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Executive Summary

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Executive Summary

INTRODUCTION

The Indonesian province of Bali is located just east of the island of Java and comprises 563,666 ha covering the main island of Bali and the smaller satellite islands of Nusa Penida, Nusa Lembongan, Nusa Ceningan, Pulau Serangan and Pulau Menjangan. Bali is known throughout the world for its unique Hindu culture and as a top global tourism destination. It is also situated in the southwest corner of the Coral Triangle — the region of the highest marine biodiversity on the planet. Bali's rich marine resources have long been an important economic asset to the island — both as a source of food security for local communities (many of whom derive a significant proportion of their animal protein needs from seafood) and also as a focus for marine tourism. Diving and snorkeling attractions such as Nusa Penida, Candi Dasa, Menjangan Island (Bali Barat National Park), and the Tulamben *USS Liberty* wreck have been drawing tourists into Bali's waters for decades, while more recently the private marine tourism sector has expanded the menu of options to include sites like Puri Jati, Karang Anyar, and Amed. Other important economic activities in Bali's coastal zone include seaweed farming and ornamental fish collecting.

Unfortunately, despite Bali Governor's Decree No. 324/2000 mandating the implementation of integrated coastal management in the province, rapid and largely uncoordinated development in Bali's watersheds and coastal areas, along with a lack of clear marine spatial planning for the island, has led to significant deterioration of many marine environments around Bali. This is due to a combination of overfishing and destructive fishing, sedimentation and eutrophication from coastal development, sewage and garbage disposal at sea, and dredging/reef channel development. At this point in time, the long-term sustainability of the many important economic activities occurring in Bali's coastal zone is in question.

The Bali provincial government has realized these threats and is now working hard to develop a comprehensive long-term development strategy for the island, including greatly improving spatial planning in both the terrestrial and marine areas of Bali. One important part of this initiative has been the decision by the Bali provincial government to design and implement a comprehensive and representative network of Marine Protected Areas (MPAs) around the island that prioritizes sustainable and compatible economic activities (including marine tourism, aquaculture and sustainable small-scale fisheries).

To initiate the planning for this network of MPAs, the government held a multistakeholder workshop in June 2010. The workshop was organized by the Marine Affairs and Fisheries Agency of Bali Province, in collaboration with the Bali Natural Resources Conservation Agency (KSDA), Warmadewa University, Udayana University, United States Agency for International Development (USAID), Conservation International (CI) Indonesia and local NGOs within the framework of a "Bali sea partnership". The Bali MPA Network workshop was attended by 70 participants from the provincial government, regency governments, universities, NGOs, private sector, community groups, traditional village groups and fishermen groups.

Importantly, the workshop participants identified 25 priority sites around Bali as the top candidates for inclusion in a network of MPAs for the island. This list of sites included existing national/local protected areas such as Bali Barat National Park/Menjangan Island, Nusa Penida, and Tulamben, while also including a number of additional sites that currently have no formal protection. Later, the 25 priority sites were short-listed into seven MPA candidate sites (see Chapter 6 for the list).

In order to move this MPA network agenda forward, the Bali government (in particular, the provincial Marine Affairs and Fisheries Agency) in early 2011 requested the assistance of Conservation International Indonesia's marine program in leading a small team of local and international experts to survey the candidate MPA sites identified by the June 2010 workshop and provide clear recommendations on priority development sites and next steps for the design of the MPA network. The team was asked to build upon the survey data compiled during the November 2008 CI-led "Marine Rapid Assessment" of the Nusa Penida reef system to provide a more comprehensive report on the biodiversity, community structure, and current condition of coral reefs and related ecosystems around Bali. Based upon this

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information, the team was also requested to provide recommendations on how to best prioritize the 25 candidate sites for inclusion in an ecologically-representative network of MPAs.

THE OBJECTIVES OF THE BALI MARINE RAPID ASSESSMENT PROGRAM

The assessment, conducted from 29 April–11 May 2011, had the following three primary objectives:

- Assess the current status (including biodiversity, coral reef condition and conservation status/resilience of hard corals and coral reef fishes) of the majority of the 25 candidate MPA sites around the island of Bali identified by the June 2010 Bali MPA Network workshop, compiling thorough species-level inventories for each site.

