ECOSYSTEM-BASED MANAGEMENT OF THE BIRD'S HEAD SEASCAPE

ECOSYSTEM BASED MANAGEMENT

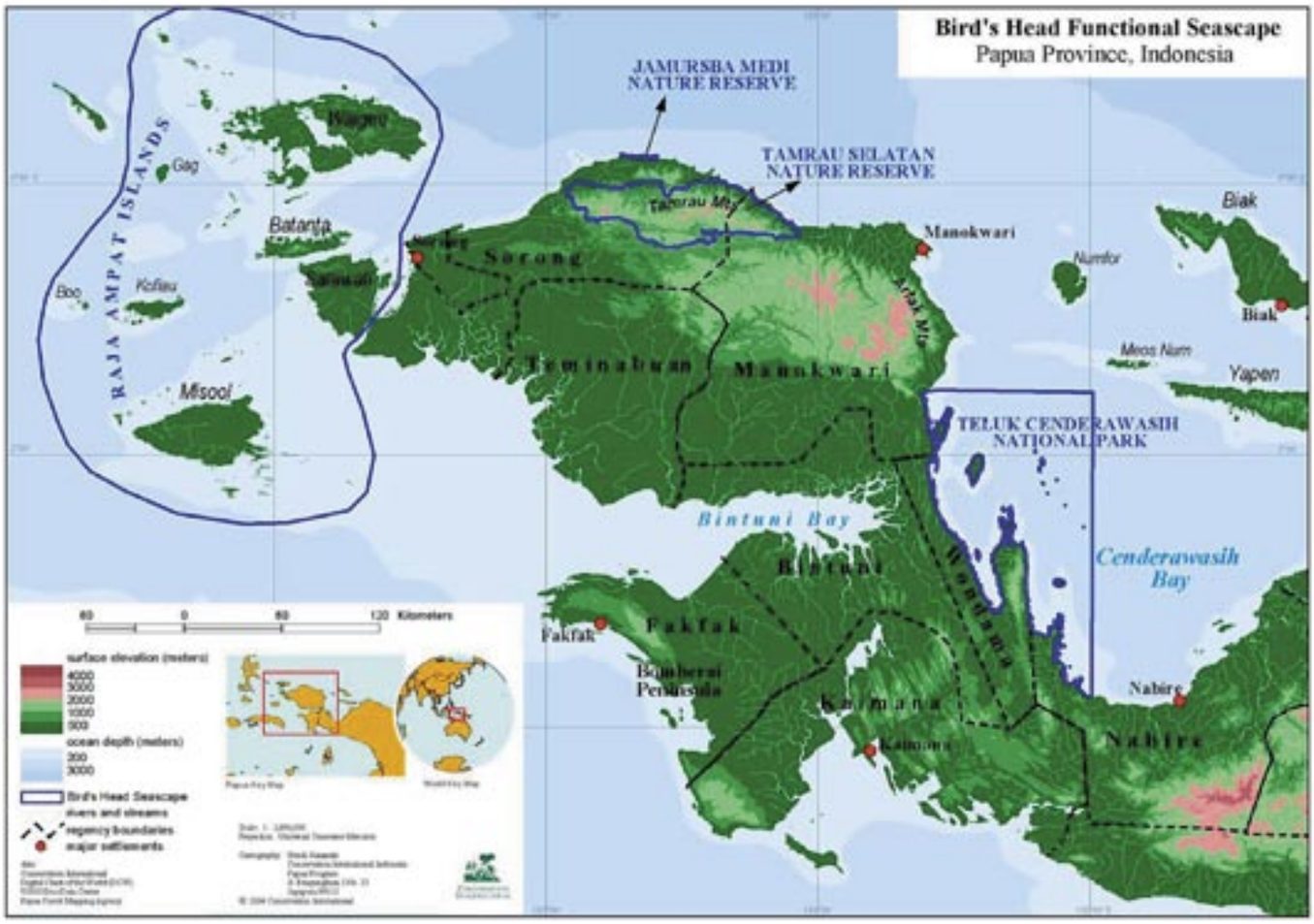
BIRD'S HEAD SEASCAPE, PAPUA

FACTSHEET

A joint initiative of Conservation International, The Nature Conservancy and WWF Indonesia
Funded by the David and Lucile Packard Foundation

Stretching from Teluk Cenderawasih in its eastern reaches to the Raja Ampat archipelago in the west, the Bird's Head Seascape in NW Papua sits firmly in the epicenter of the "Coral Triangle", the area of the world's highest marine biodiversity. Recent surveys in the Raja Ampat archipelago, an area encompassing over 4.5 million hectares and nearly 1500 islands and submerged reefs, have recorded over 1,000 species of coral reef fishes and nearly 540 species of scleractinian coral (roughly 70% of the world's total) – the highest coral reef biodiversity recorded for an area of this size anywhere in the world. Though the surrounding seascape is not nearly as well-known as Raja Ampat, it is clear that these areas harbor equally impressive marine ecosystems – including the largest Pacific Leatherback Turtle nesting site in the world in Jamursbamedi.

The area's incredible marine biodiversity and rich marine resources make it both a global marine conservation priority while at the same time a target for development of economic sectors ranging from fisheries to marine tourism to oil and gas. The local governments in the Bird's Head Seascape (including Sorong, Sorong Selatan, Raja Ampat, Manokwari, Teluk Wondama, Biak Numfor, Yapen, Supiori, Nabire, Waropen, and the neighboring regencies of Teluk Bintuni, FakFak and Kaimana) are now facing very important decisions on how to balance between sustainable economic development of rich marine resources and conservation of globally-significant marine diversity. The future prosperity of the people living in the Bird's Head Seascape (and their grandchildren) urgently depends upon responsible, well-informed policies that allow for sustainable development while preventing the environmental destruction that has occurred in many other areas of Indonesia, including severe overfishing and illegal logging of forests that protect vital watersheds. To be most effective, these policies must be coordinated with



The beautiful Bird's Head Seascape of Papua © Mark Erdmann

neighboring local governments, as many ecological and economic processes within the Bird's Head Seascape are strongly "connected" and operate across administrative boundaries.

In order to assist in developing these environmentally-sound development policies, three environmental NGO partners (Conservation International, The Nature Conservancy's Southeast Asia Center for Marine Protected Areas, and WWF Indonesia) have begun a science-based initiative to explore (in partnership with local stakeholders representing the government, civil society, academia and the private sector) the ecological, socioeconomic, and governmental processes that are most important to understand and include in management decisions in the Bird's Head. Increasingly, scientists and fisheries/natural resource managers around the world are recognizing that an "ecosystem-based management" (EBM) approach that takes into account the effects of interactions among the living organisms, the physical and biotic environment, and the human actors in an ecosystem is necessary to achieve truly sustainable use of marine resources (see the full definition of EBM at the end of this fact sheet).

This EBM initiative will conduct a series of thirteen separate studies (each described in their own separate fact sheet) over a two-year period that will help elucidate those processes and factors most critical to designing ecosystem-based management plans for the regencies and cities in the Bird's Head Seascape. The results of this comprehensive set of studies will be used to develop and refine a synthesis ecosystem model which will be used to assess the consequences of a range of different management scenarios that attempt to balance conservation and sustainable economic development. Results from this extensive modeling exercise will be used to develop a comprehensive ecosystem-based management plan for the coastal and marine resources in Raja Ampat Regency as a first "test-case". Though the first iteration of this ecosystem-based management planning will focus on the Raja Ampat Regency, the data collected in the 13 studies will be valuable to ALL of the local governments in the Seascape, and the implementing partners are committed to involving government and local stakeholders from all the kabupaten/kota in the Seascape in this process and sharing all data collected. If this approach proves successful for Raja Ampat, we will strive to assist each of the other kabupaten/kota in designing similar EBM plans for their areas of the Seascape.

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ADDENDUM: WORKING DEFINITION OF ECOSYSTEM-BASED MANAGEMENT USED IN THE BIRD'S HEAD SEASCAPE EBM INITIATIVE:

We define Ecosystem-Based Management as a management regime in which decisions explicitly take into account the effects and values of interactions among the living organisms, the physical and biotic environment, and the human actors1 in an ecosystem. Measuring, evaluating, and forecasting the dynamics of these interactions constitute the science that underpins EBM. EBM for the marine environment aims to create a sustainable relationship between humans and marine resources by: (1) maintaining or restoring the structure, function, resiliency, biodiversity and ecosystem services of the Seascape; (2) recognizing that human use and values, and the health of human communities are dependent on marine resources; (3) recognizing that ecosystems are dynamic, interrelated, and respond to changing natural and anthropogenic factors; (4) reflecting a shared vision, a common perception that is based on "real evidence" (such as monitoring and scientific surveys), and working toward mutually agreed upon objectives among stakeholders; and (5) implementing adaptive management based on the best scientific knowledge, and reconciling short-term losses brought about by restrictive management with long-term benefits (adapted from Ward et al. 2002).

Ward T, Tarte D, Hegerl E, and Short K. (2002). Policy proposals and operational guidance for ecosystem-based management of marine capture fisheries. World Wide Fund for Nature, Sydney, Australia. 80pp.

ECOSYSTEM BASED MANAGEMENT

BIRD'S HEAD SEASCAPE, PAPUA

FACTSHEET

Genetic Connectivity of Marine Ecosystems in the Bird's Head

Introduction

The majority of fishes, corals and other marine organisms do not give birth, but rather release eggs into the water that hatch as tiny larvae. These larvae then swim or drift in the currents for periods ranging from several days to several months before they transform into juveniles and settle to the bottom, during which time they may move great distances of up to hundreds of kilometers or more. Alternatively, if the ocean currents are weak or move in gyres, they may not move very far at all from their place of origin before settling.

