheries succeeded and failed in this region. The first to harvest the NWHI's bounty were Hawaiians feeding their families and villages. Centuries later, larger, commercial endeavors began. These included diving for pearl oysters; longlining for tuna and swordfish; trapping lobster, shrimp and Kona crab; directed longline shark fishing; seining for ulua; and even illegal coral dragging. And of course there is a long history of bottomfishing for snappers and groupers in the NWHI.

When my husband Tim and I started fishing in the NWHI in 1983 we could pretty much fish from Nihoa to Kure. Three mandates changed that access: The Western Pacific Regional Fisheries Management Council's (WESPAC) fishery management plan (FMP) for bottomfish, an Executive Order signed by President Clinton in 2000, and President Bush's Executive Order, which created the NWHI Marine Monument. These three management measures were developed using very different processes.

With input from an array of people including fishermen, scientists, and economists, WESPAC implemented an FMP that started with dividing the huge area of the NWHI into two zones. The farthest from the main Islands is the Ho'omalu and the closest is the Mau. The Ho'omalu zone became a limited entry fishery. People who had fished in the NWHI were eligible for a permit but now with restrictions. There was a time limit to claim the permit and then these permitted fishermen had to either use it or lose it, where a minimum number of trips and pounds caught per year was required in order to retain the permit. This measure quickly reduced the field of participants. The most contentious part of this FMP was the non-transferability of the permits. Fishermen with permits were of the opinion that the value of their boats would be reduced if they could not sell or transfer the permit along with the sale of their boat. But others wanting a permit thought the permit was an unearned windfall. The decision to make the permits non-transferable ultimately was not a top down decision, but instead was arrived at after public meetings with active fishermen and potential stakeholders.

President Clinton's executive order # 13178 of 2000 created the NWHI Coral Reef Ecosystem Reserve. It also created an advisory committee charged with creating a NWHI National Marine Sanctuary. The Sanctuary establishment process was to be public and transparent, with stakeholder input from a wide variety of sources. For most working fishermen this was their first exposure to the concept of Marine Spatial Planning. It was an excruciatingly painful process and the NWHI fishing community did not fare well. While ostensibly this was a coral reef initiative, where bottomfishing has little ecological impact, it was obvious from the start that most of the committee members believed that a total ban on any fishing would be the only acceptable outcome.

One of the first hurdles that we never did overcome was simply the makeup of the advisory committee. Designated members came from a wide array of interest groups. There were multiple representatives and alternates from environmental non-governmental organizations (NGOs), Native Hawaiian groups, marine tourism industry representatives, and representatives of the general public. The education and outreach seats were filled with folks whose mantra was to look and learn, but not allow any access to the NWHI. An environmental NGO seat was filled by a lawyer who had sued the bottomfishermen over killing and harassing endangered Monk seals. The suit was baseless and he lost the case, but this individual continued to assert when he could that the NWHI bottomfish fishermen were harming Monk seals. Fishermen were represented through a single seat on the advisory committee, with one alternate. We asked for at least a second alternate as the designees were working fishermen and could not always be there without serious sacrifice. We were soundly voted down. Many of the other reps were in paid positions that facilitated their presence or outright paid for them and they suffered no loss of income by participating in the government meetings, as did the commercial bottomfish fishermen.

Over the next several years, working NWHI and Main Hawaiian Islands fishermen participated in seemingly endless and futile public 'visioning' sessions, working groups, policy groups and advisory council sessions. However 8-14 fishermen didn't make an impact and we were pretty much ignored, and not benignly.

Probably the worst moment came when we still thought we would be allowed to fish and had attended meeting after meeting with contractors representing the NWHI Reserve and government officials to hash out closed fishing areas to meet concerns about seals, essential fish habitat and nursery grounds. We had identified areas important to us and agreed to not fish in others. When proposed regulations were published, huge areas of prime bottomfish fishing grounds were closed to fishing. To add insult to injury, these had been identified by scientists as areas of low concern.

These regulations, along with the end of all fishing in 2011, became final rules when President George Bush created, by Executive Order, a National Marine Monument under the Antiquities Act. The NWHI fishing community was stunned. And then enraged. So many flat out lies and questionable science had led to this. Our small group of fishermen and supporters never had a chance against huge environmental NGOs, deep pocket foundations, and their sophisticated politicking.

NWHI fishermen as a group have always been a proud bunch. We are proud of the quality product we took such care to bring to market. We are proud to share our catch with family and friends. We are proud that the waters we have fished for years are considered pristine. The concept of a marine sanctuary with input on governance from myriad stakeholders is not without merit. However, I believe the folks of Hawaii really lost out on this one.

Fishing Industry Experiences with Great Barrier Reef Marine Park Marine Spatial Planning

Andrew Tobin[1]
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The Great Barrier Reef World Heritage Area (GBRWHA) Representative Areas Program (RAP) legislated in June 2004, increased no-take (no fishing) area coverage within the marine park from a previous 4.6% to 33.3% with understandable consequences on extractive commercial fishing industries with historical activities within the park. Although the RAPs primary objective was to protect the unique biodiversity within the GBRWHA, throughout the consultation process theoretical benefits to sustainable fisheries production were often claimed by advocates of marine spatial planning as a significant secondary benefit of RAP that the fishing industry should be happy about. Espousing these values in the absence of empirical evidence is nonsensical, and marine spatial planning advocates should practice more caution before pushing these claims that often create undue tensions within fisheries sectors.

The theoretical fishery benefits of marine parks are two-fold: animals are directly protected from fisheries extraction while harboring within no-take zones; and progeny spill-over from no-take zones. The first claim, protection from fisheries extraction may well be sound for sedentary species provided non-extractive area coverage is larger than the species of interest usual home range. However, many species have pelagic and semi pelagic ecologies that encompass large scale movements often across a wide variety of habitats. In such instances, marine spatial protection benefits may be marginal at best. The second claim of spill-over benefits is also largely restricted to species that may be likely to re-build their populations in the absence of fishing extraction, with the resultant net benefit of progeny spill-over either through larval dispersion, or by adult individuals moving out of an area that is limited by carrying capacity.

The focus of this case study is to present some preliminary data from projects investigating the efficacy of the GBRWHA RAP in offering protection to a suite of coastal shark species targeted by a commercial net fishery. Some preliminary data will also be presented on the benefits offered to sedentary reef fishes (population increases), as well as potential benefits from spillover effects.

Industry Experiences with Atlantic Sea Scallop Area Rotation

Bill Wells[1]
[1] Seafood Scallop Company

Abstract

Area rotation has dramatically changed the yearly harvest of Atlantic sea scallops. Area rotation began in 1998 with three special management areas. The fishery now operates with six special scallop management areas and the harvest within these areas is approximately 50% of the yearly industry harvest.

Pre-Area Rotation

Fleet-wide landings averaged 10-12 million pounds per year. Vessels were in the ocean approximately 240 days per vessel. Every peak in biomass was soon harvested due to an immediate and significant pulse of effort. In 1994 limited entry special management areas, maximum crew size, gear restrictions and a limit on days at sea were implemented.

Post-Area Rotation

Fleet-wide landings are averaging 50-55 million pounds per year. The average landed size is 10-20 meats per pound, with an increased opportunity for even larger sizes. A major benefit is reduced bottom time due to high catch-per-unit-of-effort.

The Future

There is an overlap with other plans that inhibit effective rotational scallop management. Surveys are critical and expensive. There is a shortage of smaller, less expensive scallops. This causes users of the smaller, less expensive scallops to either buy larger and more expensive scallops, purchase foreign scallops that are generally opened by machine and less tasty, or purchase processed U.S. scallops of a larger size with a lower price point.

The other negative aspect of area rotation is philosophical: Fishermen want to compete against other fishermen. Closed area fishing makes all men and all boats equal, because there is a universal harvest limit of 18,000 pounds per vessel per trip.

On the positive side, biomass is up, bycatch is down, the market is adapting to larger scallops, average landed meat count is up and revenues and profitability are both higher – area rotation works.

Taiwan Experiences with Marine Spatial Planning: The Case of Chunghwa County

Yi-Ping Hung[1]
[1] **Changhua Fishery Association**

Abstract

The coastal area of Chunghwa County, located in the central-western portion of Taiwan, has a 50 km-long coastline and the largest mudflat in Taiwan. A branch of the Kuroshio Current flows from South to North into the Taiwan Strait, together with a current from the South China Sea and a North-South current flowing along mainland China. These current systems create a highly productive marine environment adjacent to Taiwan, and support productive fishing grounds of commercial fish and shellfish species. However, Taiwan's coastal ecosystems have been degraded from recent high fishing effort, altered coastal morphology from sand mining, and coastal pollution. Wise management and use of Taiwan's coastal resources are critical to ensure sustainable fisheries development. To this end, the Chunghwa Fishermen Association applied for exclusive fishery rights in accordance with the Fisheries Act and obtained a Fishery Right Permit in 2009. An area of 42,071 hectares is included in this permit, which extends seaward from the mean high-tide line. Through these exclusive fishery rights, the Chunghwa Fishermen Association has established time/area management measures for shallow marine aquaculture and offshore fishing operations within the coastal area of Chunghwa.

1. Marine Spatial Planning

The broad intertidal zone along the Chunghwa coast, with marine and river sand deposits, provides suitable habitat for shallow marine aquaculture. The area between the low tide line and offshore is zoned for shallow marine aquaculture use, and is used primarily to breed oysters and clams. In coastal areas that are not suitable for aquaculture, various coastal fishing gears are permitted and used. The channel entrance is used to collect fish fry. The area from the low-tide line to 25 m depth is zoned for traditional fishing, and is reserved for use by small-scale gillnet and pole-and-line fisheries, as well as some trawl fishing. To conserve fishery resource, trawlers are prohibited from operating within 3 miles of the coastline, while trawl vessels greater than 50 tons are prohibited from operating within 12 miles of the coastline.

2. Management of Coastal Fisheries

- **Shallow marine aquaculture management:** Permits for shallow marine aquaculture are issued for oyster farming and boundaries are demarcated using a global positioning system.
- **Offshore fisheries management:** The Changhua Fishery Association issues licenses for offshore fishing. A list of fishers issued exclusive fishing rights has been established and maintained. The Association also guides and assists fishers to meet catch reporting requirements.
- **Coastal area management measures:**
    a. A management structure to issue exclusive fishing right has been established.
    b. Guidelines for marine capture and aquaculture fishing operations and dispute settlement have been established to fulfill the objectives of the management of coastal areas.
    c. Volunteers are organized to staff a patrol unit. These volunteer enforcement staff prevent the entry of tourists or other non-permitted groups to enter the commercial fishing areas.
    d. Fisheries culture tours are organized seasonally to provide an opportunity for the general public to improve their understandings of the fishing industry and fishing culture.

e. Conduct outreach in order to improve the knowledge of fishers on their fishing grounds, by disseminating information on fishing and aquaculture zones, closed area zones, and rules, including the establishment of a bulletin board with information posted on the extent of exclusive fishing rights.
f. Beach cleanup activities are held annually to provide a clean marine environment and to ensure navigation safety for vessels.
g. Navigational channel markers are deployed and managed. From 2005 to 2009, 7825 stakes were installed in major navigation waterways of Chunghwa County to guide fishing vessels and rafts entering and leaving port.
h. Roadways to beaches are paved and maintained to enable vehicle access.

3. Conservation Measures for Marine Resources

- **Marine patrol unit:** The Association established six at-sea patrol units to conduct surveillance, and report illegal fishing activities.
- **Marine pollution warning system:** Marine pollution liaisons have been established in seven branch offices of the Association to quickly communicate with the Authority of Environment Protection when marine pollution incidents occur.
- **Dissemination of information on fisheries conservation measures:** Workshops and tours are held annually to disseminate information on fisheries conservation measures to improve the knowledge of conservation measures and to promote support amongst the fishing sector to comply with the measures.
- **Release of fry:** From 2004 to 2008, 1.45 million sea bream fry were released into the marine area adjacent to Chunghwa County.
- **Establishment and management of a mud shrimp conservation area:** To conserve sensitive species of Chunghwa County, a 36 hectare conservation area has been established to protect mud shrimp habitat in Shenkang Township. Conservation groups for mud shrimp have been established to conduct surveillance and management of the conservation area. Employing the assistance of volunteers from community and school groups, an environmental education campaign was initiated in order to raise community support for natural resources conservation activities. In addition, a second mud shrimp conservation area is planned for the Wang Kung area.

Fishing Industry Experiences with Marine Spatial Planning on the U. S. West Coast

Mr. Marion J. Larkin[1]
[1]**Owner and Manager, Ocean Hunter Enterprises LLC**

When Mr. Larkin began fishing in 1973, there were few regulations restricting how, when and where fishers could fish. Since then, a plethora of management measures has been implemented, which restrict fishing activity. Among these measures are caps on vessel deliveries by species in monthly or bi-monthly periods, and closed and restricted fishing by gear type. This has involved closing most of the shelf inside 125 fathoms to trawl fishing to protect and hasten the rebuilding of overfished species such as Yellow Eye Rockfish, Canary Rockfish. Forty one non-bottom trawl areas were also designed, where the use of bottom contact gear by the trawl fleet is prohibited. This overlaid patchwork of regulated areas has created a burdensome but flexible management system, which has increased enforcement problems, created economic inefficiencies as well as concentrated the fleet into smaller, more intensely fished areas. The closing of a fishing area near shore off the north Washington coast eliminated the 70 year old trawl fleet operating from Neah Bay, Washington. Fishermen no longer pursue migrating fish year around throughout their range of depths and habitats, but instead must wait for the fish to come to an open area.

Marine spatial planning and implementation has direct impacts on the efficiencies and economies of fisheries and the communities they support. The costs of harvest have gone up as the fleet fishes more inefficiently in areas of lower abundance, and travels greater distances to open areas.

Fishers must be included in marine spatial planning at all levels of discussion, and in particular, when restrictions are placed on where they can fish. Without fishing grounds, there are no fisheries.

Assessing Bycatch in Small-scale Fisheries and an Estimate of Global Impacts

Rebecca Lewison[1]
[1] **San Diego State University**

Recent evidence points to the potential for artisanal fisheries to have significant negative impacts on marine mammals and sea turtles caught incidentally as bycatch. Because artisanal fisheries are globally ubiquitous and may account for > 95% of the world's fishers and because of the highly migratory nature of bycatch species, the putative impact of bycatch from artisanal fisheries can extend far beyond endemic populations in particular countries and has been linked with population declines of bycatch species at the level of the ocean basin.

One of the central challenges to understanding the impact of artisanal fisheries is the lack of fishing effort data (i.e., the number of boats, the amount of gear deployed, or the frequency of fishing activities), and a lack of knowledge of the spatio-temporal dynamics of coastal fishing fleets. Efforts to describe small-scale fisheries are hindered by lack of resources directed toward data collection, the dispersed nature of the fisheries, disparity among data sources, limited data availability in some areas, a scarcity of spatial information, as well as the high rate of change in both target species and gear types within a short time frame. Here I describe research conducted as part of Project GloBAL (PG) that presents two different approaches to collecting fisheries and bycatch information from artisanal fisheries: spatial mapping of fisheries data and interview-based assessments. These data, paired with existing bycatch information, highlight the larger issue of fisheries sustainability in artisanal fisheries, both in terms of catch and bycatch. We introduce a model for pairing these data with more detailed socio-economic studies as a way of providing meaningful context and a framework for addressing these challenges.

Using a mapping tool developed for assessing fishing effort in Caribbean fisheries, the PG research team integrated United Nations Food and Agriculture Organization (FAO) data, national fisheries reports and published research to characterize fishing pressure in the coastal waters of six marine regions: West Africa, the West Indian Ocean, Southeast Asia, the Caribbean, the Southwest Atlantic, and the Eastern Tropical Pacific. Through this process we were able to map regional-scale patterns of coastal fishing effort and examine the relationship among average fishing effort densities, economic development levels and other demographic parameters within and among countries and regions. We present a novel approach to mapping fishing effort across disparate ocean regions, based on the development of a common fishing effort metric that allows for interregional comparisons. The goal of our analysis was to compare the relative density of coastal fishing effort and to consider potential socioeconomic and physical correlates of fishing density among six different marine regions. Our approach provides a method for quantifying fishing effort and serves as a means to identifying areas where overcapacity may threaten fisheries sustainability and the integrity of coastal ecosystems

PG also conducted an intensive pilot study to evaluate whether low-cost interview surveys can be effective in assessing fishing effort and bycatch in artisanal fisheries over large areas. Results of this preliminary study suggested that high bycatch of marine mammals and sea turtles are the rule rather than the exception in the world's artisanal fisheries. The apparent magnitude of cetacean and sea turtle bycatch in each country surveyed was comparable to the alarming numbers from recent case studies of other artisanal fisheries. However, challenges encountered during this pilot work precluded statistically robust bycatch estimates or comparing bycatch levels across study areas and species. The pilot study did provide support for the interview-based methods and has led to additional work to develop a methodology by which local scientists and managers can collect and analyze small-scale fisheries and socioeconomic data. This new phase of work will serve as a first step in the process of the development and evaluation of management plans that minimize bycatch and ultimately improve fisheries sustainability in small-scale fisheries. While our bycatch data quality is less accurate than direct observation, the survey efforts we describe provide essential information on fishing activity and will also explore the social drivers of bycatch, focusing on the fundamental factors that ultimately lead to bycatch. Our proposed efforts will improve our understanding of the drivers of bycatch and provide a means of evaluating the socio-economic impacts of proposed management actions that could be implemented to reduce bycatch.

Managing Whale Shark (Rhincodon typus) Fishing Mortality in Taiwan

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The whale shark *(Rhincodon typus)* is the largest fish in the world, with a circumglobal distribution. Due to its life history characteristics and high mortality in fisheries, this species is listed as Vulnerable by IUCN and is included on CITES Appendix II. From 1996 to 2008, a total of 597 individual whale sharks were caught in Taiwan fisheries. These ranged from 1 to about 13 m in total length (TL) with an average length of 4.6±1.2 m (1SD). Mean TL of whale sharks caught from June to October was smaller than the mean TL of those caught from November to May. Most landed whale sharks were sold to markets in eastern Taiwan. Males comprised the majority of the whale shark catch in Taiwan waters. The mean annual catch of whale sharks in set nets in southwestern Taiwan were the highest of all of the Taiwan fishing areas.

A whale shark catch reporting system was initiated by the Taiwan government in 2001. Since 2002, a total allowable catch (TAC) limit was set at 80 whale sharks per year. In 2005 the TAC was reduced to 65, was further lowered to 60 in 2006, then 30 in 2007, and finally the retention of whale sharks was banned in 2008. Total annual catches were dropping annually from 2001 to 2004, but catch levels in the set net fishery increased since 2005; in 2008 165 individuals were caught in set nets, all of which were released.

Nine individuals (3.8-9.6 m TL) were tagged and released with SPOT or PAT tags. Data from electronic tags was compared to information on sea surface temperature, the location of thermal fronts, ocean color, bathymetric topography, and typhoon paths. Findings suggest that whale sharks generally stay within 50-150 m below the sea surface, and in waters with temperatures between 15 and 32 °C. Additionally, in the summer and fall, whale sharks were observed to remain in deeper waters during the daytime, and ascend to shallower depths at night, especially from midnight to dawn. In the winter and spring, whale sharks surfaced frequently both during the day and nighttime. Whale sharks were observed to migrate in the open ocean and reached 146.77° E in the summer and fall, and moved to coastal areas of the East Asian continental shelf during the winter and spring.

In order to study whale sharks' age and growth, biannual growth rings in vertebrae of 92 whale sharks were studied. Vertebrae from two full-term embryos, a 61.0 cm TL female and a 54.8 cm TL male, obtained from a pregnant female caught in 1995, were also investigated. Previously published data from a 64-cm-TL embryo was also pooled into the dataset. Data from these 95 vertebrae were fit to a three-parameter von Bertelanffy growth equation (VBGE). The parameters for VBGE were estimated to be L_∞=16.31 m TL, k=0.037 year-1, and t_0=-1.24 years for both sexes. Age at maturity was back-calculated from VBGE and estimated to be 17.2 years for males and 19.2-22.6 years for females. Maximum age was estimated to be more than 79 years, and the average annual growth rate over the whale shark's life span was estimated to be 19.8 cm/year.

Findings from analyses of fisheries data and from additional research conducted on whale sharks indicate that the whale shark is a very slow growing species. The northwest Pacific population likely migrates into Taiwan coastal waters when they are between 3 and 14 years old. As a result, the sustainability of this whale shark stock is at risk if there is a lack of adequate rules to manage mortality levels in Taiwan fisheries. A larger number of whale sharks occurred in Taiwan waters following the ban on retention, but further study of stock dynamics is needed. Because this is a highly migratory species, international cooperation and management is needed.

Acoustic Pingers to Mitigate Marine Mammal Gillnet Bycatch - The Biosonar Basis for their Optimum Utilization, and Approaches for Mitigating both Bycatch and Depredation

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Acoustic devices used to mitigate the incidental bycatch of marine mammals by commercial fishing nets (generally called acoustic alarms or pingers) were originally designed to alert these animals at times of inattention, such as a sleep equivalent. Pingers were attached to nets so the acoustic signal warning was associated with an obstruction, hence avoided and the behaviour was reinforced via associative learning. Providing an effective association between pingers (the warning) and a net (the obstruction) is essential; if there is no obstruction, then is no need for avoidance and, logically, no behavioural reinforcement to the warning. In this case, of a pinger presented without an obstruction, an intelligent marine mammal's behavioural reaction to the "warning" will not be consistent.

