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Executive Summary

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Introduction

Timor-Leste is situated at the heart of the Coral Triangle and home to some of the most significant marine biodiversity on earth. Eleven of its thirteen districts border the coastline and fishing communities are directly reliant on marine and coastal resources for both food security and their livelihoods. The Timorese Government has also identified nature-based tourism as one of the cornerstones for its future economic development, with plans to establish a tourism trail from Dili to the eastern-most tip of the country. Dive tourism forms an integral part of these plans.

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In 2007, after just five years as an independent nation, Timor-Leste declared its first National Park – the Nino Konis Santana National Park (NKSNP). Located in the country's eastern extremity, NKSNP includes a 55,600 hectare marine component. While the decision to declare the National Park was a welcome move towards improved protection of Timor-Leste's important and valuable marine environments, there remain significant challenges to its successful implementation.

A key challenge for the NKSNP management is the current lack of zoning. NKSNP was established as an IUCN Category V Protected Area, meaning that people continue to live within, rely on, and actively use the resources of the Park. Multiple-use zoning is required to establish the 'rules' within this space, to afford the best possible protection for the natural environment without undermining the needs of the people who live there. These 'rules' can then inform how the park is managed.

Under the Coral Triangle Initiative (CTI), the National Government requested assistance from USAID's Coral Triangle Support Partnership (CTSP) to explore the possibilities for cost effective management solutions with strong community participation. CTSP has, in turn, co-facilitated a process whereby fishing communities in the National Park have completed multiple-use zoning of their local marine area. The zones include no-take zones, buffer zones, and special regulation zones with a mix of gear restrictions, temporal closures and species specific take limits. This community-based zoning is accompanied by community-based management plans and covers 22,360 hectares of the 55,600 hectare marine park.

To move this work forward, CTSP was requested to undertake a marine survey, and to provide a report – with recommendations – on the biodiversity, community/assemblage structure, and current condition of coral reefs and related ecosystems. This information will be used to verify the zoning decisions to date, provide data to inform zoning of the remaining 33,240 hectares, and inform development of the marine component of the NKSNP management plan. The survey was also tasked with providing recommendations about priority sites beyond the NKSNP which should be prioritised for increased protection – particularly as they relate to the development of marine tourism along the north coast of Timor-Leste.

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Timor-Leste MRAP Objectives

The assessment, conducted from 14-23 August 2012, 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 approximately 20 sites representing the full range of oceanographic and ecological conditions found in the Nino Konis Santana National Marine Park, compiling thorough species-level inventories of each of these groups.

- Compile spatially-detailed data on biological features which must be taken into consideration in development of the Nino Konis Santana National Park Management Plan. This includes not only an analysis of any differences in reef community structure across the 20 priority sites, but also specifically identifying areas of outstanding conservation importance and/or marine tourism interest 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 Timor-Leste government on development of the MPA's management plan (including zonation plan) and on developing marine tourism in the MPA.

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Survey Results: General

- The MRAP was successfully completed during a 10-day period of 14-23 August 2012, with a presentation of preliminary findings to the Timor-Leste government on 24 August 2012. The survey team comprised 9 individuals, including 7 local and international marine taxonomists from Conservation International/Coral Triangle Support Partnership (CTSP) and the Timor-Leste Ministry of Agriculture and Fisheries, and 2 videographers. The survey was funded in its entirety by the United States Agency for International Development (USAID), through the CTSP.

- In total, twenty-two sites were successfully surveyed (see Table 1 below), including 14 sites within Nino Konis Santana National Park (both mainland coast and Pulau Jako), as well as 4 sites on the northern mainland coast east of Dili and 4 sites on Pulau Atauro. Unfortunately the southern coastline including Lore was not surveyed due to weather conditions. Two of the sites were assessed for corals only (sites 14 and 22), and two of the sites were assessed for fishes only (sites 12 and 13).