The extent to which larval marine organisms move between reefs in the Bird's Head Seascape determines the amount of "connectivity" between these reefs – which is very important for managers to understand. For example, tuna larvae from Biak may be carried by currents and settle on reefs in Yapen, Manokwari, or even Raja Ampat. Obviously, if the adult tuna in Manokwari all come from Biak, it is important for the Manokwari government to work closely with the Biak government to ensure a future supply of larval tuna for the fishermen in Manokwari!

This same principle applies to corals, lobster, and many other marine organisms of importance in the Bird's Head. For instance, if all of the reefs in Teluk Wondama are bombed, they may depend on new coral larvae from Waropen or even FakFak to recover. As another example, the villagers who catch lobster in Raja Ampat might be dependent upon Supiori as the source of new larval lobsters to renew their stock. Results of initial studies in the Bird's Head show that there is indeed a high degree of connectivity between the reefs there, but there is still much work to be done.

Objective

The examples above demonstrate why it is extremely important to understand the patterns of connectivity between the marine ecosystems in the Bird's Head Seascape. This study will elucidate the patterns of connectivity for a wide range of important marine organisms in the Seascape in order to allow local governments to set policies that will ensure the long-term sustainability of their reefs and fisheries, including development of MPAs that protect reefs that are vitally important as sources of larvae for other reefs in the region.

A school of trevally. © Mark V. Erdmann

Methods

This study will use cutting-edge genetic analysis techniques to determine the patterns of connectivity of a range of different marine organisms in the Seascape, including corals, tuna, fusiliers, Spanish mackerel, teripang, coral shrimps, giant clams, and even worms and starfish. This involves taking small tissue samples from each of these organisms from reefs throughout the Seascape (from Biak to Kaimana) and using genetic analysis to determine connectivity between the reefs. The results of these analyses will be used to construct maps that show patterns of connectivity within the seascape for each species, and these will be shared with our primary governmental, academic and civil society partners in order to inform fisheries and natural resource use policies that are based upon the principles of ecosystem-based management.

Genetic Connectivity of Marine Ecosystems in the Bird's Head

Preliminary Results

To date, over 16,000 samples have been collected from 70 different species and 97 sites across the Bird's Head Seascape, Halmahera, North Sulawesi, and all the way to Banda Aceh. Within the Bird's Head, samples have been collected from Biak, Numfor, Yapen, Teluk Cenderawasih, Manokwari, Raja Ampat, FakFak and Kaimana. Results to date have shown one of two primary patterns:

1) With many wide-ranging species such as tuna, there is a high-degree of genetic connectivity across the Bird's Head Seascape. That is, populations of tuna in Raja Ampat are connected with those in FakFak and Biak – which further stresses the importance of managing these stocks from an ecosystem-based management perspective that looks beyond administrative boundaries.

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2) With other species, including several fusiliers, clownfish and some corals, we see that while populations in Raja Ampat and FakFak and Kaimana are well-connected, Teluk Cenderawasih populations are genetically distinct and not well-connected with these other areas in the Bird's Head. This indicates that for these species, Teluk Cenderawasih should be looked at as a separate management unit. Within Teluk Cenderawasih, populations from Manokwari to Nabire to Yapen are well-connected and need to be managed as a unit, but these are separate from the populations outside of Teluk Cenderawasih.

Analyses of the full data set will continue through 2007. By mid-2007, we hope to understand which of the above two patterns is most common in the different species we are testing, or if there are in fact other patterns as well. From this we will be able to make strong management recommendations for the governments of the Bird's Head Seascape.

Satellite Tagging of Hawksbill and Green Turtles

FACTSHEET

Introduction

Six of the seven sea turtle species known worldwide, are found in Indonesian waters. The distributions of these turtles are closely linked to their life cycles, whereby the juvenile and adult turtles often utilize different habitats. Turtle tagging programs allow researchers to track the movements of turtles over periods of months or even years.

Objective

The aim of this study is to understand the migration and dispersal of the green and hawksbill turtles in their habitats within Raja Ampat and the Bird's Head Seascape.

Geoffrey Gearheart presented results in a scientific poster titled: "Post-Nesting Migrations of Green Turtles of an Endangered Rookery in Raja Ampat, Indonesia, and Implications for Conservation."

Methods

From Oct 6-9, 2005, on Piai Island, 5 nesting green turtles were intercepted after egg-laying. Piai is 112 hectares in size and located at the N-W tip of the Raja Ampat archipelago. Piai and Sayang island, (size 2,461 hectares) are possibly a major rookery for C. mydas.

Turtle Kadek leaves her nesting beach in Piai with a satellite tracking tool attached on her carapace. © Geoffrey Gearheart

Adult Hawksbill turtles could not be found and a second attempt will be done in July 2006.

Satellite Transmitter (PTT) attachment followed the procedures described by Balazs et al. and included two adaptations: 1) the use of a "PTT bumper" of molded resin to prevent the transmitter against damage and 2) "q-cell" –a chemical compound that binds with polyester resin- to fill gaps between PTT and carapace.

Telonics transmitters were used of type ST20 A1010 and with duty cycle: 9 hrs on, 3 off. Data was processed by STAT2. Maps made with Maptool, which is a product of www.seaturtle.org.

Results

Turtle LIZA

During the inter-nesting period Liza stayed within 25 km of the origin islands. On day 42, she left this area and after a two-day stop in Wayag she swam straight towards the N-shore of Waigeo, covering 72 km with average speed of 0.8 kph. She has stayed there since, making localized trips (<11 km) along the coast.

Turtle ORNELLA

Ornella was one of three turtles saved from poachers. She was just starting her nesting period and remained

Satellite Tagging of Hawksbill and Green Turtles

around Sayang and Piai until she went offline 74 days later. She was reportedly killed on Piai by people from Ayau.

Turtle LIDA
This turtle left Piai 4 days after tagging and reached Tanjung Winsop on Oct. 19th, covering ~400 km at an average speed of ~1.8 kph. She remained in the same area until Dec. 3rd, date of her last transmission.

Penyu Lida adalah penyu hijau pertama di Indonesia yang dipantau melalui satelit. Penyu Lida sedang berada dalam "kotak penyu" yang digunakan untuk menahan penyu selama proses pemasangan alat pemancar. © Geoffrey Gearheart

Turtle MONA
Mona left the nesting rookery 3 days after she was tagged and traveled during 50 days from Piai to her resident feeding ground in Kumai Bay (off Tanjung Puting National Park), S-W Kalimantan. She covered 5079 km at an average speed of 4.0- 5.0 kph. Mona also made a 6 day "stop" in the waters off Buton Island, renowned for its blast- and cyanide fishers as well as turtle poachers. She has stayed in Kumai Bay for over 70 days. Mona's efficient migration route -barring the "loop" made off Buton- highlights the species' navigational abilities. She stopped transmitting on Feb. 10th, 148 days after leaving the beach where she was tagged.

Turtle KADEK
Kadek apparently hadn't finished nesting when she was tagged and stayed around the islands for 39 days before heading due South. On Dec. 9th, after traveling 22 days, it reached its final destination: a shallow reef area off Aru's S-E Coast, between the Islands of Workai and Trangan. She made frequent localized trips (<40 km), until Jan. 12th, 2006, date of her last transmission. Kadek covered the 2083 km of her post-nesting migration at the approximate speed of 4 kph.

Discussion

This study has enabled to identify the –divergent- migratory pathways and resident foraging areas of 4 of the satellite-tagged turtles.

Tracking data suggests swimming speed is proportional to distance traveled. This point needs further investigation.

The study confirmed urgency of protecting Raja Ampat's turtles from poachers. The use of a warning card on the PTT didn't dissuade poachers from killing one of the satellite tagged turtles.

On the "Birdshead" scale, the important information comes from turtle Liza. In an upcoming expedition, Liza's feeding ground in N-Waigeo will be visited and surveyed. If important, the area should be included in future conservation plans. In the longer term, all the identified foraging areas should be visited and surveyed.

This project had an unexpectedly strong effect on local communities: for many it was the first time sea-turtles were valued for anything else but their meat and eggs. Many fishermen were deeply impressed turtles can travel to such faraway places –and faithfully come back to Raja Amapat and Piai and Sayang islands.

A threat the turtle population is facing around Piai Island: Turtle Lida, Mona and Ornella stretched out on a beach to be slaughthered on a hunting ritual of Ayau Island. © Geoffrey Gearheart

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FACTSHEET

Sea Surface Temperature Monitoring

Introduction

Sea surface temperature is one of the most important physical factors influencing the growth, health, and distribution of marine organisms in the Bird's Head Seascape. Many reef organisms are adapted to the normal temperature ranges on the reefs where they occur, and if the water temperature becomes much cooler or hotter than normal, they may become unhealthy or even die. Especially with organisms like corals that cannot move to warmer or cooler waters like fishes, large temperature changes can cause widespread bleaching and death.

With the onset of global climate change, reef organisms are increasingly subject to more extreme temperatures, often much warmer ones than they can tolerate. Many reefs around Indonesia and the world have experienced severe bleaching and degradation due to unusually warm waters, and these degraded reefs are much less productive for fisheries.

However, scientists have noticed that some reefs are more resilient to coral bleaching than others and recover much more quickly; these reefs are often either subject to cold-water upwellings from nearby deep water or are previously adapted to warmer temperatures due to their physical location in areas normally exposed to warm, still water.