A pinger-net association would be established by pinger detection from passive biosonar detection (i.e. simply listening) followed by active biosonar echolocation onto the net material (dolphins). For non-echolocating mammals pinger detection could be followed by eyesight detection and/or passive biosonar acoustic detection of the net based on the detection of the acoustic signature of water flowing through a net (particularly for baleen whales and dugong). More complex associations could include behavioural reactions to the relevance or context of the sounds themselves, resulting in the mammals' giving a sufficient berth away from the pingers establishing safe zones around each net.

What constitutes an appropriate alarm or pinger sound should be based on its capability to modify the overall behaviour of marine mammals whether the mammals' reactions were detected by human observers or not, in order to avoid entanglement when applied in the exact fishery condition in which it is to be used. Fisheries sociologists looking at the effectiveness of bycatch reduction technologies have reinforced the need to incorporate such pinger-net association material in real world fishery situations.

At the most basic level, an effective acoustic device may be expected to evoke cognition in mammals in order to achieve a behavioural response such as aggression or withdrawal from the immediate or broader region of the pinger-net (often context driven). Yet it is the change in bycatch rate that is important. Demonstrating this change is often extremely difficult particularly for species of limited population size and restricted habitat. It has often been concluded by fishery critics that failure to demonstrate an unattainable reduction in bycatch could be seen as failures of pingers per se, instead of the more reasonable result that it is failure of the experimental design. Unilateral fishing industry description of any associative positive effects between pingers-nets is gaining relevance.

For bycatch mitigation, factors such as the hearing capabilities of the marine mammals, the deployment spacing along the net of acoustic pingers, water clarity and acoustic propagation of pinger sounds in the acoustic environment and consistency of Target Strength and acoustic highlights under biosonar interrogation of the nets are all important additional complications for successful deployment. By example,

- If nets were left for long periods and algae were to grow on the net twine the Target Strength of the net under biosonar investigation would decline, the association between pinger and net could be lost with a resulting increase in risk of entanglement.
- Pingers set at distances too far for the sound to even reach mid-way between pingers at mammal detectable sound levels due to poor propagation of sound would not generate a consistent net-pinger association.
- While net twine and dimension characteristics may have utility in fishery regulations to protect target species, it may also have bycatch reduction capability given Target Strength is a complex interaction of the net material density and the quantity of mesh within the beam-width of the mammals' biosonar.

For depredation mitigation, factors such as an as yet-to-be-defined pinger sound 'dislike', pinger or mammal biosonar sonar interference, or simply pinger-associated enhancement of the presence of foreign and potentially dangerous fishing gear materials not previously detected by biosonar, would be important.

Mitigating Sea Turtle Interactions in Pound Nets and Set Nets

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* Presenter

Abstract

Pound net and set net fisheries are two of the major Japanese coastal fisheries. These types of passive gear are considered to be eco-friendly in that they require a minimum of labor and cause nominal habitat degradation. These fishing gears have high potential to be disseminated and utilized worldwide especially in the ASEAN region, although the introduction of the gears is at an incipient stage. While information on the interaction between sea turtles and these fishing gears is still limited and fragmentary, several studies report substantial levels of incidental sea turtle captures in pound net fisheries (Gilman, et al, 2010).

In general, pound net and set net gear consist of leader nets, surrounding nets and fish bags or pocket nets. However, the gear design and operation of set nets are highly variable, where local factors, such as oceanographic and topographic features of local fishing grounds, target fish species and sizes, and labor, influence the fishing gear design and methods. Therefore, the development or selection of marine turtle mitigation measures needs to be fishery-specific.

Sea turtle captures in these gear types occur through entanglement and entrapment. Entanglement of turtles occurs in netting when relatively large mesh sizes are used. Entanglement of turtles in

netting is a major problem in the pound net fishery in the USA. However, in Japanese pound nets, sea turtle entanglement in netting is reported to be relatively rare, where turtle entrapment in the bag net and pocket net is problematic. The presence or absence of a fish bag and pocket nets in pound net gear has a large effect on the occurrence of turtle captures. Even though turtles enter the surrounding areas of the pound net, survival is high because they can reach the sea surface to breathe. Conversely, the risk of drowning is high for turtles that enter a fish bag net and become entrapped underwater, as the bag net contains a room that prevents the turtles from reaching the sea surface to breathe. This can be mitigated through four approaches:

- Prevent sea turtles from entering the pound;
- Prevent sea turtles from entering the bag net;
- Allow sea turtles to breathe in the bag net;
- Allow sea turtles to escape from a bag net, while retaining commercial species.

1. Prevent Sea Turtles from Entering the Pound

This is the first step to prevent the entrapment of sea turtles in pound nets. Turtles enter the pound as they swim along the pound net leader. A simple mitigation approach is to incorporate a sorting grid at the mouth of the pound to prevent turtles from entering the pound. The spacing of bars in such a sorting grid would need to be wide enough to allow target fish to still enter the pound. Another approach is to incorporate some sort of sea turtle deterrent to cause sea turtles from entering the mouth of the pound.

2. Prevent Sea Turtles from Entering the Bag Net

A second-stage approach to mitigating sea turtle interactions is, for turtles that enter the pound, prevent them entering the bag net. Again, a sorting grid could be considered to accomplish this. Interactions between turtles and targeted fish should also be studied, to determine whether the presence of fish in the pound net attracts fish, and vice versa, and also to determine whether the presence of turtles in the pound affects target fish catch levels and quality. Also, methods for handling and safely releasing turtles that enter the pound need to be developed.

3. Allow Turtles to Breathe in the Bag Net

Turtles that enter the fish bag would not drown if they were able to reach the sea surface to breathe. The bag net design could be modified to allow turtles to reach the sea surface. This would only be feasible for gear deployed in very shallow areas. The gear would need to be designed to be sufficiently durable for use in rough sea conditions and strong tidal currents. The modified gear design would also need to account for practicality of use during the fishing operation. Again, research is needed to better understand the interaction between fish and turtles in the bag net, and to develop best practice handling and release protocols for turtles caught in the bag net.

4. Allow Sea Turtles to Escape from a Bag Net

The bag net could be designed to allow sea turtles to escape, while retaining commercial catch. We have initiated development of a turtle releasing devices (TRD) to allow turtles to escape from the bag net. The TRD is composed of a vent and a flap on the roof of the fish bag/pocket net. A turtle can open the flap by pushing with its body and exit the bag net through the vent. The flap then closes automatically after the turtle escapes due to the tension in the netting. Different TRD designs are required for small- vs. large-scale nets, due to the difference in size and design of their bag/pocket nets.

4.1. Small conic-shaped pocket net

We conducted research on a small pound net with a cone-shaped bag. The bag was 10m in length and 1.3m in diameter. The bag is tied to the seafloor employing sufficient tension to maintain its cone shape. We inserted a square vent with a flap (40 x 50 cm) at the top of the cone-shaped bag. The flap was hinged to the vent, which was designed to open outwards when a turtle pushed on the flap from the inside of the bag. This TRD effectively released turtles; where more than 80% of green turtles that were put into the bag successfully escaped through the TRD (Abe, et al, 2002).

4.2. Large box-shaped bag net

Most large pound nets use an underwater, box-shaped bag net, with a roof, which is much bigger relative to the cone-shaped bag net of smaller pound nets. While turtles could effectively escape from small cone-shaped bags through a TRD, there was concern that the concept might be less effective in the larger gear, because turtles might not be able to locate the TRD, and then exit through the device. To address this concern, a mechanism to guide turtles towards a TRD was considered. To direct the turtles to the TRD, we considered how to adjust the slope of the roof of the fish bag and considered locating the TRD at the highest point of the roof, based on the assumption that turtles might swam upward when they are attempting to reach the sea surface to breathe (Takahashi, et al, 2010).

Another issue for the huge fish bag is how to keep the net tension consistent and appropriate for the turtle to open the flap, and for the flap to then automatically close after the turtle escapes. To address this problem, we developed a new TRD design, called the ‘TRD Unit’. The TRD Unit was constructed in the center of plastic netting in order to create stable tension, allowing the TRD to open and close. This TRD design worked well, and all loggerhead and green sea turtles tested successfully escaped through the TRD; however, about half of the hawksbill turtles failed to escape through the TRD, as they pushed on the flap with less force than the other turtle species (Shiode, et al, 2010). These findings suggest that we need to consider behavioral difference by turtle species.

5. References

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Sea turtle Bycatch in Taiwan Coastal Pound Nets and Satellite Tracking of Loggerhead Turtle (Caretta caretta) Bycatch

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Marine fisheries are known to have incidental interactions with sea turtles, especially in the coastal waters where they aggregate to search for foods or where there is overlap with migration corridors. The coastal pound net fishery in Taiwan is a stationary coastal fishery and experiences significant sea turtle bycatch. From March, 1998 until May, 2010 (i.e., 12 years), a total of 90 sea turtles were captured as bycatch from pound nets in Don-Ou, I-Lan County, in the northeast of Taiwan. The highest bycatch occurred in 2008 (28%), followed by 2007 (18%) and 2009 (11%). All sea turtles were alive, unharmed, and released later by the fishermen. Among them, 51% were green (46), 48% were loggerhead (43), and 1% was a hawksbill (1) turtle. For the green turtles; 61% were immature (28), and 39% were mature (18). Among the matures 72% were females and 22% were male. The average CCL was 73.2±13 (n = 28) cm for immatures, and 93.1±23.2 (n = 18) cm for matures. For the loggerhead turtles; 21% were immature (9), and 79% were mature (34). Among the mature turtles 94% were females and 6% were male. The average CCL was 72.3±0.6 (n = 9) cm for immatures, and 80.4±6 (n = 34) cm for matures. The hawksbill sea turtle was an immature with a size of 33 cm CCL. Most bycatch green turtles were subadults, and most bycatch loggerhead turtles were mature females. Because the bycatch of mature loggerheads occurred mainly from late fall to winter, it is possible that the pound net fishing grounds overlap with the migratory corridor of adult loggerhead turtles. For this reason, a multinational collaborative tagging project was accomplished. Taiwan is not known to have any loggerhead nesting sites currently, and genetic analysis indicates that these individuals are likely from the Japan nesting stock. This North Pacific stock of loggerheads nesting in Japan is thought to be in healthy condition at present. Hence, this is a vital component of the worldwide loggerhead population and any additional sources of mortality for this stock needs to be carefully examined and minimized. The purpose of this study was to analyze the movement patterns of loggerhead turtles taken as pound net fishery bycatch in Taiwan and tagged with satellite transmitting tags. Remotely-sensed satellite data was used to infer patterns of habitat use of these loggerhead turtles with respect to regional oceanographic features such as large oceanic eddies.

Thirty four loggerhead turtles were tagged with satellite transmitters after being captured as bycatch in the coastal pound net fishery off the Pacific coast of Taiwan (Table 1). Captures occurred from 2002-2008, and individuals ranged in size from 64-92 cm SCL (69-95 cm CCL). Several different types of tags were used over the course of this study: Telonics ST-18 (n=10), ST-14 (n=2), ST-20 (n=14), ST-24 (n=3), and Wildlife Computers SPLASH tags (n=6). Tags were affixed to turtle carapaces using polyester resin and fiberglass cloth. Tag transmission failure was very rare in this study. One ST-24 tag that was deployed in this project malfunctioned and was not used in this analysis. The remaining 34 tags continued to transmit an average of 172 days (range of 6-503 days) providing a grand total of 5860 individual days tracked. Positional data were downloaded from ARGOS and archived locally for processing. The study was concluded when all 34 tags ceased transmitting. Raw ARGOS positional data from the satellite tags were processed using a Bayesian state-space modeling (SSM). The SSM produced the most likely trajectory through the datapoints taking into account the ARGOS data quality codes and temporally adjacent positions. The SSM also recast the tracks into daily streams of points, thereby removing effects due to the variable duty cycles used (Fig. 1).

PTT ID	PTT Type	SCL (cm)	Date deployed	Start latitude (°N)	Start longitude (°E)
19593	ST-14	71.8	25-Jan-07	24.50	121.80
19597	ST-18	64.0	02-Apr-03	24.49	121.90
19599	ST-18	74.5	16-Jan-04	24.46	121.94
19606	ST-18	67.7	19-Feb-03	24.45	122.00
22981	ST-18	74.0	22-Mar-04	24.47	121.89
23068	ST-18	72.0	30-Nov-04	24.47	121.84
23513	ST-18	68.7	08-Mar-04	24.49	121.81
23559	ST-18	72.1	19-Apr-04	24.50	121.80
25360	ST-18	76.5	05-May-02	24.56	122.00
29066	ST-18	71.3	21-Dec-03	24.50	121.80
40470	ST-24	74.5	23-Dec-08	25.59	122.20
40473	ST-24	66.5	04-Dec-07	25.38	122.66
41315	ST-20	74.5	17-Oct-06	24.50	121.80
41423	ST-20	92.0	19-Oct-07	24.51	122.03
41788	ST-20	82.5	14-Jan-08	26.37	125.20
41789	ST-20	70.0	18-May-08	25.94	122.80
42714	SPLASH	78.0	10-Jun-08	25.49	123.30
4800	ST-14	69.5	09-Feb-07	24.33	122.10
50144	ST-20	72.0	14-Jan-05	25.51	123.00
50145	ST-20	70.0	19-May-05	24.58	121.90
5152	ST-18	69.7	02-Jun-03	24.50	121.80
53743	ST-20	74.5	26-Jun-05	24.49	121.87
53745	ST-20	79.0	21-Nov-05	24.49	121.86
53746	ST-20	83.0	14-Apr-05	24.49	121.81
53747	ST-20	67.3	15-Mar-05	24.50	121.80
53748	ST-20	74.5	21-Dec-05	25.23	122.70
53750	ST-20	76.0	04-Apr-05	24.91	123.70
53758	ST-20	80.5	01-Feb-05	24.44	121.90
53768	SPLASH	72.5	28-Apr-06	24.44	122.59
53769	SPLASH	73.0	10-Mar-06	22.41	118.83
53770	SPLASH	78.5	17-Jan-06	24.56	121.89
53771	SPLASH	76.0	10-Feb-06	24.59	121.50
53772	SPLASH	73.0	13-May-06	24.64	122.00
67469	ST-20	77.0	04-Jan-07	25.47	122.40
	Mean	74.0	24-Sep-05	24.71	122.13
	Median	73.5	08-Sep-05	24.50	121.90
	Minimum	64.0	05-May-02	22.41	118.83
	Maximum	92.0	23-Dec-08	26.37	125.20

Table 1. *Summary of information for 34 satellite-tagged loggerhead turtles (Caretta caretta) captured as pound net bycatch in Taiwan.*

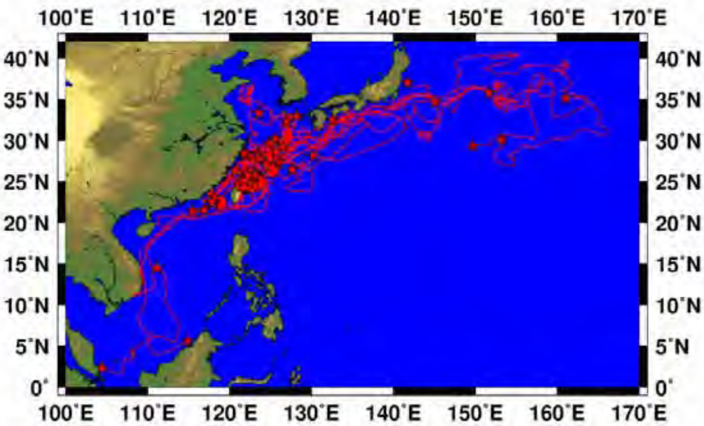

Fig. 1. *Map of loggerhead turtle satellite tracks. Circles denote release location, and stars denote last transmission position.*

Tracks were merged to a suite of available oceanographic, bathymetric, and magnetic data products. These include NOAA Pathfinder sea surface temperature (SST), AVISO altimetry products (sea surface height (SSH), geostrophic u-component, and geostrophic v-component), SeaWiFS ocean color, Smith and Sandwell bathymetry, and earth magnetic field data from the IGRF-10 model (total force, declination, and inclination). Data were examined both on a daily basis and integrated over the entire track duration by averaging across the daily exposures per individual. The SSM tracks were then merged to a new oceanographic data product which quantifies individual eddies from a time-series of remotely-sensed altimetry fields. These energetic mesoscale features are one of the primary dynamic features in the ocean after large oceanic currents and gyre circulation. Eddy shapes were reconstructed as circles using eddy-specific parameters, and the daily SSM turtle positions were compared to points along the circumference of the eddy. Radii at intervals of 5° of arc originating from the eddy central locations were used for the circle construction and these radii endpoint locations used for comparison to the SSM data. The central locations of all eddies were also compared to the SSM data. Eddies were classified as either cyclonic or anticyclonic by the nature of their SSH anomaly (negative SSH anomaly=cyclonic, positive SSH anomaly=anticyclonic), and further classified by eddy strength as indicated by their vertical amplitude. Twelve distant measure metrics were calculated from this merging of datasets, reflecting a nested ordering based on the eddy type (cyclonic or anticyclonic), eddy strength (any strength or strong), and the feature of interest (eddy edge or eddy center), respectively.

A novel approach was proposed called eddy field randomization (EFR) which statistically evaluates the match/mismatch of turtle positions with specific eddy features. EFR infers attraction and/or aversion to such features, and was used to demonstrate differential responses by pelagic loggerhead turtles to eddies depending on their orientation (i.e., cyclonic vs. anticyclonic eddies), and to specific portions of the eddy (i.e., edges vs. centers). A test of the EFR approach itself was to examine how the approach performs on 3 sources of non-sentient data in addition to the SSM daily turtle positions. Firstly, EFR was applied to a set of random-walk tracks. Secondly, EFR was applied to a set of simulated passive particle tracks. Thirdly, EFR was applied to subsurface drifter buoys (drogued at 15 m depth) which occurred in the spatial and temporal domain of this analysis (n=1291 buoys with 32963 individual locations). Comparison of the SSM test results and these additional applications yields insights into the underlying mechanism of eddy utilization patterns by loggerhead turtles, and the role of passive versus active orientation. The EFR analysis did not discern any associations between eddy features and the non-sentient objects evaluated, indicating no significant tendency for either attraction or aversion. The EFR analysis applied to the loggerhead turtle tag data indicated that there was an attraction to cyclonic eddy features. This was most pronounced for the edges of any strength cyclonic eddy (Fig. 2).

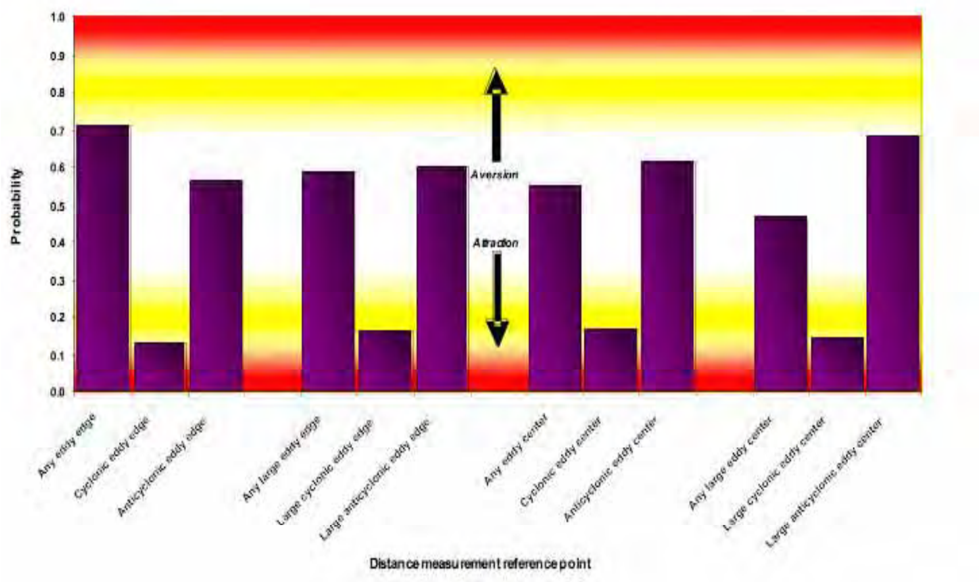

Fig. 2.
EFR results loggerhead turtles tagged in Taiwan.

Loggerhead turtles in the Taiwan area also appear to utilize the continental shelf adjacent to the Yangtze River as a foraging area. This region is where the Yangtze River plume meets the Kuroshio Current intrusion. The complex dynamics make this region very productive. The sea floor here is shallow enough for benthic foraging, yet also contains much eddy activity. This area is also intensively fished, primarily by boats from China. The incidental or targeted take of loggerhead turtles by these and other fisheries over the continental shelf is largely unknown and needs further investigation. Loggerhead turtle diet and community structure of both the benthic and pelagic habitat are not well understood in this region and need further study.

Assessment and Mitigation of Problematic Bycatch in Small Scale Coastal Fisheries of Latin America

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The elements to consider when dealing with any bycatch problem are always the same: effort, and bycatch-per-unit of effort. To assess the bycatch in a fishery requires estimates of both elements. Observer programs appear to be the only way to obtain reliable estimates of BPUE. They are expensive, and logistically complex, and in artisanal fisheries the complexity increases. But they have to be organized. Given the cost and complexity, the sampling design is critical to optimize the use of resources. Observer selection and training is a major factor in the success of this type of program.

