ECOSYSTEM - BASED MANAGEMENT IN THE BIRD'S HEAD SEASCAPE INDONESIA

Translating the results of scientific studies into recommendations for marine resource management

ECOSYSTEM BASED MANAGEMENT

Conservation International Bird's Head Seascape · The Nature Conservancy, Protecting nature. Preserving life. · WWF

BIRD'S HEAD SEASCAPE, PAPUA

Photos, cover: Background of healthy coral reefs: © Burt Jones and Maurine Shimlock/Secret Sea Visions; Left to right sequence: Ayau island: © Crissy Huffard/CI, Sedimentation: © Burt Jones and Maurine Shimlock/Secret Sea Visions, Turtle: © Burt Jones and Maurine Shimlock/Secret Sea Visions, Catching sharks in the area of Sasi: Anonymous

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EXECUTIVE SUMMARY

Although West Papua is rich in natural resources, over 40% of people living there fall below the poverty line. Many local residents rely on coastal resources, particularly fisheries for income and food security. Although ecosystems here are relatively healthy compared to many other areas of Southeast Asia, they are no longer pristine and the fishery stocks of some areas are severely depleted. Furthermore, unsustainable exploitation of natural resources, poor development practices, and rapid human population growth threaten these ecosystems and the local communities who depend on them.

Given its high biodiversity, good habitat condition, presence of rare and threatened species, and importance to fisheries, the Bird's Head Seascape (BHS) is a regional, national, and global priority for marine conservation. The West Papua government agencies have developed a network of 12 Marine Protected Areas (MPA) protecting over 3.6 million hectares of islands and coastal waters. These MPAs include Cendrawasih Bay National Marine Park, Abun, 7 MPAs in Raja Ampat, and a large MPA in Kaimana.

Ecosystem-based management (EBM) aims to maintain healthy, productive, and resilient environments that provide humans with the ecosystem services they need today and in the future. To assist the governments of the BHS in adopting an EBM approach, three environmental non-governmental organizations (NGOs) [The Nature Conservancy (TNC), Conservation International (CI) Indonesia and World Wildlife Fund (WWF)-Indonesia] have worked with local partners since 2001 to help establish EBM and inform policy decisions related to:

MPA MANAGEMENT	MPA management for the BHS MPA network
FISHERIES MANAGEMENT	Fisheries management at Regency, Provincial and Regional scales
SPATIAL PLANNING	Spatial Planning for marine and coastal areas at Regency, Provincial and National Government levels
THREATENED SPECIES MANAGEMENT	Species management for endangered species such as turtles, dugongs, cetaceans, and whale sharks.

ECOSYSTEM-BASED MANAGEMENT STUDIES

The adoption of EBM in the BHS has been facilitated through the Ecosystem-Based Management Program, which supported 18 studies (2005-2010) by NGOs, academics, and government partners to provide managers of the BHS information about socio-economics, ecological conditions, oceanography, and governance. While many studies produced site-specific results, they also yielded recommendations that are relevant to the broader BHS. The key threats, inputs and management recommendations generated are listed for the following select studies, addressing specific management themes in color code.

1	HISTORICAL ECOLOGY OF THE BIRD'S HEAD SEASCAPE	FISHERIES MANAGEMENT, SPATIAL PLANNING
2	THE DISTRIBUTION, STATUS AND MANAGEMENT OF GROUPER SPAWNING AGGREGATIONS IN RAJA AMPAT	FISHERIES MANAGEMENT, MPA MANAGEMENT
3	SEA TURTLES MIGRATION, NESTING, AND FORAGING ECOLOGY	FISHERIES MANAGEMENT, MPA MANAGEMENT, SPATIAL PLANNING, THREATENED SPECIES MANAGEMENT
4	SEA SURFACE TEMPERATURE PATTERNSOF THE BHS	MPA MANAGEMENT
5	GENETIC CONNECTIVITY OF REEF ASSOCIATED ANIMALS IN THE BHS	FISHERIES MANAGEMENT, MPA MANAGEMENT, SPATIAL PLANNING, THREATENED SPECIES MANAGEMENT
6	CATCH PROFITABILITY OF THE LIFT-NET FISHERY IN RAJA AMPAT	FISHERIES MANAGEMENT, MPA MANAGEMENT
7	PATTERNS OF MARINE RESOURCE USE IN RAJA AMPAT	FISHERIES MANAGEMENT, MPA MANAGEMENT, SPATIAL PLANNING, THREATENED SPECIES MANAGEMENT
8	UNDERSTANDING COMPLEX ECOLOGICAL INTERACTIONS AMONG SPECIES AND THE STATUS OF FISHERIES SPECIES POPULATIONS	FISHERIES MANAGEMENT
9	DEVELOPING ZONING PLANS FOR THE NETWORK OF MPAS IN RAJA AMPAT – BALANCING COMMUNITY USE AND CONSERVATION	FISHERIES MANAGEMENT, MPA MANAGEMENT, SPATIAL PLANNING, THREATENED SPECIES MANAGEMENT
10	ECONOMIC VALUATION OF ECOSYSTEM SERVICES IN THE BIRD'S HEAD SEASCAPE	FISHERIES MANAGEMENT, MPA MANAGEMENT, SPATIAL PLANNING, THREATENED SPECIES MANAGEMENT
11	DEVELOPING A GOVERNANCE STRUCTURE FOR THE RAJA AMPAT MPA NETWORK	FISHERIES MANAGEMENT, MPA MANAGEMENT

COMMON PROBLEMS, POTENTIAL SOLUTIONS

Several large-scale threats are common to all MPAs in the BHS, and have the potential to quickly destroy livelihoods. Overfishing, destructive fishing practices, and coastal development have contributed to the decline in BHS fish communities and marine habitats. Prominent threats and potential impacts are listed in this report. In all of these cases, conservation of intact ecosystems may be cheaper than the costs of these threats to health, income potential, and habitat loss. Human population density and consumption patterns are at the root of many management challenges listed herein, and in general governments should aim to slow West Papua's current rapid population growth of approximately 5.5% per year. It is important that governments provide infrastructure and sustainable support for existing communities rather than encouraging immigration and transmigration, and that any decisions regarding natural resource management garner the approval of local communities.

PRIORITY RECOMMENDATIONS FOR THE BHS

Priority recommendations have been identified for management action across the BHS, and listed under the following topics: Fisheries—Reducing illegal, unreported, and unregulated catches to prevent overfishing and reduce bycatch; Spatial planning—Enforcing best practices for coastal development to conserve ecosystem services for the people of West Papua; MPA management—Establish zoning system that spatially regulates natural resource uses and development to protect marine ecosystems and ecosystem services for communities; and Threatened Species management—Eliminate threats to threatened and endangered species from oil and gas industries, fisheries, and habitat destruction (Tables 1–4). In addition to following these minimum recommendations, government agencies should fund the hiring of experts in these fields who can evaluate the latest best-practices, develop management plans, and support the enforcement of their implementation.

CONCLUSIONS

One of the most common themes noted throughout these studies is that fisheries are already significantly depleted yet overfishing continues. 'Shifting baseline syndrome' is common in the BHS. As each new generation of fishers accepts a lower abundance of fish as 'normal,' they do not recognize that fisheries are already in decline, and continue harvesting at levels that lead to overfishing. To combat this trend and support EBM in the long-term, it is essential that managing bodies (or partners) measure ecological change regularly using a standardized method, and use these results to inform decisions about natural resource management. To maximize effective use of work conducted in the BHS, scientists and decision-makers should meet regularly to review conservation science and monitoring data, discuss key results, and identify current information needs.

BACKGROUND

The Bird's Head Seascape (BHS) of West Papua boasts globally significant biodiversity, coral reef habitats, and populations of threatened marine species. Although rich in natural resources, over 40% of people living in West Papua (currently 761,000 people[I]) fall below the poverty line[II]. Fisheries provide a main source of income and food security to people throughout the BHS[III,IV], including in remote island communities and the population centers of Sorong and Manokwari. While ecosystems here are far from pristine and the fishery stocks of some areas are severely depleted (in some cases up to an order of magnitude decline in the past 30-40 years[V,VI]), low human population density and environmental factors have kept them relatively healthy compared to many other areas of Southeast Asia. However, unsustainable exploitation—both legal and illegal—of natural resources, poor development practices, and the Bird's Head's rapid human population growth rate of over 5.5% per year, threaten the health and survival of these ecosystems and the local communities who depend on them.

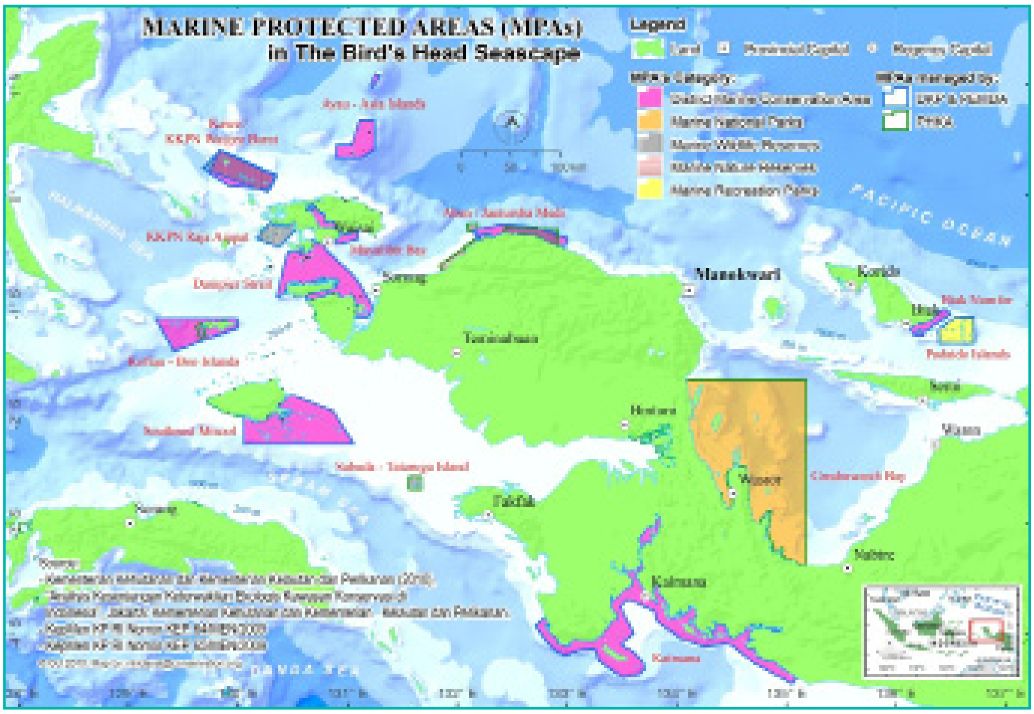
Community member in Batanta drying mixed reef and pelagic fishes for sale in Sorong.
Photo: ©Erdi Lazuardi/CI

The Bird's Head Seascape is a regional, national, and global priority for marine conservation[VII]. This area holds the planet's most diverse coral reefs with more than 1635 species of coral reef fish[VIII] and over 600 species of hard coral[IX] confirmed in the region, some of which might be resilient to the negative impacts of climate change. Cendrawasih Bay is home to the second largest marine park in Indonesia and due to its unique geologic and oceanographic history of repeated isolation has become a major regional center of endemism[VIII]. Abun is a globally important Pacific Leatherback turtle nesting site[X], while Kaimana hosts globally significant mangrove stands and populations of threatened marine mammals[XI].
Raja Ampat is a tourism hot-spot, world famous for its unmatched coral reef diversity. Maintaining the health of these highly productive waters and diverse habitats is critical to sustainable natural resource industries such as fisheries, tourism and aquaculture. Furthermore, the protection of seagrasses and mangroves is essential to carbon storage mechanisms that may help slow climate change and thus associated sea-level rise and ocean warming[XII].

Local, provincial and national governments of Indonesia currently face important decisions about how to promote sustainable economic growth for local communities, while also conserving the natural characteristics (including high biodiversity) and processes that maintain the rich array of ecosystem services of the BHS. The West Papua government agencies have contributed significantly to sustainable marine resource management by developing a network of 12 Marine Protected Areas (MPA) protecting over 3.6 million hectares of islands and coastal waters. These MPAs include Cendrawasih Bay National Marine Park, Abun, 7 MPAs in Raja Ampat, and a large MPA in Kaimana.