- Compile spatially-detailed data on biological features which must be taken into consideration in finalizing the Bali MPA Network design. This design includes not only an analysis of any differences in reef community structure of the priority sites, but also specifically identifying areas of outstanding conservation importance due to rare or endemic hard coral or fish assemblages, presence of reef fish spawning aggregation or cleaning sites, reef communities exposed to frequent cold-water upwelling that are resilient to global climate change, or other outstanding biological features.

- Taking the above into account, provide concrete recommendations to the Bali government on the next steps to be taken to finalize the design of the Bali MPA Network.

SURVEY RESULTS: GENERAL

- The MRAP was successfully completed during a 13-day period of 29 April–11 May 2011, with a presentation of preliminary findings to the Governor of Bali on 12 May 2011. The survey team comprised 12 individuals, including representatives of the Marine and Fisheries Affairs of the Bali Province (DKP), the Perancak Research Centre for Oceanography (BROK), Warmadewa University, and six local and international marine taxonomists from Conservation International. The survey was funded in its entirety through the Coral Triangle Support Program (CTSP) of the USAID.

- In total, 33 sites were successfully surveyed (see Table 1), representing the majority of the 25 candidate MPA sites that were previously identified by the June 2010 expert workshop. The survey began at the southern tip of Bali and proceeded in a counter-clockwise fashion around the island until the northwest corner was reached—at which point the survey team could not continue any further down the west coast due to wave conditions making it impossible to dive. The data from these 33 sites have been combined with previous data taken from 19 sites during the November 2008 Nusa Penida MRAP; coral and reef fish taxonomic and community structure analysis presented in the report thereby utilize this combined data set for 52 sites.

- With over 350 man-hours of diving conducted during the MRAP, the team was overall very impressed with both the surprisingly high biodiversity (including a number of new species) and especially the finding that Bali's coral reefs are in a very active stage of recovery after the coral bleaching, destructive fishing and crown-of-thorns starfish outbreaks that were largely thought to have decimated these reefs in the late 1990s and into 2001. The impressive ratio of live to dead hard coral recorded of 7:1 is extremely encouraging and is testament to the resilience of these reefs. At the same time, the team found abundant evidence of serious management problems for Bali's marine ecosystems, such as: omnipresent plastic trash; severe signs of overfishing including near complete depletion of reef sharks and large commercially valuable fishes such as Napoleon wrasse; and serious resource use conflicts between communities engaged in marine tourism livelihoods and outside fishing interests unsustainably targeting the very resources upon which marine tourism depends.

SURVEY RESULTS: REEF FISH BIODIVERSITY

- The biodiversity of reef fishes was assessed for 29 of the 33 survey sites by G. Allen and M. Erdmann, using underwater visual census from a 1–70m depth. A total of 805 species were recorded during the survey. When combined with results of the previous Nusa Penida MRAP, the total diversity recorded for the Bali region includes 977 species of reef fish representing 320 genera and 88 families.

- Wrasses (Labridae), damselfishes (Pomacentridae), gobies (Gobiidae), cardinalfishes (Apogonidae), groupers (Serranidae), butterflyfishes (Chaetodontidae), and surgeonfishes (Acanthuridae) are the most speciose families on Bali reefs with 114, 96, 84, 59, 54, and 39 species respectively.

- Species counts at individual sites ranged from 42 to 248, with an average of 153 species per site. Those sites with the highest diversity recorded included Anchor Wreck, Menjangan (248 species), Batu Kelibit, Tulamben (246 species), Kepah, Amed (230 species), Jemeluk, Amed (220 species) and Bunutan, Amed (217 species).