Experimental work, performed on actual fishing vessels, is recommended to test mitigation options. The cooperation of the fishing community is needed throughout the whole process. The experiences acquired in the Sea Turtle Regional Program in the eastern Pacific will be used to illustrate the challenges encountered and the solutions developed.

An introduction to the Taiwanese Whale Watching Industry and its Evolution from Traditional Fisheries

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Concomitant with increasing overexploitation of fishery resources and fisheries overcapacity in Taiwan's coastal and offshore waters, Taiwanese traditional fisheries have declined. In order to reduce the pressure on fishery resources, the Fisheries Agency of Taiwan actively guides and assists fishers to improve practices of traditional fisheries. Recreational fisheries have gradually gained in popularity. Whale watching is another growing recreational industry in Taiwan. Recreational fisheries are comprised of both full-time part-time vessels. The full-time recreational fishery mainly conduct whale watching, visitation to offshore islands and boating trips. The part-time recreational fishery primarily conducts recreational fishing. There has been a recent increase in the number of people participating in whale watching activities. Since the first whale watching vessel began operations in July 1997 at Shiti Harbor, Hualien, the whale watching industry has grown in popularity along the eastern coast of Taiwan. Income generation currently exceeds 1.2 billion New Taiwan Dollars from the whale watching and supporting industries.

Whale watching activities in Taiwan occur along the east coast, mainly in the areas around Guishan Island, and near Hualien and Taitong. There are currently at least 24 recreational fishing vessels conducting whale watching operations. Whale watching is most active in Taiwan from May to October. At other times, ocean conditions are too rough for whale watching due to the northeast monsoon. During the whale watching season, there are two to three trips daily, and four trips per day during the peak period during the summer vacation period. Each trip is about two to thre hours long. Each passenger is charged NT$800 to NT$1,000, depending on the total number of customers on a trip. The whale watching vessels typically operate within 20 miles of the harbor. Some of the whale watching vessels also provide transportation to visit offshore islands, conduct recreational fishing and provide scenic tours. About 70% to 90% of whale watching trips observe small dolphins, such as Risso's dolphins, spinner dolphins, pantropical spotted dolphins, bottlenose dolphins, and occasionally Fraser's dolphins, pygmy killer whales, false killer whales, and short-finned pilot whales. Very rarely, whale watchers will encounter larger whales, such as killer and sperm whales.

Since the industry began in July 1997, Taiwan's whale watching industry reached a peak in 2002, as the numbers of whale watching vessels increased from 25 to 33. There is variability by area in the number of whale watching tourists and vessels. The numbers of whale watching tourists steadily increased in Guishan Island, Yilan, while the number of whale watchers has begun to decline in Shiti and Taitong. According to the statistics of the Taiwan Cetacean Society, whale watching activity was concentrated in six harbors in 2009, operated by 19 companies and 24 ships, with an estimated 259,000 tourists.

Beginning in 2003, the whale watching industry encountered several marketing and management challenges, including competition in prices between the whale watching companies; variable prices, routes and quality; and possible adverse effects on cetaceans by whale watching vessels. These problems have been studied by academics and conservation groups. To pursue improvements in the whale watching industry, in 2003, the Fisheries Agency of Taiwan developed a Whale Watching Award certification system. The Whale Watching Award involves assessment of companies against 44 criteria, including service, quality, environmental actions, environmental education, performance, and pilot standards. Currently, there are eight whale watching vessels that have been certified through receipt of the Whale Watching Award: three in Hualien Harbor, one in Shiti Harbor, three in Wushih Harbor and one in ChengKung Harbor. The Whale Watching Award is the only eco-tourism certification scheme in Taiwan. It is hoped that consumer choices and the positive competition amongst the whale watching industry will result in improved eco-tourism quality, and sustainable development of Taiwan's whale watching industry.

The International Seafood Sustainability Foundation and Bycatch Mitigation: Centerpiece of the Global Tuna Sustainability Mission

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[1] **WWF Global Coral Triangle Programme**
[2] **International Seafood Sustainability Foundation**

* Presenter

Of the various factors that bear on the sustainability of the world's tuna stocks – data collection and reporting, IUU disclosure and compliance; stock assessment; RFMO governance and enforcement; net-to-plate traceability; capacity management; operational monitoring, surveillance, and control -- bycatch mitigation stands as a centerpiece for the role it plays as nexus of all the other elements.

Reducing tuna bycatch to any significant degree will require comparable progress across the range of other sustainability factors. With that awareness, the recently formed industry-science-WWF partnership International Seafood Sustainability Foundation acted in its first year of operation to intervene directly with industry conservation actions or otherwise lay foundations for driving change across the range of factors, then followed by convening the first global tuna bycatch reduction workshop. Thus buoyed, sustainability stakeholders are poised for at-sea bycatch research and best-practices development as complements to on-going collaboration with the world's tuna RFMOs regarding governance, fisheries management systems, compliance and enforcement. These developments promise to improve the state of tuna bycatch mitigation, now characterized by a patchwork of measures and substantial differences in compliance levels: observer coverage in large purse seiners at nearly 100 percent in the IATTC and WCPFC but widely varying in other RFMOs; discards reporting varying not only by RFMO but also by species and gear/vessel type; moratoria of purse seine and pole-and-line fishing in some areas at some periods (ICCAT), full time closures in FAD-dominant areas (IOTC), and retention of tuna (IATTC and WCPFC by resolution, IOTC by recommendation); mandated FAD monitoring-management plans (IATTC and WCPFC) and a requirement (IOTC) for purse seiners to report on FAD seedings; and relatively common measures by all four tuna RFMOs to limit or reduce bycatch of non-tuna species, notably sharks, sea turtles and sea birds; likewise measures to assess the impact of fisheries (particularly longline) on seabirds.

None of the Tuna RFMOs has systematically adopted a set of measures that stand as best practices to address bycatch issues, although all four RFMOs have adopted numerous measures to deal with different aspects of bycatch monitoring and mitigation.

Notwithstanding the largely prospective nature of bycatch best practices, the 1995 UN Fish Stocks Agreement provides at an international level what could be the goals to be achieved by any set of best practices that might be adopted by RFMOs, in particular, obtain and evaluate scientific advice, review the status of the stocks and assess the impact of fishing on non-target and associated or dependent species and compile and disseminate accurate and complete statistical data, to ensure that the best scientific evidence is available, while maintaining confidentiality where appropriate.

Among the recommendations taking shape for bycatch mitigation best practices are those, RFMO-specific, related to discard estimates, observers, recording of bycatch by gear, FAD management, experimental fishing, full retention, gear specifications, small tunas and sharks, turtles, seabirds, marine mammals, other non-target species, bycatch data collection and reporting, RFMO dissemination of bycatch data, and fishery impact on bycatch species, ecosystem research, and reduction of discards and bycatch.

While no silver bullet waits to be fired, ample room for improvement waits to be filled with new ideas, practices, technology, and attitudes about degree of urgency associated with bycatch mitigation and the full range of sustainability factors. Committed effort is fully warranted so as to preserve marine resources that support one of the single most valuable segments of the global seafood industry. Excluding bluefin stocks, there are 19 principal stocks of tuna that support commercial fishing around the world. Of these 19, 12 are in good condition, meaning they are not overfished. These 12 stocks include all five stocks of skipjack, the most commercially important species by catch. The 12 stocks in good condition account for 85 percent of world's annual tuna catch. Of that 85% however, 20% are currently experiencing overfishing, so will become overfished if effort is not limited. ISSF, of course, is striving for all 100% to be healthy.

Joining with founding partner WWF, Bolton Alimentari, Bumble Bee Foods / Clover Leaf Seafoods, MW Brands, Princes Ltd., Sea Value Co., Ltd., StarKist Co., Thai Union Mfg. / Chicken of the Sea, and Tri Marine International launched ISSF publicly in March, 2009. FRINSA and Negocios Industriales Real NIRSA S.A have since joined ISSF. The foundation's world-caliber science committee is led by Chairman Dr. Victor Restrepo, former assistant executive secretary, ICCAT, and Vice Chair Dr. Meryl Williams, founding coordinator, FishWatch-AsiaPacific a project of the Asian Fisheries Society. The ultimate goal of ISSF is to see targeted stocks sustained at or above levels of abundance capable of supporting maximum sustainable yield in a healthy ecosystem. Its chief priorities are to work with RFMOS and their scientists; follow and enforce sound scientific recommendations; strive to eliminate any and all illegal, unregulated and unreported catch of the target stocks; provide for the maintenance and health of the ecosystem to which the target species belong; facilitate the application of the precautionary approach in conserving, managing, and utilizing fisheries resources; support implementation of appropriate measures to minimize operational waste, discards, abandoned or lost fishing gear, by-catch, and negative impacts of fishing on associated or dependent species; improve the understanding of the status of target fisheries by facilitating the collection of appropriate data and the exchange of information with all relevant groups; support fisheries seeking sustainability certification through programs that meet the 2005 FAO *"Guidelines for the ecolabeling of fish and fishery products from marine capture fisheries."*

The Coral Triangle Fishers Forum: Market-based Partnerships for Managing Bycatch

Keith Symington[1], Lida Pet-Soede[1]
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Abstract

Addressing bycatch through the use of bycatch-reducing technologies and adoption of better fishing practices can help seafood businesses immediately reduce some of the negative impacts of fishing while also setting them on a path towards more sustainable and responsible management. The growing demand in the marketplace for more sustainably caught seafood, together with new and emerging trade restrictions, provides clear opportunities for expanding the adoption of bycatch reduction gear and techniques in the Coral Triangle. While the eco-certification of fisheries in the Coral Triangle under Marine Stewardship Council (MSC) certification remains a critical objective, in most cases the meeting of MSC sustainability and management criteria remains a longer-term aim. Thus, bycatch-reducing technology, such as the use of circle hooks in longline fisheries and of excluder devices in trawl nets, can provide the basis of a stepwise and "continual improvement" approach to sustainability. This approach has indeed attracted the interest of several seafood companies and producers, many of which are currently working to reduce fisheries bycatch in the region. However, in order to optimize success and ensure that supply chain partnerships are of a sufficient scale and scope to create a groundswell of change, a set of strategies for engaging the enlightened self-interest of fisherfolks and fishing companies is required, with strong focus given to understanding the economic incentives and disincentives that directly influence both the harvesting of bycatch species and the likelihood of mitigating impacts through gear technology. The Coral Triangle Fishers Forum (CTFF), inspired by the International Fishers Forum series of conferences, and proposed as an ongoing series of biennial dialogues on fisheries in the Coral Triangle region, promises to provide an opportunity to address these issues head-on among all segments of the seafood supply chain. Results, recommendations, priorities and new concrete projects stemming from the inaugural CTFF multi-stakeholder meeting in June 2010 will be presented and a strategic agenda forward outlined.

1. Introduction

The incidental capture of untargeted species - bycatch - has become a major political, management, sectoral and environmental focus, bringing its implications to the forefront as a conservation, sustainability and food security imperative. The pervasiveness of fisheries bycatch and unmanaged "multi-species" fisheries are among the most urgent marine conservation and resource management issues in the Coral Triangle today. However there is great potential for fisheries to reduce bycatch, improve management of multi-species fisheries and tangibly improve fishing practices in the region.

Addressing bycatch through the use of bycatch-reducing technologies and adoption of better fishing practices can help seafood businesses immediately reduce some of the negative impacts of fishing while also setting them on a path towards more sustainable and responsible management. Already several seafood business actors in the Coral Triangle have made important commitments to work along the supply line to reduce bycatch, leading to more responsible fisheries and a more sustainable long-term forecast for seafood businesses.

Coral Triangle governments are likewise making key pledges on bycatch reduction, as demonstrated by Philippine President Arroyo's announcement in January 2010 in support of circle hooks - technology that can reduce sea turtle bycatch in longline fisheries by up to 80% - and various MOUs with seafood businesses aimed at implementing better fishing practices.

However, gear solutions for bycatch are still not adopted in the region at a sufficient scale and scope to create lasting positive conservation impacts and to create a groundswell of change. While a wide variety of factors including lack of regulations, low enforcement capacity[26] and poor management capacity contribute to this low level of adoption, in terms of economic incentives and disincentives, several obstacles have been documented, including:

- Few direct economic incentives for local fishermen to adopt appropriate gear or implement best practice;
- High cost of fishing and production (and/or cost of changing operational practices);
- Poor product quality and post-harvest losses (i.e. buyer requirements);
- Poor access to international markets/ development of new markets;
- Limited awareness/concern about market requirements on responsible seafood among key supply chain actors (processors, middlemen etc.);
- Lack of collaborative arrangements/contracts with buyers interested in more sustainable seafood;
- Poor management capacity at local levels to implement progressive operational practices and regulations; and
- Lack of traceability programs to document the details of the fisheries supplying seafood to processors, suppliers and exporters.

2. Making a Market-Based Case for Bycatch Reduction

Recognizing these practical issues and obstacles, WWF Coral Triangle Program has developed a strategy for bycatch adoption that is focused foremost on incentivizing the use of appropriate technology and techniques through the enlightened engagement of supply chain actors based primarily on their economic self-interest.

This new approach must foremost address the main economic incentives and disincentives impeding the use of appropriate technology (generally the extra income received from bycatch) and establish new incentives including:

- Combining bycatch gear deployment with new capacity/training for improving post-harvest measures and quality management in the supply chain, for high-value products, increasing income from target species;
- Developing direct contracts between major buyer(s) and local producers for the sourcing of bycatch-appropriate seafood, reducing market uncertainties;
- Developing niche markets for bycatch-appropriate products, providing higher value for target catch;
- Developing and testing directly with fishers new technology that aims to reduce fuel costs, providing higher profits per trip;
- Raising awareness on the potential difficult market-access for problematic fisheries with high bycatch levels, in the international marketplace stemming from recent EC and other restrictions on seafood trade; and
- Exploring the use of “good” subsidies in support of programs aimed at introducing bycatch-reducing technology, and seeking new commitments for long-term private sector and government support of bycatch programs.

3. Coral Triangle Fishers Forum

Inspired by the example of information exchange facilitated by the International Fishers Forum series, lessons learned and dialogue between peers and among all segments of the supply chain, the Coral Triangle Fishers Forum (CTFF) is proposed as an ongoing series of biennial dialogues on fisheries in the Coral Triangle region. The inaugural meeting of the CTFF (June 2010, co-hosted by SEAFDEC, WWF and the Indonesian Ministry of Marine Affairs) is adopting a thematic focus on market-based partnerships for bycatch reduction, providing an opportunity to address the above issues head-on and identify possible solutions and models as well as develop new partnerships.

The objectives of the meeting include incentivizing the adoption of bycatch mitigation techniques throughout the supply chain, expanding market-based partnerships for bycatch mitigation and cultivating innovation in the development of new bycatch mitigation technology and techniques.

The presentation will describe the results of the inaugural meeting and progress in meeting the stated objectives and outcomes. Results, recommendations, priorities and new concrete projects stemming from this multi-stakeholder meeting will be presented and a strategic agenda forward outlined.

[26] For example, there is little capacity for enforcement of rules for the employment of Turtle Excluder Devices (TEDs) in countries such as Indonesia where their use is required.

MSC Protocols for Assessing Bycatch in Data Deficient Fisheries

Bill Holden[1]
[1] Marine Stewardship Council

This paper discusses how the Risk Based Framework (RBF) is used to assess bycatch in data deficient fisheries.

At the centre of the Marine Stewardship Council (MSC) is a set of *Principles and Criteria for Sustainable Fishing* which is used as a standard in a third party, independent and voluntary certification programme. These were developed roughly 10 years ago, by means of an extensive, international consultative process through which the views of stakeholders in fisheries were gathered.

The MSC promotes equal access to its certification programme irrespective of the scale of the fishing operation. The implications of the size, scale, type, location and intensity of the fishery, the uniqueness of the resources and the effects on other ecosystems will be considered in every certification. The three Principles that underlie the MSC programme are:

1. A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery;
2. Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends; and
3. The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable.

The presentation will focus on Principle 2 and specifically the protocols for assessing bycatch and retained species in data deficient fisheries. The intent of this principle is to encourage the management of fisheries from an ecosystem perspective under a system designed to assess and restrain the impacts of the fishery on the ecosystem.

The system that has been designed to assess all fisheries in the MSC program is the Fisheries Assessment Methodology (FAM). This methodology takes the *MSC's Principles and Criteria for Sustainable Fishing* (the MSC standard) as its foundation and provides a hierarchical, multi-criteria structure for assessing fisheries. This is called the default Assessment Tree and this structure and the prescribed default set of performance indicators (PI) and scoring guideposts (PISGs) shall be used in all assessments.

The Assessment Tree structure is divided into three levels for the purposes of scoring:

- **Level 1:** Is the MSC Principle as described in the MSC's Principles and Criteria for Sustainable Fishing.
- **Level 2:** Is the Component which is a high level sub-division of the Principle.
- **Level 3:** Is the performance indicator (PI) which is a further sub-division of the Principle and the point at which scoring of the fishery occurs.

Under Principles 1 and 2, there are PIs evaluating the outcome (status), information, and implementation of management to maintain the status, for each component.

Principle 2 considerations have been categorized into five Components; which are considered to cover the range of potential ecosystem elements that may be impacted by a fishery.

- **Retained species:** Species that are retained by the fishery under assessment (usually because they are commercially valuable or because they are required to be retained by management rules).
- **Bycatch species:** Organisms that have been taken incidentally and are not retained (usually because they have no commercial value).
- **ETP species:** Endangered, threatened or protected species are those that are recognised by national legislation and/or binding international agreements (e.g. CITES) to which the jurisdictions controlling the fishery under assessment are party.
- **Habitats:** The habitats within which the fishery operates.
- **Ecosystem:** Broader ecosystem elements such as trophic structure and function, community composition, and biodiversity.

The default assessment tree structure is suitable for fisheries where data on such species is sufficient to develop a quantitative score. In data-deficient situations, there is an expanded range of qualitative and semi-quantitative risk-assessment tools available for assessing the outcome status of these components. This set of tools is called the Risk-Based Framework (RBF), which is incorporated into the FAM. In data deficient fisheries a decision will be made at the beginning of the assessment to use the RBF.

The presentation will consider the rules for assessing the first two components of Principle 2 in data deficient fisheries. Please note the definition for retained and bycatch species used by MSC during the assessment process.

The RBF includes a set of methods for assessing the risk to each of these ecological components from activities associated with the fishery in assessment. The methods range in complexity and data requirements from a system based on expert judgment (Scale Intensity Consequence Analysis-SICA), to a semi-quantitative analysis to assess potential risk (Productivity Susceptibility Analysis - PSA). The RBF is designed to be precautionary in the absence of data.

If sufficient information to allow a performance indicator to be scored does not exist, then the risk-based assessment phase is entered. First, the SICA analysis is undertaken, and if the risk posed to a component is low enough, resulting MSC score is 80 or greater, that score is fed back into the assessment tree and the RBF process for that PI is complete. If the SICA results in an unacceptably high risk, a score of less than 80 is assigned, then a PSA is conducted. The score resulting from the PSA is then fed back into the assessment tree, concluding the RBF for the PI in question.

The steps for applying the risk-based methods for the specific Performance Indicators which have been identified as data-deficient are:

1. Gathering information relevant to the risk-based assessment (scoping);
2. Carrying out a SICA; and
3. Carrying out a PSA.

The scoping stage provides the background information needed to apply the MSC RBF.

The SICA is a qualitative analysis which aims to identify through extensive stakeholder input which activities lead to a significant impact on any species, habitat or ecosystem. The SICA operates as a screening tool; a "worst case" approach that is used to measure the impacts of a range of activities on particular scoring elements.

The PSA approach examines attributes of each species that contribute to or reflect its productivity or susceptibility, in order to provide a relative measure of the risk to the scoring element from fishing activities. Productivity is the average of seven attributes, while susceptibility is the product of four aspects.

The PSA approach is based on the assumption that the risk to a species will depend on two characteristics: (1) the extent of the impact due to the fishing activity, which will be determined by the susceptibility to the fishing activities (Susceptibility) and (2) the productivity of the species, (Productivity), which will determine the rate at which recovery can occur after potential depletion or damage by fishing. It is important to note that the PSA analysis essentially measures potential risk.

Three MSC-relevant outcomes can result based on the PSA score for a species:

- Where any score is >80, the indicator is passed for that species;
- Where any of the species scored in the PSA are at moderate risk (or <80 but higher than 60) a condition is set on that Performance Indicator. This is similar to the setting of conditions in the "normal" MSC certification process; and
- High risk for any of the species assessed in the PSA (guidepost scores <60) will result in failure for the Performance Indicator, unless evidence can be presented to suggest that the risk was overestimated.

The level of fishing impact a species can sustain depends on the inherent productivity of the species. The productivity determines how rapidly a species can recover from depletion or impact due to fishing. The productivity of a species is determined by species attributes such as longevity, growth rate, fecundity, recruitment and natural mortality.