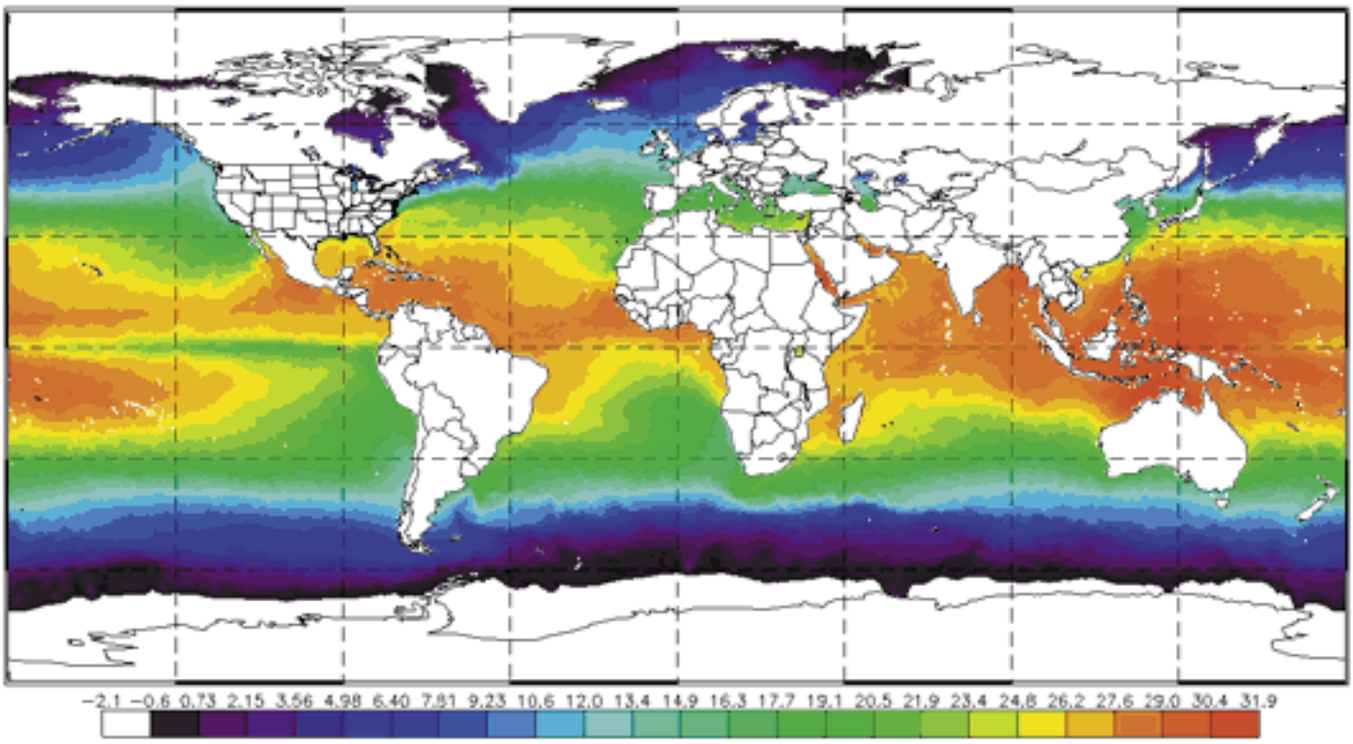
Most scientists now believe that we should specially protect these resilient reefs in MPAs in order that they can function as larval sources of corals, fish and other organisms for other less resilient reefs in the seascape that might suffer severe degradation from global warming and need larvae from these source reefs to ensure recovery.

Objective

The purpose of this study is to uncover sea surface temperature patterns from a wide variety of reef areas and oceanographic conditions throughout the Bird's Head Seascape. By doing this, we can identify important areas of cold-water upwellings (that are important for both fisheries and for identifying reefs that are resilient to global warming) and also areas which are normally subject to very warm waters and might have corals and fishes that are adapted to tolerate global warming.

Identifying these important areas will allow governments to better plan a network of MPAs that are resilient to global climate change and can thereby insure long-term sustainability of coral reefs and the fisheries and tourism that depend on them.

Monthly Mean Satellite - only Nighttime SST for November, 1998



Sea Surface Temperature Monitoring

Methods

This study will collect and analyze data from 60 miniature electronic temperature loggers that will be installed at a series of sites throughout the Bird's Head Seascape. Loggers will be installed at either 1, 3, or 20m depth and will record temperature every 30 minutes for a two year period. The sites that have been chosen were selected to represent a wide range of different oceanographic conditions, including reefs that are thought to be exposed to cold-water upwelling and those that are inside shallow enclosed bays that are routinely exposed to very warm water. Temperature data will be downloaded from these loggers every 6-12 months and used to produce maps of sea surface temperature variations across the seascape that will be shared with all primary partners in the Bird's Head.

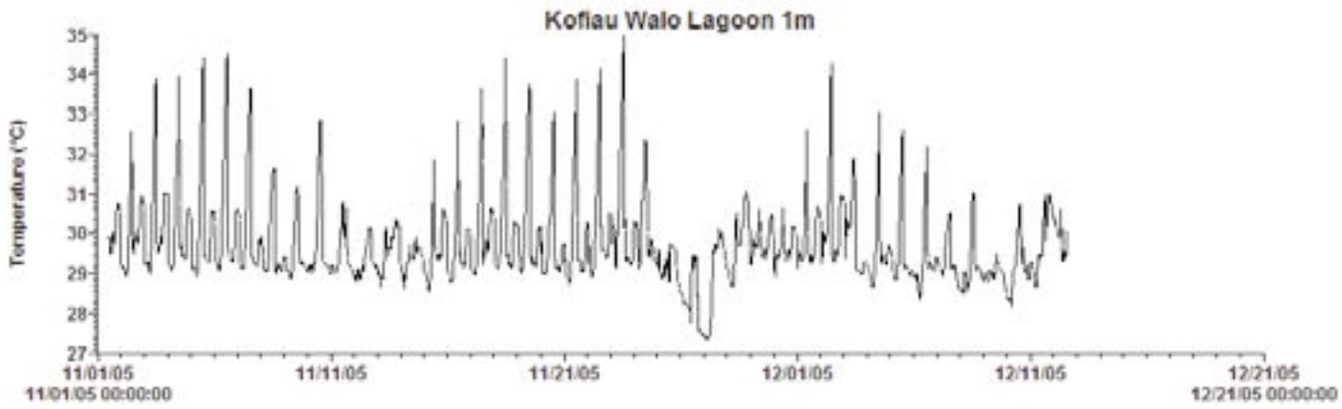
Preliminary Results

As of August 2006, all sixty temperature loggers have been installed, with 42 in Raja Ampat, 10 in Teluk Cenderawasih National Park, 4 in Biak, and 2 each in Manokwari and Jamursba Medi. Many of these loggers have been recording data now for over a year, while some were only recently installed. Data has already been downloaded from many of the Raja Ampat loggers and the Biak, Manokwari and Teluk Cenderawasih loggers.

Results from Raja Ampat show that there is a very wide range of temperatures commonly experienced by reefs in the area, with a maximum temperature recorded of 34.97°C (within the shallow lagoon of Kofiau's Walo Island) and a minimum of 22.06°C (at 40m depth at Cape Kri). This huge range in temperatures of nearly 13°C to which corals within Raja Ampat are regularly exposed and adapted to indicates that this area in general may have a high resilience to climate change. Further studies are planned to investigate this hypothesis. While the overall average temperature recorded in Raja Ampat was 29.10°C, the monitoring has revealed at least two areas subject to cold-water upwellings on a regular basis (Cape Kri at the mouth of the Dampier Strait and Salawati's Tanjung Yupleket at the mouth of the Sagewin Strait). Areas shown to be regularly exposed to high temperatures above 31°C include the lagoons at Walo (Kofiau) and Wayag, as well as Kri Island reef flat, Jefman Island and Tg. Yupleket. This data will be invaluable in the design of a network of MPAs in Raja Ampat that is designed to be maximally resilient to climate change.

By comparison, the initial data from Teluk Cenderawasih, Manokwari and Biak show that these reefs are exposed to a more narrow range of temperature, with a maximum temperature of 31.22°C (at Yop Island near Wondama) and a minimum of 27.58 at Biak's Owi Island. The overall average temperature in this region was slightly higher than Raja Ampat at 29.48°C.

Data will continue to be downloaded every 6-12 months and this data will eventually be presented using temperature maps of the BHS region to aid in management decisions.



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Monitoring of Reef Fish Spawning Aggregation Sites

FACTSHEET

What are reef fish spawning aggregations?

A reef fish spawning aggregation is a grouping of a single species of reef fish that has gathered in greater densities than normal for spawning. Examples of fishes that form spawning aggregations are certain species of grouper, snapper, surgeonfish, rabbitfish, parrotfish and wrasse. Aggregations vary widely between reef fish species. Some species, such as Napoleon wrasse *Cheilinus undulatus*, form only small aggregations of few individuals, whereas other species form aggregations that number hundreds or thousands of fish. Some species migrate hundreds of kilometers to reach an aggregation site, whereas aggregation sites for other species may only be a short distance from their home reef.

Large aggregations usually form during part of the year, whereas small aggregations may form every month. Often, aggregations form just before full moon or new moon. Spawning usually takes place during one or two nights, after which the aggregation rapidly dissolves. Various fish species may use the same site on a reef to aggregate for spawning. An example from the Asia-Pacific of a species assemblage that often aggregate at the same site, during the same season, and during the same moon phase, are the commercially important squaretail coraltrout *Plectropomus areolatus*, tiger grouper *Epinephelus fuscoguttatus*, and camouflage grouper *E. polyphekadion*. Reef fishers often know where and when these species aggregate.

Why are reef fish spawning aggregations important?

Spawning aggregations are important because they are essential for the survival of aggregating species. Commercial or subsistence fisheries on aggregating species can only exist if there are aggregation sites where these fish can spawn. Spawning aggregations of commercial species are extremely vulnerable to over-fishing, because fishers can predict when and where fish aggregate for spawning. A spawning aggregation concentrates a large part of the fish population in time and space, and thus fish become readily accessible to the fishery. With the development of a strong domestic and foreign market for aggregating species (notably groupers and Napoleon wrasse), the catch from spawning aggregation sites far exceeds what nature can produce. As a result, populations of many aggregating species have dwindled, and fisheries that depend on these populations can no longer sustain local livelihoods. For this reason, spawning aggregations need protective management.

Why monitoring reef fish spawning aggregations?