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- The majority of Bali fishes have broad distributions in the Indo-Pacific (56.4%) or western Pacific (25.3%). Minority categories of special interest involve species that are mainly distributed in the Indian Ocean (3%) and Indonesian endemics (3.3%). A total of 16 reef fish species are now currently only known from Bali and the nearby Nusa Tenggara Islands to the east and are considered local endemic species.
- At least 13 new and undescribed reef fish species were recorded and collected during the survey, including two fang blennies (*Meiacanthus*), two jawfish (*Opistognathus*), three dottybacks (*Pseudochromis* and *Manonichthys*), a dartfish (*Ptereleotris*), a clingfish (*Lepidichthys*), a grubfish (*Parapercis*), a cardinalfish (*Siphamia*), and two gobiids (*Grallenia* and *Priolepis*). Though most of these undescribed species have been previously recorded from surrounding regions, five were recorded for the first time during the two MRAP surveys.

Table 1. Summary of survey sites for Bali MRAP 29 April – 11 May 2011.

Site No.	Date Surveyed	Location Name	Coordinates
1	29 April 11	Terora, Sanur (Grand Mirage)	08° 46.228′S, 115° 13.805′E
2	29 April 11	Glady Willis, Nusa Dua (Grand Mirage)	08° 41.057′S, 115° 16.095′E
3	29 April 11	Sanur Channel	08° 42.625′S, 115° 16.282′E
4	30 April 11	Kutuh Temple, Bukit	08° 50.617′S, 115° 12.336′E
5	30 April 11	Nusa Dua	08° 48.025′S, 115° 14.356′E
6	30 April 11	Melia Bali, Nusa Dua	08° 47.608′S, 115° 14.192′E
7	1 May 11	West Batu Tiga (Gili Mimpang)	08° 31.527′S, 115° 34.519′E
8	1 May 11	East Batu Tiga	08° 31.633′S, 115° 34.585′E
9	1 May 11	Jepun (Padang Bai)	08° 31.138′S, 115° 30.619′E
10	2 May 11	Tepekong (Candidasa)	08° 31.885′S, 115° 35.167′E
11	2 May 11	Gili Biaha/Tanjung Pasir Putih	08° 30.270′S, 115° 36.771′E
12	3 May 11	Seraya	08° 26.010′S, 115° 41.274′E
13	3 May 11	Gili Selang North	08° 23.841′S, 115° 42.647′E
14	3 May 11	Gili Selang South	08° 24.079′S, 115° 42.679′E
15	4 May 11	Bunutan, Amed	08° 20.731′S, 115° 40.826′E
16	4 May 11	Jemeluk, Amed	08° 20.221′S, 115° 39.617′E
17	4 May 11	Kepa, Amed	08° 20.024′S, 115° 39.244′E
18	5 May 11	Batu Kelibit, Tulamben	08° 16.696′S, 115° 35.826′E
19	5 May 11	Tukad Abu, Tulamben	08° 17.603′S, 115° 36.599′E
20	6 May 11	Gretek, Buleleng	08° 08.969′S, 115° 24.733′E
21	6 May 11	Penutukang, Buleleng	08° 08.270′S, 115° 23.622′E
22	7 May 11	Puri Jati, Lovina	08° 11.032′S, 114° 54.869′E
23	7 May 11	Kalang Anyar, Lovina	08° 11.344′S, 114° 53.841′E
24	8 May 11	Taka Pemuteran	08° 07.775′S, 114° 40.007′E
25	8 May 11	Sumber Kima	08° 06.711′S, 114° 36.451′E
26	9 May 11	Anchor Wreck, Menjangan	08° 05.467′S, 114° 30.131′E
27	9 May 11	Coral Garden, Menjangan (transect only)	08° 05.485′S, 114° 30.486′E
28	9 May 11	Post 2, Menjangan	08° 05.813′S, 114° 31.608′E
29	10 May 11	Secret Bay, Gilimanuk	08° 10.862′S, 114° 26.544′E
30	10 May 11	Secret Bay Reef North, Gilimanuk	08° 09.771′S, 114° 27.116′E
31	11 May 11	Klatakan Pearl Farm 1	08° 13.911′S, 114° 27.249′E
32	11 May 11	Klatakan Pearl Farm 2	08° 14.000′S, 114° 27.463′E
33	8 May 11	Pura Pulaki (reef fish survey only)	08° 08.719′S, 114° 40.756′E

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- Though Bali hosts an astounding diversity of fishes for its size, we also found strong signs of overfishing at nearly every site, with large reef fishes of commercial value nearly absent. In over 350 man-hours of diving, the survey team only recorded a grand total of three reef sharks (only at Gili Selang and Menjangan), three Napoleon wrasse (*Cheilinus undulatus*; observed only at Gili Selang and Tulamben), and four coral trout of the genus *Plectropomus*. Equally concerning, the team only recorded a grand total of five marine turtles observed during the survey.