The level of fishing impact that a species can sustain also depends on its vulnerability or susceptibility to capture or damage by the fishery activities. The susceptibility of a species is determined by attributes such as the degree of overlap between the distribution of the fishery and the distribution of the species; whether the species occurs at the same depth in the water column as the fishing gear; and whether the species is kept, or released alive

Use of either the SICA or PSA requires the scoring to be converted back to scores that are meaningful within the default assessment tree. This allows data deficient fisheries to be scored using the same standard as for other fisheries. Each of the methods provides a risk-based estimate of the impact of the fishery on the ecological component addressed within the Performance Indicator.

PSA can be used to help set conditions in a fishery under assessment. The PSA score is derived from a set of attributes (productivity attributes, such as age at maturity and susceptibility attributes, such as interaction with the fishing gear). Thus, it can be seen which attributes have contributed to a high risk, and these can indicate how the risk can be reduced: i.e. the setting of a corrective action, or condition.

An example will be given during the presentation that demonstrates the way the RBF works for multiple bycatch species in P2. I will present the PSA attributes to demonstrate what type of data are needed and then show an example of how to score a couple of bycatch species using simple information about the fishery, and also to show what could be done in the way of getting information or changing practices to address conditionally passing species.

Market Influences and Sustainable Tuna: A Diverse and Changing World

Duncan Leadbitter[1]
[1] Sustainable Fisheries Partnership

The range of market related approaches for encouraging good resource stewardship has grown enormously in recent years and there is a great deal of overlap and synergy between some of the approaches. An example is the growth of Corporate Social Responsibility in some seafood companies which is a driver for the creation of tools like sustainable procurement policies, supply chain agreements, ecolabelling and other initiatives.

In broad terms there is a mix of positive and negative measures which provide advice/incentives to source/buy on one hand or to avoid certain species/gear types or source areas on the other. Some examples include the buy and don't buy cards for consumers produced by many NGOs, vessel black (and white) lists, and sustainability oriented labelling, just to name a few. In some cases there are increasing overlaps with government schemes aimed at targetting the supply of illegal products into the market place such as catch documentation schemes, vessel black lists and trade restrictions. Indeed there is often a need for government and private schemes to work in a mutually reinforcing way as both realms have strengths and weaknesses.

Whilst no stranger to controversy as the tuna dolphin, longlining and 'decline of large predator' issues have illustrated in the past, the world's tuna industries have found themselves exposed to an increasing number of issues as some stocks have become seriously depleted, wildlife put at risk and the consequences of inadequate traceability and regulatory control have come to the fore.

There are many challenges for the tuna industries which are made more complex by the multinational distribution of the fish themselves as well as the complexity of global trade. Arguably, many of the issues are solvable if thought about in a constructive manner as the industry can put in place mechanisms that suit their modus operandi. An example is the application of traceability systems for ensuring that product in the supply chain is legal.

This paper will explore the diversity of approaches currently in play that have some 'market' related aspects. It will explore some of the drivers that are motivating the private sector in particular and will also explore some of the dilemmas and potential dangers that the rapidly moving world of sustainable seafood will create, such as greenwashing. In doing so it takes a wide view of the term 'market' as consumer demand is only a small part of the considerations that companies factor into decisions about sourcing and public positioning.

Tools for Tilting the Balance in Favor of Sustainability

Governments act to regulate both catches and markets. Involvement in market regulation remains a contentious area for government involvement under the current climate of global market place deregulation. However, markets are imperfect and tightly targeted interventions may have value for supporting legitimate operators. As documented by the OECD in (year) the production costs for tuna for IUU operators are estimated to be 30% lower than for legitimate operators.

Some examples of government actions that have market implications include:

1. Actions to restrict market access to products from fisheries that are not part of an established management regime. The most recent example is the regulations adopted by the European Union in January of this year that excludes products from IUU fisheries. A second, tuna focused, example is the ability of ICCAT to require its members to prohibit the imports of relevant species from countries which are undermining ICCAT's conservation and management measures. This ability is restricted to only a few RFMO's.
2. Publication of and increasing global integration of, black vessel lists and port access limitations on such vessels via port state agreements. This is proving an effective deterrence mechanism, further enhanced if a company involved in the receipt of products is an unwitting bystander but is normally committed to a high standard of legitimacy, as was the case when US company Trident inadvertently took possession of pollock supplied by the black listed transshipment vessel, the Polestar.

The growth in the use of trade related measures demonstrates an increasing realization that an integrated approach along the supply chain as far as the market state is vital if the threats to sustainability posed by IUU fishing are to be adequately addressed. As alluded to above, government regulations become part of the portfolio of tools employed by the private sector that go beyond compliance, i.e. a company's interest in these regulations is increasingly driven by public risk management concerns even if the regulation itself is not directly applicable.

Private Sector Initiatives

A wide variety of private sector initiatives for supporting sustainable use has been documented in the past and the range of options continues to grow. Some examples documented to date include:

- Industry initiatives – the fishing industry has taken a variety of initiatives aimed at addressing factors that affect sustainability, especially, but not restricted to, IUU fishing and excess capacity.
- Catching sector/NGO initiatives – 'alliances for good' between NGOs and the catching sector
- Company/NGO (including public aquaria) alliances
- Codes of Practice and Environmental Management Plans
- Retailer procurement policies
- Supply chain certification for controlling illegal product

Some new approaches include the development of control documents which are company to company agreements that establish legally binding commitments. These commonly relate to product quality and quantity but have been expanded to include sustainability matters, at least as far as compliance with rules and regulations are concerned. The aim is to ensure that companies that are exposed to public risk occasioned by the supply of IUU product can take action against the supplier directly.

This approach was developed on a large scale by the EU Fish Processors Association which was concerned about the level of IUU fishing of Baltic Sea cod and cod and haddock from the Barents

Sea. Control documents, given effect by a Letter of Warranty set out the obligations of suppliers to be aware of the rules governing the fishery and to not knowingly supply product in contravention of these rules. Supply companies agree to random third party audits and if found in breach of the agreement (either via these audits or more traditional enforcement means) then the supply contract is null and void and the product can be forfeited and sold without benefit to the suppliers.

There is little doubt that this approach has added to the pressure on companies to keep within the law as the consequences of being blacklisted as a supplier may have greater consequences than a fine.

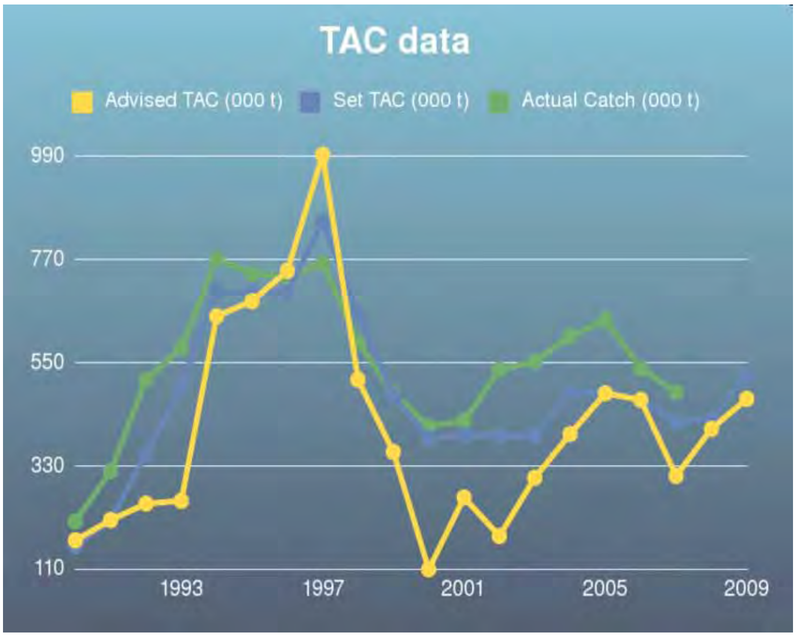

Fig. 1. *Decline in IUU catches of Barents Sea cod following supply chain pressure.*

Corporate Social Responsibility – A Major Driver of Private Action

Corporate Social Responsibility can be described as ""the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large".

Whilst there is much debate over the value of CSR and the underlying reasons behind the adoption of CSR policies the fact remains that CSR policies are a mechanism for NGOs to engage with business.

NGO pressure on the retailers of seafood taps into CSR policies and retailers engage in risk management behaviour when scrutinized over procurement decisions which may put perceptions about company ethics or reputation at risk. The majority of large European retailers have a generic seafood policy in place and many have specific requirements regarding tunas. Almost all of the top 20 US retailers have partnership agreements with NGOs regarding seafood and, in Japan, CSR has been a key component of customer relations for many big retailers.

CSR has been a key driver of the growth in other areas of seafood business (i.e. in addition to procurement policies) such as the growth in the availability of ecolabelled products.

Certification and Labeling

Certification and labeling has grown enormously in the past ten years primarily due to the growth of the Marine Stewardship Council. In the past, the model upon which certification to the MSC Standard was promoted to industry was that consumers would pay more for seafood that was guaranteed sustainable – as determined by the MSC. Although there are many anecdotal reports about price premiums, independent evidence is not available and other factors such as CSR management and market access have assumed prominence.

Integration of Approaches – The Way Forward?

The past ten years has been a period of great change and experimentation in the development and implementation of mechanisms for incentivising sustainable use and much of this development has been at the market end of the chain. Some approaches have proven more valuable than others and it would appear that many approaches cannot work effectively in isolation. Fig. 2 documents that conceptual strategy being implemented by the Packard Foundation but such a strategic approach is not proprietary to that organisation and could be applied to other groups, public and private.

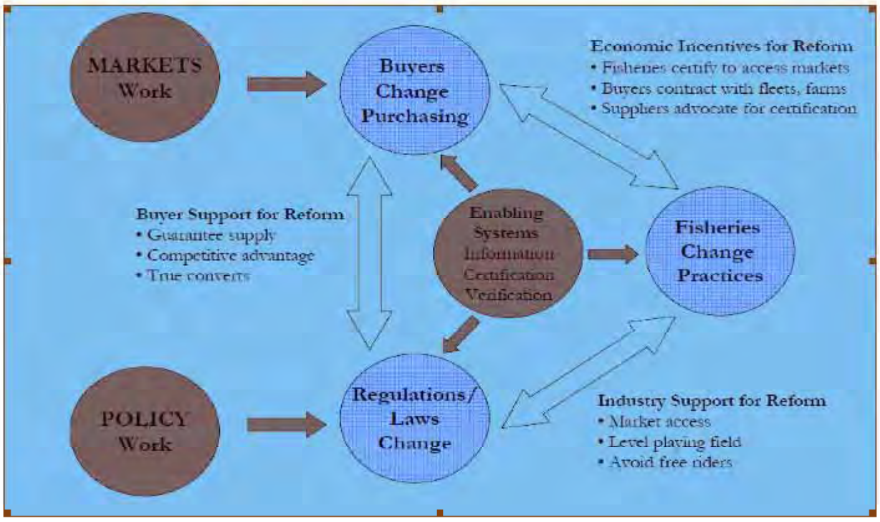

Fig. 2. Seafood markets strategy: Dynamic model of change (Sourced from Packard Foundation strategic plan for sustainable seafood).

Monitoring, Control and Surveillance and the Ability of Market-based Mechanisms to Change Fishing Practices: Lessons from US Trade Rules on the Importation of Shrimp and Uptake of TEDs in Tropical Shrimp Trawl Fisheries

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Abstract

The United States' shrimp import embargo that went into effect on 1 May 1996 stipulates that fishing methods used in shrimp capture in harvesting countries should inflict no harm on marine turtles. To comply with the condition, Southeast Asian Fisheries Development Center (SEAFDEC), together with its member countries, conducted a series of experiments and trials to develop a suitable Turtle Excluder Devices (TEDs) for use in shrimp trawls in Southeast Asian countries. The design of Thai Turtle Free Device (TTFD) was found to be the most convenient and efficient for use by fishermen due to a low escape rate of their target species, easy operation and its low construction cost. TTFD and Super Shooter were selected as suitable TEDs to promote for use in Southeast Asian countries.

Monitoring, Control and Surveillance (MCS) is one set of fisheries management tools which has been promoted in combination with market- based mechanisms in order to implement the use of TEDs by fishermen in trawl fisheries. Thailand, Malaysia and Indonesia are used here for a case study on MCS and the ability of market-based mechanisms to change fishing practices.

1. Introduction

The embargo posed a threat to the livelihood of fishermen of Southeast Asian countries. National governments in the region viewed the threat very seriously and through an agency of a SEAFDEC governing body, the Council of Directors, approval was given for the urgent consideration of practical designs of additional shrimp trawling gear to lift the U.S. import ban by effecting the release and potential conservation of sea turtles.

The SEAFDEC Training Department (TD) and Marine Fisheries Resources Development and Management Department (MFRDMD) were assigned to study this problem in cooperation with the Departments of Fisheries (DOF) of SEAFDEC member countries. A series of experiments commenced in Thailand and as progress was made, more trials were carried out in other SEAFDEC member countries. Since a large number of fishermen in the region live by catching shrimp, various activities have been conducted to safeguard them and to minimize the impact that could be anticipated by the enactment of the import embargo. Through workshops and seminars, the results of studies were disseminated to fishermen and served to make them understand the use of the devices to avoid shrimp embargo and also to promote the conservation of sea turtles through the use of the devices.

2. TEDs Implementations in Southeast Asia

2.1. Thailand

To comply with the condition set by the U.S. shrimp import embargo, SEADEC/TD in cooperation with DOF, Thailand, conducted a series of experiments to develop a suitable device for use with shrimp trawls in Thailand. Five types of TEDs were imported for testing, namely, Anthony Weedless, Super Shooter, Bent Pipe, Georgia Jumper and Mexican TED.

Based on studies of the design and construction of various types of TEDs, the Super Shooter and Georgia Jumper were modified into what has become known as the TTFD. The results from the experiments suggested that the Super Shooter and TTFD have acceptable escape rates and are convenient to operate. In comparing the two devices, the TTFD was found to be the most suitable due to a lower escape rate of fish, lower fuel consumption and easier construction and installation due to all materials used being locally available.

DOF, Thailand organized a workshop on the use of TEDs for shrimp trawls in October 1996. Participants were representatives of fisheries from 22 coastal provinces in Thailand. The fishermen had a positive reaction to the use of TEDs and accepted the reasons for their introduction. The results of the fishing trials gave them confidence in the low escape rate levels and cleaner shrimp caught. The first 100 TTFDs were contributed for voluntary use. Another 2,900 TTFDs have been distributed to fishermen, so that all 3,000 shrimp trawlers registered in Thai shrimp fisheries were provided with the device. In November 1996, the U.S. shrimp embargo was lifted for Thailand fisheries.

2.2. Malaysia

To comply with the condition set by the U.S. shrimp import embargo, the SEAFDEC/MFRDMD and TD in cooperation with the DOF, Malaysia, have conducted several experiments to develop TEDs and implement their use by fishermen in Malaysia. The first trial was carried out in Thailand and MFRDMD sent their staff to join the experiment in September 1996. Following the trial, experiments were conducted in Perak State, Malaysia in February 1997. Results indicated that the shrimp catch rate was not adversely affected by the TEDs.

MFRDMD and TD carried out the first demonstration and a workshop in March 1997 in Perak State in cooperation with DOF, Malaysia. There was also a shore-based exhibition to introduce the TEDs. At-sea demonstrations of the TEDs on shrimp trawlers were then conducted.

During July 1997, training on the use of TEDs was conducted at MFRDMD for DOF staff from various states. Follow-up training was again conducted for Sabah fisheries officers in December 1997. A questionnaires on the use of TEDs was also given to fishermen.

2.3. Indonesia

The DOF, Indonesia, has banned trawl fishing throughout the country since 1980. For various reasons, however, industrial shrimp trawling has been licensed only in the Arafura Sea and its adjacent waters since 1 January 1983. BED is an Indonesian acronym for the Hooped TED, which was introduced by the U.S. National Marine Fisheries Service (NMFS).

When the US shrimp import embargo went into effect in May, 1996, Indonesia was not included, because the Hooped TED was already in use. NMFS introduced the Super Shooter TED to Indonesia in October 1996 to replace the Hooped TED. In November 1997, SEAFDEC/TD also introduced the TTFD to Indonesia, based on their experience in Southeast Asian countries.

Indonesia has exported shrimp globally, particularly to Japan and in small quantities to the U.S. Indonesia has continued to promote selective shrimp trawling by using the Super Shooter and TTFD in Indonesian waters.

3. MCS and Market-based Effect to the Use of Trawl Fisheries

Considering the MCS system and mechanism in Southeast Asia particularly in these three countries, we can conclude in general that the implementation of TEDs in each country depends much on the government policies and governance. For example, in Thailand during the promotion of TEDs, 3,000 sets of TEDs were been distributed amongst trawlers in the Gulf of Thailand and the Andaman Sea through a workshop held in Southern Thailand. However, there was nominal surveillance to ensure that the TEDs were employed, as enforcement staff had other priorities and enforcement agencies believed that this was a trial period for using TEDs. Lack of personnel and patrol boats to cover all the area of trawl operations make it impossible to conduct adequate surveillance and enforce trawler use of TEDs. To complement MCS, market-based activities, such as compensating fishermen for the loss of shrimp resulting from using TEDS, should be introduced in order to create an incentive for increased use of TEDs.

In the case of Malaysia, follow-up activities to determine if TEDs were being used were not continued, despite100 TTFDs having been distributed to fishermen for a trial period. However, MCS activities in Malaysia are relatively very strong in terms of personnel, patrol boats and a zoning system. TEDs are not currently employed in Malaysia as this country is not currently permitted to export shrimp to the U.S.

In the case of Indonesia, because Indonesia exports shrimp to U.S. markets, most of the shrimp trawlers that employ TEDs belong to industrial companies, and fishing grounds have been limited to the Arafura Sea and adjacent waters, MCS has been relatively effective. However, the MCS system in Indonesia is extremely complex with multiple authorities involved.

Currently, Thailand and Malaysia do not rely on exporting shrimp to US markets. As a result, there is limited use of TEDs in these two countries, where the use of TEDs is not compulsory. Only Indonesia has continued the implementation of TEDs.

4. Conclusion

The implementation on the use of TEDs needs the strong support of MCS systems. Based on lessons learnt from the implementation of TEDs in the region, MCS activities will not be successful if there is an absence of understanding and acceptance by fishers of the rationale for MCS activities.

The adoption of TEDs by fishermen in the region has been limited and local support has generally been lacking, due in part to the high cost of fishing, the commercial value of non-target catch, the emergence of multi-species trawling, ineffective enforcement of regulations requiring the employment of TEDs. As a result, the growing use of market incentives through interactions between buyers/exporters and fishing fleets is critical to achieve broad, effective use of TEDs in shrimp trawl fisheries.

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Sequential Game Theoretic Models of Western Central Pacific Tuna Stocks

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* Presenter

The purse seine fleet used by domestic countries of the Western Central Pacific Tuna Stock (WCPT) such as the Philippines and Indonesia are in a sequential game situation with the longline fleet used mainly by distant water fishing nations (DWFNs) to target tuna in the same region. We develop sequential game theoretic models involving these two fleets. Purse seines target mainly skipjack but in so doing they also catch a sizable quantity of juvenile bigeye and yellowfin tuna. The longline fleet is split into two groups, that is, the shallow water longline fleet that targets mainly yellowfin and the deeper water longline fleet, which targets both bigeye and yellowfin tuna stocks. The purse seine fleet take juvenile bigeye and yellowfin tuna before the longline fleet get the chance to target them, thereby creating a sequential game situation. We analyse joint (cooperative) versus separate (non-cooperative) management of these three stocks of tuna in the WCPT with a view to isolating the net benefit loss due to separate management. Results of the analyses suggest that (i) it is economically optimal to cut back significantly on the bycatch of bigeye and yellowfin by reducing the use of Fish Aggregating Devices (FADs); and (ii) such a cut in bycatch will result in a loss to the domestic countries that target skipjack but this loss is much smaller than the gain in the potential benefit to the longline fleet. For joint management to be implemented, an institutional arrangement is needed to allow domestic countries using purse seines to share in the gains from cooperation, thereby meeting the individual rationality requirement.

Effects on the Bigeye Tuna Stock in the Eastern Pacific Ocean from the Inter-American Tropical Tuna Commission's Measures for Allocation of Tuna by Gear Type [27]

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[1]Inter-American Tropical Tuna Commission

Abstract

A simulation study was conducted in 2008 to gain further understanding as to how hypothetical changes in the amount of fishing effort exerted by the tuna fishing fleet might simultaneously affect the stock of bigeye tuna in the Eastern Pacific Ocean (EPO) and the catches of bigeye by the various fisheries. Several scenarios were constructed to define how the various fisheries that take bigeye in the EPO would operate in the past and in the future and also to define the future dynamics of the bigeye stock.

Fishing Effort

Future projection studies were carried out to investigate the influence of different levels of fishing effort (harvest rates) on the stock biomass and catch. The analyses carried out were:

1. Quarterly harvest rates for each year in the future were set equal to the average harvest rates from 2005 to 2007, to simulate the reduced effort due to the conservation measures of IATTC Resolution C-04-09.
2. An additional analysis was carried out that estimates the population status if the resolution was not implemented. For 2004-2007, purse-seine catch in the third quarter was increased by 86% and the catch in the southern longline fishery was increased by 39% in all quarters. For 2008-2012, the purse-seine harvest rate was increased by 13% for all quarters and the harvest rate in the southern longline fishery was increased by 39% in all quarters.