For generations, traditional communities throughout the Asia-Pacific have implemented protective management for spawning aggregations. However, traditional management systems have become less effective with population growth, increasing socio¬political dynamics, and increasing domestic and foreign demand for reef fish.

Figure 1. The floater vial of which 1000 pieces were released at the SPAG site in Gebe Besar Island, Kofiau.

Modern protected area management systems, which comprise government agencies as well as representatives of local communities, may help to protect spawning aggregations for the benefit of present and future generations. Such systems, however, require accurate knowledge on the location and status of spawning aggregations. Fortunately, methodologies have been developed to monitor spawning aggregation sites, and results from monitoring programs can be used to support management.

Monitoring of spawning aggregation sites in Gebe Besar Island, Kofiau

A training workshop for SPAGS monitoring was conducted in Kofiau during the week of December 7-20, 2005. This workshop involved the TNC and CI monitoring teams, local partners from the Raja Ampat Fisheries Office, local villagers, community organizers, as well as the natural resources management office (BKSDA). The workshop resulted in a protocol that is used for SPAGS monitoring in Raja Ampat. After the training workshop, the TNC CTC monitoring team conducted the SPAGS monitoring with SCUBA in Gebe Island Kofiau during the full moon period in December 2005.

In addition to SPAGS monitoring, 1000 floating vials were distributed on a SPAG at Gebe Island at full moon in March 2006. Through a reward system for fishers who bring back one or more vials, the team was able to study how eggs and larvae disperse through Raja Ampat

Preliminary Results

The first assessment of the SPAG site at Gebe Island suggests that the number of aggregating fish has plummeted to a very low level due to over-fishing. It is unlikely that coral trout and grouper still form large aggregations at Gebe, and this site will need at least 5 – 10 years of full protection to recover.

Monitoring of Reef Fish Spawning Aggregation Sites

Figure 2. Estimated tracks of floater vials released from the SPAG site in Gebe Besar Island, Kofiau.

1000 floater vials for the planktonic stage dispersal study were released on the full moon period at 6-7 PM on the week of March 15th 2006 located in Gebe Besar Island near Kofiau. On March 20th, five days after the release, 30 vials were found by fishermen. These vials were washed ashore approximately 40 miles to the SE on North Misool. More vials were later recovered from scattered areas all over Raja Ampat during the period of April – June 2006, and in total 286 vials were recovered.

Most were recovered from the Southern Raja Ampat region: from North and South Misool only, 254 vials were reported. Some vials were also found to the north of the SPAG – including 1 vial from Reni Island (District of Ayau) to the North of Waigeo Island, 2 vials from the West of Waigeo Island, 10 vials from the South of Waigeo Island, 13 vials from the Sagawin Strait between Batanta Island and Salawati Island, and 5 additional vials from Kofiau. These findings show the complexity of current patterns in Raja Ampat, which suggests good potential for larval dispersal throughout the area. In total, 40 fishermen from all around Raja Ampat have been rewarded for collecting these vials. As more vials will be collected by the fishers, we will get a better idea of the dispersal of eggs and larvae from this SPAG site.

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Tabel 1. Vials distribution in Raja Ampat region

DISTRICT	RECOVERED SITE	AMOUNT
MISOOL	We ijim	247
	Adowey	1
	Satukurano	7
		255
AYAU	Reni	**1**
SAMAT E	Kaliam	1
	Batanta	2
	Solol	3
	Yen anas	1
	Arevi	6
		13
SOUTH WAIGEO	Kabui	8
	Sawingr ai	2
		10
WEST WAIGEO	Fam	**2**
KOF IAU	Diba lal	3
	Deer	2
		5
Total		**286**

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FACTSHEET

Marine Resource Utilization Surveys

The Need for Understanding Patterns in Resource Use

Ecosystem-based management (EBM) is a management regime that takes into account interactions among the living organisms, the physical and biotic environment, and the human actors in an ecosystem. The Bird's Head research program aims to provide the scientific basis for EBM by constructing a holistic simulation model of the coastal and marine ecosystems in the Bird's Head Seascape. With this model, consequences of management interventions on all major components of the ecosystem can be simulated. A quantitative understanding of the effects of fishery and other resource uses on fish populations and habitats is essential for the construction of this model.

Whereas information on some aspects of resource utilization can be obtained by village surveys and through fishery statistics, a more comprehensive description of marine resource utilization patterns in the area can only be obtained through direct observations on the fishery in the field. A study of who is doing what, where, when and how, combined with direct observations on catch quantity and composition is analogous to a study of the feeding behavior of apex predators. As such, the information obtained during this survey can directly be used to inform the holistic ecological model of the Bird's Head Functional Seascape.

One of the challenges for this survey is the large size of study area: ca. five million ha. Obviously, it would be very expensive to do observations from a speed boat, whereas surveying from a more fuel-efficient vessel would be too time-consuming. Therefore, part of this survey may have to be done from a small airplane, where observers take notes on fishing operations while flying at low altitude and low speed over the area-of-interest

Management Implications

Besides informing the ecosystem simulation model, results from this survey will also be used as input for the design of a network of protected areas. This network will preserve the Seascape's unique biodiversity and it will sustain fisheries for present and future generations.

Figure 1. An aerial survey to map out fisheries distribution over Raja Ampat.

Survey Methods

A team has conducted this research through a frame survey, which aims to determine how fishing effort is distributed throughout the Seascape, in combination with a catch assessment survey, which describes catch composition and volume as well as which gears are used. The catch assessment survey will be based on a sample of fishing operations encountered in the field. These surveys will be repeated at least four times to cover different phases of the lunar cycle and take account of the two primary monsoon seasons in the area (both of which factors have a strong temporal impact on resource utilization patterns). In addition to the vessel-based-survey, a first round of the aerial survey was conducted to map out the spatial distribution of fisheries activities in Raja Ampat.

Preliminary Results

TNC, CI and the Raja Ampat Fisheries Office conducted 5 days aerial surveys of fisheries, coastal habitats and large marine fauna in the Raja Ampat Islands from January 9 – 13, 2006. Using a Pilatus Porter aircraft, the survey team completed a flight path of 2,200 nm (4,070 km) in 10 trips of 3 hours each (Figure 1). The team recorded ca. 1000 features, and took ca. 3500 pictures and 5 hours of video. Furthermore, the survey team mapped coastal habitats such as reefs, mangroves, seagrass beds, and estuaries, and the team discovered 5 "marine lakes" which will soon be explored. Fishing vessels, even small canoes, were easily spotted from the plane.

Fishing was concentrated in the central part of the Dampier Strait and Southeast Misool, but overall fishing intensity appeared low compared to other areas

Marine Resource Utilization Surveys

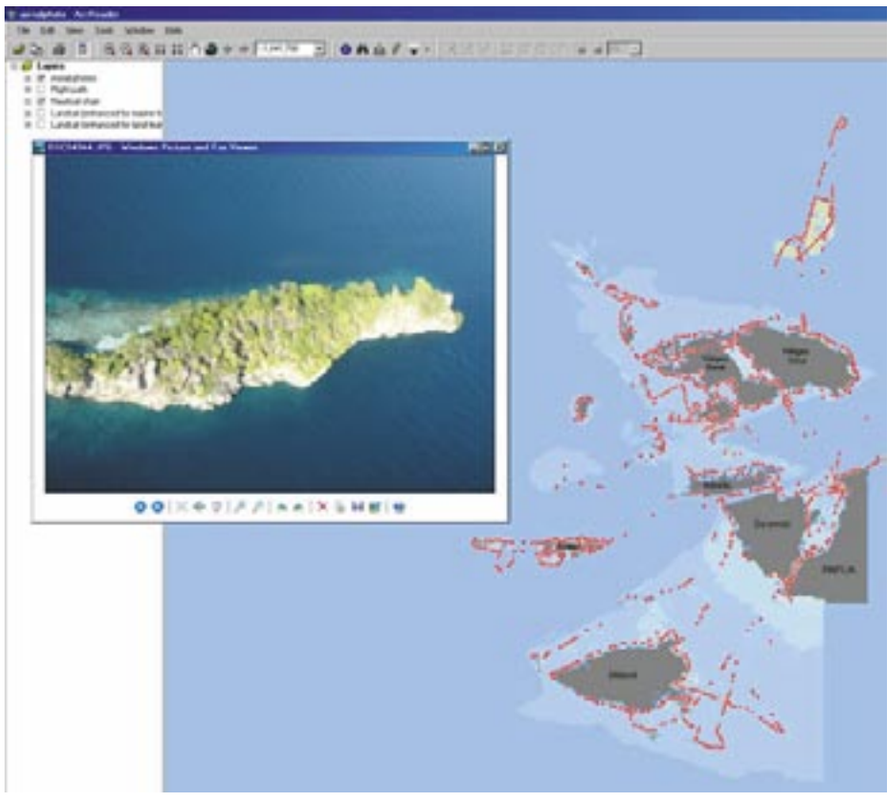

Figure 2. Iinteractive map on DVD, based on results from the aerial survey.

Reef resources utilization by the local community.

ECOSYSTEM BASED MANAGEMENT

BIRD'S HEAD SEASCAPE, PAPUA

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in Indonesia. The low number of fishers observed is seemingly a result of the very low human population density in Raja Ampat, and it appeared that coastal communities were fishing only part-time. In addition to fishing, local coastal communities practice farming as well, and the team observed significant farming activity. The team also noted that in some areas, the seas appeared too rough for fishing. Encouragingly, the team did not observe blast fishing, and only one hookah compressor operation was encountered. The team also spotted whales, hundreds of dolphins, dugongs and manta rays (including one aggregation of at least 50 individuals).

An interactive map that contains all pictures made during this survey was developed (Figure 2). The map will help with ground-truthing of remote sensing data, and the map presents a comprehensive overview of coastal and marine habitats in Raja Ampat. In addition to the aerial survey, the monitoring team carried out resource use monitoring in Kofiau area using a protocol that was developed in a monitoring workshop, held in December 2005. The team found that the illegal fishing practices are still common around in Kofiau. This survey is still continuing.