- From the perspective of reef fish assemblage structure, Bali is broadly divisible into four major zones: Nusa Penida, east coast (facing Lombok Strait), north coast, and Secret Bay (Gilimanuk). The developing Bali MPA Network should strive to include representative sites from each of these zones. Other than those areas already included in MPAs(including Menjangan, Nusa Penida, Tulamben and Amed), survey sites worthy of specific conservation focus (based on remarkable fish diversity and excellent habitat conditions) include Batu Tiga, Gili Selang, Taka Pemuteran, Sumber Kima, and Secret Bay (Gilimanuk).

SURVEY RESULTS: HARD CORAL BIODIVERSITY

- Combining the 2008 Nusa Penida and 2011 Bali mainland MRAPs, a total of 85 sites (adjacent deep and shallow areas) at 48 stations (individual GPS locations) were surveyed for hard coral biodiversity. Coral communities were assessed in a broad range of wave exposure, current and sea temperature regimes, and included all main habitat types: cool water rocky shores, cool water reefs with broad flats, warm water reefs with broad to narrow flats, and coral communities developed on predominantly soft substrate.

- Bali hosts a diverse reef coral fauna, with a confirmed total of 406 reef-building (hermatypic) coral species. An additional 13 species were unconfirmed, requiring further taxonomic study. At least one species, *Euphyllia* sp. nov. is new to science, and a second, *Isopora* sp., shows significant morphological difference from described species, such that there are likely to be more than 420 hermatypic Scleractinia present, in total. To place this in perspective with other regions surveyed within the Coral Triangle, this figure for overall coral species richness is similar to those from Bunaken National Park and Wakatobi (392 and 396 spp. respectively), significantly higher than for Komodo and Banda Islands (342 and 301 spp. respectively), and lower than Derawan, Raja Ampat, Teluk Cenderwasih, Fak-Fak/Kaimana and Halmahera (all with ca. 450 spp. or more).

- Within-station (point) richness around Bali averaged 112 species (s.d. 42 spp.), ranging from a low of just two species (at Station B22, a muddy non-reefal location) to a high of 181 species at B16 (Jemeluk, Amed). Other species-rich stations included the Anchor Wreck, Menjangan (168 spp., Station B26) and Penutukang (164 spp., Station B21).

- Using cluster analysis at the station level, five major coral community types were identified, related to levels of exposure to waves, currents/upwelling, substrate type and geographic location. They include: the relatively sheltered north coast of Bali (Menjangan to Amed); wave exposed reefs along south Bali, south Nusa Penida and northwest Bali; clear-water, current-swept reefs of northern Nusa Penida (and several reefs of east Bali); fringing reefs of east Bali from Nusa Dua to Gili Selang; and several predominantly soft-bottom, marginal reef habitats including Puri Jati, Kalang Anyar and Secret Bay (Gilimanuk). These five communities were further sub-divided into ten main coral assemblages, with each of the five communities characterized by a more-or-less distinctive suite of species and benthic attributes.

- Cover of living hard corals averaged 28%. Dead coral cover was typically low, averaging < 4% overall, such that the overall ratio of live to dead cover of hard corals was highly positive (7:1), indicative of a reef tract in moderate to good condition in terms of coral cover. Areas of high soft coral cover occurred on rubble beds, likely created by earlier destructive fishing, coral predation and the localized dumping of coral down-slope during creation of algal farms. Minor evidence of recent and not-so-recent blast fishing and coral diseases was also present, the latter typically on tabular species of *Acropora*. Some localized damage from recreational diver impacts was also apparent. A very strong stress response (in the form of cyanobacterial growth) of corals in the southeast of Bali (Sanur and Nusa Dua) was likely linked with eutrophication and sewage seepage from coastal tourism development.