Many natural resource management decisions made in the BHS would greatly benefit from ecosystem-based management (EBM) principles (below). These categories of management include but are not limited to:

- MPA MANAGEMENT for the BHS MPA network
- FISHERIES MANAGEMENT at Regency, Provincial and Regional scales
- SPATIAL PLANNING for marine and coastal areas at Regency, Provincial and National Government levels
- THREATENED SPECIES MANAGEMENT for endangered species such as turtles, dugongs, cetaceans and whale sharks



Marine protected areas in the Bird's Head Seascape, West Papua, Indonesia

ECOSYSTEM-BASED MANAGEMENT

Ecosystem-based management aims to maintain healthy, productive, and resilient environments that provide humans with the ecosystem services they need today and in the future. In the BHS, local and regency governments have committed to establishing EBM initiatives that invest in the long-term wellbeing of both human communities and natural ecosystems. In order to accomplish these goals, decision-makers require information about the relationships among and between terrestrial and marine ecosystems, socio-economic characteristics of stakeholders, and patterns of resource use, especially fisheries. Governance mechanisms underlie effective natural resource management, and ensure that EBM is enforceable by law.

To assist the governments of the BHS in adopting an EBM approach, three environmental non-governmental organizations (NGOs) [The Nature Conservancy (TNC), Conservation International (CI) Indonesia and World Wildlife Fund (WWF)-Indonesia] have worked with local partners since 2001. Initially, support focused on the establishment and implementation of a marine-protected area (MPA) network. Collaborations have expanded in recent years to include assistance with fisheries management, marine and coastal spatial planning, and environmental education.

Sea turtles contribute to coral reef health.
Photo: ©Burt Jones and Maurine Shimlock/Secret Sea Visions

ECOSYSTEM-BASED MANAGEMENT STUDIES

The adoption of an ecosystem-based approach to natural resource management in the BHS has been facilitated through the Ecosystem-Based Management Program, which strove to develop conservation science initiatives, and communicate results to meet managers' information needs. From 2005–2010 NGOs, academics, and government partners collaborated on 18 studies to provide managers of the BHS with a broad-scale understanding of socio-economics, ecological conditions, oceanography, and governance in the areas where they work. These studies and current monitoring programs continue to influence policies ranging from the village to national level. The key threats, inputs and management recommendations generated by select studies are listed below under biological, socio-economic and governance themes. Brief factsheets and full reports for each are available upon request. Recommendations are categorized according to the management principles mentioned above. While many studies produced site-specific results, they also yielded recommendations that are relevant to the broader BHS.

1. HISTORICAL ECOLOGY OF THE BIRD'S HEAD SEASCAPE

MANAGEMENT PRIORITIES: FISHERIES MANAGEMENT, SPATIAL PLANNING

BACKGROUND

The Paris Natural History Museum and the University of British Columbia's 'The Sea Around Us' program reconstructed the historical ecology of the Raja Ampat area and assessed changes in environmental conditions in the region from 1800 to the present time. Reconstructions were based on detailed analyses of historical ecological data from the Bird's Head, recorded mainly in logs and reports of thirteen major expeditions between 1820–2002, including British, French, and Dutch exploration voyages. For example, estimates were made of fish abundances and forest health before the advent of large-scale commercial fishing and logging in the region.The results of this study demonstrated a significant shift from subsistence activities in Raja Ampat over 200 years ago to an increasing focus on commercial fisheries, especially over the past 30 years, which has resulted in significant declines in marine resources.

KEY FINDINGS

Specific changes in the perception of ecological condition from 1820–2002 include:

1. A 50% decline in the perceived occurrence of turtles, fish, and invertebrates;
2. Commercial extraction of invertebrates continues despite signs of overexploitation;
3. Perception of human population density in coastal villages has increased sharply;
4. A sharp decrease in the perceptions that marine resources are fished only for subsistence, and that marine resources are fished extensively;
5. A general decline in the perception that turtles, fish, and marine plants are abundant.

KEY RECOMMENDATIONS

- Recent increases in commercial fishing in Raja Ampat have reduced population abundance and reproductive potential, pointing to the urgent need for management (especially fisheries regulations) before further degradation occurs.

REFERENCE

- Palomares, M.D. L., J.J Heymans, D. Pauly, 2007. Historical Ecology of the Raja Ampat Archipelago, Papua Province, Indonesia. *History and Philosophy of the Life Sciences* 29: 33–56.

- Ainsworth, C.H., T.J. Pitcher, C. Rotinsulu, 2008. Evidence of fishery depletions and shifting cognitive baselines in Eastern Indonesia *Biological Conservation* 141:848–859.

2. THE DISTRIBUTION, STATUS AND MANAGEMENT OF GROUPER SPAWNING AGGREGATIONS IN RAJA AMPAT

MANAGEMENT PRIORITIES: FISHERIES MANAGEMENT, MPA MANAGEMENT

BACKGROUND

In Raja Ampat, reef fish species have high cultural, ecological, and economic value to communities, often forming the primary source of cash income. Unfortunately, many fishers have become reliant on fishing practices that negatively impact reef fish populations and ecosystems, and the sustainability of their livelihoods. Among these methods are destructive fishing, fishing of juveniles, and harvest of reproductively active adults.

Some coral reef fish species, such as grouper, gather at predictable times and locations to reproduce, forming what are known as fish spawning aggregations (FSAs). Fishing on FSAs typically removes adults in large numbers just prior to reproduction, and quickly leads to overfishing, particularly when FSA fishing are commercialized. Globally, aggregation fishing has resulted in FSA loss and associated reductions in stock abundance, reproductive output, recruitment, and average fish size. In Raja Ampat, all known FSA sites of highly valued commercial fishes have been targeted by the Live Reef Food Fish Trade (LRFFT) to supply Asian seafood and restaurant markets at some point since the 1980's. By supporting unsustainable fishing of FSA throughout Raja Ampat, the LRFFT has contributed to overfishing and in some cases caused the localized extinction of fish stocks at formerly productive fishing grounds. Despite the economic importance the LRFFT-targeted species, very little is known about their population status, reproductive biology or the management needs in Indonesia.

To support informed fishery policy decisions for Raja Ampat, fisher surveys, underwater visual census, and tagging methods were conducted at FSAs in Ayau, Kofiau and Southeast Misool to determine the location, timing, species composition, and abundance of spawning reef fish. Catch-per-unit-effort (CPUE) was calculated for fishers in Ayau to estimate the impact of the local LRFFT fishery on the aggregation viability.

THREATS

- Overfishing of grouper populations through the targeting of FSA for the LRFFT is leading to fishery collapse, decline in ecosystem function, and loss of livelihoods.

KEY FINDINGS AND INPUTS

1. Grouper spawning aggregations have been severely depleted due to overfishing, and no functional FSAs were found in Southeast Misool and Kofiau MPAs. Evidence suggests that a number of diminished grouper spawning aggregations exist at Southeast Misool, but remain under threat from the LRFFT. The recovery of FSA in either location will require strict bans on fishing from FSA.
2. At Ayau, small but viable grouper spawning aggregations still exist, some of which are targeted by local fishers for the LRFFT, while others are closed to fishing by the declaration-of traditional rules by village leaders. Recently, protection of FSA has been influenced by buyer pressure and community support for MPAs. However ministerial decree will soon formalize the protection of FSA.
3. Studies of a squaretail coral grouper (*Plectropomus areolatus*) FSA in Ayau showed that:
   a) Ayau fishers were highly effective at catching *P. areolatus*, with approximately 75% of the spawning fish caught from one aggregation over 10 days.
   b) *Plectropomus areolatus* moved 4-5 km from the spawning aggregation following reproduction, as shown by acoustic tagging studies.
   c) High spawning site fidelity was observed, with males residing at FSA sites longer than females. This situation created the potential to reduce reproduction through the disproportionate removal of males before females arrive at the spawning site, and limiting access of females to sperm for egg fertilization.
4. Given the severe depletion of grouper populationsand spawning aggregations in Raja Ampat, any recovery will be slow, and depends on protecting target species from fishing during the critical spawning season at both the FSA sitesand along migratory corridors.

CI monitoring team member measures a grouper before operating to insert an acoustic tag.
Photo: ©Joanne Wilson/TNC

KEY RECOMMENDATIONS

1. Spawning aggregations and migratory corridors (spawning sites, plus at least 4-5 km on each side, a total of 10km) must be closed to fishing for the full spawning period. Small-scale no-take zones or no-take zones that are closed for only a portion of the spawning season will not fully protect these populations, stop grouper population declines, or prevent FSA loss. If FSAs remain unprotected or without full protection, then grouper populations and this fishery have the strong potential to collapse.
2. Formalize the permanent closure of all FSA, including those currently mandated by the *sasi* system, aconservation-oriented customary practice of spatiotemporal closures for resource replenishment and subsequent harvest. Include all FSA in MPA No-Take Zones (NTZ).
3. Reduce overall catch of grouper to sustainable levels to allow fish populations to recover.
4. Regularly monitor grouper populations and spawning site activity to understand population trends and management effects. Stop fishing altogether if populations show any indication of decline in fish abundance or reductions in average length of spawning individuals. Consider resuming fishing outside the FSA only when stocks reach desired levels.

REFERENCES

- Rhodes, K. 2008. Packard EBM Bird's Head Seascape Tag-Recapture Training Workshop and Fish Spawning Aggregation Identification and Characterization, Raja Ampat, Indonesia. TNC Indonesia Marine Program Technical Report.

- Rhodes, K. 2010 Final Technical Report: Tagging and Monitoring of squaretail coralgrouper, *Plectropomus areolatus*, in Ayau, Raja Ampat, West Papua, for Conservation Planning 8 October 2009 to 20 April 2010. TNC Indonesia Marine Program Technical Report.

- Wilson, J.R, Rhodes, K. L., and Rotinsulu, C. 2010 Aggregation fishing and local management within a marine protected area in Indonesia. *SPC Live Reef Fish Information Bulletin* 19: 7-13.

3. SEA TURTLES MIGRATION, NESTING, AND FORAGING ECOLOGY

MANAGEMENT PRIORITIES: FISHERIES MANAGEMENT, MPA MANAGEMENT, SPATIAL PLANNING, THREATENED SPECIES MANAGEMENT

BACKGROUND

The BHS is a refuge to four of the world's seven sea turtle species, and holds globally important nesting beaches and foraging grounds. These threatened species travel through the coastal waters of the BHS on their long migratory journeys to the Pacific and Indian Oceans. Throughout their life-cycle, sea turtles play an important role in the ecology and well-being of coastal and open ocean environments. Scientists believe that Hawksbill turtles may maintain the health of coral reef systems by grazing on sponges and coralimorphs, which if left to grow unchecked, overgrow corals and kill the reef[XIII]. Because of these relationships, researchers believe that declining numbers of Hawksbill turtles may be a factor in the inability of reefs to resist increasing pressures from pollution, algal overgrowth, overfishing, and climate change. Constant grazing by Green sea turtles increases the health and growth rate of seagrasses[XIV]. As the top predators of jellyfish, Leatherback sea turtles are thought to inadvertently protect larval fish from predation[XV]. Sea turtles are also culturally important to people throughout the tropical Pacific, playing an important ceremonial role[XVI].

Even though sea turtles are protected by law in Indonesia, they are threatened by people and predators who remove eggs from nests, fishers who hunt adults, and fishing nets that entangle and drown individuals at sea. Sea level rise and coastal development put them at further risk by reducing the size and condition of nesting and foraging habitats worldwide. Information on the location of important turtle nesting beaches, feeding grounds, and migratory pathways is critical to managing these iconic species, especially if migrations include passage through areas where they may be killed. Between 2005 and 2009, local community groups in Raja Ampat, Abun and Cendrawasih Bay were trained to monitor Leatherback and Green turtle populations. WWF-Indonesia scientists and partners used satellite tags to document the migration patterns and distribution of 5 Olive Ridley and 11 Green turtles over a one to two year period. Inputs reflect results from these and other sea-turtle studies in the region.

Sea turtle hatchlings making their way to the sea.
Photo: ©Burt Jones And Maurine Shimlock/Secret Sea Visions

THREATS

Sea turtles in the BHS are threatened by:

1. Illegal poaching of eggs, and hunting of adults for meat and carapace;
2. Destruction of turtle nests and egg predation by monitor lizards, dogs, and pigs;
3. Loss of nesting habitat due to coastal development (seawalls, beach modification, and erosion from vegetation removal), sea-level rise, and storms;
4. Loss of seagrass beds used as Green turtle foraging grounds through the smothering with mud and sand from coastal development, land reclamation and road construction, and trampling during gleaning;
5. Entanglement and drowning as bycatch in long lines and trawls, or in discarded fishing nets, especially gill nets, beach seine, and pound nets, especially during nesting season;
6. Changes in sex ratios of hatchlings caused by increased temperatures of beaches affected by sedimentation from mining run-off, forest clearance around watershed areas, and loss of coastal vegetation such as mangroves, *Pandanus*, and other beach trees;
7. Baiting for the shark finning fishery attracts sharks to hatchling areas, leading to high rates of hatchling predation;
8. Plastic ingestion leading to death by gut blockage and starvation.