Historical Ecology of the Bird's Head Seascape

FACTSHEET

Introduction

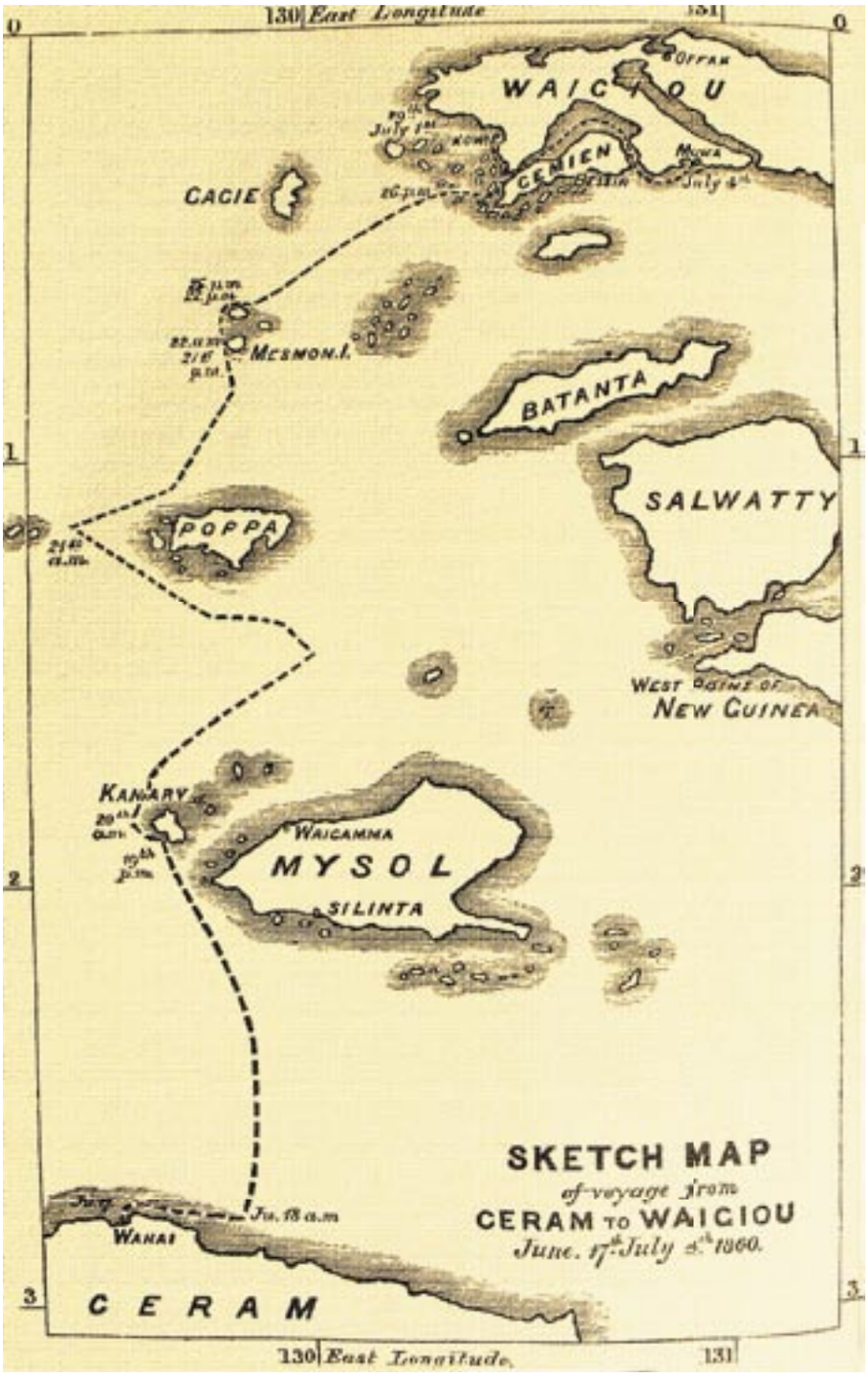
Over the past decade, scientists and resource managers have realized the dangers of the 'shifting baseline' phenomenon, whereby our perspective of 'what is natural and pristine' is blurred by the increasing overexploitation of reefs over the last half-century. We have 'forgotten' what a truly healthy reef or fish stock looks like; a reef that today seems healthy and dense with fish may actually be only a vestige of its former self.

A 'good catch' for a fisherman using a motorized dugout canoe today might actually be tiny compared to what a fisher used to be able to catch twenty years ago by simply fishing from the beach with a bow and an arrow. Accounts from the late 1700s and early 1800's which mention seas swarming with big fish and beaches packed with turtles are nowadays hard to believe, though we are coming to understand that this really was the way that reefs naturally existed – but sadly we have greatly reduced the numbers of most large marine life over the past 100 years.

In order to set appropriate management targets for maintenance and restoration of fish stocks and ecosystem integrity in the Bird's Head Seascape, it is imperative to reconstruct, as best we can, what these fish stocks and ecosystems looked like in their state before the onset of commercial fishing and logging.

Fortunately, the Maluku region and parts of the Bird's Head Seascape was visited by at least five major naturalist expeditions in the early to mid 1800s, including the French ships the Uranie (1818-1819), the Coquille (1823), and the Astrolabe (1826), the British ships the HMS Samarang (1843, 1846), the HMS Challenger (1874-1875).

Naturalists individually conducting research on marine life in the area included the Dutch ichthyologist Peter Bleeker's comprehensive studies on Indonesia's fish fauna throughout the 1860's, and the Briton Alfred Russel Wallace, whose travels within the Malay Archipelago in the



Historical Ecology of the Bird's Head Seascape

early 1860s introduced us to the concept of the center of biodiversity. At the turn of the century, the area was again visited by the Siboga expedition (1899-1900) and later by the Snellius expedition (1929-1930).

Additionally, there is a wealth of information collected by Dutch colonial administrators (recording volumes of fisheries products landed and traded, etc) and the Allied Forces during WWII, all of which can be mined for information on the original state of the fish stocks and reefs in the Bird's Head Seascape.

Objective

The main objective of this study is to reconstruct, to the extent possible, a broad picture of the status of the living marine and coastal resources of the Bird's Head Seascape prior to the onset of commercial fishing and logging demonstrating how the perception of population size changed over time.

Another objective is to show how the impact of human extractive activities has changed over time, by looking at the perceived human population and their perceived impact on the ecosystem. This data will be used to create management targets for fish biomass and other stock densities, as well as overall ecosystem condition (i.e,, establish the 'historical baseline conditions' which resource managers will strive to return Bird's Head marine ecosystems to).

Methods

Researchers from the University of British Columbia in Canada collected data from the various reports of the early European expeditions mentioned above (many of which are in various museums around Europe) and also combed through local archives in Papua to extract any useful data on the status of marine resources in the Bird's Head during the period of 50-200 years ago. This data was compiled into a comprehensive report and used to provide target inputs to the overall synthesis ecosystem model being prepared for the EBM project. The final report and collated data will be made available to all stakeholders from the Bird's Head.

Results

More than 500 documents on the study area were identified and located in various museums in the Netherlands, the UK (documents obtained by Dr J.J. Heymans), in France (documents obtained by Dr M.L.D. Palomares) and at the University of British Columbia library (Vancouver, Canada). Some of these were available in electronic format and some were photocopied. Not all the documents were available for consultation or were 'off limits', notably those in special and rare book collections. Most of the electronic versions of these older documents are bound by copyright to the holding libraries. Of these 500 documents, 350 were obtained, more than 250 were processed (25,000 pages scanned) of which only 50% (in 900 pages of text or 4% of the total number of pages scanned) contained abundance observations and observations on the impact of the human population on the ecosystem within the geographic bounding box established at 2° North and 2° South between 127-132° East (see Figure 1).

In general, these observations suggest: 1) a decline, by about 50%, of the perceived occurrences of turtles, fish and invertebrates; 2) a general decline in the perception that turtles, fish and marine plants were abundant; 3) a sharp increase in the perception of populousness in coastal kampungs; 4) a sharp decrease in the perception that marine resources are fished only for subsistence; 5) a decrease in the perception that marine resources are fished extensively; and 6) a slow increase in the perception that marine resources are fished for commercial purposes at medium and low levels of activity. These results corroborate those of qualitative data from independent sources of time series trends of catches of fresh fish, dried and salted fish, and shrimp as well as time series trends of exports of fish products, e.g., teripang, terasi, turtle shells, mollusk shells, crocodile skin, shark fins and jellyfishes.

Conclusions and Recommendations

Electronic versions of the older documentation, though available, are bounded by copyright to the holding libraries. There is a need to make this documentation widely available through, e.g., the Historic Expeditions and Scientific Surveys website of the Sea Around Us Project (www.seaaroundus.org). A recommendation is thus needed in order to get copyright waiver for this database and website.

There are indications of continuing commercial extraction of invertebrates, e.g., mollusk shells and tripang, in spite of signs of overexploitation. However, recent fishery expansion studies sug-gest that subsistence fisheries can be supported by the current fish, shellfish and echinoderm stocks. Commercial, e.g., trawl, fisheries seem to be a generally unprofitable enterprise.

The un-profitability of commercial fisheries might be a blessing in disguise for the Kepulauan Rajaampat ecosystem. As the larger species of fish, crustaceans, mollusks and echinoderms, though consid-erably reduced in abundance, have not been extirpated, discouraging commercial trawling in a largely shallow water zone would be beneficial to what is still left of this ecosystem. Thus, em-phasis must be placed on the proper management of subsistence and small-scale fisheries.