- Bali's coral faunal composition is typical of the larger region, with most species recorded being found elsewhere in the Coral Triangle. The overall high similarity in species composition with other parts of Indonesia notwithstanding, several important differences were apparent among these regions in the structure of their coral communities. Bali showed closest similarity to Komodo, also in the Lesser Sunda Islands and subject to a somewhat similar environmental regime in respect of current flow and cool water upwelling. These regions showed moderate to high levels of dissimilarity from most other regions to the north, notably from the more species- and habitat-rich regions of Derewan, Sangihe-Talaud, Halmahera and the Bird's Head Seascape of West Papua.

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- Discovery of an undescribed species of *Euphyllia* on the east coast of Bali, and the presence of other apparently local endemic corals, notably *Acropora suharsonoi*, suggests that the region does have a degree of faunal uniqueness, possibly related to the strong current flow through Lombok Strait. Given this situation, a precautionary approach demands that Bali's reefs require careful management of local impacts, as replenishment from outside sources may be a prolonged process.

- Reefs of particularly high conservation value around mainland Bali were widespread along the east and north coasts, and include Jemeluk, Menjangan, Gili Tepekong, Penutukang, Bunutan, Gili Selang and Gili Mimpang. Coral communities of Nusa Penida differ significantly from those of the mainland of Bali, and are subject to different environmental conditions and human uses, and hence may require separate management focus. Reefs of high local conservation value around Nusa Penida include those at Crystal Bay, Toya Pakeh, Sekolah Dasar and Nusa Lembongan.

- The wave-exposed south coast was not thoroughly surveyed because of large ocean swell. Many of the south coast reefs are highly prized for surfing, and as such draw large numbers of tourists to Bali each year. In the latter respect, their future conservation should be considered a priority for maintaining surf tourism on the island (noting that the surf conditions are generated by the shallow reefs of the area). Further offshore, the south coast also holds crucial migration corridors for cetaceans and other species.

- The presence of cool water upwelling and/or strong consistent current flow in some areas (especially Nusa Penida and eastern Bali) may be particularly important in buffering the incident reefs against rising sea temperatures associated with global climate change. As such, the Bali MPA Network should strive to include a significant percentage of these reefs within it to best ensure climate change resilience in the network design.

SURVEY RESULTS: CORAL REEF CONDITION

- Coral reef condition was assessed at 27 of the survey sites utilizing a modified "point-intercept transect" method. Two 50-meter transects were placed longitudinally along the reef face at each of two depths (5–7m and 10–14m) for a total of four transects per site. The reef benthos was recorded at 50cm intervals along each transect, using categories of live hard coral (identified to genus level), soft coral, algae, other living benthos (eg, sponges, zoanthids), dead standing coral, coral rubble, and abiotic substrate (eg, sand, rock, silt). Percentage cover of each of these substrate categories was then calculated, along with an index of coral mortality that compares the percentage of living and dead hard coral.

- At the 5–7m depth range, percentage of living hard coral ranged from 21.5–68%, averaging 45.3%. The highest percentage live coral at this depth was found at the Anchor Wreck (Menjangan), with the lowest at East Klatakan. At this depth range, live hard coral was the predominant substrate cover, followed by an average of 17.3% "abiotic substrate" and 11.3% coral rubble.

- At the 10–14m depth range, percentage of living hard coral ranged from 11–76%, with the highest cover recorded at Gili Tepekong and the lowest at Kutuh. On average, reefs at this depth range were dominated by hard coral (32.8%), followed by abiotic substrate (21.7%), soft coral (14.9%), and rubble (13.6%).

- In combining the results of both depth ranges, Bali's reefs have an average live hard coral cover of 38.2%. Overall averages of other substrate types in descending order of abundance include: abiotic substrate (20.6%), rubble (12.6%), soft coral (12.1%), other living fauna (6.8%), algae (5.2%), and dead standing coral (4.6%).

- A total of 54 hard coral genera were recorded in the transect surveys, with three genera overall dominating the reefs of Bali: *Acropora* (averaging 9.67% total coverage on each reef), *Porites* (8.12%) and *Montipora* (3.92%).