KEY FINDINGS AND INPUTS

1. Individual Green, Hawksbill, and Leatherback sea turtles returned to the same nesting areas about every three to four years;
2. Nesting beaches with the highest number of nests have wide and high sandy stretches, suitable sand/substrate structure, beach vegetation (especially trees), and no beach lights.
3. The following beaches in the BHS were discovered to be regionally and in some cases globally important nesting beaches:
   - Green turtles: Ayau-Asia, Piai-Sayang, Waigeo, Venu-Kaimana, Pisang-Tuturuga-FakFak, Wairundi
   - Hawksbill turtles: Misool, Wayag-Sayang, Venu-Kaimana
   - Leatherback sea turtles: Abun-Jamursba Medi, Warmon, Kaironi
   - Olive Ridley sea turtles: Abun-Jamursba Medi, Warmon, Kaironi

4. After remaining in an area for a few months to nest, individuals of all species dispersed to areas outside the BHS, including to the Arafura Sea, South Kalimantan, throughout Southeast Asia, Eastern Australia, New Zealand, and even North America to reside and feed. Two of six Green turtles remained in the BHS to reside and feed during inter-nesting periods.
5. Increased terrestrial input and sedimentation to beaches is increasing sand temperature 1° C and potentially altering hatching success and sex ratios.
6. Olive ridley turtles are at risk of being hooked by longline fisheries operating in the Western Pacific, Banda and Aru Seas.

KEY RECOMMENDATIONS

1. Important turtle nesting beaches should be protected from poaching by setting up community patrols, community based monitoring, and local community agreements to stop harvesting of eggs and hunting of adults.
2. It is important to protect turtle nesting beaches and foraging grounds (seagrass beds) from the impacts of coastal development by a) ensuring sand mining, seawall, road or other construction activities do not occur in areas of turtle nesting beaches b) protecting beach and dune vegetation, especially large trees, and c) protecting nesting beaches and foraging grounds from sedimentation associated with coastal development and mining.
3. Collaborate with provincial and national fisheries authorities to enforce the use of turtle-excluder devices for trawls in the Arafura Sea, and introduce regulations requiring circle hooks for long lines throughout the BHS and Eastern Indonesia.
4. Local fisheries authorities should prohibit the use of passive fishing gear (gill nets, pound nets, beach seine) from an area within 50 km of nesting beaches, and in seagrass beds.
5. Establish a municipal trash disposal system that prevents any trash from reaching the ocean or beaches. Create a public campaign against litter, particularly in Sorong, Manokwari, Kaimana, Waisai, and on all passenger ferries.
6. Encourage shipping lanes in the BHS to avoid inter-nesting areas at a vicinity of 15 km from nesting beaches to protect turtles during their peak nesting period (Hawksbill and Green turtles: April and September; Leatherbacks: June/July; Olive ridleys: March/April).
7. In case of necessary nest relocation, follow best practices to ensure physical conditions lead to high hatching success and even sex ratio. Protocols for nesting beach management has been developed by WWF and can be accessed at: www.wwf.or.id/about_wwf/whatwedo/marines_species/publication or contact WWF and University of Papua for the most recent practices.

REFERENCES

- Adnyana I.B., I.M. Jayaratha, 2009. Post-Nesting Migrations of Olive Ridley Turtles (*Lepidochelys olivacea*) from The Bird's Head Peninsula of Papua, Indonesia. Udayana University, Bali. Indonesia. Brief Technical Report.

- Adnyana I. B., C. Hitipeuw, 2009. Nesting Beach Monitoring Manual. WWF-Publication in Bahasa Indonesia. www.wwf.or.id/berita_fakta/publications/?8900/Buku-Panduan-Pemantauan-Penyu

- Benson, S.R., P.H. Dutton, C. Hitipeuw, B. Samber, J. Bakarbessy, D. Parker, 2007.Post-Nesting Migrations of Leatherback Turtles (Dermochelys coriacea) from Jamursba-Medi, Bird's Head Peninsula, Indonesia *Chelonian Conservation and Biology* 6(1):150-154.

- Hitipeuw, C., P.H. Dutton, S.R. Benson, J. Thebu, J. Bakarbessy, 2007. Population status and internesting movement of leatherback turtles, *Dermochelys coriacea*, nesting on the northwest coast of Papua, Indonesia. *Chelonian Conservation and Biology* 6(1):28–36.

- Troeng, S., M. Chaloupka, 2007. Variation in adult annual survival probability and remigration intervals of sea turtles. *Marine Biology*, 151(5): 1721-1730.

4. SEA SURFACE TEMPERATURE PATTERNS OF THE BHS

MANAGEMENT PRIORITIES: MPA MANAGEMENT

BACKGROUND

Sea surface temperatures that are beyond an organism's normal tolerance can be a significant source of stress. High sea surface temperatures can be dangerous to coral reefs if they stress *Zooxanthellae* into leaving the coral polyps where they normally live. *Zooxanthellae* are single-celled algae that live inside coral tissues, and give them their color, sugar, and extra energy to form reefs. Without this delicate relationship corals turn white in a process called coral bleaching and generally die of starvation, leaving fleshy algae to invade the area and transform it into a habitat that does not appeal to many coral reef inhabitants including fish. Coral stress and bleaching are less common in areas with some exposure to cooler waters, and areas with varieties of *Zooxanthellae* that can tolerate higher temperatures.

Since 2005, scientists from Universitas Negeri Papua (UNIPA) and CI have maintained 78 temperature loggers placed throughout the BHS in areas with live coral, at depths of 1-3m and 15-20m. These loggers record temperature every fifteen minutes. The practical goals of this initiative are 1) to describe the temperature tolerance of living corals, and 2) identify areas with temperature conditions that are good for long-term coral reef survival, namely conditions leading to selection for warm-water tolerant populations, or upwelling and/or frequent but brief cooling events that help prevent coral stress and bleaching. These areas should be considered high priority refugia that may survive adverse oceanographic events and re-seed the recovery of more heavily impacted areas.

THREATS

1. Climate change is causing increases in sea surface temperature and changes in oceanographic conditions worldwide that are associated with more frequent and more severe coral-bleaching.
2. Coral bleaching can lead to the death of coral reefs, especially if they are also stressed in other ways, such as by sedimentation, and/or algal overgrowth because there are not enough herbivorous fish, grazing snails, and sea-cucumbers to maintain ecosystem balance.

KEY FINDINGS AND INPUTS

1. Numerous sites in the BHS experienced upwelling and seasonal cooling that may be associated with a lower tendency for temperature-induced coral bleaching. Notable upwelling areas (with temperatures as low as 19.3°C) include Southeast Misool (particularly Fiabacet chain of islands, along the southern continental shelf break), Northwest Misool, the Sagewin Strait, the Dampier Strait (especially the eastern end), the Bougainville Strait in Northwest Waigeo, and Triton Bay in Kaimana. Seasonal cooling related to the southeast monsoon was generally an annual phenomenon that most reefs in the BHS experienced from April to August, with coolest temperatures normally recorded in July/August.
2. Many corals living in enclosed habitats in the BHS experienced especially high temperatures (up to 36°C, which is generally considered lethal to corals) that would often fluctuate dramatically with daily tidal changes. Noteworthy sites for frequent but temporary exposure to high temperatures (and thus exhibiting high temperature tolerance) include the lagoonal areas in Kofiau's Walo and Gebe islands, Wayag lagoon, the Mesempta karst channels of Southeast Misool, the "blue water mangrove" channels in Nampale and Gam, the nearly-enclosed Mayalibit Bay, and the intertidal coral reef flat on Kri Island in Raja Ampat.
3. Many of the monitored sites experienced repeated, extreme temperature variations with a 6-12°C range over all years. Sites that were particularly noteworthy for their dramatic temperature variations included the Kofiau Walo lagoon, the Kri reef flat, Cape Kri, the blue water mangroves of Nampale and Gam, and Triton Bay's two sites (Saruenus and Mauwara Islands).

4. In strong contrast to the moderate to extreme temperature variation experienced by almost all reefs monitored in Raja Ampat, Kaimana and the northern Bird's Head, the reefs in Cendrawasih Bay were shown to live in an extremely stable temperature environment with little daily, monthly or even seasonal variation—temperatures generally stayed within the range of 28-30°C.

Coral with white ("bleached") tips resulting from the loss of symbiotic Zooxanthellae that normally inhabit hard coral tissues. Photo: ©Crissy Huffard/CI

KEY RECOMMENDATIONS

1. Because periods of cooler-water inundation may provide corals relief from stress and reduce the chances of coral bleaching, all MPAs in the BHS network should site no-take zones in areas with the strongest upwelling (identified previously).
2. Because reefs with frequent exposure to abnormally warm (31-36°C) water may be more tolerant of future oceanographic conditions, corals in these areas (identified above) should also be prioritized for inclusion in no-take zones. Additionally, healthy intertidal reef flats should also be included in no-take zones and especially protected from trampling and gleaning.
3. Because biodiversity (and thus recovery from perturbation) can be strongly linked to habitat variation including temperature environment, MPAs and no-take zones should protect a variety of temperature regimes and habitat types.
4. The reefs of Cendrawasih Bay, with their generally stable temperature regime, may prove to be particularly susceptible to temperature variations caused by climate change. As such, these reefs require extra attention to minimize the other potential stressors to which they are exposed (including destructive and overfishing and sedimentation from land clearing in surrounding watersheds) in order to maximize their likelihood of adapting to future temperature changes. Under no circumstances should mining tailings or other industrial waste be discharged into Cendrawasih Bay.

REFERENCES

- Purba, G.Y.S., R. Bawole, M.V. Erdmann, C. Rotinsulu, M.E. Lazuardi, T. Pattiasina, 2009.Sea surface temperature as a criterion for establishing a sea conservation area at Cendrawasih Bay, Papua. *World Oceans Conference, Manado, Indonesia.* 8 pages.

5. GENETIC CONNECTIVITY OF REEF ASSOCIATED ANIMALS IN THE BHS

MANAGEMENT PRIORITIES: FISHERIES MANAGEMENT, MPA MANAGEMENT, SPATIAL PLANNING, THREATENED SPECIES MANAGEMENT

BACKGROUND

Many planktonic larvae travel on ocean currents from the area where they hatched to the place where they eventually settle and grow, and can be transported anywhere from a few meters to thousands of kilometers during this time. This distance determines whether or not a larva may eventually grow to mate with members of its own species in another area, and "connect" those two populations. Populations that are too far from each other, or have some other barrier that prevents larvae from traveling between them are "isolated." Isolated populations must rely on their own local stock to provide larval recruits for the next generation. By knowing whether populations are connected to or isolated from each other, managers can assess how they depend on each other for larval and stock replenishment. 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 tuna for the fishermen in Manokwari. Similarly, if populations are isolated, local managers must work to ensure that these stocks do not become depleted, as these stocks may not be replenished from elsewhere.

Researchers at the State University of Papua and the University of California at Los Angeles are studying genetic diversity to determine patterns of connectivity of different species throughout the BHS. The more similar the genetic make-up of two populations, the more frequently they exchange larvae, and the more connected their populations. Genetic diversity is ultimately responsible for how well an organism survives in its natural habitat and changing environmental conditions—more diverse populations are more likely to be able to handle a greater diversity of situations.

THREATS

1. If isolated populations are overharvested or otherwise threatened (for example by habitat loss, poor water quality, or problems with reproduction or recruitment), then there is no outside source that can replenish stocks, and these communities are especially vulnerable to collapse.
2. When organisms from other areas are released into a new area (typically by aquaculture or in the ballast water of ships), then they can mate and interfere with the native population's genetic diversity and natural ability to survive.