Simulation Results

IATTC Resolutions C-04-09 and C-06-02 call for restrictions on purse-seine effort and longline catches during 2004-2007: a 6-week closure during the third or fourth quarter of the year for purse-seine fisheries, and longline catches not to exceed 2001 levels. To assess the utility of these management actions, we projected the population forward 5 years, assuming that these conservation measures are not implemented in the future.

Comparison of the spawning biomass predicted with and without the restrictions from the resolution show substantial difference (Fig. 1). Without the restrictions, SBR would increase only slightly and then decline to lower levels.

The reductions in fishing mortality that could occur as result of the continuation of IATTC Resolution C-06-02 are insufficient to allow the population to maintain above levels corresponding to the MSY in the long term, although an increase above the MSY level is expected for a few years, due to recent high recruitment.

The conservation resolution that was approved in 2009, IATTC Resolution C-09-01, calls for more restrictive measures than pervious resolutions and by 2011 the purse seine closures (73 days) will approach those (84 days) recommended by IATTC staff.

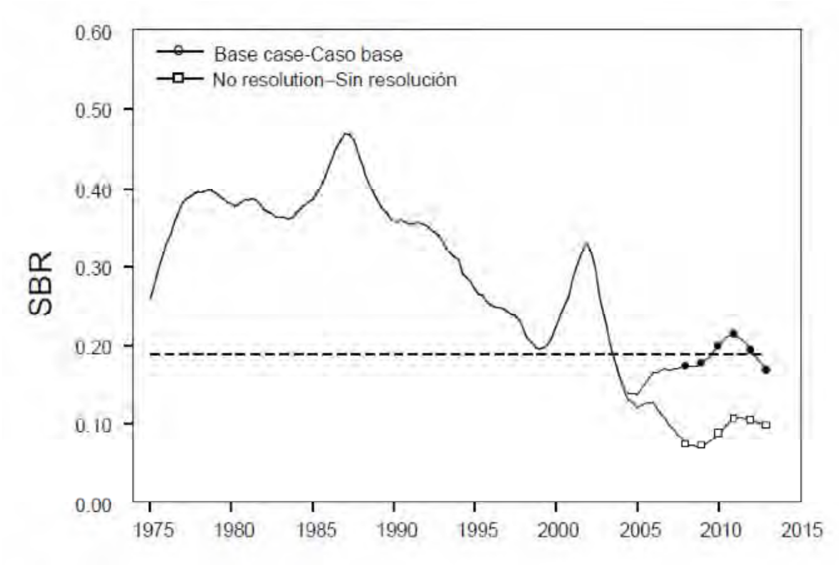

Fig. 1. Predicted spawning biomass ratio (SBR) from the base case model and without restriction from IATTC Resolution C-04-09.

Mitigating Unwanted Bycatch in Global Tuna Fisheries

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Abstract

There has been mixed progress in addressing unwanted bycatch in longline and purse seine tuna fisheries. It is likely that, given sufficient investment in research and development, commercially viable changes in fishing gear and methods are possible to nearly eliminate bycatch. However, even in the gear types where substantial progress has been made, despite the availability of effective bycatch reduction methods that, in some cases, also increase fishing efficiency and provide operational benefits, the majority of fleets do not employ these methods. While Regional Fisheries Management Organizations have made recent, progress in addressing bycatch for some bycatch species groups, compromises made during consensus-based decision making processes has resulted in the adoption of measures that do not employ best practices. Furthermore, because resources for surveillance and enforcement are lacking or weak, compliance is likely low. Due to a lack of mechanisms for performance assessment, including inadequate monitoring, with sparse or no observer coverage and inadequate and inconsistent data collection protocols for non-landed catch, there is insufficient information to guide adaptive management to ensure mitigation of problematic bycatch in tuna fisheries is ecologically and economically sustainable.

1. Introduction

Responsible fisheries conduct requires the effective governance of all sources of fishing mortality, including from retained target catch, both retained and discarded bycatch, and unobserved mortalities. Bycatch is comprised of the retained catch of non-targeted but commercially valuable species (referred to as ‘incidental catch’), all discards of unwanted catch, plus all unobserved mortalities (e.g., from catch and bycatch that is depredated or falls from the gear before gear retrieval, and from ghost fishing, including from hooks left in discarded bait) (Alverson et al., 1994; Kelleher, 2005; FAO, 2009b). Bycatch contains species critical for the maintenance of the structure sand functioning of marine ecosystems, and continued provision of ecosystem services. Sensitive species groups subject to bycatch include seabirds, sea turtles, marine mammals, elasmobranchs and other fish species, which are particularly vulnerable to overexploitation and slow to recover from large population declines (Hall et al., 2000; FAO 1999a, 1999b, 2010; Gilman et al., 2005, 2006a,b,c, 2007a,b, 2008a,b, 2009; Gilman and Lundin, 2010). Discarded catch, offal and bait change the foraging behavior and diet of marine species, for instance, by scavenging seabirds, marine mammals, sharks, and benthic scavengers, and may also cause localized anoxia of the seabed (Goñi, 1998; Gilman et al., 2006a; Furness et al., 2007).

Unsustainable levels of bycatch have negative socioeconomic consequences for fishing communities, as bycatch is an important income source and contribution to food supply in some fisheries and countries (Kelleher, 2005; FAO, 2008, 2009d). Overexploitation of commercially important non-target bycatch species, including bycatch of juvenile and undersized individuals of a commercial species, can adversely affect future catch levels (Hall et al., 2000), and can result in allocation issues between fisheries (Gilman and Lundin, 2010).

This paper reviews bycatch problems in tuna fisheries and gear technology solutions, involving changes in the design of fishing gear and methods. Other bycatch mitigation approaches include input and output controls, compensatory mitigation, time/area closures, fleet communication and industry self-policing (Gilman et al., 2009; FAO, 2010; Gilman and Lundin, 2010). A combination of mitigation approaches will be effective and commercially viable depending on the fishery-specific context.

2. Bycatch in Tuna Fisheries

Table 1 summarizes bycatch problems in pelagic longline and purse seine fisheries, the primary commercial fishing methods for catching tunas (Majkowski, 2007). In pole-and-line fisheries, the third largest contributor to tuna landings, nominal bycatch occurs.

Species Group	Pelagic longline	Purse seine
Seabirds	Problematic primarily in higher latitudes (Brothers et al. 1999).	Not problematic.
Sea turtles	Problematic primarily in the tropics and subtropics (FAO, 2010).	Sea turtles can become entangled in Fish Aggregating Devices (FADs) and can be caught in the pursed net (Hall et al. 2000). Turtles are typically encountered alive in the net and are released (FAO, 2010). Sets on FADs and logs result in higher turtle catch rates than dolphin-associated and unassociated (free-swimming tuna school) sets (Hall 1998, Hall et al. 2000, Molony 2005).
Sharks	A large proportion of the total catch in some non-shark fisheries (Gilman et al. 2008a).	Sets on FADs and logs can result in high shark catch rates (Hall 1998, Hall et al. 2000, Molony 2005).
Marine Mammals	Cetacean-longline interactions occasionally result in entanglement and hooking, causing injury and mortality (Gilman et al., 2006a). Fishers may harass and kill cetaceans to try to prevent depredation (removal of hooked fish and bait) and gear damage. Resident cetacean populations may be most at risk.	While there has been substantial success in reducing direct dolphin mortality in purse seines in the eastern Pacific (Hall 1998, IATTC 2007a), dolphin populations have not recovered as anticipated. Stress from purse sets on dolphins has been observed to cause miscarriages or separation and loss of calves, hypothesized to be a contributing factor (Archer et al. 2004, Edwards 2006). Purse seining in other areas typically does not involve setting around dolphins. Purse seine sets on whale-associated tuna schools can result in whale injury and mortality (Romanov 2002, Molony 2005).
Juvenile/under-sized tunas	Might be problematic at seamounts (Passfield and Gilman, 2010).	Restrictions on setting on dolphin schools resulted in a shift to setting on FADs and logs, where the catch rates of juvenile and undersized tunas and unmarketable fish species are higher than in unassociated sets (Romanov 2002, Secretariat of the Pacific Community 2006).

Table 1. *Bycatch problems in pelagic longline and purse seine fisheries.*

3. Solutions

Of the bycatch problems in pelagic longline and purse seine fisheries, there has been substantive progress only in identifying effective bycatch reduction methods for seabirds and sea turtles on longlines and direct mortality of dolphins in purse seines:

Gear technology methods for mitigating bycatch in pelagic longline fisheries:

- **Seabirds:** A growing number of seabird bycatch avoidance methods have been identified, with varying degree of efficacy. These include: night setting, tori line, underwater setting devices, side setting, branch line weighting, blue-dyed bait, thawed bait, bait casting machine, and mainline shooter (Brothers et al. 1999, Gilman et al. 2003, Gilman et al. 2005, Gilman et al. 2007a).
- **Sea turtles:** The best practice for reducing sea turtle bycatch and injury in pelagic longline fisheries is to employ wider, circle-shaped hooks with < 10o offset in combination with large fish bait (Gilman et al. 2006c, FAO, 2010). Deeper setting also holds promise (FAO, 2010).
- **Sharks:** Methods to mitigate unwanted shark bycatch include: (i) using fish instead of squid for bait, (ii) prohibiting wire leaders, (iii) avoiding hotspots, (iv) deeper setting, and (v) moving when shark interaction rates are high (Ward et al. 2007, Gilman et al. 2008a). There is a need to invest in research on various shark deterrents (Gilman et al., 2008a; Stoner and Kaimmer, In Press).
- **Marine Mammals:** Methods to mitigate marine mammal bycatch include: (i) Avoiding hotspots; (ii) fleet communication; and (iii) weak hooks (Gilman et al. 2006a,b). Deterrents and echolocation disruption are a potential additional methods.

Gear technology methods for mitigating bycatch in purse seine fisheries:

- **Sea turtles:** Restricting setting on FADs, logs, and other debris; avoiding encircling turtles; monitoring FADs and releasing any entangled sea turtles; and recovering FADs when not in use are methods to reduce sea turtle bycatch (FAO, 2010). There is a need to invest in research on modified FAD designs to reduce sea turtle interactions (e.g., Molina et al. 2005).
- **Sharks:** Methods to mitigate shark bycatch include: (i) avoiding hotspots; and (ii) restricting setting on FADs, logs, other debris, and whales. There is a need to invest in research on shark repellents for deployment on FADs (Stoner and Kaimmer, In Press).
- **Marine Mammals:** Methods to reduce dolphin bycatch include use of a Medina dolphin safety panel, conducting backdown after dolphins are captured, deploying rescuers during backdown, and using dolphin rescue equipment (Hall, 1998; IATTC, 2007b). Further restricting setting on marine mammals is another approach.
- **Juvenile and Undersized Tunas:** Restricting setting on FADs avoids catch of small and juvenile tunas. There is a need for investment in research on sorting grids (Nelson, 2007).

4. Principles and Approaches

Bycatch solutions may be fishery-specific. For instance, while an underwater setting chute has been shown to be effective at avoiding seabirds in the Hawaii longline fleet, trials in Australia have been less promising, likely due to the seabird species complex and behavioral interactions, the weighting design and the use of live bait (Gilman et al., 2005).

Fishers have a large repository of knowledge, which can be tapped to contribute to finding bycatch solutions. Several bycatch reduction methods were developed by fishermen, including the bird-scaring tori line for longlining, and methods to reduce dolphin mortality in purse seines.

Given limited resources for monitoring, control and surveillance in most marine fisheries, methods shown to be effective in research experiments at reducing bycatch may not be employed as prescribed or at all if they are not convenient, safe and economically viable.

It is critical to identify conflicts as well as mutual benefits amongst species groups from mitigation approaches. For example, use of wider circle hooks and fish bait to reduce turtle bycatch rates and mortality in pelagic longline fisheries has been found to also cause a reduction in shark and seabird bycatch (Gilman and Lundin, 2010). However, for instance, in some regions, setting longlines at night to protect diurnal foraging seabirds led to higher bycatch of nocturnal-foragers (Weimerskirch et al., 1999). Restrictions on purse seine dolphin sets resulted in increased FAD setting, which increased bycatch of juvenile and undersized tunas, sharks, dolphin fish, sea turtles and marine mammals (Hall, 1998; Molony, 2005; Secretariat of the Pacific Community, 2006; Gilman and Lundin, 2010).

5. RFMO Governance

Gilman and Lundin (2010) and Gilman et al. (2007c) review measures adopted by Regional Fishery Bodies, including Regional Fisheries Management Organizations, to address bycatch of sensitive species groups in marine capture fisheries. The legally binding measures that have been adopted do not fully employ best practices for gear technology bycatch mitigation, some require improvements in the areas where they are required, allowing relatively ineffective measures as options, and providing exclusions for classes of vessels with problematic bycatch. Inadequate observer coverage, inadequate and inconsistent data collection protocols for non-landed catch, inadequate resources for surveillance and enforcement, and ineffective or no measures to evaluate performance are additional problems.

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Creating Incentives for the Development and Uptake of Effective Bycatch Mitigation and Management Methods

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The mitigation of bycatches in fisheries depends on several stages that go from the identification of the problem, to the testing and implementation of technical or operational solution, the implementation of management programs, and the adoption of the changes proposed. Most of these stages have costs that need to be covered, or impose additional burdens on the fishers. There is a clear need of incentives to drive this process to a successful conclusion. Examples from different fisheries will be used to illustrate that there are practical approaches developed in a variety of settings that are being implemented without significant negative impacts on the fisheries, and even in some cases with benefits to them. There is a clear need to promote innovation and creative thinking among those trying to solve bycatch problems, especially the fishing community, whose knowledge of the activity makes them the most likely source of practical ideas. Economic incentives are the most common, and there is a broad range of opportunities to develop or to facilitate the adoption of new technologies.

Outcomes of the Kobe II Bycatch Meeting

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This presentation will summarize the outcomes of the Kobe II Bycatch Workshop (K2B). K2B is being co-hosted by the United States and the Pacific Island Forum Fisheries Agency (FFA) and will be held June 23-25, 2010 in Brisbane, Australia. K2B is taking place through the "Kobe process," a series of joint meetings of the five Tuna Regional Fishery Management Organizations (T-RFMOs). This year three other Kobe workshops also took place: a Workshop on the best practices on Provision of Scientific Advice, the Workshop on Monitoring, Control and Surveillance, and the Workshop on RFMO Management of Tuna Fisheries.

The objectives for these workshops were adopted by the participants of the second joint meeting of the tuna RFMOs (Kobe II) in San Sebastian, Spain in 2009. The K2B objectives are as follows:

- Review available information on incidental catch of non-target species and juveniles of target species;
- Provide advice to tuna RFMOs on best practices, methods and techniques to assess and reduce the incidental mortality of non-target species, such as seabirds, turtles, sharks, marine mammals, and of juveniles of target species;
- Develop and coordinate relevant research programs and observer programs; and
- Make recommendations on mechanisms to streamline the work of tuna RFMO Working Groups in this field in order to avoid duplication.

During the workshop, panels of experts will present the current knowledge of bycatch in tuna fisheries, improving assessment of bycatch within and among T-RFMO, improving ways to mitigate/reduce bycatch within and among T-RFMOs, and improving cooperation and coordination across RFMOs. The recommendations by the participants will then be forwarded to the five T-RFMOs and the 2011 Kobe III meeting.

Seabird Bycatch in Pelagic and Demersal Longline Fisheries: Progress and Obstacles

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The rapid expansion of global fisheries in recent years, due to increasing demand for fish combined with advances in fishing technology and a general failure to effectively integrate sustainable development principles into fisheries policy and management, has resulted in a major decline in marine biodiversity. The primary driver of the continuing decline of albatross and petrel (*Procellariiformes*) populations is bycatch in pelagic longline fisheries. Globally, 17 of the 22 species of albatrosses and petrels are now threatened with extinction under IUCN criteria; in most cases this is primarily due to mortality in longline and trawl fisheries. For example, the Wandering albatross (*Diomedea exulans*) population of South Georgia has undergone a 30% decline since 1984 and has declined at a rate of over 4% annually since 1997.

It has been well documented that in the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) waters seabird bycatch has been reduced to zero in most demersal Patagonian Toothfish (*Disosstichus eleginoides*) longline fisheries. It has also been demonstrated that a combination of the technologies (mitigation measures) and other management measures that proved so successful in CCAMLR can be exported to achieve dramatic reduction in seabird bycatch in other demersal longline fisheries. The continuing dramatic population declines in many albatross populations are being caused by the overlap between migratory seabirds and fishing effort outside the Convention Area, predominantly pelagic longline fisheries.

There are a range of political and financial issues that retard progress in the implementation of measures to reduce seabird bycatch to negligible levels in pelagic longline fisheries. But, it must be recognised that mitigating seabird bycatch in such fisheries is inherently more difficult than in demersal longline fisheries. This is due to fundamental differences in gear design with demersal gear being configured to sink rapidly to the sea-bed while pelagic gear is configured to float in the water column. One of the greatest challenges to replicating the success achieved in many demersal longline fisheries is to conduct the scientifically defensible at-sea experimentation to identify a suite of effective mitigation measures for pelagic longline fisheries. These findings then need to be implemented through management measures and regulations in coastal states and on the high seas.

In the last three-four year significant gains have been made in identifying a suite of best practice mitigation measures for pelagic longline fisheries. This has been achieved through the work of the Agreement on the Conservation of Albatrosses (ACAP), specifically the ACAP Seabird Bycatch Working Group, key fishing States, and the BirdLife Albatross Task Force (ATF). The ATF works in seven countries (seabird bycatch 'hotspots') in southern Africa and South America to conduct the at-sea research required to identify fishery specific mitigation measures for target longline fisheries.

There is a rapidly increasing awareness in the fishing industry of the need to improve fisheries sustainability and with considerable action underway to review the performance of, and reform, Regional fisheries Management Organisations (RFMOs) there is currently a unique window of opportunity to undertake this at-sea research and have these findings promulgated in both coastal States and RFMOs to realise a dramatic decline in seabird bycatch levels in pelagic longline fisheries.

Evolution of Mitigation Methods for Depredation by Toothed Whales in Industrial Tuna Longline Fisheries over a Half Century: Who is Smarter and the Winner, Humans or Dolphins?

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* Presenter

In this presentation we will discuss the evolution of mitigation methods for depredation by toothed whales in tuna longline fisheries over a half century from industrial fisheries operations. Based on our reviews it is learned that there are five major mitigation approaches in the past some 60 years: (i) Self-reliant efforts (boat and line handling and other techniques); (ii) chemical methods (use of powders and other materials); (iii) population control; (iv) physical methods (nets, covers, etc.); and (v) acoustics methods (active and passive approaches). We will discuss the historical progress and evolution of these methods and will evaluate which methods are logistically effective within industrial tuna longline fisheries. Then we will discuss our on-going research on acoustical methods using depredation mitigation pingers and also special streamers with light alloy balls developed to strongly disturb echolocation capability based on longline industry experiences. Lastly, we will discuss the future prospects of the mitigation methods in order for humans to win this long standing competition between humans and toothed whales to demonstrate (hopefully) that we are smarter.

Shark Bycatch in the Taiwanese Longline Fishery

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* Presenter

The Taiwanese tuna longline fishery has operated in the three Oceans since the late 1960's. However, shark by-catch in the Taiwanese tuna longline fishery has never been reported until 1981 because of the low value of sharks relative to tunas. Species-specific shark catch data were not available until 2003 because shark catch was not recorded to the species level prior to then. Subsequently, since 2003, the category "sharks" in logbooks is separated into four species: blue shark, mako shark, silky shark, and 'other'.

As the fishing grounds of the Taiwanese longline fishery occurs across the three oceans, shark by-catch data are valuable as they can be used to determine the stock status of pelagic sharks. The observer program for the far seas fishery is one of the ways to obtain detailed data for more comprehensive stock assessments and management studies. To fulfill the obligations of a far seas fishing nation, a pilot observer program was initiated by scientists in 1999 and launched by the Taiwanese Fisheries Agency in 2001. This paper presents a summary of shark by-catch of Taiwanese tuna longline fishing vessels operating in the three oceans reported by observers from 2002 to 2008. The averaged proportion of shark catch (both in number) to the total catch of target species reported by observers from 2002 to 2008 (Fig. 1) was used to adjust the historical shark catch data on a per-set basis for1991-2008.

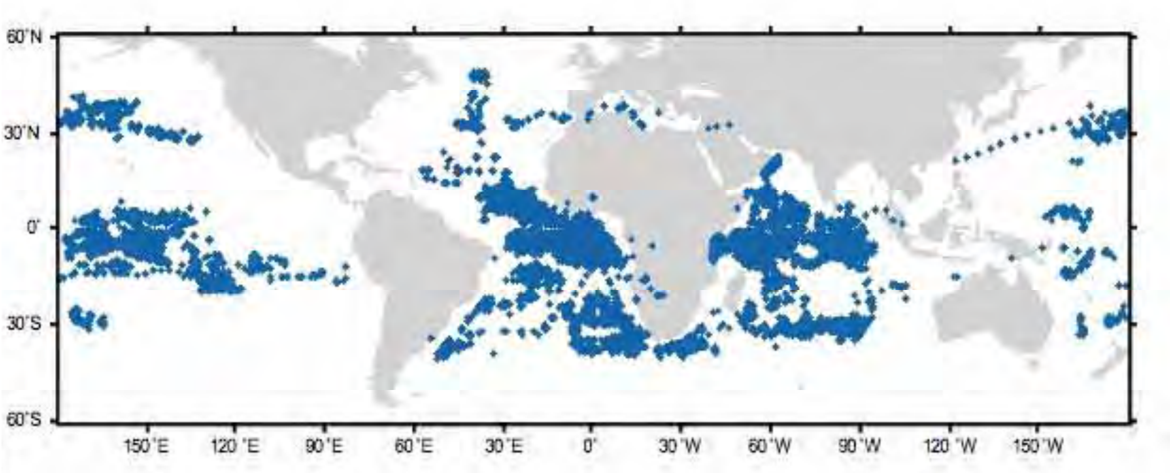

Fig. 1. Fishing effort of Taiwanese tuna longline vessels operating in the three Ocean reported by observes (2002-2008).