- If hard and soft coral coverage is combined to give percentage live (hard + soft) coral cover, reefs on mainland Bali showed a range of 31.5–85% (average 54.2%) live coral cover in the 5–7m transects, with the highest figure recorded for Coral Garden, Menjangan and the lowest at Sumber Kima. In the 10–14m depth transects, live coral cover ranged from 12–80.5% (average 47.7%), with the highest recorded at Nusa Dua and lowest at Tukad Abu. It is important to note that, while soft coral is pleasant for divers to look at and does provide shelter and food to certain reef organisms, it does not lay down permanent skeleton (ie, it does not contribute to reef-building) and hence a high percentage of soft coral cover is not preferable for the long-term maintenance of reef structures.

- An index of coral mortality (0 meaning 100% live and 1 meaning 100% dead coral) was calculated for each reef and ranged between .02 and .56 for Bali mainland reefs, with an average of .24, further confirming that Bali's reefs are currently in a state of active recovery from past major mortality events caused by coral bleaching and crown-of-thorns starfish outbreaks.

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SURVEY RECOMMENDATIONS:

- Based upon the results of this survey, it is clear that the province of Bali should take decisive action to set up a network of multiple-use MPAs designed to protect the long-term sustainability of local community fisheries livelihoods as well as the burgeoning marine tourism industry. MPAs must be designed, gazetted and managed with the strong participation of local coastal communities, tourism operators and civil society groups, and should be explicitly embedded within a coastal/marine spatial planning framework that seeks to minimize resource user conflict while clearly prioritizing those economic activities that are the most sustainable and benefit the greatest percentage of Bali's communities.

- In order to ensure the recovery of larger reef fishes that both provide an important protein source for local communities while also serving as a primary attraction for divers and snorkelers, these MPAs must include significant "no-take" areas where all forms of fishing and resource extraction are prohibited in order to allow a refuge for these stocks to recover, grow and reproduce — thereby repopulating the reefs of Bali and eventually providing increased catches to fishers operating outside of these no-take areas. To be effective, these no-take areas need to cover 20–30% of the important marine habitats of Bali.

- In designing the Bali MPA Network, it is very important to ensure that all major fish and coral community types are represented in the network — both to protect the full range of Bali's marine biodiversity while also providing the greatest insurance for climate change resilience/adaptation. The results of the Bali MRAP suggest there are at least five major coral community types (fish assemblages largely follow this pattern as well) around Bali, roughly dividing as: northern Nusa Penida; east coast of Bali from Nusa Dua to Gili Selang; north coast reefs of Bali from Amed to Menjangan; north coast soft-bottom habitats in Puri Jati/Kalang Anyar and Gilimanuk Secret Bay; and high wave energy environments on the west and south coasts of Bali and south coast of Nusa Penida.

- In addition to capturing the representativeness of these five major community types, the Bali MPA Network should also strive to include sites of specific high conservation value due to extraordinary biodiversity, particularly intact habitats, rare or endemic species, or fish spawning aggregations or aggregations for cleaning or nesting. Specific sites recognized by the MRAP team as being of particularly high conservation value on the Bali mainland include Batu Tiga (Gili Mimpang), Tepekong, Gili Selang, Tulamben, Amed (Jemeluk and Bunutan), Menjangan, Penutukang, Taka Pemuteran, Sumber Kima, and Secret Bay (Gilimanuk). Previous sites identified of high conservation value in the Nusa Penida MRAP (both due to high biodiversity and for importance as cleaning sites for oceanic sunfish and manta rays) include Crystal Bay, Toya Pakeh, Manta Point, North Lembongan, Batu Abah and Sekolah Dasar (Penida). The turtle nesting beach of Perancak was also previously identified as being of particularly high conservation value. Each of these sites should at least be included in MPAs within the Bali network, and should in fact be strongly considered for inclusion in no-take zones where all fishing and resource extraction is prohibited.