KEY FINDINGS AND INPUTS

1. For many species, populations in Cendrawasih Bay are genetically isolated from those in other areas in the BHS, suggesting limited connectivity between this region and the rest of the BHS. Populations in Cendrawasih Bay must be self-seeded, because no larvae from the outside can recruit and survive there.
2. For many species, Western Papua and Halmahera are isolated from the rest of Indonesia.
3. For many species, Northern and Southern BHS populations are distinct from one another, but Fak-Fak-Kaimana populations are connected to those in Sulawesi and Central Indonesia.
4. Overall genetic diversity in the BHS is very high. This diversity must be protected from invasive species that can outcompete and/or displace native populations.
5. Cendrawasih Bay is the premier example of endemicity in the BHS.
6. This region also hosts a high proportion of warm-tolerant giant clam symbionts, which may allow these animals to tolerate a small amount of climate-change associated temperature increase.
7. Connectivity between populations in the BHS is variable. About half of species studied appear to have high connectivity across the seascape and to neighboring regions of Maluku and Sulawesi, while the other half appear to have many isolated populations. However for most species, BHS populations have limited connectivity to other regions of Indonesia.

8. Species with isolated populations appear to rely on recruitment from adults within a small range of approximately 25-100km. Isolated species include some corals that form the foundation of coral reefs.

KEY RECOMMENDATIONS

1. Represent the genetically distinct Raja Ampat, Kaimana, and Cendrawasih coral reef populations in strategically placed large NTZ of MPA networks.
2. Maintain protected corridors and stepping stones of healthy habitat every 25-100km through a combination of enforced fishery laws and the use of responsible coastal development practices across the entire BHS to allow animals with limited dispersal and connectivity (especially broadcast spawners) to populate a large area.
3. Consider that the scale of management depends on scale of dispersal. Some animals can be managed over small ranges (e.g. corals) while others require large-scale international agreements (e.g. tuna);
4. Minimize the chances that plants and animals from other areas will be introduced to the BHS and potentially lower the natural genetic diversity through competition.
   - Prevent the release of ship ballast water into sensitive areas, such as Cendrawasih Bay;
   - Prohibit the aquaculture, introduction, and/or release of non-native animals or plants into lakes, streams, beaches, hillsides, islands, coral reefs, estuaries, and bays.

REFERENCES

- Barber, P.H., S.H. Cheng, M.V. Erdmann, K. Tengardjaja, Ambariyanto, 2011. Evolution and Conservation of Marine Biodiversity in the Coral Triangle: Insights from Stomatopod Crustacea. Crustacean Issues 19 *Phylogeography and Population Genetics in Crustacea*: pp. 129-156; CRC Press.

- DeBoer, T.S., Ambariyanto, A.C. Baker, P.H. Barber, 2012. Patterns of *Symbiodinium* distribution in three giant clam species across the biodiverse Bird's Head region of Indonesia. *Marine Ecology Progress Series*. 444:117-132.

- DeBoer, T., M. Subia, K. Kovitvonga, Ambariyanto, M.V. Erdmann, P.H. Barber, 2008. Phylogeography and limited genetic connectivity in the endangered boring giant clam, *Tridacna crocea*, across the Coral Triangle. *Conservation Biology* 22: 1255-1266.

- K. E. Carpenter, P.H. Barber, E. Crandall, et al. 2011.Comparative phylogeography of the coral triangle and implications for marine management. *Journal of Marine Biology*, 2011:Article ID 396982, 14 pages.

6. CATCH PROFITABILITY OF THE LIFT-NET FISHERY IN RAJA AMPAT

MANAGEMENT PRIORITIES: FISHERIES MANAGEMENT, MPA MANAGEMENT

BACKGROUND

Migrant fishers from Sulawesi have operated lift-net fisheries in Raja Ampat for over a decade without formal licensing or legal permission. Unregulated anchovy fisheries occur throughout the BHS and so findings from this study can be applied to similar situations in other areas. These fishers pay a small retribution to local villagers with tenure rights over the area, and this compensation has not increased despite yearly expansions in fisher effort. Local villagers complain of declining anchovy stocks, which are important not only as a food source for local villagers but also as forage for many important commercial fish species such as sharks, tuna and mackerel. Movements to regulate and tax this fishery require information on the economics and catch profitability so that Raja Ampat and its people receive optimum economic benefits for the use of their resources, and to prevent overexploitation of this important food source.

Researchers from the University of British Columbia and Ecosystem-based Management Science Unit interviewed active fishers in Kabui Bay (April and November 2006) to estimate anchovy fishery income, the amount of fish caught annually per boat, and fishing effort.

THREATS

1. Fisheries productivity and income earning opportunities for local communities are threatened by overfishing of anchovy stocks due to unregulated harvesting by migrant fishers.
2. Overharvest of anchovies and silversides can limit the food supplies of other high-value fisheries such as tuna and threatened marine animals such as Bryde's whale and dolphins.
3. Nets with small mesh size can catch juveniles before they have a chance to reproduce, thereby eliminating stock replenishment capabilities.

KEY FINDINGS AND INPUTS

1. In 2005 the economic value of the lift-net fishery was estimated at as much as 2.1 million US dollars (USD) per year in Kabui Bay, and 9.22 million USD for overall commercial and traditional fisheries of Raja Ampat.
2. In 2005 lift-net boat owners earned about $10,870 per year after they paid all of their expenses. Individual lift-net fishers in Kabui Bay made approximately $1835 USD per year, which is about 1.8 times that of other fishermen in Raja Ampat.
3. The number of lift-net fishers in Kabui Bay increased rapidly from 20 fishers in 1999 to more than 250 fishers in 2005.
4. Migrant fishers from areas elsewhere in Indonesia are the primary lift-net operators in Raja Ampat. Almost all of the profit from the lift-net fishery is spent outside Raja Ampat when fishers return home for holidays.
5. The average annual catch of each lift-net boat was 62 tons in 2005, including significant amounts of juvenile anchovy as by-catch.
6. Lift net fishers do not pay yearly taxes or license fees to the Raja Ampat Regency.

The lift-net fishery in Raja Ampat earns millions of dollars per year, but pays no tax or license fee, and very little money is spent locally.
Photo: ©Burt Jones and Maurine Shimlock/Secret Sea Visions

KEY RECOMMENDATIONS

1. Introduce regulations for anchovy and lift net fisheries in Raja Ampat and throughout the Bird's Head Seascape to prevent overfishing. Charge a fair license fee and income tax for a small number of lift-net boats, and use this money to fund fishery surveillance/patrols, and fisheries monitoring. Evict all remaining unlicensed (and thus illegal) fishers from the area.
2. Department of Fisheries should regularly monitor the anchovy fishery stock and catch.
3. Based on results of stock assessments, limit the number of boats, the gear used, and establish temporal, seasonal and/or spatial closures to allow natural regeneration of stocks and prevent overfishing and loss of food to other pelagic fish.
4. Monitor size at maturity, and establish size-at-maturity data for anchovies in Raja Ampat, and require a minimum mesh size that ensures catches have a 50% chance of reproducing before capture.

REFERENCES

- Bailey M., C. Rotinsulu, U.R. Rashid, 2007. The migrant anchovy fishery in Kabui Bay, Raja Ampat, Indonesia: Catch, profitability, and income distribution. *Marine Policy* 32(3): 483-488

- Varkey D.A., C.A. Ainsworth, T.J. Pitcher, Y. Goram, R. Sumaila,2010. Illegal, unreported and unregulated fisheries catch in Raja Ampat Regency, Eastern Indonesia. *Marine Policy*, 34(2):228-236.

7. PATTERNS OF MARINE RESOURCE USE IN RAJA AMPAT

MANAGEMENT PRIORITIES: FISHERIES MANAGEMENT, MPA MANAGEMENT, SPATIAL PLANNING, THREATENED SPECIES MANAGEMENT

BACKGROUND

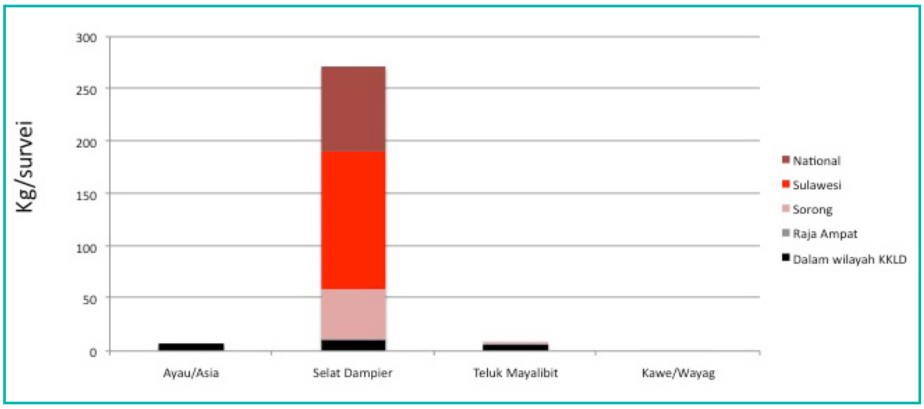
An understanding of marine resource-use patterns and compliance with regulations is a vital component of sustainable fisheries and marine livelihoods management. While illegal and unreported fisheries are known to threaten marine resources, recent studies have shown that even small scale and artisanal fisheries can also cause overfishing if not managed carefully. The Raja Ampat MPA network's large size is ideal for the protection and recovery of important ecosystems and fishing grounds, but its remoteness means illegal fishers can easily evade detection in outlying areas. CI and TNC use a combination of vessel-based and aerial surveys to monitor marine resource use in Raja Ampat, and document the type, size, location, and activity of vessels (including but not limited to fishing boats), as well as fixed fishing gear such as pound nets. Vessel-based surveys have the advantage of documenting fisher origin and estimated catch, while aerial surveys can cover large distances quickly. During aerial surveys it is also possible to identify large marine fauna such as whales, dolphins, dugongs, manta rays, large sharks and turtles, and areas of increasing coastal development.

THREATS

1. Illegal, unreported and unregulated fisheries, including fishing in NTZ, undermine the protection of community resources, and can lead to fishery collapse, high by-catch, and loss of an important food source to other animals.
2. Overfishing, or fishing activity on spawning grounds, can cause fisheries to collapse.
3. Disproportionally high fishery yields by outside interests rather than local fishers could negatively impact the economic benefit of MPAs and sustainable fishery practises to local fishers, and lead to social conflict.
4. Illegal and unreported fisheries deny income to government agencies at Regency, provincial and national levels and undermine fisheries management measures.

KEY FINDINGS AND INPUTS

1. Although most fishers encountered in MPAs using vessel-based surveys were local community members in small boats, people living within Dampier Strait, Southeast Misool, and Kofiau MPA boundaries took only approximately 5% percent of total fishery catch by wet weight, while fishers from Sorong, Sulawesi, and elsewhere in Indonesia took the remaining 95%. By contrast, local fishers from Mayalibit Bay and Ayau were responsible for nearly all catch in those MPAs.
2. Illegal fisheries (including bomb fishing) continue to operate in Raja Ampat, in some cases with the (illegal) permission of local community leaders or sub-district heads. Detections of shark finning in Raja Ampat have not declined since 2006, despite the new ban of these licenses for Raja Ampat, and the delivery of illegal fishers and their gear to enforcement authorities.
3. Reef fisheries (grouper, sea cucumbers) and pelagic fisheries (tuna, Spanish mackerel, and anchovies) represent the highest-volume catches detected.
4. Fisheries activity currently takes place in proposed NTZ in Mayalibit Bay, Ayau and Dampier MPAs of Raja Ampat. No-take zones will likely displace these activities to other areas.
5. Many important migratory and aggregation areas for large marine animals have been identified from aerial surveys. Mayalibit Bay is an important habitat for the endangered Indo-Pacific Humpback dolphin, and Dampier and Sagewin Straits are important refuges for dugongs. Greater numbers of cetaceans have been documented in Raja Ampat from October–May as compared to the rest of the year.
6. Coastal development observed during aerial surveys, including foreshore reclamation, road construction and clearing for expansion of suburban areas is causing significant damage to key coastal ecosystems such as mangroves, seagrass and coral reefs through direct smothering or sediment runoff. Mayalibit Bay is particularly affected due to the amount of coastal development and the shallow enclosed nature of the bay.



Total catches and number of boats by fisherman origin and gear type detected during from 6242 km of vessel-based marine resource use surveys in Dampier, Malayibit, and Ayau MPAs (June 2009- May 2011).