According to shark catch rates, the Atlantic Ocean was stratified into the following five areas: (A) 5ºN-15ºS; (B) 15ºS-50ºS, west to 20ºW; (C) 15ºS-50ºS, 20ºW-20ºE; (D) 5ºN-20ºN; and (E) north of 20ºN. Because areas A and D are tropical waters, bigeye tuna (BYT) and yellowfin tuna (YFT) are the major target species, and swordfish (SWO) is the predominant bycatch species (Table 1). In areas B, C and E, the ratio between sharks and albacore (ALB) was used to adjust historical shark catch data on per-set basis. Based on observer records, the seasonal proportion of sharks to the total catch in numbers of BYT, YFT, and SWO in area A were 28.74%, 85.03%, 40.62% and 17.37%, respectively (Table 1). In area B, the proportion of sharks to the total catch of ALB was 22.59% in number (Table 1). In areas C, D, and E, sharks comprised 0.89%, 21.75%, and 5.83% of ALB or (BYT+YFT+SWO) catch and blue shark was the dominant species (Table 1).

Area		shark ratio	blue shark ratio	mako shark ratio	other sharks ratio	target species
Atlantic Ocean						
A	Quarter 1	28.74%	25.08%	0.57%	3.09%	BET_N+YFT_N+SWO_N
	Quarter 2	85.03%	78.63%	3.11%	3.29%	
	Quarter 3	40.62%	35.20%	2.01%	3.41%	
	Quarter 4	17.37%	14.72%	0.95%	1.70%	
B		22.59%	20.04%	1.45%	1.10%	ALB_N
C		0.89%	0.58%	0.12%	0.19%	
D		21.75%	19.83%	0.94%	0.98%	BET_N+YFT_N+SWO_N
E		5.83%	3.96%	0.59%	1.28%	ALB_N
Pacific Ocean						
A		5.83%	4.50%	0.31%	1.02%	ALB_N +BET_N+ YFT_N+SWO_N
B		2.28%	1.81%	0.44%	0.03%	ALB_N
C		8.41%	2.71%	0.22%	5.48%	ALB_N +BET_N+ YFT_N+SWO_N
D		4.23%	1.54%	0.82%	1.87%	ALB_N
Indian Ocean						
A		28.70%	16.10%	1.83%	10.77%	YFT_N
B		41.53%	30.23%	10.13%	1.17%	BET_N
C		2.22%	1.83%	0.32%	0.07%	ALB_N +SBT_N

Table 1. *The proportions of shark to target species catch estimated from observers' records of Taiwanese tuna longline fishery in the three Oceans, 2002-2008.*

In the Pacific Ocean, four areas, namely, A (0º-20ºS), B (south of 20ºS), C (0º-20ºN), and D (north of 20ºN), were categorized based on the distribution of shark bycatch rates recorded by observers during the period 2002-2008. The major by-catch species was sharks followed by billfishes, other bony fishes, and 'others'. The blue shark, *Prionace glauca*, silky shark, *Carcharhinus forcilformis*, bigeye thresher shark, *Alopias superciliosus*, and mako sharks, *Isurus spp.* are the main shark by-catch species, and blue shark is the major discarded shark species.

The Indian Ocean was stratified as 3 areas: (A) 10ºN-30ºN; (B) 15ºS-10ºN, west to 20ºW; and (C) 15ºS-50ºS, 20ºW-150ºE. The predominant by-catch is other bony fishes, sharks followed by billfishes. The blue shark, *Prionace glauca*, sandbar shark, *Carcharhinus plumbeus*, pelagic thresher shark, *Alopias pelagicus*, and mako sharks, *Isurus spp.* are the dominant shark by-catch species, and blue shark is the major discarded shark species.

The historical shark by-catch in logbooks and the total shark catch for Taiwanese longliners in the three Oceans were estimated based on shark by-catch data reported by observers from 2002-2008. Shark bycatch in weight ranged from 4689 tons (2007) to 15117 tons (1996) in the Atlantic Ocean (Table 2), from 2357 tons (1998) to 12746 tons (2004) in the Pacific Ocean, and from 730 tons (1991) to 9957 tons (1995) in the Indian Ocean (Table 2)

Table 2. *Estimated annual shark bycatch by weight (tons) in the Taiwanese tuna longline fishery in the three Oceans.*

Year	Atlantic Ocean	Pacific Ocean	Indian Ocean
1991	10900	2985	730
1992	13688	4824	1988
1993	8073	3590	2857
1994	12657	3086	1850
1995	10473	7170	9957
1996	15117	8822	4413
1997	12245	2943	1922
1998	10794	2357	4126
1999	10626	3817	2764
2000	11318	4367	1990
2001	7684	10657*	5532*
2002	10564	10642*	4528*
2003	9543	10242*	5052*
2004	8157	12746*	5398*
2005	6516	12289*	3280*
2006	5667	12482*	4438*
2007	4689	12550*	4391*
2008	5300	12461*	5009*

* Includes small-scale longline fishing vessels


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Speaker Biographies

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Osamu Abe, Ph.D., is Chief of the Planning and Coordination Section, National Research Institute of Far Seas Fisheries, Fisheries Research Agency, Japan. He has a PhD from the Faculty of Science, University of Tokyo. His career in fisheries science began in 1991 at Shimonoseki Branch, Seikai National Fisheries Research Institute (SNF), conducting stock assessments of pelagic fish in the East China Sea. In 1995, he was assigned to the Ishigaki Tropical Station, SNF, where he studied the conservation of tropical marine species, focusing on sea turtles. He has worked on reducing sea turtle interactions with fishing gear, with a focus on poundnet fisheries. From 2007 through April 2010, he served as the Deputy-Chief of the Marine Fishery Resources Development and Management Department, Southeast Asian Fisheries Development Center, in Malaysia, where he worked on planning and management of Japanese Trust Fund projects, including research on stock enhancement of sea turtles in the Southeast Asian region. His main areas of expertise are in: (i) conservation ecology of sea turtles; (ii) development of fisheries bycatch mitigation measures; and (iii) conservation ecology of coral reefs.

Deirdre Boelke has been a staff member of the New England Fishery Management Council in Newburyport, Massachusetts, U.S.A. since 2001 and she has been the Scallop Plan Coordinator since 2006. The New England Fishery Management Council is one of eight Councils in the United States that are responsible for proposing fishery management measures to the National Marine Fisheries Service. Ms. Boelke has a MSc degree in Marine Affairs from the University of Rhode Island (URI). Her concentration at URI was in fisheries management and her Master's thesis evaluated the potential use of individual fishing quotas (IFQs) as a management strategy for Atlantic Sea scallops. Perceptions about IFQs were evaluated by conducting personal interviews with numerous scallop permit holders and managers. Ms. Boelke has a BS degree from Georgetown University in Washington, DC. Her BS is in Biology with a concentration in Ecology. Her undergraduate thesis was on the survivability of visually impaired California sea lions off the northern coast of California. Previous employment includes: SeaWeb in Providence, Rhode Island; Cold Spring Harbor Fish Hatchery in Cold Spring Harbor, New York; Marine Mammal Center in Sausalito, California; and National Geographic in Washington, DC. Specific career interests include: bycatch mitigation; social impacts of fishery regulations on fishing communities; cooperative research; improving communication and cooperation between managers and stakeholders; as well as maintaining unbiased, transparent fisheries management decision making.

Henk Brus was born in the Netherlands in 1957 as the son of a canned foods importer. After he finished his study on Psychology, he became a family therapist in 1980. In 1987 he decided to apply his problem solving and communications background to the commercial sector and accepted a position as a junior salesman with the international canned fish importer MCM Foods in the Netherlands. From 1992 to 1998 he was vice-president of the company. During this period, he expanded the company to obtain a European-wide presence, especially in the canned tuna markets. In 1998 he founded his own company, Atuna, a global tuna trading company covering the total vertical supply chain. In 1998 he also started a tuna blog at atuna.com, which has since become the world's leading internet portal on tuna. He has been a speaker at major tuna conferences and meetings on tuna sustainability over the last 15 years, and was Co-chairman of the World Tuna Conferences in Bangkok. Atuna bv trades tuna from all oceans and processing areas in the world, and Mr. Brus has close to 20 years of trading experiences in most tuna products with the majority of Asian and Pacific nations. These products are mostly shipped to Europe and North Africa. In 1997 he delivered a speech at World Tuna '97 in Bangkok, "Sustainable Marketing - necessity or Naïveté?", promoting the sustainable use of tuna resources. In 2000 he was one of the co-founders of the World Tuna Purse Seiner Organization, which aims to halt the further expansion of the global tuna purse seiner fleet capacity. Over the last decade, he has been a frequent speaker at all major tuna conferences and meetings on tuna sustainability. In early 2007, he founded Sustunable, a company which aims to sell "responsibly caught and produced tuna", at prices accessible to the average consumer. The company is supplying canned tuna to close to 20 European supermarket chains, and providing complete transparency for each individual can throughout the entire tuna supply chain on responsible tuna fishing and social accountability by making such information available directly to consumers via internet technology.

Milani Chaloupka, Ph.D., is a recognized expert in statistical and mathematical modeling of complex ecological systems including development of interactive stochastic computer simulations of endangered species population dynamics. He runs an international research consultancy that provides innovative statistical and mathematical solutions to ecological and economic issues for a wide range of industry, government, university and international non-governmental organization clients such as Chevron, International Union for the Conservation of Nature, Food and Agriculture Organization of the United Nations, and U.S. NOAA Fisheries. Previously he was Director of the Office of

Director-General (Queensland Department of Environment, Australia) and was responsible for strategic policy issues relating to environmental management in Queensland including the Great Barrier Reef Marine Park, national parks and wildlife conservation. He was also project leader of the ecosystem modeling initiative at the Australian Cooperative Research Centre (Coastal Zone, Estuary & Waterway Management). Dr. Chaloupka is currently the Chair of the Western Pacific Regional Fishery Management Council (WPRFMC) Sea Turtle Advisory Committee, member of the WPRFMC Scientific and Statistical Committee and member of the scientific advisory board of the Caribbean Conservation Council (Florida, Costa Rica). He is a Vice-Chair for the International Union for the Conservation of Nature (IUCN)/SSC/Marine Turtle Specialist Group and responsible for the Pacific Islands region and Chair of the IUCN Marine Turtle Red List Authority. He was also recently appointed to a blue ribbon committee of the National Research Council of the US National Academies to review sea turtle assessment methods for all US marine turtle stocks. He has a substantial list of international peer-reviewed publications in marine science and environmental management fields.

David Chang is the Operation Director of Overseas Fisheries Development Council (OFDC) of the Republic of China, a non-profit and non-governmental organization established in 1989 to assist the fisheries industry in reaching fisheries cooperation and reducing the incidence of Taiwanese fishing vessel detentions by foreign authorities. Mr. Chang has more than 20 years of experience working on bilateral fisheries cooperation and managing the detention of Taiwanese fishing vessels. Recently, OFDC's work has focused on assisting the Fisheries Agency of Taiwan to formulate fisheries policies that will ensure sustainable utilization of fisheries resources, urging fishermen and operators to apply fishing practices that are consistent with guidelines stipulated in the Food and Agriculture Organization of the United Nation's Code of Conduct for Responsible Fisheries and comply with conservation and management measures adopted by tuna regional fisheries management organizations. Mr. Chang is also involved in multilateral fisheries issues, including the tuna regional fisheries management organizations and Fisheries Working Group of the Asia Pacific Economic Cooperation.

Charles C. Cheng, Ph.D., was trained in the department of biology, Imperial College, London and was awarded a PhD with a major in population ecology. Teaching in the Department of Biomedical Science and Environmental Biology, Kaohsiung Medical University, he is in charge of the course on ecology and conservation biology. Since 2004, Dr. Cheng has served as the Moderator of the seabird conservation group, Chinese Wild Bird Federation (BirdLife in Taiwan), which aims to promote research on seabird bycatch in fisheries, raise awareness and advocate conservation actions for seabirds, and provide information on the identification of seabirds and information on seabird bycatch mitigation measures for the Taiwan observer training program. He has been elected President of the Chinese Wild Bird Federation. Since 2005, Dr. Cheng has contributed to teaching the Taiwan fisheries observer training program, providing courses on seabird identification and the application of seabird bycatch mitigation measure. He was granted a Fulbright Scholarship, USA, in 2007/2008. His research involved the evolving mechanism of education in the U.S. national observer program, and working at the office of WWF-U.S. In the University, his research teams include bird biochemical systematic and ecology, morphometrics and image analysis.

I-Jiunn Cheng, Ph.D., was born in Hsinchu City, Taiwan in 1953. He received a PhD from the Marine Science Research Center (renamed the School of Atmospheric and Ocean Sciences), State University of New York at Stony Brook (renamed Stony Brook University), U.S.A. in 1998. His specialties are benthic ecology, physiological ecology and estuarine ecology. After graduation, he worked as a post-doctoral fellow at the Department of Ecology and Evolution in the same university. Dr. Cheng returned to Taiwan and has taught in the Institute of Marine Biology, National Taiwan Ocean University since 1991. He was elected the Chairperson of the Institute from 2000 to 2003. Currently, he is a full professor at National Taiwan Ocean University. Cheng was supported by the National Science Council to serve as a visiting scholar at the Banyulus Laboratory, France and Swansea University, UK. His current academic interests are sea turtle biology and physiological ecology. His laboratory is the only research unit conducting research on sea turtle ecology and conservation in Taiwan. In 2009, the Council of Agriculture, Executive Yuan. Taiwan awarded Dr. Cheng the "Distinct Contributive Person for Forestry and Nature Conservation".

Bundit Chokesanguan works for the Training Department of the Southeast Asian Fisheries Development Center (SEAFDEC), an intergovernmental organization established in 1976 for the purpose of promoting the fisheries development in the Southeast Asian region. At present, SEAFDEC has 11 member countries, namely, Brunei Darussalam, Cambodia, Japan, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. He has a BS degree from the Faculty of Fisheries, Kasetsart University, Thailand, and a MSc degree from Tokyo University of Fisheries, Japan. After completing his education, Mr. Chokesanguan started his career as a fishing gear technologist at the Training Department, located in Thailand. Since then, he has held various posts at SEAFDEC, including Assistant Instructor, Master Fisherman, Fishing Technology Section Head, Head of Office of Training Department Chief, Information and Extension Division Head and his current post of Information and Training Division Head. Mr. Chokesanguan brings many years of experience in the development and use of fishing gear that follow the concept of responsible fishing gear and practices based on his extensive knowledge of all forms of capture fisheries technology and gear ranging from inshore fixed gear and shrimp trawling to the operation of deep-sea purse seines and gear that is relevant to Southeast Asian waters. His most recent activities are in the development and promotion of selective methodologies in turtle exclusion and trash fish and immature target fish exclusion devices for SEAFDEC member countries through demonstrations and experiments. In addition, he has taken the initiative in an issue of safety at sea for fishers in the region which has long been neglected. From the administrative standpoint he is involved in the regional implementation of the guidelines on the Food and Agriculture Organization of the United Nation's Code of Conduct for Responsible Fishing.

Larry Crowder, Ph.D., is a Professor of Marine Biology at Duke University. Dr. Crowder's research centers on predation and food web interactions, mechanisms underlying recruitment variation in fishes, population and food web modeling in conservation biology, and interdisciplinary approaches to marine conservation. He has studied food web processes in both freshwater and marine ecosystems, and has used observational, experimental, and modeling approaches to understand these interactions in an effort to improve management. He was Principal Investigator for a number of large interdisciplinary research projects including the South Atlantic Bight Recruitment Experiment (SABRE), OBIS SEAMAP (Spatial Ecological Analysis of Megavertebrate Animal Populations), and Project GLOBAL (Global Bycatch Assessment of Long-Lived Species). He has also directed and participated in a number of research, analysis, and synthesis groups at the National Center for Ecological Analysis and Synthesis (NCEAS) and for the National Research Council's Ocean Studies Board. His recent research has focused on marine conservation, including research on bycatch, spatial ecological analysis, nutrients and low oxygen, sustainable seafood, ecosystem-based management, marine spatial planning, and governance. He is an AAAS Fellow and was awarded Duke University's Scholar/Teacher of the year award in 2008-2009.

Richard B. Deriso, Ph.D., is Chief Scientist of the Inter-American Tropical Tuna Commission. He received his PhD in Biomathematics from the University of Washington. Dr. Deriso's research interests include population dynamics, quantitative ecology, and fishery stock assessment. A former member of the Ocean Studies Board of the National Academies, he has served on four National Research Council committees. He is a member of the Scientific and Statistical Committee of the Western Pacific Regional Fishery Management Council and has served as consultant to numerous organizations, both private and public.

Daniel C. Dunn is a Research Associate for the Marine Geospatial Ecology Lab of the Nicholas School of the Environment at Duke University. His work focuses on ecosystem-based management and marine spatial planning, particularly as they apply to fisheries. His current research centers on applying spatio-temporal management measures to dynamic pelagic zones to reduce bycatch and discards, and increase fishing selectivity. The Marine Geospatial Ecology Lab is the Mapping and Visualization Team for the Census of Marine Life (CoML), and he is a liaison for CoML to the Global Oceans Biodiversity Initiative (GOBI) and the Secretariat to the Convention on Biological Diversity. In this capacity he edited a group of illustrations depicting methods to identify ecologically or biologically significant areas (EBSAs) in the open ocean and deep seas. He also leads the GOBI Dynamic and Pelagic EBSA Working Group. Previously, he worked on Project GloBAL looking at novel methods to map fishing effort in industrial longline fisheries and artisanal fishing effort in data poor situations. Other past work includes the management of a fund to support EBM software tool development, the investigation of the role of tools in EBM workflows, and the spatio-temporal modeling of sea-turtle movement, nesting patterns and overlap with fisheries.

David Fluharty, Ph.D., is an Associate Professor with the School of Marine Affairs and Wakefield Professor of Ocean and Fishery Sciences, University of Washington where he has been employed since 1976. His Doctoral degree is from the University of Michigan, School of Natural Resources in the interdisciplinary field of Natural Resource Conservation and Planning. His research and teaching interests are in natural resource policy and management at national and international levels, ecosystem approaches for management of marine resources, watersheds, coastal zones, fisheries, marine protected areas, and regional effects of global climate change. Significant professional activities include: Chair, NOAA Science Advisory Board (2006-current); Chair, External Ecosystem Research Team for NOAA-wide Ecosystem Science and Research (2005–2007); Advisor of National Center for Ecosystem Analysis and Synthesis (NCEAS) study groups on Marine Protected Areas, Models for Fisheries Ecosystems (2002-2005) and Ecosystem Management Feasibility in Tropical Areas (2006-current); Member, North Pacific Fishery Management Council (1994-2003); Acting-Editor-In-Chief, Coastal Management Journal; Chair, Editorial Board, Marine Protected Area News and Marine Ecosystems and Management; Member, National Research Council, Study on Evaluation, Design and Monitoring of MPAs and Reserves for the United States (1998-2000); Chair, Ecosystem Principles Advisory Panel (1997-2000) reporting to Congress on Ecosystem-Based Fishery Management. Member; Murray-Metcalf Northwest Straits Citizen Advisory Commission (1997-1999); Co-Chair, Institutional and Regulatory Issues, Sub-Committee and Member, Scientific Advisory Committee for Puget Sound Water Quality Authority (1984-1987); Member, Puget Sound Science Advisory Committee, U.S. Environment Protection Agency (1985-1987); Member, WA Department of Ecology/U.S. Environmental Protection Agency Puget Sound Action Program Implementation Committee (1984-1986); Member, WA Department of Ecology, Secondary Treatment Committee (1985-1987); Vice-Chair, Puget Sound Water Quality Authority (1983-1985).

Eric Gilman, Ph.D., is Associate Faculty of the College of Natural and Computational Sciences, Hawaii Pacific University. He has over 17 years of experience in coastal and marine science and policy, at local to international levels. His main disciplines are (i) fisheries science and policy, focusing on mitigating the bycatch of sensitive species groups in marine capture fisheries; (ii) coastal ecosystem responses to climate change and adaptation options; and (iii) large temporal and spatial scale change and loss in marine biodiversity, including designing and applying suites of criteria to identify networks of sites of biodiversity value, and determining availability and quality of open source, primary, species-level data. Dr. Gilman manages project activities of decentralized, multidisciplinary, multicultural teams, and forms coalitions of stakeholders from the private, public and non-profit sectors. His previous employment has included serving as the Marine Science Advisor with the International Union for the Conservation of Nature (IUCN) Global Marine Programme, Visiting Scientist at the Food and Agriculture Organization of the United Nations, Head of Participation of the Global Biodiversity Information Facility, Pacific Representative for the National Audubon Society Oceans Program, Special Assistant for the Environment with the Office of the Governor of the Northern Mariana Islands, and Environmental Advisor to the Pohnpei Port Authority of the Federated States of Micronesia. His publications are on fisheries bycatch and governance, coastal ecosystem responses to climate change, biodiversity informatics, wetlands ecology and management, site-planning and community-based management. He has a PhD from the University of Tasmania School of Geography and Environmental Studies, Australia; MSc from Oregon State University Department of Oceanography, USA; and BA from Wesleyan University, USA.