- As a final criterion in site selection/prioritization for the Bali MPA Network, reefs on the east coast of Bali (particularly around Candidasa and Padang Bai) and Nusa Penida are considered particularly important to include within the MPA network from the perspective of climate change resilience; these reefs are subject to both strong currents as well as frequent cold-water upwelling (both a result of the oceanographic feature of the Indonesian Throughflow moving through the Lombok Strait) that should help minimize the effects of warming from climate change.

- Based upon survey findings of only three reef sharks observed in 350 hours of diving, as well as recent evidence of the wholesale slaughter of pregnant female thresher sharks in the waters between Padang Bai and Nusa Dua, the Bali government should strongly consider implementing legislation to create a shark sanctuary in Bali that outlaws the capture or killing of any shark species in Bali provincial waters. The creation of a Bali shark sanctuary will be well-received by the international press at a time when Bali is increasingly criticized for its environmental problems, and will prevent even further criticism when information on the thresher shark slaughter is exposed internationally. Moreover, such a move would keep Bali in good stead with its competitor destinations for marine tourism, as many of these (including the Maldives, Palau, Micronesia, the Bahamas, and Guam) have recently declared shark sanctuaries to strong international praise. In October 2011 alone, the Marshall Islands created the world's largest shark sanctuary at 1,990,530 km^2. Bali would be well-served to follow suit, noting that a shark sanctuary will not only create a strong positive media impression of the political will to act decisively on serious environmental problems, it will also over time (as shark populations recover) contribute significantly to increasing the value of Bali's marine tourism.

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- The last chapter also analyses secondary data on other marine mega fauna around the island (including whales, dolphins, sea turtles and manta rays). Important sites for Bali's marine mega fauna are included in the seven MPA candidate sites identified in June 2010. The 2011 Marine Rapid Assessment does not cover all crucial information for the design of an MPA network, such as mangrove distribution and basic oceanographic information. In depth analyses on social, cultural and economic contexts are also excluded from the report. Nevertheless, despite the absence of all required data, the Precautionary Principle dictates the immediate implementation of conservation management.

- Taking the above recommendations into account, we strongly recommend that the following nine regions within Bali be prioritized for development of MPAs (or improvement of MPA management in the case of those regions that have already gazetted MPAs): Peninsula region (Bukit Uluwatu to Nusa Dua), Nusa Penida, Padang Bai-Candidasa, Tulamben-Amed, Buleleng Timur (Tejakula), Buleleng Tengah (Lovina), Buleleng Barat (Pemuteran), Bali Barat National Park (including Menjangan and Secret Bay), and Perancak. Depending on local conditions (oceanographic, political, and cultural), it may be appropriate in each of these regions to consider a single larger MPA, or a series of smaller MPAs; either way, it is important that all nine of these regions be prioritized within the Bali MPA Network. We also note that this recommendation should not preclude the gazettement of additional MPAs in areas we have not recommended as priority areas; new information (including data on factors the MRAP did not consider such as mangrove or seagrass distribution, etc) may strongly recommend this, or local communities may simply show strong motivation to implement an MPA.

- It is imperative that the Bali government and all stakeholders recognize that effective management of the MPA network will require serious enforcement efforts and will be a relatively expensive undertaking that will need significant governmental funding to succeed. The government should strongly consider working with the marine tourism sector to develop MPA user fee systems (such as those already working effectively in MPAs like Bunaken and Raja Ampat) that could contribute significantly to the costs of enforcement and MPA management. The government should also consider allocating a percentage of tax revenues from both the tourism and fisheries sectors towards management of the MPA network.

- Bali's coastal zone faces a serious problem of marine litter (especially plastic trash) and pollution from high concentrations of nutrients and sewage entering the ocean through streams and rivers, and seepage in areas of large coastal tourism infrastructure development. The Governor's goal to eliminate the use of fertilizers and pesticides in Bali's agriculture by 2014 is highly commendable and will certainly have a positive effect on this problem. However, much more needs to be done in this regard, including a strong public education campaign (backed up with enforcement and fines) to stop the widespread practice of littering and especially waste-dumping in waterways (all of which eventually lead to the sea). Efforts to seriously reduce the amount of plastic packaging from retail outlets (such as a ban on plastic bags) should also be strongly considered.

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