Grouper fishermen in Ayau, using snorkel gear, hook and line.
Photo: ©Crissy Huffard/CI

KEY RECOMMENDATIONS

1. Continue to support community members in their resource use monitoring efforts.
2. Enact and legally enforce more severe penalties for illegal and unlicensed fishing, especially shark-finning, compressor fishing, cyanide fishing, and bomb fishing.
3. Ban the practice of village and sub-district heads issuing licenses to outside fishers, as these licenses are illegal and undermine fisheries management measures.
4. Ensure members of the judicial system are informed of the true severity of destructive and illegal fishing to ensure that these violations are prosecuted to the full extent of the law.
5. Where possible improve the effectiveness of vessel-based enforcement patrols for illegal fishing and MPA regulations by communicating with simultaneous aerial monitoring. Use evidence from aerial surveys, such as photographs and global positioning system (GPS) locations, to prosecute vessels undertaking illegal activities.
6. Monitor marine resource use to identify key users and fishing locations in MPAs. Based on these results, socialize the demarcation of no-take zones and other regulations to ensure compliance, especially where NTZ may displace existing fishing activities.
7. Identify the location and season of cetacean migration and aggregation, and restrict activities that may harm cetaceans at these areas or times. October – May is the peak season for cetacean activity and therefore seismic surveys, longlining, and purse seines should be prohibited from migratory corridors and aggregation sites at that time.
8. Do not allow the use of fixed nets in areas frequented by dugong (namely Gam, Salawati, and Batanta in Raja Ampat, and the extensive seagrass beds of the Fak-Fak and Kaimana coastlines) or in cetacean migratory corridors (including Sagewin Strait, and Dampier Strait).
9. Because unsustainable coastal development and land usesare negatively impacting marine habitats, ensure best practices to reduce sediment runoff or destruction of coastal habitat due to land reclamation and road construction (*see Common Threats, Potential Solutions section below*).

REFERENCES

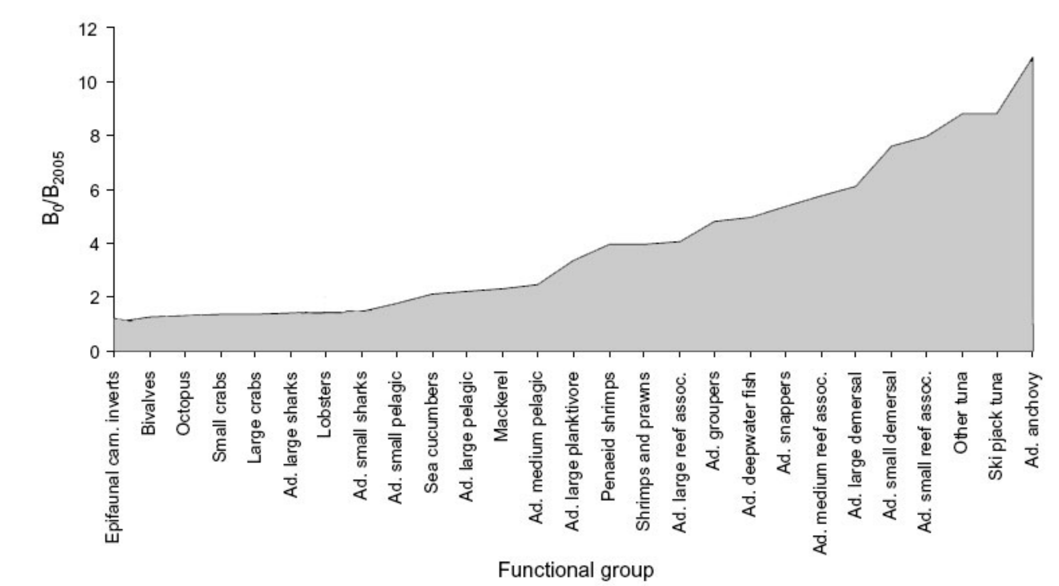
- Wilson, J., Rotinsulu, C., Muljadi, A., Barmawi, M., Wen Wen. 2010. Spatial and Temporal Patterns in Marine Resource Use within Raja Ampat Region from Aerial Surveys 2006. TNC Indonesia Marine Program Technical Report.

8. UNDERSTANDING COMPLEX ECOLOGICAL INTERACTIONS AMONG SPECIES AND THE STATUS OF FISHERIES SPECIES POPULATIONS

MANAGEMENT PRIORITIES: FISHERIES MANAGEMENT

BACKGROUND

Coral reef fishers harvest multiple species across diverse functional groups. By removing fish and invertebrates, people alter natural predator-prey densities that have cascading effects on habitats and other marine animals. Thus fisheries managers must consider the status not only of single target species, but also the impacts of multiple fisheries on entire ecosystems. These complex interactions can be very difficult to consider simultaneously, especially when trying to manage for both recovery and extraction based on information from multiple large datasets. Many managers use computer programs to assess ecosystem condition, and understand the real and potential impacts of fisheries when developing management strategies for a region. This can help them assess which fisheries species are most depleted and should be a focus for management, or what will happen to the ecosystem if protection of sharks leads to increased populations of these top predators. To assist managers in Raja Ampat, a computer based ecosystem model was developed by the University of British Columbia to estimate the current and historical states of fisheries (including assessments of stocks and illegal catches), food web interactions, catch per unit effort, and in general illustrate to managers important data values necessary for managing coral reef and pelagic fisheries. This endeavor integrated an enormous dataset, incorporating fisher interviews, stomach contents, coral reef surveys, fish biomass surveys, and government fishery statistics.



Relative decline in biomass since pre-exploitation (B0 grey) through to 2005 (B2005). Adapted from Ainsworth et al. (2007)

THREATS

1. Single-species management approaches often lead to inaccurate estimates of catch that will impair managers' ability to assess fishery condition, resulting in an overestimate of maximum sustainable yield, lack of fisheries restrictions, and ultimately overfishing of each target species.

KEY FINDINGS AND INPUTS

1. The ECOSIM model predicted benefits of large MPAs, including increase in fish abundance, average individual fish size, and biodiversity of coral reefs.
2. The ECOSIM model was used to assess the likely degree of illegal, unregulated, and unreported (IUU) fisheries by comparing government catch estimates to the status of the ecosystem. This assessment showed that for most fishery groups, IUU currently comprises a significant part (often more than 50%) of the fishery, particularly for reef fish, tuna, sharks, lobster and anchovy.
3. In Raja Ampat, stocks of Napoleon wrasse, large sharks, tunas (both skipjack and others), large pelagic fish, small pelagic fish, and large reef fish, and herbivorous fish are currently overfished.
4. Fishermen interviewed in Raja Ampat indicated that they thought fish species targeted by commercial and artisanal fisheries have declined. Older fishers consistently remembered higher fish abundance than younger fishers. This provides evidence for the 'shifting baseline syndrome', where each new generation of fishers accepts a lower abundance of fishes as 'normal' and they do not recognize that fisheries are already in decline and are likely to be overfished.
5. Analysis of government CPUE statistics indicated that some exploited fish species might have declined by as much as an order of magnitude since 1970.

KEY RECOMMENDATIONS

1. To effectively regulate fisheries and prevent overfishing, decision-makers must take into account the high level of IUU fishing in Raja Ampat and likely throughout the BHS by a) increasing enforcement and prosecution of illegal fishing, b) licensing or banning currently unregulated fisheries, c) reducing licenses issued for legal fisheries, and d) calculating fishery activity to be higher than that allowed by current licenses.
2. Species such as Napoleon wrasse, large pelagic and demersal species, sharks and large herbivores should be a priority for fisheries management to reduce overfishing and localized extinctions of these species.

REFERENCES

- Ainsworth, C.A., T.J. Pitcher, C. Rotinsulu, 2008. Evidence of fishery depletions and shifting cognitive baselines in Eastern Indonesia. Biological Conservation 141: 848-859.

- Varkey, D.A., C.A. Ainsworth, T.J. Pitcher, Y. Goram, R. Sumaila, 2010. Illegal, unreported and unregulated fisheries catch in Raja Ampat Regency, Eastern Indonesia. Marine Policy 34: 228-236.

- Ainsworth, C.H., D. Varkey, T.J. Pitcher, 2007. Ecosystem simulation models of Raja Ampat, Indonesia in support of ecosystem based fisheries management. Final technical report for the Birds Head Seascape Ecosystem Based Management Project. Fisheries and Ecosystems Restoration Research Group. University of British Columbia Fisheries Centre. 111 pp.

9. DEVELOPING ZONING PLANS FOR THE NETWORK OF MPAS IN RAJA AMPAT – BALANCING COMMUNITY USE AND CONSERVATION

MANAGEMENT PRIORITIES: FISHERIES MANAGEMENT, MPA MANAGEMENT, SPATIAL PLANNING, THREATENED SPECIES MANAGEMENT

BACKGROUND

The Raja Ampat government is currently working with TNC, CI and other partners to develop management and zoning plans for MPAs within the Raja Ampat MPA network. Zoning plans will be developed for each MPA and will identify areas that are suitable for different types of uses such as no-go and no-take zones for conservation, research and education, and sustainable use zones for local sustainable fisheries, tourism and aquaculture. When applying these zones to different areas it is important to consider the high reliance of local communities on fishery resources for food and income and the need to protect the conservation features of the MPA. To support the development of zoning plans for the Raja Ampat MPA network, a computer based 'decision support tool' was used to identify potential solutions for zoning plans that included areas for conservation and human use while still achieving the goals of the MPAs. All available information on ecological habitat characteristics, distribution of rare species, fishing grounds, areas of aquaculture, tourism and other activities, and threats was gathered from existing studies, databases, and through expert mapping exercises involving communities and stakeholders. Spatial planning software (Marzone) was used to identify important areas for conservation and fishing which could then be used to develop zoning plans based on ecological and socio-economic criteria. The process also incorporated input on preferred locations for different zones based on input from MPA managers and communities. One of the special features of this project was its support for integrated management of the Raja Ampat MPA network by accounting for the unique features of individual MPAs and the connections with the broader MPA network.

THREATS

1. MPA zoning plans may not be effective if they do not represent all important habitat types in no-take zones, if the placement of no-take zones is over unhealthy areas, or in conflict with areas that are essential for local community use.
2. The placement of no-take zones may impact communities if they are situated in important fishing grounds.

KEY FINDINGS AND INPUTS

1. Information gathered through expert mapping with stakeholders and communities provided key local knowledge that is essential to a zoning process, and was specific enough to be used in the analyses.
2. A variety of marine habitats must be represented in MPA NTZ in order to maintain the diverse ecosystem services they support

(e.g. sheltered coral reefs which are important to juvenile fish, high-current fore-reefs important to large pelagics, and mangroves which provide coastal protection).

3. Information on distribution and types of seagrass and mangroves in Raja Ampat is lacking at a scale that is relevant for spatial planning and MPA design and management.
4. Areas for NTZ identified by local communities and stakeholders do not always include representative areas of all habitat types, and have potential inequitable impact on community fishing grounds.
5. In Raja Ampat it is possible to find solutions for MPA zoning that adequately capture community fishery areas and biodiversity conservation.

KEY RECOMMENDATIONS

1. Potential conflict over the zoning plan can be reduced by facilitating the involvement of community members and stakeholders in the zoning process. Expert mapping exercises provide an opportunity for community and stakeholders to contribute important local knowledge of both conservation targets and fishing grounds to improve MPA design.
2. Zoning plans for MPAs should align with ecological and socio-economic criteria to reduce the impact of the zoning regulations on local communities while protecting areas of high conservation value.
3. Site any new MPAs that may be added to an existing network where they will form stepping stones in the distribution of critical habitats (e.g. reefs, mangroves, seagrass beds, turtle nesting beaches) and threatened species (e.g. whales, sharks, turtles).

REFERENCES

- Grantham, H. and Possingham H. 2010. Zoning marine protected areas for biodiversity conservation and community livelihoods: a case study from Raja Ampat, West Papua. University of Queensland Report to TNC Indonesia Marine Program.

- Grantham, H., V. Agostini, J. Wilson, S. Mangubhai, N. Hidayat, A. Muljadi, Muhajir, M. Beck, M. Erdmann and H. Possingham. 2012. Multi-objective zoning analyses to inform the planning of a marine protected area network in Raja Ampat, Indonesia. Marine Policy, in press.

Diver surveying coral breakage following dynamite fishing. Destructive fisheries are not compatible with sustainable reef fisheries or tourism. Photo: © Burt Jones and Maurine Shimlock/Secret Sea Visions

Seagrass is the primary food for some threatened species, provides a nursery ground for certain fisheries targets, and is important for carbon storage mechanisms. Photo: © Burt Jones and Maurine Shimlock/Secret Sea Visions

10. ECONOMIC VALUATION OF ECOSYSTEM SERVICES IN THE BIRD'S HEAD SEASCAPE

MANAGEMENT PRIORITIES: FISHERIES MANAGEMENT, MPA MANAGEMENT, SPATIAL PLANNING, THREATENED SPECIES MANAGEMENT

BACKGROUND

Healthy ecosystems are valuable assets that can be difficult or impossible to replace. Decisions impacting natural resource extraction must be made with full awareness of potential long-term losses incurred by immediate gains. Likewise conservation practitioners must understand the incentives of stakeholders when proposing management scenarios. In order to help meet these information needs in Raja Ampat, in 2006 State University of Papua (UNIPA) Economics Department professors and two natural resource economists 1) estimated the costs and benefits of direct economies like fishing, tourism, and mining, and indirect ecosystem services such as coastal protection; 2) analyzed the impact and damages resulting from economic activity or natural resource use; and 3) identified for policy makers options for optimized economic development for the people of Raja Ampat, while also minimizing negative impacts on critical ecosystems and habitats. Recent tourism data are also reported here.