ECOSYSTEM BASED MANAGEMENT

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ECOSYSTEM BASED MANAGEMENT

BIRD'S HEAD SEASCAPE, PAPUA

FACTSHEET

Monitoring of Knowledge, Attitudes and Practices Among Resource Users and Policy Makers in the Bird's Head Seascape

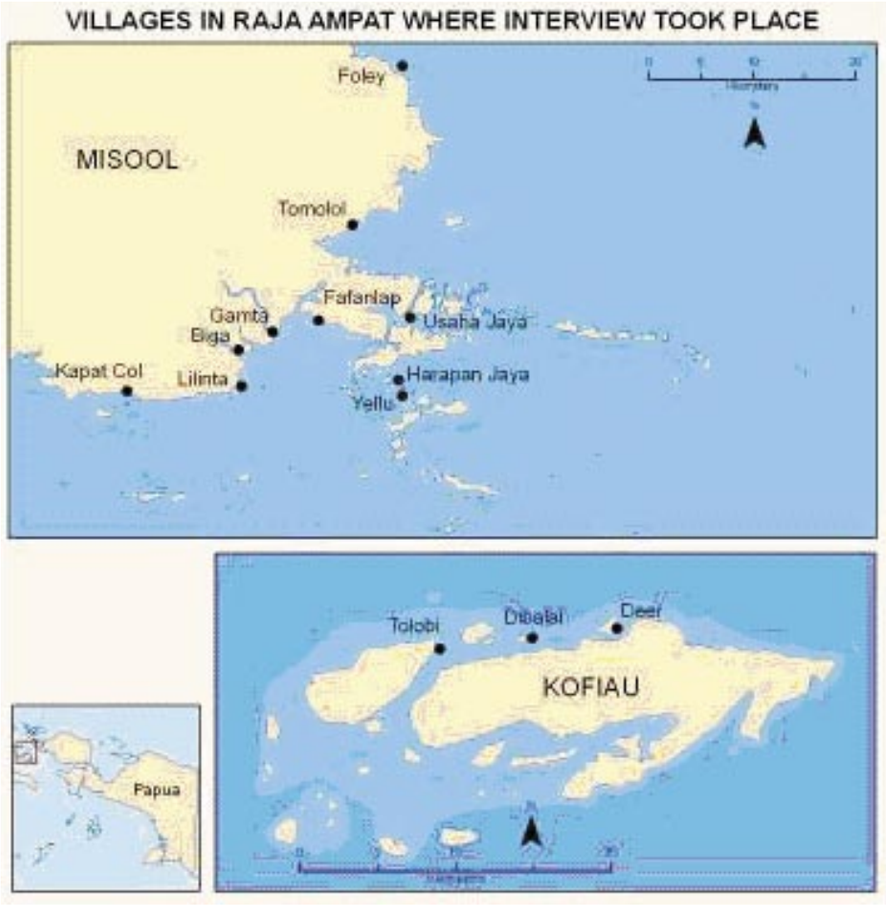

Figure 1: Villages at Raja Ampat district where interviews took place

Measuring knowledge, attitudes and practices (KAP)

Resource users, especially fishers, are an integral part of the Bird's Head Seascape, and their practices co-determine ecosystem dynamics. As their practices are influenced by their knowledge and attitudes, achieving change of behavior through management interventions requires an assessment of these three attributes. At the other end of the stakeholder spectrum are local policymakers and officials, who co-determine behavior of resource users by through design and enforcement of new regulations. Therefore, it is important to also measure their knowledge, attitudes and practices (KAP) on marine resource use and marine conservation. Ultimately, KAP assessments will not only inform ecosystem-based management, they will also measure the effectiveness of on-going awareness programs.

Objectives of KAP monitoring

KAP monitoring will allow managers to become better acquainted with knowledge attitudes, perceptions and practices in the communities residing in and interacting with protected areas. This monitoring program will: a) produce qualitative and quantitative data portraying the community's knowledge, attitudes and practices concerning the environment in general, and concerning (planned) protected areas where they live; b) identify cultural and socioeconomic factors that may either obstruct or facilitate the adoption of more environmentally responsible practices; c) become a source of information to ascertain the types of management interventions that are more likely to have a noticeable impact on people's attitudes and practices. This program will also provide baseline information to monitor trends in the communities' perceptions on management effectiveness and the state of natural resources for the duration of the program intervention.

Methods

The first round of KAP monitoring was conducted through village surveys that focus on the Raja Ampat regency. A total of 120 villages have been surveyed by field staff, supported by TNC CTC Bali and experts from Johns Hopkins University. It is likely that knowledge, attitudes and practices will change over time as Conservation International, The Nature Conservancy and WWF Indonesia are expanding their awareness programs. Therefore, local KAP will be measured at least once a year.

Preliminary Results

It appears that the majority of respondents (53%) in Raja Ampat were uncertain regarding Marine Protected Areas. This percentage is much higher than at other sites where a similar survey was conducted. It is imperative that the awareness teams intensify their programs to turn this large group of individuals who are uncertain into supporters of MPA development projects.

Overall, respondents show a positive correlation between awareness of, and compliance with regulations. Furthermore, the distance of management authorities (national ¬park ¬local/traditional) from the users themselves seems to be negatively correlated with their awareness of these regulations. Hence, especially national

Monitoring of Knowledge, Attitudes and Practices Among Resource Users and Policy Makers in the Bird's Head Seascape

management authorities must put more effort towards awareness programs in order to bring the management regime closer to the people.

In Raja Ampat, a relatively high percentage of respondents perceived the condition of coral reefs and mangroves around their villages as good. Blast fishing and cyanide fishing are regarded as the major coastal and marine environmental threats, whereas over-fishing is not perceived as a major problem. Considering that SPAG sites in Raja Ampat have already been fished out, conservation program must enhance awareness on the problem of over-fishing, whereas the already high level of awareness on blast fishing and cyanide fishing suggests that it is now time to actively abate this threat through enhanced enforcement in consultation with local communities and enforcement agencies.

Most respondents perceived villagers and fishers themselves as responsible for creating major coastal and marine environmental problems, and most respondents in Raja Ampat believe that the head of the village or an enforcement agency should solve these environmental problems.

Regarding individual and household occupations, the majority of respondents in Raja Ampat are farmers. These farmers also practice fishing, but they did not regard this as their principal occupation. They predominantly fish to fulfill their daily consumption needs or to sell at a local market.

The majority of communities living in Raja Ampat use radio rather than television as their source of information and entertainment. Therefore conservation messages are best communicated through radio.

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Figure 2: Blast fishing perceived as the main problem to the coastal and marine environment in Raja Ampat. © WWF-Indonesia / Geoffrey MCKELL

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ECOSYSTEM BASED MANAGEMENT

BIRD'S HEAD SEASCAPE, PAPUA

FACTSHEET

Institutional Mapping and Assessment of Marine Tenure Systems in the Bird's Head

Introduction

An ecosystem-based management approach, by its nature, requires broad involvement of all primary stakeholders in the region that play a part in or are affected by natural resources management policies. Moreover, ecosystem-based management requires a decision-making framework that takes into account both the formal and informal institutions that play a role in determining natural resources management policies and/or influence stakeholder decisions in their resource utilization patterns. Such institutions may range from the local fisheries or forestry department to the Camat, the Dewan Adat, religious figures or even influential families in a particular village – all of which play an important role in setting regulations and practices governing resource use. In some cases, it is common that national or even international institutions or organizations play a role – a powerful Malaysian logging company, for example, may be extremely influential in setting local forest use policy!

In Papua, it is also imperative to understand the nature and role of traditional tenure systems (hak ulayat), which may often be more important in the daily lives of local villagers than kabupaten, provincial or national laws governing resource use. The extremely important role of these traditional tenure systems should fit in very well with an ecosystem-based management approach, but it is necessary to better understand and eventually map these tenure claims in order to ensure that they are accommodated in any broader management scheme.

These two related activities – institutional mapping and assessment of traditional tenure systems – will provide data that is essential in transitioning towards ecosystem-based management – as EBM does not require any new institutions for implementation, but rather relies on implementation through the formal and informal institutions that currently play a role in setting natural resource use policy and practice.

Fishermen and children of Gam Island, Raja Ampat. © Jennifer Jeffers

Objective

The objective of this study is to first conduct an institutional mapping exercise to thoroughly understand the local context and primary institutions (from the village up to the provincial, national, and even international level) that act as either formal decision-makers or influential actors in marine and coastal management in the Bird's Head Seascape. At an even more detailed level, this study will focus in on understanding and possibly mapping the traditional marine and coastal tenure systems that currently exist in select areas of the Bird's Head.

Methods

A participatory rural appraisal has been conducted by CI's field officers through out 55 Raja Ampat coastal villages. This study has involved local community members to conduct the institutional mapping and design a culturally-sensitive assessment of traditional marine and coastal tenure. Because the tenure assessment will be very labor-intensive, it will focus first on the villages in Kabupaten Raja Ampat. The results of this study will be invaluable for designing the most effective ecosystem-based management framework for the Bird's Head.

Preliminary Results

Though the results of the institutional mapping study are not yet available, a large amount of data on marine tenure in Raja Ampat have been collected, summarized below:

Currently, the people of Raja Ampat consist largely of two primary groupings: the "original" inhabitants (consisting of the Maya tribe in northern Raja Ampat

Institutional Mapping and Assessment of Marine Tenure Systems in the Bird's Head

and the Kalanafat tribe in southern Raja Ampat) and immigrants from either Biak or the Malukus (Tidore, Ternate and Seram) – many of whom arrived over a century ago for various reasons, including the "Hongi War" against the Dutch East Indies Company. Despite the existence of these two groupings, the current inhabitants of Raja Ampat have a strong traditional bond as reflected in their beliefs, culture, shared history, as well as their vision for their future. The Raja Ampat people have two major religions, Christian and Moslem, and their livelihoods are predominantly derived from fishing and farming.