Martin Hall, Ph.D., has been the Principal Scientist, head of the Tuna-Dolphin Program of the Inter-American Tropical Tuna Commission (IATTC) since 1984. The program succeeded in reducing dolphin mortality to less than 1% of the initial figures, without reducing the productivity of the fishery. Key to the success were the implementation of an observer program to diagnose the causes of mortality, a fishers education program to disseminate information on the solutions to the problems identified, together with the widespread adoption of improved gear and procedures. Dr. Hall has also been directly involved in developing and implementing the international agreements that address the tuna-dolphin issue. In 2003, IATTC received a request from the government of Ecuador to assist in the development of a program to mitigate sea turtle bycatch by vessels that fish for tunas and mahi-mahis with longline gear. This program was developed in cooperation with WWF, U.S. NOAA, national fisheries agencies, and local and international conservation groups, and is currently underway in most countries of the Pacific coast of America, from Peru to Mexico. More recently, he became involved in the coordination of the global efforts to reduce bycatch in the fishery for tunas associated with floating objects. His publications center on bycatch issues in general, and the strategies and approaches to implement successful mitigation programs. He has presented papers at numerous scientific and management conferences, and organized well over a hundred workshops for fishers, on bycatch problems and solutions. Dr. Hall got his first degree from the University of Buenos Aires, Argentina, and his PhD from the University of Washington.

Peter S.C. Ho is the President of the Overseas Fisheries Development Council of ROC, a non-profit organization funded mostly by the Government, with the function of assisting the industry in acquiring foreign fishing access, compiling tuna statistics, and conducting monitoring, control and surveillance programs, including implementing observer program and vessel monitoring activities. Mr. Ho has over 20 years of experience in bilateral and multilateral fisheries negotiating, and has been attending various Commission meetings of tuna management organizations since 1997 as an advisor to the Taiwan delegation. Notably, he was a member of the Taiwan delegation for the negotiation of the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean, with subsequent adoption of the Convention enabling Taiwan to become a member of the Commission, which was the first time that Taiwan became a member of a regional fisheries management organization. His career in fisheries began as the manager of a tuna fishing company, providing him with an industry perspective for his later role in regional fisheries management.

Bill Holden is currently the Pacific Fisheries Manager for the Marine Stewardship Council (MSC) operating from the Sydney Australia office. He began working with the MSC in February 2009 and his work involves fisheries outreach in the Pacific and Indian Oceans with a focus on tuna fisheries. Another component of his work is with small scale fisheries in South East Asia, working towards sustainable fishing practices. Prior to joining MSC, he lived in the Kingdom of Tonga and managed ‘Alatini Fisheries Co., which he started in 1989. This company operates tuna longliners and snapper dropliners fishing for the fresh chilled markets of Japan and the United States. Prior to joining the MSC, he was also the President of the Fishing Industry Association of Tonga and was also a director of the Pacific Islands Tuna Industry Association. He grew up in San Diego, California where he began commercial fishing. He has a BA in Political Science and Communications from the University of California, Santa Barbara.

Paul Holthus is the founding Executive Director of the World Ocean Council which brings together the diverse international ocean business community in a cross-sectoral leadership alliance for ocean stewardship. The World Ocean Council is fostering leadership and collaboration on “Corporate Ocean Responsibility” and catalyzing industry action on specific marine environmental challenges in support of improved business operations. The first “Sustainable Ocean Summit” will take place in 2010 to bring industry leaders together on ocean sustainability, and develop the programs and working groups to advance solutions on priority shared marine environmental issues. He works with the private sector and market forces to develop practical solutions for achieving sustainable development and addressing environmental concerns, especially for marine areas and resources. His experience ranges from working with the global industry associations or directors of UN agencies to working with fishers in small island villages. He has been involved in resource conservation and sustainable use work in over 30 countries in Asia, the Pacific, Central America and West Africa. He has worked with companies, industry associations, UN agencies, international NGOs and foundations on sustainability, especially in the areas of oil and gas, fisheries, aquaculture, standards and certification as a consultant on sustainable development and environmental management. Past positions include: Deputy Director for the Global Marine and Coastal Program of the International Union for the Conservation of Nature (IUCN); Senior Officer in the Asia-Pacific Program of The Nature Conservancy; Senior Program Officer of the UNEP South Pacific Regional Environment Programme; and founding Executive Director of the Marine Aquarium Council (an international business/environment organization creating standards and certification the global live fisheries trade). He graduated from the University of California and the University of Hawaii, with advanced degrees in coastal/marine resources and international business.

Wen-jung Hsieh is the Chairman of the Taiwan Deep Sea Tuna Long-line Boat-owners and Exporters Association (also known as Taiwan Tuna Association or TTA). He graduated from National Kaohsiung Normal University with a BA in English, and received his EMBA degree from National Sun Yat-Sen University in 2004. His Master’s thesis was entitled “A Strategic Study on the Operation of Ultra-low Temperature Tuna Longline Fishery under the Pressure of Fishing Quota System in the Indian Ocean”. During his 37-year career in the fishing industry, he has demonstrated his expertise in fishing industry management. His main responsibility is to ensure compliance with domestic and international management measures, while maintaining his business competitiveness. For his success and leadership in the fishing industry he was honored with a Kaohsiung Outstanding Fishing Professionals of the Year award in 1990 and a National Ten Outstanding Fishermen award in 2004. Through his leadership of the Taiwan tuna industry, he has actively devoted time and knowledge to fishery policy-making and other public affairs. From 2002 to 2005, he served as the director of TTA and chair of the Indian Ocean Committee of TTA. He has facilitated communication between the government and fishermen, urging his fellow boat owners and fishing operators to ensure compliance with measures of the Indian Ocean Tuna Commission and Commission for the Conservation of Southern Bluefin Tuna by Taiwanese vessels fishing in the Indian Ocean. After serving as the standing director of TTA from 2005 to 2009, he was elected chairman in 2010. With such trust and recognition from his fellow tuna boat owners, he will continue to lead the Taiwan tuna industry to face the ever growing challenge facing global tuna fisheries within the scope of Regional Fisheries Management Organizations.

Hong-Yen Huang is the Director for Deep Sea Fisheries Division, Fisheries Agency, Council of Agriculture, Executive Yuan. His main duties in the Fisheries Agency include: (i) developing deep sea fisheries policies, laws, regulations, and plans; (ii) facilitating international cooperation on matters related to deep sea fisheries, including executing multilateral and bilateral access arrangements; (iii) participating in meetings of international fishery bodies; (iv) managing the activities of all of Taiwan's deep sea fishing vessels; and (v) coordinating other matters related to deep sea fisheries, including scientific research. He has worked for the government in the field of deep-sea fisheries for more than 33 years, since graduating from National Taiwan Ocean University. Over the past decade, he has served as the Head of Delegation for meetings held by the five tuna Regional Fisheries Management Organizations (RFMOs), and for RFMO Commission meetings and subsidiary Committee meetings. He has long committed to implementing the ecosystem-based approach to managing Taiwan's far seas fisheries for the sustainable use of tuna and tuna likes species in three oceans.

Edward C. C. Huang is the General Secretary of the Taiwan Deep Sea Tuna Long-line Boat-owners and Exporters Association (TTA). He earned a MSc degree from the Department of Environmental Biology and Fisheries Science, National Taiwan Ocean University, and BS degree from National Kaoshiung Marine University, Taiwan. He is also the Secretary General of the Taiwan Fisheries Association and President of the Taiwan Deep Sea Tuna Fishery Development Foundation. His involvement in the field of fisheries began from his university days and has continued throughout his career. In his work with TTA over the past thirteen years, he has successfully coordinated Taiwan's tuna fishing industry, especially in this era of turmoil in global fisheries management. Taiwan's tuna fishing industry has undergone substantial reforms in the last decade following the application of more stringent conservation and management measures by the global tuna regional fisheries management organizations (tuna RFMOs). In his role as the General Secretary of TTA, he helped tuna longline fishing boat owners as well as the Fisheries Agency of Taiwan to complete the implementation of a three-year tuna longline vessel reduction program, under which a total of 183 ultra-low temperature longline fishing vessels were scrapped between 2005 and 2007. This enabled Taiwan's fishing capacity to comply with the quota allocations set by the tuna RFMOs. One of his responsibilities is to promote the domestic market of ultra-low temperature sashimi-grade tuna products. Through a subsidy from the Fisheries Agency of Taiwan and Kaohsiung City Marine Bureau, the private business constructed Taiwan's first ultra-low temperature cold storage facility, with the capacity to store 1300-tons. Construction was completed and the facility became operational in 2008. Huang was assigned to manage the project, which began with securing funding in 2005, followed by issuing a commercial tender, supervision of construction, and concluding with the facility's completion in 2008.

Yi Ping Hung was born in 1959 at Lukang Township located in western Taiwan, which has a long history and is known for its humanistic spirit. In 1981, he received his BS degree from the National Ocean University. After completing military service, Mr. Hung was recruited by the Chunghwa Fishermen Association in 1984. Since 1989, Mr. Hung has served in the post of Chief of the Popularization Section of the Chunghwa Fishermen Association and was promoted to Secretary in 2009. In 2008, he received his MSc degree from Dayeh University, with his thesis entitled, "Research on Oyster Farm Development in the Wang-Kong Area".

David Hyrenbach, Ph.D., is an Assistant Professor at Hawai'i Pacific University and an Adjunct Professor at the Duke University Marine Laboratory. His research focuses on mobile marine predators, and the design and effectiveness of protected areas in pelagic systems. Born in Spain, he completed his PhD at the Scripps Institution of Oceanography. In 2007, he was awarded a Pew Fellowship in Marine Conservation to work on the distributions of marine birds, turtles and mammals in the Alborán Sea, Western Mediterranean. His current research focuses on two main areas: how oceanographic variability in time and space shape the distribution and community structure of pelagic vertebrates, and how these habitat associations influence the efficacy of spatially-explicit management strategies for their conservation. The applications of this research include identifying potential concentration and foraging areas for the development of spatially-explicit protective measures (e.g., marine protected areas, time-area closures), and monitoring anthropogenic impacts on seabird populations (e.g., plastic ingestion, bycatch).

Shoou-Jeng Joung is an Associate Professor in the Department of Environmental Biology and Fisheries Science, National Taiwan Ocean University. He holds PhD, MSc and BS degrees from the Faculty of Fisheries, National Taiwan Ocean University.

Donald R. Kobayashi, Ph.D., is a Research Fishery Biologist in the Ecosystems and Oceanography Division at the Pacific Islands Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration located in Honolulu, Hawaii, USA. He has a PhD degree in Environmental Sciences from the University of Technology Sydney, Australia; MSc degree in Biological Oceanography from the University of Hawaii, USA; and BS degree in Ecology and Evolutionary Biology from the University of Arizona, USA. He is interested in a wide range of subjects, including fishery oceanography, larval transport modeling, population dynamics, computer simulation modeling, marine biology/ecology, ichthyology, plankton ecology, conservation biology, remote sensing, protected species mitigation, fishing gear selectivity, and fishery management. In addition to his regular duties, Dr. Kobayashi also serves as a member of the Scientific and Statistical Committee of the Western Pacific Regional Fishery Management Council, is the Chairperson of the NOAA Biological Review Team for the bumphead parrotfish (Bolbometopon muricatum), and is Coordinator for the PIFSC Student Intern Program (PSIP). He has numerous peer-reviewed publications and has twice been awarded the NOAA Bronze Medal (in 2005 for research pertaining to sea turtle mitigation in the pelagic longline fishery, and in 2009 for scientific contributions towards understanding of larval transport).

Marion J. Larkin operated trawl vessels for over Marion J. Larkin began his fishing career in 1971, trying his hand at the crab, salmon gillnet, seine and troll fisheries from Alaska to California, until, in 1978, he settled into operation and management of a trawl vessel. He pursued the trawl fishery as captain for over 21 years catching groundfish, including Pacific Whiting. Upon reaching the ripe old age 60 he retired from the captain position and has since been the owner and manager of Ocean Hunter Enterprises LLC. This company operates trawl vessels, which participate in the whiting and traditional groundfish fisheries. The company vessels catch and deliver iced, in the round groundfish, which includes Dover Sole, Ling Cod, Petrale Sole, and Whiting, to name a few of the major species. Prior to entering fisheries, Mr. Larkin attended Western Washington University where, in 1971, he received a BS degree in Geology. Mr. Larkin has been actively engaged in the fisheries management process with the State of Washington where he has served as advisor to the Director of Fish and Wildlife, and as a board member of the Coalition of Ocean Fishers, representing the Washington trawl industry. For the last 26 years, Mr. Larkin has been engrossed with management at the federal level through the Pacific Fisheries Management Council. He has served for the last 24 years on the Groundfish Advisory Committee representing Washington trawlers. During the last eight years, he has been actively involved in the Trawl Rationalization Amendment process as a member of the Trawl Individual Quota Committee. He has also been a member of the Essential Fish Habitat Technical Review Panel, which laid the groundwork for defining the benthic zones and directly resulted in setting aside 41 areas on the Pacific Coast of Washington, Oregon and California as 'non-trawl zones' to protect critical and essential habitat from the impacts of bottom trawl. For the last eight years, Mr. Larkin has served as an Advisor to the Washington delegation to the Pacific States Marine Fisheries Commission. Mr. Larkin, for the last 12 years, has represented Washington trawlers on the board of the Fishermen's Marketing Association, a trawl advocacy group representing 40% of the groundfish trawl industry.

Duncan Leadbitter is the Director of the Australia-based fisheries and natural resource consulting company, Fish Matter, which was established in March of 2009. The role of Fish Matter is to provide practical advice to industry, government and NGOs regarding the sustainable use of fish and other aquatic natural resources. Over the past 20 years, Mr. Leadbitter has gained extensive experience in fisheries in Europe, Asia, North America and the Pacific. A major client is Sustainable Fisheries Partnerships, an NGO that works with seafood businesses to assist their moves towards sustainable sourcing and management. As an in-house consultant Mr. Leadbitter provides advice on a wide range of issues such as aquaculture feed fish fisheries, tunas and deep water species, as well as liaising with seafood producers, NGOs and multilateral fisheries and aid bodies. Before creating Fish Matter, Mr. Leadbitter was International Fisheries Director for the Marine Stewardship Council, which he joined in 2000. In 2002 he became responsible for developing and managing the MSC's Asia Pacific region and in that role he encouraged fisheries, the post harvest sector and consumers to become involved in the program. Prior to joining the MSC, Mr. Leadbitter was the Executive Director of Ocean Watch Australia, a non-profit organization that aims to protect and improve fish habitats and reduce the impacts of fishing. He has also worked for the fisheries agency in New South Wales, Australia as a habitat/conservation manager and in the private sector as an environmental consultant. Mr. Leadbitter was the Deputy Director of the Australian Seafood Industry Council and held a number of positions on federal and state based natural resource and biodiversity advisory councils. Until recently, he chaired the national Squid Management Advisory Committee for the Australian Fisheries Management Authority. With a background in the management of aquatic habitat and fishing impacts, Mr. Leadbitter has worked on marine protected areas, aquaculture assessments, habitat rehabilitation, pollution assessments, environmental education and bycatch management. He has also worked collaboratively with a variety of fishery stakeholders including industry, environment groups and government. He has written a number of published works on fisheries, coastal zone and habitat matters. He holds a BS Honours degree from the University of Sydney and an MSc degree in Environmental Planning from Macquarie University, Sydney. Mr. Leadbitter is a keen scuba diver and photographer.

Charles C. P. Lee is General Secretary of the Taiwan Deep Sea Tuna Purse Seine Boat-owners and Exporters Association (TTPSA), a nonprofit, non-governmental organization established in July 2008. TTSPA was formed to help purse seine boat owners to execute bilateral foreign license access fishing agreement and to participate in the Nauru Agreement, an international agreement providing purse seine access to fish within the Exclusive Economic Zones within eight Pacific Island Country Parties to the Nauru Agreement (Federated States of Micronesia, Papua New Guinea, Solomon Islands, Nauru, Kiribati, Tuvalu and Marshall Islands). The purse seine fishing industry was established in Taiwan in 1984. Before establishing its own association, the purse seine fishery was a part of the Taiwan Tuna Association. Mr. Lee worked at the Taiwan Tuna Association from 1993 through 2008, where he was responsible for meeting the needs of the purse seine fishing sector. Previous to the establishment of TTPSA, Taiwan purse seine fisheries negotiated bilateral agreements with individual Pacific Island Countries. Through his extensive career working with the purse seine fisheries, Mr. Lee has had the opportunity to gain direct knowledge of the evolving regional management of tuna fisheries in the Western and Central Pacific Ocean through working with staff of the Pacific Islands Forum Fisheries Agency and negotiations with officers of various fisheries management authorities of the eight Parties to the Nauru Agreement.

Ming Hua Lee is the Secretary General of the Taiwan Cetacean Society, where she has worked in various positions since 1998. She holds an MSc degree from the Institute of Applied Economics, National Taiwan Ocean University, where she conducted research on the performance and improvement of the whale-watching industry in Taiwan. She has published a cost-benefit analysis of whale-watching enterprises in the east coast of Taiwan.

Rebecca Lent, Ph.D., is the Director of the Office of International Affairs, National Marine Fisheries Service, National Oceanic and Atmospheric Administration (NOAA Fisheries Service) in Silver Spring, MD, USA. As Director, her portfolio includes oversight of the conservation and management of shared stocks of fish and protected species, including multilateral marine management organizations such as the International Whaling Commission and the five global Tunas Commissions. Dr. Lent received a PhD in Resource Economics at Oregon State University in 1984. Following a year of Post-Doctoral research in France, she served as a Professor at Université Laval in Quebec City for eight years. Dr. Lent joined NOAA Fisheries Service in October 1992, working first as an Economist and then Division Chief for Atlantic Highly Migratory Species in the Office of Sustainable Fisheries, NOAA Fisheries Service. She served as the Regional Administrator for the Southwest Regional Office in Long Beach, California for a year, overseeing marine stewardship in California as well as Hawaii and the Pacific Territories. In this position, she served as the U.S. Government Commissioner for the Pacific Tunas Commission. Dr. Lent was then selected to serve as the Deputy Assistant Administrator for Regulatory Programs at NOAA Fisheries Service Headquarters in Silver Spring, where she provided leadership and direction for the agency's regulatory programs. Following that, Dr. Lent was selected to serve in her present position as Director, Office of International Affairs.
In addition to her responsibilities for leadership and direction of the office, she is also currently the U.S.

Commissioner to the International Commission for the Conservation of Atlantic Tunas. Dr. Lent served as the Head Delegate from the United States at the Second Joint Meeting of the Tuna Commissions (Kobe II) in San Sebastian, Spain in 2009 and also served as the Head Delegate to the United States at the joint U.S.-FFA hosted Kobe II Bycatch Workshop in Brisbane Australia in June, 2010.

Jo-Ann C. Leong, Ph.D., is the Director of the Hawai'i Institute of Marine Biology and Professor in the School of Ocean and Earth Science and Technology at the University of Hawai'i at Mānoa. Dr. Leong is also a Distinguished Professor Emeritus of Microbiology and the former Chairman of the Department of Microbiology at Oregon State University. There, she held the Emile Pernot Endowed Professorship. She is an elected member of the American Academy of Microbiology. She now serves as the Chairman of the Board of Directors for the Center of Tropical and Subtropical Aquaculture in Hawai'i, is President Elect of the National Association of Marine Laboratories, is Co-Chair of the Ecosystem Science and Management Working Group for the U.S. National Oceanic and Atmospheric Administration (NOAA) Scientific Advisory Board, and is on the National Committee of the Census of Marine Life. She served as the editor of the Viral Diseases section of Diseases of Aquatic Organisms for more than 10 years and was on the Editorial Board of Marine Molecular Biology and Biotechnology and the Journal of Marine Biotechnology. Dr. Leong has published over 100 refereed research papers that resulted from the work of her 18 doctoral students and 6 MSc students. She holds three patents for the first viral vaccine for fish and the first DNA vaccine for aquacultured species in the U.S. It was in her laboratory that a new genus of Rhabdoviridae, the Novirhabdovirus, was discovered and the type virus for this new genus, Infectious Hematopoietic Necrosis Virus, kills millions of young trout and salmon each year. She has devoted much of her career to the development of vaccines and control strategies for diseases of aquatic organisms. She retains funding from the National Science Foundation and NOAA.

Rebecca Lewison, Ph.D., is a conservation ecologist and is an Assistant Professor at San Diego State University (SDSU). She serves as the Director for the Institute for Ecological Management and Monitoring, a multi-disciplinary research institute at SDSU. Using innovative field, quantitative and lab-based approaches, she studies vulnerable wildlife populations that live in both terrestrial and aquatic environments and face pressing conservation issues (e.g., habitat fragmentation, habitat degradation, harvest and incidental mortality, disease and other disturbances). Over the past decade, Dr. Lewison has been spearheading integrative research in conservation ecology, policy and resource use, with expertise and experience across a wide taxonomic range of organisms. Dr. Lewison has been a forerunner in fisheries bycatch research and for the past four years has been leading Project GloBAL, a large-scale research initiative funded by the Gordon and Betty Moore Foundation (bycatch.env.duke.edu/) designed to develop new tools and methodological approaches to understand the magnitude and extent, the population-level and the community level effects of fisheries bycatch worldwide. Dr. Lewison serves on the Editorial Boards of Conservation Biology, Marine Biology and Endangered Species Research.