This study provided an in-depth simulation of conflicting economic activities in Mayalibit Bay District (Waigeo, Raja Ampat) to illustrate the connectivity of different sectors and the potential damage extractive industries such as logging and mining can have on other economic activities and critical ecosystems. Logging and nickel mining are lucrative industries that can devastate tropical forests, mangrove forests, and coral reefs through erosion and sedimentation.

THREATS

Large-scale businesses or trades with immediate pay-outs appeal to many people because the economic benefits sometimes far precede costs. Estimates of ecosystem value demonstrate to communities how short-term gain can incur much greater long-term loss.

KEY FINDINGS AND INPUTS

1. The fishing sector accounted for 50% of Raja Ampat's Gross Domestic Product (GDP) in 2006, and 82% of the *Pendapatan Asli Daerah* (PAD). Furthermore, almost 80% of Raja Ampat's population is dependent upon direct marine resource utilization (fisheries) for their livelihoods.
2. Realized revenue from the tourism entrance fee system grew from Rp 482 million (USD 54,000) in 2007 to nearly Rp 2.9 billion (USD 323,711) in 2011.
3. Marine resource utilization (traditional and commercial fisheries, pearl culture, reef gleaning, and seaweed culture) in Raja Ampat had an estimated economic value of Rp 126 billion in 2006 and predicted net present value (NPV) of Rp 1.2 trillion within 20 years.
4. Nickel mining and oil drilling were valued at Rp 1.3 trillion and Rp 113 billion respectively, and forestry resources (timber) at Rp 12 billion in 2006 (NPV Rp 115 billion). These industries contributed no money to local PAD and instead paid the federal government through a lucrative system of profit sharing. Less than 10% of the revenue from these industries reached local communities.
5. The total indirect use value for ecosystem services in Raja Ampat (including the services from forests, mangroves, coral reefs, sea grasses, and freshwater ecosystems) was calculated to be Rp. 1.7 trillion/year (NPV Rp 16 trillion), more than five times the total value of direct uses (NPV of Rp 3 trillion).
6. Results showed that the perceived value of ecosystem services in Raja Ampat is much lower than the calculated value. Communities have little understanding of how expensive deteriorated habitats will be to their ecosystem services and livelihoods.

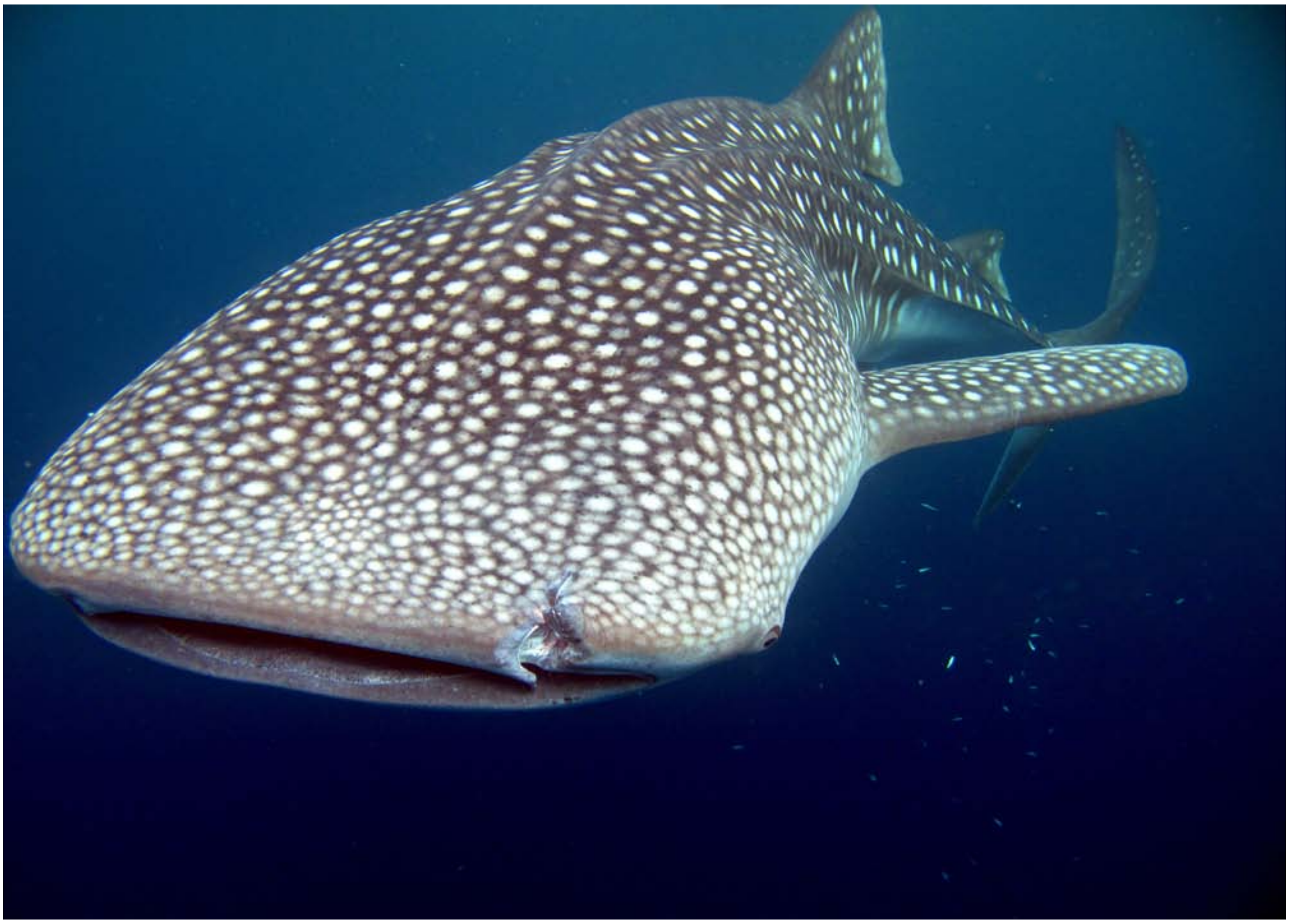
7. The loss of income (tourism, fisheries), and the costs of impaired ecosystem services (disaster prevention, erosion control, regulation fresh water availability) after ecosystem degradation by the logging and mining industries is estimated to cost Waigeo Rp 1.4 trillion over 20 years (based on a 10% discount rate).

KEY RECOMMENDATIONS

1. Sustainable fisheries and marine tourism should be developed to provide long-term economic stability for communities and substantial income to Raja Ampat's GDP and PAD.
2. All land use and development decisions should consider impacts on the indirect use value (or ecosystem services) derived from Raja Ampat's functioning ecosystems.
3. In the best interest of the people of the Raja Ampat Regency, oil, mining, and logging industries should not be developed within MPAs or their watersheds because:
    - technological failure during oil extraction is a realistic potential threat to ecosystems, fisheries, and tourism (especially deep sea wells, as demonstrated in the Gulf of Mexico oil spill disaster, 2010, USA);
    - these industries significantly weaken critical long-term economic potential through direct and sometimes irreversible damage to habitats;
    - these industries do not provide substantial income either to the Raja Ampat PAD or community members.

REFERENCES

- Dohar A, Anggraeni D. (2006) Laporan akhir valuasi ekonomi alam Kepulauan Raja Ampat (in Indonesian). Conservation International Indonesia Report, 2006. 72pp



Whale sharks are a high-value tourist attraction. Elsewhere they are worth more alive to tourism than dead to capture fisheries [XVII]*.*
Photo: ©Crissy Huffard/CI

11. DEVELOPING A GOVERNANCE STRUCTURE FOR THE RAJA AMPAT MPA NETWORK

MANAGEMENT PRIORITIES: FISHERIES MANAGEMENT, MPA MANAGEMENT

BACKGROUND

The Raja Ampat Government formed the Raja Ampat MPA network in 2006 through the declaration of six MPAs, bringing the total number of MPAs in the network to seven. This network needed a management structure that aligns with government regulations for MPA management, and identifies ways in which traditional tenure and customary conservation practices can be incorporated. The resultant management institution and process could then be used as a model for existing and future MPAs and MPA networks declared under similar legislation throughout Indonesia. Important aspects of this process include the strong leadership role taken by the government in developing this management structure, and the need for formal recognition of MPA regulations at all governmental levels in Indonesia.

KEY STEPS

1. In 2007 representatives from government agencies agreed to form a management institution to administer the (then) 6 MPAs declared under Regency laws.
2. Following the development of guidelines for the implementation of MPA management structure by the Ministry of Marine Affairs and Fisheries, the Raja Ampat Government passed a Regency Law, PERDA # 27, 2008 in December 2008. The Law has become the basis of legal support to develop Raja Ampat governance structure to managing the MPA network.
3. In May 2009 a Technical Management Unit Institutional Development Prepatory Team (Bupati Decree No.84 Tahun 2009) was formed. The team's main task is the establishment of the Technical Management Unit (UPTD) that will be supported by teams from Ministry of Marine Affairs and Fisheries, the Ministry of Home Affairs, Conservation International Indonesia, and The Nature Conservancy.
4. In November 2009 the Raja Ampat government committed to developing a Technical Management Unit (UPTD) as a Management Body to manage the Raja Ampat MPA network. On November 16, 2009, the Government of Raja Ampat issued Bupati Decree No.16 Tahun 2009 on the establishment of Technical Management Unit of Raja Ampat MPA. UPTD and Raja Ampat Marine and Fisheries Agency was given the task to prepare all matters relating to the Establishment of Regional General Service Body (BLUD) including the structure, duties, functions, and human resources on BLUD UPTD.

KEY RECOMMENDATIONS

1. Establish a UPTD to be responsible for the management of the Raja Ampat MPA network under the Raja Ampat Department of Marine Affairs and Fisheries, with the legal precursor to the BLUD UPTD.
2. Use a BLUD UPTD framework to allow for flexibility of financial management, fundraising, and staffing, and ensure that critical activities such as enforcement are not disrupted due to delays in disbursement of funds from the central government.
3. Involve high-level executives at all relevant Regency and National level government agencies, especially those concerning fisheries, natural resource management, spatial planning, finance, enforcement, and internal affairs.

COMMON PROBLEMS, POTENTIAL SOLUTIONS

The marine and coastal ecosystems of the Bird's Head Seascape are of great value for conservation, to support the livelihoods of local communities, and as a basis for economic development in the region. Most local communities rely on wild capture fisheries and small scale aquaculture for food and a source of income. Several large and severe threats are common to all MPAs in the BHS, and have the potential to quickly and permanently destroy livelihoods, fisheries, and tourism potential. Unfortunately, increases in overfishing, and the persistence of destructive fishing practices over the past 20-30 years have contributed to the decline in BHS's coral reefs and fish communities, with some areas now lacking large and commercially important species, and others bombed beyond the hope of recovery. More recently, coastal development has also compromised important nursery and breeding habitats though mangrove destruction, seagrass burial, and the sedimentation of beaches and coral reefs. Some of the BHS's most prominent threats and potential impacts are listed below, as identified by MPA managers, monitoring staff, and academic partners during a workshop to summarize the results and management recommendations of EBM studies. In all of these cases, conservation of intact ecosystems is likely cheaper than the costs of these threats to health, income potential, and habitat loss.

Human population density is at the root of many of the management challenges listed below, and in general governments should aim to minimize population growth[XVIII]. Overwhelmingly, research shows that areas with high human populations have poor fish communities that are quickly over-fished[XIX]. Additionally, rapidly growing human populations further increase 1) demands on natural resources, 2) introduction of unnatural substances into the environment, and 3) change to natural habitats in ways that can impair ecosystem function[XX].