The original inhabitants of Raja Ampat generally have basic ownership rights for the land, forest, sea and all natural resources in Raja Ampat, though it is important to note that they also tend to have smaller community groups than later immigrants and predominantly occupy villages only on the four largest islands of Raja Ampat (Waigeo, Bantanta, Salawati, and Misool Islands). By contrast, the immigrants from Biak are now distributed across the smaller islands to the north and south (including Ayau, North and East Waigeo, Batanta and Kofiau), and the Malukan immigrants are now largely based in Saonek, Salawati and Misool.

Importantly, although the original community has primary rights to Raja Ampat's resources, in practice the immigrants have over time gained both user rights and even ownership rights through historical relationships, inter-marriage and explicit agreements made between the groups. Unfortunately, in practice it is often difficult to distinguish between user and ownership rights, and in recent times this distinction has become even more blurred as the history of various agreements has been forgotten or lost as generations pass.

In everyday village life, the issue of user or ownership rights is generally not a problem or point of debate. However, conflicts over tenure rights in general tend to be initiated by the arrival of either private investors or government development projects. Under these conditions, discussions/negotiations occur between the family groups ("keret") that claim collective traditional ownership rights. Though these groups are often represented by individual spokespeople in discussions, any decisions on ownership must come from the collective family group.

Our research has also shown that in general, ownership and user rights (tenure) are more clearly defined for land-based resources, where boundaries between claims are generally defined by landmarks such as mountains, capes, rock, and trees. Although there are also some boundaries that are applied to marine areas (eg, land claims that extend to lowest tidal margin or out to the reef drop-off), in general the sea is viewed as a commons area where people can mutually seek subsistence from marine resources. In other words, marine tenure is not (yet) a well-developed concept in Raja Ampat, although it has increasingly been claimed by inhabitants as commercial use of marine resources (either for fishing, tourism, or pearl farming) has increased. In many ways, this poses both a challenge and an opportunity to developing a management plan for Raja Ampat's marine resources, and it will be important to carefully navigate these issues as we move towards integrated management of the Bird's Head Seascape.

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ECOSYSTEM BASED MANAGEMENT

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ECOSYSTEM BASED MANAGEMENT

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FACTSHEET

Economic Valuation of Natural Resources in Raja Ampat Islands

Introduction

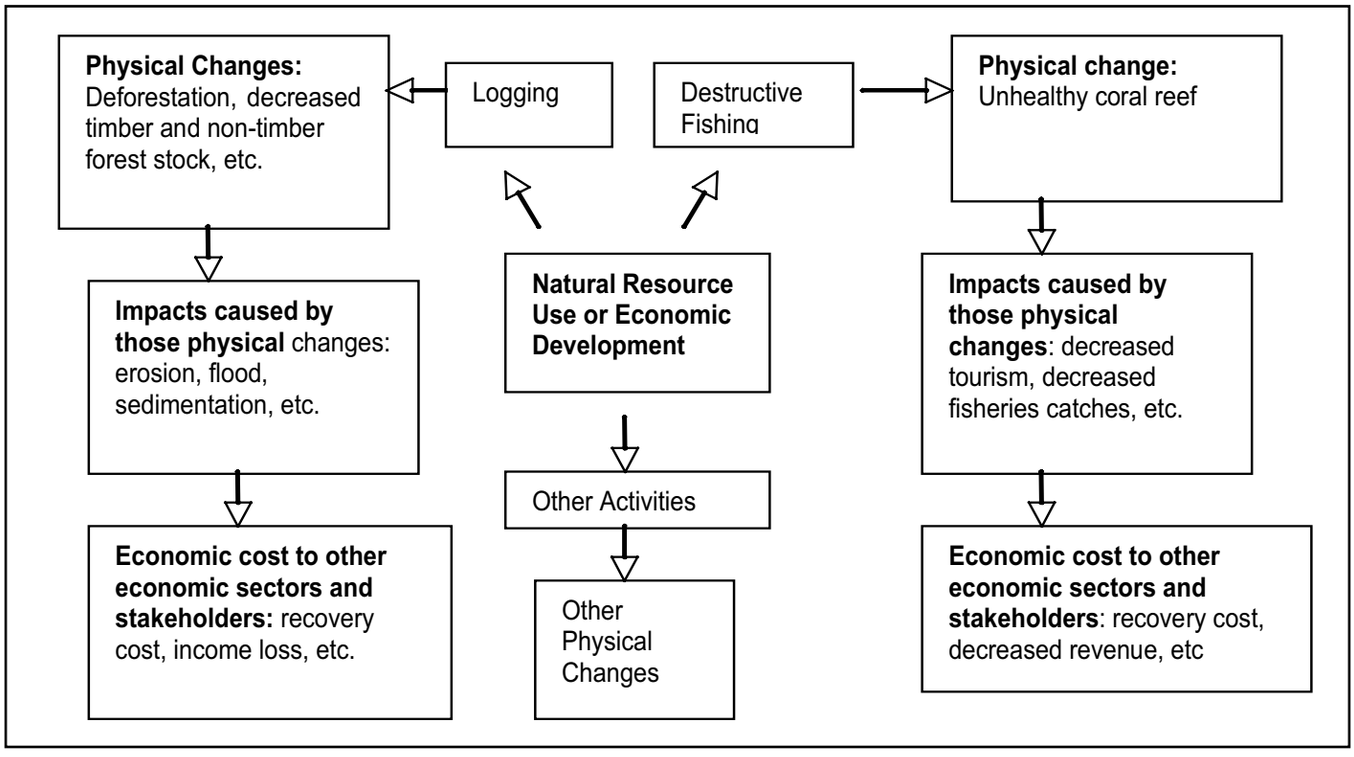
Throughout the world, local governments often make important and far-reaching policy decisions based upon incomplete economic data that strongly favors short-term gains from exploitation of natural resources. Raja Ampat Islands Regency is certainly no exception; many of the economic development plans currently being considered are heavily focused on exploitation of natural resources through forestry, mining, commercial fishing, and oil and gas extraction.

Unfortunately, these decisions rarely are based upon a complete cost-benefit analysis that takes into account the "ecosystem services" that are lost or diminished after resource exploitation begins. One of the reasons is because ecosystem services have failed to show and offer tangible (and short term economic) benefits to local stakeholders while at the same time exploitation of natural resources have been perceived to generate direct benefits (in terms of direct revenue, employment, etc) to local stakeholders in the short term. Intangible benefits and non-marketed value of environmental services, high economic incentives of natural resources exploitation and the urgent needs for short term economic return from local stakeholder (government, local community, etc) have generated the rapid exploitation of natural resources.

Economic valuation seeks to include all costs and benefits in the analysis and determine the net benefits to society. The aim of economic valuation is to determine the true economic performance of competing and interacting development options and resource uses. This information will also be useful to analyze the economic costs of the impacts of different activities as measured by changes in productivity or earnings in the other activities to other stakeholders. For instance, though cutting down a forest can produce large revenues for villagers and government alike through sale of the timber, it is important to note that this forest will no longer provide the services it once did such as provision of rainwater for drinking, protection from erosion and landslides, and production of non-timber forest products like honey or fruits or nuts that may be very important to local villagers.

Objective

The objective of this study is to provide governmental decision-makers in Raja Ampat Islands with a much more complete understanding of the current economic values of the natural resources in their regency to be considered in land use and development decision making process. Specific objectives of this study are: 1) to assess the total economic value (TEV) of goods and services currently derived from the ecosystems of Raja Ampat Islands



Simulation of economic costs of impacts of different economic activities to other sector and stakeholders.

Economic Valuation of Natural Resources in Raja Ampat Islands

and their distribution among the different stakeholders that share the ecosystems; 2) to assess current or potential environmental impacts/damages that can impose significant cost to the region caused by one economic activity/sector to other sector; 3) to assess returns from conservation and management options with extended Cost Benefit Analysis and provide recommendations to the local decision makers. The result of this assessment can also assist in identifying which of these competing and interacting economic development activities (or possible new large scale investments in natural resource exploitation sectors) and land-uses produce the highest benefits for the Raja Ampat communities while avoiding or minimizing the need to destroy ecosystems and habitats critical to biodiversity.

Methods

This study has been conducted in the first year of the EBM initiative in order to quickly provide governmental decision-makers with the data they need to make more informed decisions on natural resource use policy. It will utilize current state-of-the-art natural resource valuation methods as well as intensive surveys and interviews with stakeholders at selected sites to gain a comprehensive understanding and estimate the economic value of the current natural resource uses (including fishery, forestry and other land based economic activities, mining and tourism) and environmental services (i.e. ecological functions) provided by ecosystems in Raja Ampat Islands. These data will be provided to governments throughout the seascape, and will also be used in the overall EBM synthesis model that tests best scenarios for sustainable development in the Bird's Head Seascape.

Preliminary Results

As of July 2006, CI's local counterpart - team from University of Papua (Unipa) in Manokwari- have prepared first draft reports on economic valuation of major natural resource sectors (fisheries, mining, forestry and other land based activities and tourism) and environmental services in the Raja Ampat Islands. The economic value natural resource use is generally analyzed from market-based data (i.e. fishing, mining, harvesting of forest products) or non-production use (i.e. tourist visitor numbers and expenditure).

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Meanwhile, economic values of ecosystem services have been focused on direct and indirect use of mangrove, sea grass and watershed ecosystems. The first round survey on willingness to pay (WTP) for environmental services provided by those specific ecosystems have been conducted in seven districts (West Waigeo, East Waigeo, North Waigeo, Ayau, Kofiau, Misool and Samate) in Raja Ampat Regency. Additional surveys have also been performed in Dampier Strait and Kabui Bay. Other goods and services for terrestrial and marine resources that are not computed in this study (e.g. climate change regulation, water regulation, biological control, nutrient cycling, etc) have also been obtained using benefit transfer approach.

The findings of these reports will be verified in technical focus group meetings that involved local experts and stakeholders. The purposes of these meetings are to fully utilize the data and knowledge of local experts and stakeholders and maximize the involvement of local stakeholders to develop and improve the resource valuation analyses. Based on the inputs from local stakeholders, the report will be refined and finalized by end of October 2006 and presented to policymakers at that time.