Kwang-Ming Liu, Ph.D., received BS and MSc degrees from the Department of Fisheries Science, National Taiwan Ocean University (NTOU) and received a PhD degree from the School of Natural Resource, University of Michigan, USA in 1992. He started his teaching career as an associate professor with the Department of Fisheries Science, NTOU in 1992 and was promoted to be a full professor in 1999. He transferred to the Institute of Marine Affairs and Resource Management in 2002 and served as the director from 2002-2005 and 2008 to present. Dr. Liu's specialty is fisheries biology, fish population dynamics, and marine resource management. He has published more than 40 peer reviewed scientific papers, including 22 in scientific journals. He has been the principal investigator of more than 50 research projects supported by the National Science Council, Fisheries Agency, Environmental Protection Administration among others, and has received research grants totaling more than two million USD. Dr. Liu also participates in academic societies. Currently, he is the chief executor of the Marine Taiwan Foundation, a member of the International Union for the Conservation of Nature (IUCN) Shark Specialist Group, director of the Taiwan Fisheries Society, director of the Taiwan Fisheries Sustainable Development Association, director of the Taiwan Ocean Conservation Society, and director of the Taiwan International Fisheries Conservation Association. He is on the editorial board of the Journal of the Taiwan Fisheries Society and has been a reviewer of many international scientific journals, including the Canadian Journal of Fisheries and Aquatic Science, Marine and Freshwater Research, Journal of Fish Biology, Fish Bulletin, Fisheries Research, and Environmental Biology of Fishes. Dr. Liu's recent research focus is on fisheries biology, stock assessment, and the management of elasmobranches. He drafted the National Plan of Action – Sharks for the Taiwan government and organized the "Shark Management and Conservation Conference –2002" and the "International Symposium on Whale Shark Eco-tourism" to promote shark conservation to academic societies and the general public. He is also interested in ecosystem-based fisheries management. He leads a research team conducting a project entitled, "Planning of marine protection area in the northeastern Taiwan waters" from the natural and social sciences prospective. In addition, Dr. Liu also contributes to outreach activities, such as promoting the idea of marine conversation to fishermen and training observers. Dr. Liu regularly attends APEC Marine Resource Management Working Group meetings and has organized two APEC Private Sector Roundtable Meetings in Taiwan since 2008. In recognition of his long-term career in fisheries resource conservation, he received the National Excellent Agriculturist award from the Council of Agriculture in 2008.

Hsueh-Jung Lu, Ph.D., received an MSc and PhD in Fisheries Science from the National Taiwan Ocean University in 1988 and 1995, respectively. After graduation, from 1995-1999, he served as a Specialist and then Deputy Director of the Information Division of the Overseas Fishery Development Council, where he was responsible for fisheries statistics of distant-water tuna and squid fisheries. He is currently an Associate Professor of the Department of Environmental Biology and Fisheries Science at National Taiwan Ocean University. His major research interest is on fisheries oceanography and the formation of fishing grounds, especially under the influence of climate changes, using hydro-acoustic, geographic information system (GIS), and remote sensing methods. For many years, he has worked to establish and maintain a web-based GIS for Taiwan coastal fisheries, with an aim to make integrated information available. In recent years, he has focused on addressing marine environmental issues; through studies that have assessed the impact of climate change on fisheries, and through his role as General Secretary of the Taiwan Ocean Conservation Association.

Sean Martin is currently President and a Director of the Hawaii Longline Association (HLA). HLA has participated in the entire series of International Fishers Forums and he has participated in all forums in the IFF series. In addition to activities associated with HLA, Mr. Martin has also participated in a number of international and domestic commissions and workshops, including the Western and Central Pacific Fisheries Commission, where he currently serves as an Alternate Commissioner on the United States delegation. As a current member and former Chair of the Western Pacific Regional Fishery Management Council, he has an extensive background in US fisheries policy and management development throughout the Central Pacific region. He has worked on several collaborative research and gear technology projects throughout the region primarily focused on stock assessment and bycatch mitigation. In addition to activities associated with fisheries management, Mr. Martin is an owner and operator of a fleet of pelagic longline fishing vessels engaged in the Hawaii longline fishery for tuna and swordfish. Additionally, he has been involved in the development, introduction and advancements in modern pelagic longline systems both domestically and internationally through a major supply facility based in Honolulu. Mr. Martin has been an active participant in pelagic fisheries for 35 years.

Geoff McPherson is an Adjunct Principal Research Fellow of the School of Engineering and Physical Sciences, James Cook University, Australia. He was originally a fisheries biologist with inshore net fishery experience with Australian barramundi fisheries and offshore tuna fishery experience in Coral Sea waters since the mid 1970's. Involvement with marine mammal bycatch mitigation commenced with driftnet fisheries in the mid 1980's with passive acoustic systems, and later incorporating active acoustic alarms/pingers developed in association with Professor Jon Lien of Memorial University Canada from the early 1990's. His interest in the physical sciences resulted in the design of low frequency Constant Frequency alarms in northern Australian waters currently used for inshore non-echolocating whales and dugong, and of higher-frequency 'Frequency Modulated' pingers for echolocating dolphins in northern Australian waters. He is closely associated with the utilization of acoustic devices to mitigate bycatch with two commercial fishing organizations, and alternate pinger types to mitigate depredation on longlines with Japanese and Hawaiian fisheries and encirclement in purse seines in Australian fisheries. A particular interest is the matching of acoustic devices to the acoustic capability of marine mammal bycatch species. The physics of pinger sounds in different ecosystems and the acoustic reflectivity of nets and fishing gear components to mammal biosonar are of particular interest. He has assisted a number of pinger manufacturers to enhance the suitability of their products for specific applications on a non-commercial basis. He has been a member of the Western Pacific Regional Fishery Management Council's Marine Mammal Advisory Committee for toothed whales and has worked with members of the Hawaii Longline Association since 2004.

Tom Nishida, Ph.D., is a Research Scientist with the National Research Institute of Far Seas Fisheries (NRIFSF), Fisheries Research Agency (FRA) of Japan. He graduated from the University of Hokkaido (Japan) and the University of Washington (USA) where he earned his BS and MSc degrees, respectively. He later obtained a PhD from the University of Tokyo in fish stock assessment. He served as the fisheries statistician in two field projects of the Food and Agriculture Organization of the United Nations (BOBP and IPTP in Sri Lanka) for six years (1986-1991). His research areas include tuna resources research, fisheries oceanography and the use of Geographic Information Systems (GIS) for spatial analyses of fisheries and ecosystem data (for details refer to http://www.esl.co.jp/Sympo/index.htm/). Dr. Nishida has a continuing interest in the issues facing longline fisheries from depredation of catches by toothed whales and he convened a workshop on this topic for the Indian Ocean Tuna Commission (IOTC) in the Seychelles (July, 2007). Currently Dr. Nishida has a project with Mr. Geoff McPherson (Adjunct Principal Research Fellow, James Cook University, Australia) to mitigate depredation in the tuna longline fisheries applying different types of devices including newly developed pingers.

Lida Pet-Soede, Ph.D., holds graduate degrees (BSc, MSc, and PhD) in Tropical Fisheries Biology and Management from Wageningen Agricultural University, The Netherlands. Major disciplines were fisheries biology and management, socio-economics of developing countries, and fish culture. She is an avid diver. She conducted her PhD research in Indonesia, supervised more than 100 students over the years (many of whom now have jobs in conservation and fisheries management), and has co-authored more than 40 papers and publications. Before joining WWF-Indonesia full time in 2003 and becoming the Marine Program Director in 2004, Dr. Pet-Soede worked as a consultant in Southeast Asia. Born in the Netherlands, she enjoys living in Indonesia with her family and showing her two daughters the beauty of the Coral Triangle.

Randall Owens is certainly not an academic. He started his working life as a commercial fisherman and diver mixed with income from surfing, and this generated his ever-growing interest in the fisheries and marine environment interface. He went on to work with Fisheries Western Australia where he became a patrol boat skipper and was later offered a newly created position as the 'on ground' manager at the Houtman Abrolhos Islands, a rich and highly productive coral reef archipelago that supports the largest single species intensive fishery (western rock lobster) on a coral reef system. He worked there for 10 years establishing an MPA under fisheries legislation and working, with marine and conservation scientists, to improve environmental management at the seasonally inhabited islands. It was at the Abrolhos that he learned about the politics of creating Marine Protected Areas and threatened species management in a fisheries world. In 2000 he joined Great Barrier Reef Marine Park Authority to 'learn how they did things'; initially he only expected to stay a year or two – 10 years later he is still there enjoying the challenge as Manager, Sustainable Fishing, for the Ecosystem Conservation and Sustainable Use Group. He has an MBA in Marine Resource Management and remains an avid fisher and waterman. He has some experience in Baltic and North Seas marine spatial planning issues following time in Germany in 2008 and following a WPRFMC invitation to speak at a 2005 fisher's forum in Honolulu. He completed his MBA dissertation comparing the scope of processes that were used to rezone the Great Barrier Reef under the Representative Area Program and the processes that were in place to establish the North Western Hawaiian Islands National Marine Monument.

Mayumi Sato, Ph.D., received a Ph.D in conservation/landscape ecology in 2008. She has conducted research on various organisms, including dragonflies, damselflies, waterfowls, and freshwater fish during and after her postgraduate study. Since November 2009, Dr. Sato has worked as the BirdLife Global Seabird Programme (GSP) Regional Coordinator for Asia, based at the BirdLife International Asian regional headquarters in Tokyo (BirdLife Asia). In this position, she facilitates regional seabird/marine conservation activities with a focus on the identification of Marine Important Bird Areas (Marine IBAs) and the mitigation of seabird interactions in fisheries. The Convention of Biological Diversity (CBD) aims to include 10% of marine areas as protected area by 2012 and requires its member countries to submit conservation plans for their waters. The Marine IBAs are expected to provide good baseline information for the identification of MPAs, because seabird species richness is an indicator of overall marine biodiversity. The greatest threat to seabirds is bycatch in marine fisheries, and it is estimated that 300,000 seabirds are caught annually. However, because fish are a vital source of food for people in Asia, imposing restrictions on fishing activities is not a viable solution. Cross-sectoral cooperation between the fishing industry, government agencies, academia, and NGOs will be key to solving regional bycatch problems.

James Sha, Director-General of Fisheries Agency, Council of Agriculture, Executive Yuan, has two MSc degrees, one in Marine Food Science from National Taiwan Ocean University, and a second in Marine Affairs from the University of Rhode Island, USA. Mr. Sha's previous employment is as follows:

(1999 – 2008) Deputy Director-General, Fisheries Agency, Council of Agriculture

(1996 – 1999) Director-General, Taiwan Fisheries Bureau

(1996 – present) Deputy Director, Fisheries Department, Council of Agriculture

(1991 – 1996) Chief, Marine Fisheries Division, Fisheries Department, Council of Agriculture

(1982 – 1991) Specialist, Agriculture Bureau, Ministry of Economic Affairs

(1981 – 1982) Specialist of Taiwan Fisheries Bureau to Cape Town, South Africa

For the past decade, Mr. Sha has been involved in international affairs, including participating in meetings of tuna Regional Fisheries Management Organizations and bilateral and multilateral meetings. He was appointed the Chair of the Extended Commission for the Conservation of Southern Bluefin Tuna (CCSBT) in 2005 and selected as the Lead Shepherd for Fisheries Working Group of Asia-Pacific Economic Cooperation (APEC) from 2005-07. In 2002, Mr. Sha was awarded the Outstanding Diplomat Award, presented by the Ministry of Foreign Affairs.

Kitty M. Simonds has served more than 30 years as the executive director of the Western Pacific Regional Fishery Management Council, following a 13-year career as an aide to U.S. Senator Hiram L. Fong. Under her leadership, the Council has established the benchmark for environmentally responsible pelagic and demersal fisheries through the prohibition of non-selective fishing gear, electronic logbooks, observer programs, vessel monitoring systems and spatial zoning for fishery management. In the realm of bycatch mitigation, measures adopted by the Council under Ms. Simonds' leadership have not only demonstrated major reductions in sea turtle and seabird interactions with pelagic longline fishing, but have also been adopted as standards for responsible longline fishing by regional fishery management organizations. Through Ms. Simonds vision, the Council drafted the nation's first ecosystem-based management plan, and has pioneered an ecosystem-based approach to fisheries management with an emphasis on the role of indigenous traditional and local ecological knowledge as a means to inform decision making. At a broader scale, Ms. Simonds has ensured that the Council continues to play a major role in the international management of tunas, and of vulnerable species such as seabirds, turtles and sharks through the dissemination of mitigation technologies and through direct support for conservation initiatives.

Ussif Rashid Sumaila, Ph.D., is Director of the Fisheries Centre at the University of British Columbia, Vancouver, Canada. He also directs the Economics Research Unit (FERU) at the Centre. Dr. Sumaila's research is in the area of natural resource and environmental economics, with particular emphasis on fisheries. Sumaila is deeply interested in how economics, through integration with ecology and other disciplines, can be used to help ensure that environmental resources are sustainably used and managed for the benefit of both current and future generations. Dr. Sumaila has won a number of awards including the Aldo Leopold Fellowship, Pew Fellowship for Marine Conservation; Craigdarroch Award for Societal Contribution; the Zayed International Prize for the Environment, and the Peter Wall Centre Senior Early Career Scholar Award. Dr. Sumaila has authored/co-authored numerous journal articles, edited books/volumes, book chapters and other publications. He selects a wide range of journals and outlets for the publication of his work. This is to allow him to reach (i) mainstream economists by publishing in outlets such as the Journal of Environmental Economics and Management, Land Economics, and Marine Resource Economics; (ii) interdisciplinary scholars by publishing in journals such as Nature, Natural Resource Modeling, Canadian Journal of Fisheries and Aquatic Sciences, and the ICES Journal of Marine Science; and (iii) policy makers and other stakeholders by publishing in Marine Policy and Natural Resources Forum. Dr. Sumaila's work is taken seriously by policy makers at the highest levels, resulting in invitations to give talks at the United Nations, the White House, the U.S. Congress, the Canadian Parliament, the Woodrow Wilson International Center for Scholars and the World Trade Organization. His work has generated significant international interest, and has been cited by, among others, the Economist, the Boston Globe, the International Herald Tribune, Maine Sunday Telegram, the Financial Times, The Globe and Mail, Voice of America, CBC News and the Vancouver Sun.

Keith Symington is the Bycatch Strategy Leader for the WWF Coral Triangle Program. He began working on marine conservation and sustainable fisheries in Pacific Canada in 1995, following a MSc (Geography) at the University of British Columbia and a BS (Specialists in Geography and Minor in International Development Studies) at the University of Toronto. In Pacific Canada, he worked with the Canadian Parks and Wilderness Society and WWF Canada in developing their joint Pacific marine conservation programs, and subsequently served as Marine Program Coordinator for the Sierra Club of Canada – BC Chapter and as a consultant to David Suzuki Foundation, BC Land Use Coordination Office and Parks Canada. In 2004, Mr. Symington began serving as Marine Program Coordinator for WWF Vietnam, and in 2008 joined WWF's regional Coral Triangle Program. His main areas of interest are: (i) fisheries bycatch reduction, management and policy, focused on South East Asia and Pacific regional fisheries; (ii) market-based reforms and approaches for advancing fisheries Best Practices; (iii) small-scale fisheries management, including co-management, poverty and sustainability, and fisheries reconstruction strategies; and (iv) MPAs and fisheries harvest refugia, particularly for mainstreaming of marine biodiversity conservation into fisheries management.

Timm Timoney is a commercial fisherman from Hawaii. She has been working and playing on and in the ocean for over 40 years.

Andrew Tobin, Ph.D., is a wild catch commercial fisher, Board Member of the Queensland Seafood Industry Association, and a Senior Research Fellow with the Fishing and Fisheries Research Centre, James Cook University, Australia. Dr. Tobin has participated in the commercial wild catch fishery within the Great Barrier Reef World Heritage Area since 1997, targeting a diverse array of finfish (Spanish mackerel – Scomberomorus commerson, grey mackerel – Scomberomorus semifasciatus, coral trout – Plectropomus leopardus, barramundi – Lates calcarifer and threadfins - Polydactylids) as well as mud crab (Scylla serrata). His fishing business experienced the roll-out of the Great Barrier Reef Marine Park Authority Representative Areas Program (RAP) legislated in June 2004, the world's largest marine park at the time covering more than 345,400 km2. The RAP increased the spatial coverage of protected areas (no extractive activity) from 4.6% to 33.3% in the park. The immediate impacts on his business were the loss of historically important fishing grounds, the need to shift effort into other areas and fisheries, and the need to cope with displaced effort. His business did receive a "restructure grant" from the government that aided his business through this transitional period. Graduating from James Cook University in 1997, and currently a fulltime research scientist and part-time commercial fisher, much of Dr. Tobin's research focuses on measuring the efficacy of marine parks in offering protection to fishery exploited species. This is a passionate area of interest for Dr. Tobin, as much of the advertising rhetoric promoting marine parks as protectors of biodiversity also claim significant benefits to fisheries exploited species. This claim is largely untested, and should be treated with caution and used less liberally than is often the case, at least until empirical evidence is available to support such.

Tzu-Yaw Tsay is the Deputy Director-General of the Fisheries Agency, Council of Agriculture, Executive Yuan. He has an MSc degree from the Institute of Applied Economics, National Taiwan Ocean University. Mr. Tsay's previous employment included serving as a Specialist at the Taiwan Fisheries Research Institute; Specialist and Division Chief of the Fisheries Department of Kaohsiung City; Senior Specialist of the Fisheries Department of the Council of Agriculture, Executive Yuan; Deputy Director of the Taiwan Fisheries Bureau; Director of the Deep Sea Fishery Research and Development Center, Fisheries Agency; and Director of the Deep Sea Fisheries Division, Fisheries Agency. He was appointed Deputy Chair (in 2009) and Chair (in 2010) of the Extended Commission of the Commission for the Conservation of Southern Bluefin Tuna. His main disciplines are fisheries management and international cooperation for fisheries governance. Mr. Tsay's recent publication is entitled "A Study on Setting up a Mechanism for the Management of Foreign-flagged Longliners Run by Taiwan Nationals in Response to the Global Trend of Deterring IUU Fishing".

Mao-Cheng Wang is the Director of the Fisheries Regulation Division, Fisheries Agency, Council of Agriculture, Executive Yuan. He has an MSc degree in Oceanography from National Taiwan Ocean University. Mr. Wang's previous employment included serving as a Specialist for the Fisheries Station. Then, he was transferred to the Keelung City Government and Fisheries Bureau, Fisheries Agency. Mr. Wang's main duties in the Fisheries Agency include: (i) Conservation and management of coastal fishery resources; (ii) Rehabilitation and conservation of coastal ecosystems; and (iii) Promotion and management of marine ranching and aquaculture industries.

Robin Warner, Ph.D., is a Senior Research Fellow at the Australian National Centre for Ocean Resources and Security and the recipient of an Australian Research Council Postdoctoral Fellowship for 2010-2012. Her research interests include Law of the Sea, oceans governance, marine environmental law, climate law, transnational crime and international criminal law. She was formerly the Assistant Secretary of the International Crime Branch of the Criminal Justice Division in the Commonwealth Attorney General's Department from 2002 to 2006. Prior to that appointment, she was a legal officer in the Australian Defence Force (ADF) where she occupied a wide range of positions including Director of International Law for the ADF. She has recently published a book, Protecting the Oceans Beyond National Jurisdiction: Strengthening the International Law Framework (Martinus Nijhoff, Leiden, 2009) and has also published a wide range of book chapters and journal articles on oceans law and policy.

Bill Wells is the Manager of Seafood Scallop Company and Wells Scallop Company in Seaford, Virginia. Seafood Scallop Company purchases scallops, flounder and monkfish and sells fuel and supplies to fourteen scallop vessels. Wells Scallop Company is the fleet of seven scallop vessels owned by Mr. Wells and the Wells family. The family has been in the seafood business for four generations beginning in 1915, initially fishing for shrimp. The family fished in six different states until leaving the Gulf of Mexico in 1979 to begin scalloping. In the last thirty years, the family has scalloped from the state of Virginia to the state of Massachusetts for Atlantic Sea scallops and for nine years in Alaska for Weathervane scallops. During this time Wells Scallop Company has worked with and been governed by the New England Fisheries Management Council, Mid-Atlantic Fisheries Management Council, North Pacific Fisheries Management Council and the Gulf Fisheries Management Council. Educated at the University of Florida, Mr. Wells has served on the Mid-Atlantic Fisheries Management Council for nine years, concluding in 2001 and is currently chairman of the Scallop Advisory Panel. During the last twenty years, he has continually served either as a Council member or an Advisor while the American Scallop fishery has adopted all of its current fisheries management tools, including limited entry, gear size restrictions, crew limits, marine mammal avoidance technology, bycatch reduction and the opening and closing of special management areas to promote an increased harvest of larger scallops.