PRIORITY RECOMMENDATIONS FOR THE BHS

Priority recommendations have been identified for management action across the BHS, and listed under the following topics: *Fisheries*—Reducing illegal, unreported, and unregulated catches to prevent overfishing; *Spatial planning*—Enforcing best practices for coastal development to conserve ecosystem services for the people of West Papua; *MPA management*— Establish infrastructure and zoning to protect marine ecosystems and ecosystem services for communities; and *Threatened Species management*—Protecting endangered species from habitat loss, bycatch, and unnatural death, and eliminating seismic testing from MPAs, and enforcing best practices for surveys in other areas (Tables 1–4). In all cases these recommendations are the absolute minimum necessary for efforts to avoid the listed threats, and are not a substitute for detailed management assessments. Government agencies should fund the hiring of experts in these fields who can evaluate the latest best-practices, develop management plans, and enforce their implementation. These efforts will require coordination with government agencies at multiple levels—especially national—to evaluate existing conflicting interests and plans.

TABLE 1. FISHERIES—REDUCING ILLEGAL, UNREPORTED, AND UNREGULATED CATCHES TO PREVENT OVERFISHING

FISHERIES MANAGEMENT:

Many of the EBM studies provided clear evidence that many BHS fisheries (invertebrates, reef fish) are already overfished and some key fisheries species (sharks, grouper) are severely depleted. Declines have been caused by destructive fishing, overfishing, and unreported, unregulated and illegal fisheries, particularly in the past 20-30 years.
An ecosystem approach to fisheries management will support sustainable fisheries by local communities, and protect marine ecosystems and fisheries species.

THREATS:

Destructive and illegal fishing

- Bomb and cyanide fishing continue to destroy reefs throughout the BHS.
- Compressor fishing continues to remove key invertebrates and reef fish in unsustainable volumes.
- Illegal fishers from within and outside BHS are harvesting large quantities of fish, currently without fear of prosecution.
- Illegal fisheries threaten food security and income of local communities and reduce potential revenue to local agencies.
- Illegal fishers harvest endangered species such as sea turtles.

Unregulated (unlicensed) fishing

- Unregulated fishing leads to a high risk of overfishing as no records of catch or gear are kept and no stock assessments done in order to manage fisheries sustainably.
- Unregulated and unlicensed fishing leads to loss of revenue from license fees.
- High risk unregulated fisheries in BHS are –
    - a. Lift nets targeting primarily anchovy and squid –Large volumes caught, depleting anchovies and squid, which are important forage species in marine ecosystems.
    - b. Shark fishing— Overfishing is common due to slow growth and low reproductive rates. High value of shark fins and lower value of meat incentivises fishermen to keep fins but throw shark bodies overboard, and stay at sea for long periods in small, economically operated boats.
- Fixed gear, including pound nets, have high rates of bycatch (including juveniles and endangered species such as turtles and dugongs) and can lead to overfishing.

Overfishing caused by

- Issuing too many licenses or high quotas based on no or inaccurate stock assessments
- Overharvesting of juvenile fishes, sharks, sea cucumbers, top shells, and lobsters
- Targeting of fish spawning aggregations
- Continued harvesting of already depleted populations such as grouper, Napoleon wrasse, sharks, sea cucumbers, top shells and lobsters
- Rapid and unregulated expansion of artisanal fisheries due to unsustainable increase in local populations who rely on fish as main protein source
- Lack of respect for or knowledge of traditional management practices such as *sasi*

Fisheries impact on habitats and species

- Some fishing gears including longlines and drifting gill nets cause high rates of by-catch of threatened and endangered species such as turtles, dugongs, dolphins and whales

POSSIBLE SOLLUTIONS:

Eliminate destructive and illegal fishing

- Regency and Provincial governments allocate resources for patrols and other surveillance methods such as radar and/or aerial surveys.
- Implement and support local community patrols to target illegal fishing especially in MPAs.
- Enforce fishery laws and educate judges about the importance of prosecuting all illegal fishing cases and other environmental crimes.

Regulate key fisheries and fishing gear

- Introduce system for regulating key commercial fisheries including lift nets (for anchovy and squid) and harvest of invertebrates through *sasi* or licensing.
- Introduce system for regulating all fixed gear such as fish cages and pound nets through *sasi* or licensing, starting in MPAs.
- Ban shark finning throughout the BHS.

Reduce overfishing

- Review license quotas for overfished species including reef fishes, grouper, anchovies, tuna, and invertebrates.
- Monitor catch per unit effort to determine status of stocks and catch, and reduce licenses to overfished fisheries.
- Design MPAs and MPA networks, including large no-take zones, that act as 'fish banks' to protect juveniles, large fecund females, their habitat and provide refuges, with the goal of protecting stock-replenishment capabilities.
- Protect all grouper, snapper, and Napoleon wrasse spawning aggregations within no-take zones with a radius of at least 5km, or through seasonal closures such as *sasi* to close aggregations to fishing for the entire spawning period.
- Consider using closed cycle aquaculture to provide fish for live reef fish food trade.

Reduce impact of fisheries on habitats and species

- Reduce bycatch through enforcement of c-hooks on longline fishing boats, turtle excluder devices in trawls, and ban gill nets within 50km of turtle nesting beaches.
- Ban fishing of endangered or vulnerable species.

Most fishermen from Raja Ampat fish from a dugout boat.
Photo: © Burt Jones and Maurine Shimlock/ Secret Sea Visions

TABLE 2: SPATIAL PLANNING—ENFORCING BEST PRACTICES FOR COASTAL DEVELOPMENT TO CONSERVE ECOSYSTEM SERVICES FOR THE PEOPLE OF WEST PAPUA

SPATIAL PLANNING:

In the BHS, road construction, coastal development, logging and mining have caused clearing and sediment run-off that damaged important marine habitats and ecosystems including coral reefs, mangroves, seagrass beds and turtle nesting beaches.

THREATS

Clearing on steep slopes, stream blockage for road construction, logging, mining, and large-scale agriculture (oil palm).

- Deforestation, construction on steep slopes, removal of vegetation buffers from alongside waterways, and blocking natural stream flow causes landslides, poor water quality, and terrestrial runoff into streams, watersheds, bays, and oceans.
- Terrestrial runoff can cause coral reef and seagrass bed death by smothering, inability of larvae to settle and grow, and introduction of coral disease. Seagrass burial then leads to loss of fish nursery grounds, coastal protection, and carbon storage.
- The release of toxic substances (including pesticides and mining tailings) into the environment contaminates waterways, causes human reproductive and developmental health problems, and threatens aquatic biodiversity.
- Blocking natural stream flow causes formation of stagnant water pools that harbor mosquitoes.

Construction of infrastructure in coastal areas

- Removal of vegetation buffers (especially mangroves) near waterways, sand mining from beaches, seawalls, land reclamation, and jetties blocks water flow, disrupt shortline integrity and increase erosion..
- These activities increase the vulnerability of coastal communities to storms, tsunamis, and sea level rise.

Clearing for mining in Raja Ampat (2007). Photo: © Indrah

Trash flowing from a stream into the sea in Raja Ampat. Photo: © Burt Jones and Maurine Shimlock/Secret Sea Visions

In Indonesia many coral reefs are not healthy, a result of reduced water quality, overfishing, pollution,destructive fisheries, and warming waters.
Photo: © Burt Jones and Maurine Shimlock/Secret Sea Visions

Terrestrial run-off from coastal development, forest clearing, and watershed disturbance in Waigeo.
Photo: © Burt Jones and Maurine Shimlock/Secret Sea Visions

POSSIBLE SOLUTIONS

Ensure strict compliance with best practices for coastal development:

- Planning and approval of clearing and construction in coastal watersheds must consider impact on coastal ecosystems, watershed health, and marine water quality.
- Hire a spatial planner with expertise in coastal development to lead recommendations and follow-up with construction firms.
- Enforce best practices at the Regency Level, and do not tolerate poor construction. Fine offenders, and require rehabilitation measures according to best practices.
- Establish zones for economic growth and business, and leave natural areas undeveloped. Build roads only where over-land transportation is important to communities. Otherwise invest in ferries and sea transport.
- Do not build, log, or clear vegetation on steep slopes.
- Maintain (or restore with native vegetation if necessary) 30m of vegetation buffer between construction and waterways.
- Do not remove mangroves or beach vegetation.
- Maintain water flow by building bridges over rivers or streams, and jetties that allow water flow underneath.
- Instead of building seawalls, protect coastal integrity and prevent erosion by protecting and planting beach trees such as mangroves, Pandanus, and/or Indian Almond trees.
- Do not mine sand from beaches. Rather, if needed, mine sand from areas well away from the beach and other bodies of water.
- Do not build on underwater or intertidal habitats to reclaim land.
- Zonation policy as stated in UU no. 27th 2007 should be planned and implemented in each district.
- Boundaries of authority jurisdiction (village, district, province, regency, and country) should be clearly stated and approved.

Ban mining of gold, nickel, and other metals in sensitive ecological areas and immediate watersheds of MPAs. In other areas where mining is considered, perform thorough environmental assessments before opening, and if operations are approved ensure strict compliance with best practices to control tailings, erosion, and run-off.

TABLE 3: MPA MANAGEMENT—ESTABLISH INFRASTRUCTURE AND ZONING TO PROTECT MARINE ECOSYSTEMS AND ECOSYSTEM SERVICES FOR COMMUNITIES

MANAGEMENT OF BHS MPA NETWORK:

The Bird's Head Seascape contains a network of 12 marine protected areas covering over 3.5 million hectares to protect marine biodiversity and support sustainable fisheries particularly in the face of the impacts of climate change. Effective management of this MPAs network is critical to achieving these outcomes.

ISSUES

Governance

- Guidelines for governance structures for MPAs and MPA networks declared under UU31/2004 and/or UU27/2005 are now available, and are being discussed for application in Raja Ampat.

Zoning plans

- The majority of MPAs in BHS do not yet have formal zoning plans.
- Lack of zoning plans means inadequate protection for key habitats, threatened species, critical areas such as spawning grounds, and 'fish banks.'
- Lack of good spatial information (maps) on biodiversity, fisheries and resource use for all MPAs hinders the quality of spatial management.
- No-take zones that are too small or poorly placed do not adequately protect critical life stages because animals may move outside NTZ boundaries and be caught, or their young may not recruit back into this area to build brood stock.

Support from local communities and stakeholders

- MPAs that do not consider stakeholder interests and marine resource uses risk non-compliance by community members, or incompatible uses in overlapping or adjacent zones.

Effective management

- Provisioning of adequate resources (staff, equipment and funds) to ensure effective management is not prioritized in government planning and budgeting.
- Staff members are not adequately trained for MPA management roles.
- The lack of coordination between capture fisheries, conservation and aquaculture divisions could allow inappropriate or incompatible fishing or aquaculture activities to operate legally in MPAs.
- Poorly planned coastal development and catchment clearing causes sedimentation of coral reefs and destruction of seagrass and mangroves in MPAs.

Seismic surveys threaten snorkelers, marine mammals, fish and turtles. Location and dates of all surveys must be socialized to community members in the BHS. During the survey, patrol a 20km radius around survey equipment to ensure there are no people or marine mammals in the area.
Photo Child: ©Burt Jones and Maurine Shimlock/Secret Sea Visions; Photo Dolphin © Crissy Huffard

POSSIBLE SOLLUTIONS

Governance

- Raja Ampat Regency should support and implement UPTD BLUD governance structure developed for Raja Ampat MPA network.
- Use Raja Ampat UPTD BLUD governance structure as a model for other MPAs and MPA networks in BHS.

Zoning plans

- Use information in GIS databases and atlases to identify the distribution of key habitats, and aid in the design of MPAs.
- Develop zoning and management plans for all MPAs in the BHS, which protect biodiversity, habitats and allow sustainable use.
- Protect fish spawning aggregations in no-take zones that extend at least 5km on either side of the aggregation core to protect important migration corridors.
- Prohibit activities such as oil exploration and exploitation that threaten MPA goals.

Support from local communities and stakeholders

- Recognize and support traditional tenure and *sasi* in MPA management by aligning zoning and management plans with local community interests and aspirations.
- Avoid creating no-take zones in areas identified as important local fishing grounds where this does not compromise MPA goals (e.g. spawning aggregation sites need to be included in no-take zones).
- Use community mapping as an inexpensive and effective tool to collect information on location and types of human activities.

Effective management

- Ensure adequate resources (staff, equipment and funds) for effective MPA management is allocated in annual budgets.
- Build capacity of local MPA managers through mentorship and attendance at MPA manager trainings.
- Support the process between Regency, Province and National levels to clarify laws regarding capture fisheries and aquaculture in MPAs. Continue training for judges to build support and understanding of the importance of prosecuting violations of fisheries and MPA regulations.
- Coordinate with Regency and National spatial planning agencies to regulate coastal development, road construction and catchment clearing within MPAs and their watersheds to prevent runoff and destruction of habitats.