ECOSYSTEM BASED MANAGEMENT

BIRD'S HEAD SEASCAPE, PAPUA

FACTSHEET

Raja Ampat Sustainable Development Options Study

Introduction

A primary concern of each of the kabupaten governments in the Bird's Head Seascape is to plan the best course for sustainable economic development in their kabupaten – one which maximizes governmental revenues (PAD) while ensuring the long-term welfare of the local people living within their borders. Indeed, the primary objective of increasing governmental revenues is to enable local governments to provide more efficient and effective services for their constituents and generally improve the standard of living for their residents.

Unfortunately, many economic development decisions are made with a very strong focus on increasing local governmental revenues, without consideration of the much broader and more important goal of improving the welfare of the local people the government serves. For instance, governments may eagerly pursue the development of a mining concession in their area based upon projected revenues to be generated, without fully taking into account the broader impact on their constituents' livelihoods. If the development of such a mining concession provides not only government revenue but also significant local employment and other development benefits and has environmental safeguards to prevent contamination of drinking water supplies and fisheries, then it might be a very good development option for a local government. However, if the mine employs mostly outside labour and severely contaminates local drinking water supplies and destroys important fisheries, then it cannot be considered a truly sustainable development option. Government decision-makers must very carefully take into account the full impact of a particular development option on local people's livelihoods before enthusiastically approving it based only on large projected revenues.

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Objective

The primary objective of this study is to provide the Raja Ampat regency government with a full range of sustainable economic development options that explicitly take into account the economic, environmental, and social implications of each development option. The results of this study should prove invaluable to local decision-makers who are aiming to improve the welfare of their constituents, and will also be used in the overall synthesis model that is being developed to evaluate the most optimal ecosystem-based management framework for the Bird's Head Seascape.

Methods

This study will draw heavily from the results of the related study that is conducting a valuation of the natural resources and environmental services in the Bird's Head and assessing the degree to which local people currently rely on natural resources for their livelihoods. The study is led by Rashid Sumaila, and will use cutting edge modeling techniques to provide local governments with a range of development options that maximize the long-term welfare of the people living within the Bird's Head and the sustainable use of the rich coastal and marine resources included within the Seascape.

Raja Ampat Sustainable Development Options Study

Preliminary results and outcomes

The results and outcomes from this component of the project will be derived from 3 sub-headings:

Valuation and development options
This part of the study draws from the study on valuation of the natural resources and environmental services in Raja Ampat, and our two research teams have been collaborating closely. The economic valuation is now nearing completion, and the results of that study will be used to carry out analysis of development options for sustainable marine policies that maximize government revenue while ensuring the long term well-being of the people living within the Raja Ampat area.

Game theoretic analysis
A large-scale principal-agent analysis has now been designed and will be conducted for all of Raja Ampat, focusing on important regency-village relationships, such as those around Kabui Bay and the Dampier Strait and Kofiau. This study will allow the identification of the issues that policy makers need to focus on when they design sustainable marine ecosystem management policies that will help improve the welfare of the residents of the regency.

Ecosystem-economic modeling
With input from the ecosystem modeling team, this component of the work will incorporate the analysis of various management/policy scenarios into ecosystem-economic models of Raja Ampat. This will be used to explore various development options, and the models are planned for completion in mid-late 2007.

ECOSYSTEM BASED MANAGEMENT

BIRD'S HEAD SEASCAPE, PAPUA

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Ecosystem Based Management of the Bird's Head Seascape

A Joint Initiative of
Conservation International,
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ECOSYSTEM BASED MANAGEMENT

BIRD'S HEAD SEASCAPE, PAPUA

FACTSHEET

Constructing a Marine Ecosystem Model of Raja Ampat in Support of Ecosystem-Based Management

Ecosystem modeling and ecosystem-based management

Ecosystem-based management (EBM) takes into account the interactions among all of the living organisms, the physical and biotic environment, and the human actors in an ecosystem. The Bird's Head research program is developing holistic simulation models of the coastal and marine ecosystems in Raja Ampat to provide scientific support for EBM. One general model will cover the whole Regency, while others will focus in higher resolution on critical areas such the islands of Waigeo, Kofiau and Misool, and the Dampier Strait. The models can simulate the consequences of management interventions on the major fishery-related components of the ecosystem. Because their need to be fitted to as much local data as possible, ecosystem models also provide a helpful way to integrate knowledge about various components of the ecosystem. Modeling is a very explicit way to ensure that results from individual studies contribute to a better understanding of management options for the entire ecosystem, including the human component.

This 2-year study by a senior, a postdoctoral and a postgraduate scientist, draws upon results of a range of local Seascape surveys in the Bird's Head research program to develop spatially-explicit ecosystem models. The models are being used to elucidate the consequences of a range of management scenarios that address specified concerns about local fishery needs, biodiversity and conservation. The results of these simulations will be shared with Regency policymakers to obtain valuable feedback that will be used to draft a strategic management plan for the Seascape. This study is implemented by the University of British Columbia's Fisheries Centre, in close cooperation with Conservation International, The Nature Conservancy and WWF-Indonesia.

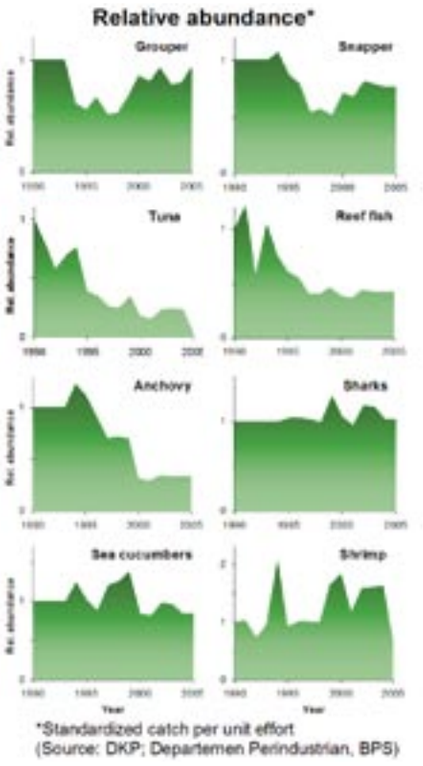
Modeling methodology

Whole-ecosystem modeling will be performed using the Ecopath-with-Ecosim (EwE) technique that simulates changes in biomass through interactions in the foodweb. This type of modeling, which has recently received wide support from researchers, is a compromise between the oceanographic and ecological realism of highly complex biogeochemical models and the practical need to quickly evaluate outcomes of management scenarios. EwE models can capture quite complex processes in ecology, but they are one of the few frameworks in which models can be progressively improved from simple, approximate forms to versions that better represent reality by tuning to highly-detailed local data on fish, invertebrates, corals, marine mammals, birds, reptiles and quantitative information about fisheries gear types and catches. The model also includes phytoplankton (small floating plants that generate the food and energy driving the ecosystem), small forage fish, euphausiids (shrimp-like crustaceans that live on plankton in the water column) and jellies: all of these small organisms drive important linkages across the ecosystem. Uncertainty about parameter values is being used explicitly to determine the credibility of model forecasts.

The operating costs, prices, profits and employment characteristics of the fisheries are being parameterized and used to build several scenarios by restricting fisheries access in the model to certain areas or to specific fishing targets. The model framework enables us to search for ecosystem-based management objectives under different scenarios that relate to the risk of local extinction, biodiversity change and socio-economic factors (profit or jobs), or a mixture of the above. The spatial version of EwE (Ecospace) is being linked to a new technique developed specially for this project; the new method zooms in on local areas and can be used to explore the costs and benefits of connected networks of managed MPAs. The estimation of risk from climate variation is also included in the work. This study is an opportunity to further test this cutting-edge methodology in a management context.

Large quantities of anchovy are caught by liftnets along the western coast of Waigeo. Anchovy are sun-dried and sold locally, or as bait for tuna boats. Little of this catch appears to be reported in the official fishery data and the project team is making estimates of quantities, markets by season. © Megan Bailey

Constructing a Marine Ecosystem Model of Raja Ampat in Support of Ecosystem-Based Management



Plots of trends in relative abundance of eight ecosystem model groups calculated from Indonesian Government fishery statistics in Sorong. Final trends used in model will likely look different to these because the values reflect ease of capture and may have to be adjusted for fish caught in spawning aggregations; they will also be adjusted for unreported catches. Trends are used to tune food web parameters of the simulation model over the fifteen years from 1990-2005.

Preliminary results

A preliminary ecosystem simulation model that contains over 90 explicit groups has been constructed using information from the literature, from databases and diet records, and from nearby tropical marine ecosystems. The model is about twice as complex as most published work using this method: the figures show a preliminary food web matrix for Raja Ampat and the relative abundance of number of target fish taken from Indonesian Government fisheries data. Some of this data has to be adjusted before it can be used: for example some fishery catches in Raja Ampat are unreported. For example, the photo shows a large fishery for anchovy in Waigeo that is unreported in official government data.

At present field sampling is taking place that will enrich the model structure and improve parameter values: as well as diet, much valuable information is being collected from interviews with scientists and fishers with long-standing experience in the region.

Implications for management, dissemination of results

Dealing in practical fashion with the perceptions of fishers and the flexibility and willingness of institutions to receive ecosystem–based advice will be essential to engender support from local constituencies for EBM regulations. Shaping the explored model scenarios and MPA designs to what is feasible in the Bird's Head Seascape is a critical task for the project. A final workshop to produce a draft strategic ecosystem-based management plan for the Seascape will be held to integrate inputs from scientists, local government agencies and local communities.

Simplified diagram of the preliminary food web used in the Raja Ampat ecosystem model: the coloured squares actually represent quantitative amounts. In the actual model these 39 groups are expanded to over 90 to include juvenile and growing stages. During the project, these food web linkages are being improved using local data gathered by the field teams.

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