TABLE 4. THREATENED SPECIES MANAGEMENT—ELIMINATE THREATS TO THREATENED AND ENDANGERED SPECIES FROM OIL AND GAS INDUSTRIES, FISHERIES, AND HABITAT DESTRUCTION

THREATENED AND ENDANGERED SPECIES MANAGEMENT:

The BHS is a refuge for many threatened and endangered species that play essential roles in keeping marine ecosystems healthy. Through ecosystem-based management protect turtles, crocodiles, sharks, and marine mammals from extinction resulting from over-fishing, by-catch, climate change, seismic surveys, oil spills and coastal habitat degradation.

THREATS

Over-exploitation of sea turtles (eggs and meat), Dugongs, Whale sharks, crocodiles, and Indo-Pacific Humpback dolphins threatens the survival and functional ecology of these species through:

- Illegal poaching of turtle and crocodile eggs and adults, and dugong adults for subsistence and commercial purposes.
- Continued harvest of depleted populations of sharks including Whale sharks.
- Licensing of wild juvenile crocodile collection without population monitoring.

Critical habitat degradation

- Loss of sea turtle and crocodile nesting habitats results from coastal development (seawalls, beach modification, and erosion from vegetation removal), sea-level rise, and storms.
- Seagrass beds and mangroves used as foraging grounds by marine species such as Green turtles and Dugongs are lost when smothered under mud and sand from coastal development, land reclamation and road construction, and trampling during gleaning.
- Terrestrial run-off due to road construction, forest clearance around steep mountainous slopes and watershed areas, and mining changes beach sand color and texture, and may increase sand temperature. These changes may lead to unsuccessful sea turtle nesting activities, low production of turtle hatchlings, and imbalanced sex ratios of hatchlings.
- Sea turtle nests are disturbed and preyed upon by monitor lizards, dogs, and pigs.

Incidental catch by fisheries (by-catch), entanglement in marine debris and boat strikes

- Endangered species die from entanglement and drowning as bycatch in long lines and trawls, or in discarded fishing nets, especially gill nets, beach seines, and pound nets, especially during nesting season.
- Baiting for the shark finning fishery around sea turtle nesting beaches attracts sharks to prey on turtle hatchlings, leading to high rates of hatchling predation.

Marine seismic surveys for oil and gas exploration on the seabed can cause:

- Injury to marine mammals (whales, dolphins) that can destroy their ability to follow migration routes, find prey, avoid predators and communicate with each other over large distances, and death of marine mammals by stranding. Impacts can extend as far as 3000km from survey activity.
- Injury to human divers by sound up to 18km from survey equipment. Permanent hearing loss or injury to divers within this radius, and possible death if too close. Sound at half this intensity (e.g. 125 decibels) can burst the human eardrum and cause permanent hearing loss.

The risks of oil spills in the BHS, particularly from deep-water wells that are very hard to repair, far exceed the threats of seismic testing. Recovery can take decades.

- Oil smothers, poisons, and kills fish, invertebrates, coral reefs, mangroves, seagrasses, and endangered species.
- Oil spills cause immediate and long-lasting damage to fisheries and tourism, sometimes bringing these livelihoods to a stop.
- Chronic exposure to oil interferes with reproduction and settlement or corals and other animals.

POSSIBLE SOLLUTIONS

Eliminate illegal poaching of marine species

- Ban harvesting of endangered species and possession of their parts.
- Establish and support community based monitoring programs and local agreements to stop the harvest of eggs and hunting of adults. Patrol local markets and enforce infractions.
- Through RESPEK programs, establish education and awareness programs to assist in finding alternative livelihoods.
- Monitor threatened populations to ensure they are stable or increasing.

Protect habitats through Integrated Coastal Zone Management

- Protect nesting beaches from commercial interests such as beach development, logging and mining.
- Integrate critical habitats of marine endangered species (sea grass beds, coral reefs, migratory corridors) into MPA zoning systems and establishment of new MPAs.

Reduce the take of threatened and endangered species in pelagic and coastal fisheries

- To protect sea turtles and Dugongs, prohibit the use of passive fishing gear from an area within 50 km of nesting beaches and in seagrass beds.
- Enforce the use of turtle-excluder devices for trawls in the Arafura Sea, and introduce regulations requiring circle hooks for long lines throughout the BHS and Eastern Indonesia.
- Collaborate with the Department of Sea Transportation to encourage shipping lanes in the BHS to avoid inter-nesting areas at vicinity of 15 km from nesting beaches to protect sea turtles especially during their peak nesting period.
- Ban shark fisheries.

Enforce compliance by all oil and gas companies and their contractors with the following worldwide regulatory guidelines to reduce noise impacts of seismic surveys on human communities and marine life[XXI]

- Do not conduct surveys in areas with sensitive species based on animal distribution and temporal data collected prior to conducting seismic surveys. In Raja Ampat, avoid seismic surveys between October–May.
- Using visual observation, patrol a 20km safety zone around the survey starting 30 minutes before launch and running continually. Look for fishers, divers, marine mammals, and sea turtles inside the safety zone. Power-down seismic activity if they are sighted.
- Use a soft-start or ramp-up of sounds. At least 30 minute after all people and marine mammals have left the safety zone, gradually build up the airgun sound level (6 decibels per minute) to further ensure marine mammals may depart the area before sound levels peak.
- Minimize airgun sound propagation and 'sweeping.' Use the lowest practical volume throughout the survey, and turn off all airgun arrays when traveling through deep-water channels.

Minimize the chances that oil spills will damage MPAs

- Do not allow oil/natural gas drilling in MPAs or areas upstream of MPAs.
- Do not allow deep-water wells (>2000m), as these can take months to repair, causing large-scale spills over time.
- Develop and practice an oil spill response plan that meets industry-recognized best practices to minimize the spread of oil and resulting damage. Regularly inspect all equipment for spill cleanup (such as booms, fire booms, and skimmers).
- Avoid causing mechanical damage to habitats during cleanup and salvage. Do not deploy booms or skimmers over shallow reefs or seagrass beds.

CONCLUSIONS

Bridging science and management to support EBM

One of the most common themes noted throughout these studies is that fishery stocks are already significantly depleted, in some cases to ten percent of their original state, and yet overfishing continues. The prevalence of "Shifting Baseline Syndrome" in the BHS demonstrates the important role that conservation science plays in informing ecosystem-based management. A worldwide phenomenon, people do not properly assess ecological declines based on their memories, and change their behavior to allow for the recovery of fish populations and ecosystems. To combat this trend and allow for wise management over long time frames, measure ecological change regularly using standardized methods, and regularly communicate results to natural resource users and managers. Monitoring must continue long term—as long as fisheries exist—because younger generations have successively inferior understanding of 'healthy' ecosystems.

This report outlines how scientific studies have quantified aspects of ecosystems and socio-economics for use in MPA management, Fisheries Management, Spatial Planning, and Threatened Species Management. EBM is successful in the BHS because 1) managers communicate to scientists about which information they need, 2) scientists interpret and communicate the results of research in ways that meet specific management needs, and 3) both scientists and managers work together to advise and inform communications and outreach strategies, and inform policy-makers. To maximize effective use of work conducted in the BHS, scientists and decision-makers should meet regularly to review conservation science and monitoring data, discuss key results, and identify current information needs. Underpinning this process is the need for conservation science teams not only to document conditions but also to analyze data, identify and highlight important trends, and communicate informed recommendations to decision-makers based on these findings and the peer-reviewed results of others.

REFERENCES

[I]2010 census, Central Statistics Agency (BPS)

[II]Rodin, S., M. Suryana, M. Widaryatmo, 2010. Profil Kemiskinan di Propinsi Papua Barat Maret; 5 pp

[III]Laporan Kunjungan Kerja Komisi V DPR Ri ke Provinsi Papua Barat Reses Masa Sidang II Tahun Sidang 2009-2010, Tanggal 11-14 Maret 2010. 60 pp

[IV]Papua Barat Dalam Angka 2010 (ed) Bidang Neraca Wilayah dan Analisis Statistik, published by Badan Pusat Statistik Provinsi Papua Barat 568 pp

[V]Ainsworth, C.H., D. Varkey, T.J. Pitcher, 2007. Ecosystem Simulation Models of Raja Ampat, Indonesia in Support of Ecosystem Based Fisheries Management. Final technical report for the Birds Head Seascape Ecosystem Based Management Project. Fisheries and Ecosystems Restoration Research Group. University of British Columbia Fisheries Centre. 111 pp

[VI]Ainsworth, C.A., T.J. Pitcher, C. Rotinsulu, 2008. Evidence of fishery depletions and shifting cognitive baselines in Eastern Indonesia. Biological Conservation 141: 848-859

[VII]Huffard, C.L., M.V. Erdmann, T. Gunawan, 2009. Defining Geographic Priorities For Marine Biodiversity Conservation in Indonesia. Based on data inputs from G. Allen, P. Barber, S. Campbell, L. Devantier, M.V. Erdmann, M. Halim, T. Hitipeuw, Guswindia, B. Hoeksema, M. Hutomo, B. Kahn, Y. Noor, M.K. Moosa, K. S. Putra, Suharsono, E. Turak, J. Randall, R. Salm, C. Veron, C. Wallace, 103 pp

[VIII]Allen G.R., M.V. Erdmann, 2012. Reef fishes of the East Indies. Volumes I-III. Tropical Reef Research, Perth, Australia. 1292 pp

[IX]Veron, J.E.N., L.M. DeVantier, E. Turak, A.L. Green, S. Kininmonth, M. Stafford-Smith, and N.A. Petersen (2009) Delineating the Coral Triangle. Galaxea, Journal of Coral Reef Studies 11:91-100

[X]Benson, S.R. P. H. Dutton, C. Hitipeuw, B. Samber, J. Bakarbessy, D. Parker, 2007. Post-Nesting Migrations of Leatherback Turtles (Dermochelys coriacea) from Jamursba-Medi, Bird's Head Peninsula, Indonesia Chelonian Conservation and Biology 6(1):150-154

[XI]Turner W.R., M. Oppenheimer, D.S. Wilcove, 2009. A force to fight global warming: Natural ecosystems and biodiversity must be made a bulwark against climate change, not a causality of it. Nature 462(19) 278-279

[XII]Sala, E., E. Ballesteros, R.M. Starr, 2001. Rapid decline of Nassau Grouper spawning aggregations in Belize: fishery management and conservation needs. Fisheries 26(10):23-30

[XIII]Leon, Y.M. K.A. Bjorndal, 2002. Selective feeding in the hawksbill turtle, an important predator in coral reef ecosystems. Marine Ecology Progress Series 245:249-258

[XIV]Moran, K.L., K.A. Bjorndal, 2005. Simulated green turtle grazing affects structure and productivity of seagrass pastures. Marine Ecology Progress Series 305:235-247

[XV]Allison, D. E. Griffin, K.L. Miller, S. Rider, 2009. U.S. sea turtles: a comprehensive overview of six troubled species. Oceana. 34 Pages

[XVI]Luna, R.W. 2003. Traditional food prohibitions (tapu) on marine turtles among Pacific Islanders. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 15: 31-33

[XVII]Norman, B. J. Catlin, 2007. Economic importance of conserving whale sharks. Report for the International Fund for Animal Welfare, Australia

[XVIII]United Nations, 2010. Department of Economic and Social Affairs, Population Division. Population Facts. 4pp

[XIX]Stallings C.D. 2009, Fishery-Independent Data Reveal Negative Effect of Human Population Density on Caribbean Predatory Fish Communities. PLoS ONE 4(5): e5333

[XX]Commission on sustainable development , 1996. Progress in the implementation of the programme of action for the sustainable development of small island developing states report of the Secretary-General, Addendum

[XXI]Herata. 2007. Proceedings of the International Workshop Impacts of seismic survey activities on whales and other marine biota. Dessau, September 6-7, 2006. Federal Environment Agency (Umweltbundesamt). 90 pages

ACRONYMS

BHS	Bird's Head Seascape
BLUD	Regional General Service Body
CPUE	Catch per unit effort
CI	Conservation International
EBM	Ecosystem-based management
FSA	Fish spawning aggregation
GDP	Gross Domestic Product
IUU	Illegal, unregulated, and underreported
LRFFT	Life Reef Food Fish Trade
MPA	Marine protected area
NPV	Net present value
NGO	Non-governmental organization
NTZ	No-Take Zones
PAD	Pendapatan Asli Daerah
TNC	The Nature Conservancy
UPTD	Technical Management Unit
USD	United States Dollar
WWF	World Wildlife Fund

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