Table 1. Summary of survey sites for Timor-Leste Marine RAP 14-23 August 2012. GPS coordinates given for each site, as well as an indication of whether site was located within the NKS National Park.

No.	Date Surveyed	Location Name	NKS Site?	Coordinates
1	14 August 12	Hera West	N	08° 31.183' S, 125° 38.664' E
2	15 August 12	Com (Vailovaia)	Y	08° 21.301' S, 127° 03.631' E
3	15 August 12	Com (Koho Vari)	Y	08° 21.693' S, 127° 05.714' E
4	16 August 12	Loikere	Y	08° 21.131' S, 127° 09.326' E
5	16 August 12	East Loikere (Big Rock)	Y	08° 20.683' S, 127° 09.822' E
6	17 August 12	NW Jako Island (Vata)	Y	08° 24.582' S, 127° 19.425' E
7	17 August 12	SW Jako Island - Perevenu - candidate NTZ	Y	08° 26.298' S, 127° 18.610' E
8	18 August 12	Hilapuna - candidate NTZ	Y	08° 26.298' S, 127° 17.391' E
9	18 August 12	West Jako Island	Y	08° 24.597' S, 127° 19.001' E
10	18,19 Aug 12	Djonu Twin Rocks - candidate NTZ	Y	08° 22.850' S, 127° 14.821' E
11	17,20 Aug 12	Ete Asa Lepek	Y	08° 21.723' S, 127° 04.488' E
12	17,18 Aug 12	Com Harbor seagrass site - fish only	Y	08° 21.762' S, 127° 03.976' E
13	18 August 12	Com Deep Cave - fish only	Y	08° 21.952' S, 127° 07.154' E
14	19 August 12	Djonu East - corals only	Y	08° 23.252' S, 127° 16.543' E
15	19 August 12	Tutuala 3 Terraces	Y	08° 22.555' S, 127° 13.828' E
16	20 August 12	Tenu (Japanese Bunker)	N	08° 19.235' S, 127° 00.070' E
17	21 August 12	Lamsana Inlet East	N	08° 30.977' S, 126° 04.388' E
18	21 August 12	Lamsana Inlet West	N	08° 30.826' S, 126° 04.157' E
19	22 August 12	Belio Barrier Reef (Pulau Atauro)	N	08° 13.603' S, 125° 36.802' E
20	22 August 12	Belio "Saddle" Patch Reef (Pulau Atauro)	N	08° 12.933' S, 125° 37.580' E
21	23 August 12	Atauro Lagoon	N	08° 14.374' S, 125° 36.728' E
22	23 August 12	Atauro Belio Harbor - corals only	N	08° 13.281' S, 125° 36.830' E

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- With over 250 man-hours of diving conducted during the MRAP, the team was overall very impressed with the extremely high biodiversity at the site level (including several new species and a number of range extensions) and pleased to note that the majority of those reefs with top conservation value have already been wisely included within the NKS National Park (and in fact many are already agreed upon by local communities to be included as no-take areas for fisheries replenishment). While there was abundant evidence of past crown of thorns starfish (COTS) outbreaks and legacy damage from blast fishing, most reefs (especially within the NKS National Park) appeared to be in an active state of recovery. Some reefs, especially those closer to Dili, suffered from sedimentation caused from erosion in the hinterlands - pointing to an urgent need for improved watershed management. On the positive side, the team also noted that most reefs surveyed were exposed to cooler temperatures (25-27°C) than reefs in nearby Indonesia as well as strong currents, two factors which likely will confer strong climate change resiliency to Timor-Leste reefs. Overall the team noted that Timor-Leste has made excellent progress in gazetting NKS National Park as a robust "anchor MPA" for its nascent national MPA network, and now needs to work on both consolidating this effort with a strategic zonation system and management plan for NKS while also making progress in gazetting new representative MPAs and focusing on watershed management to keep its marine ecosystems and their related fisheries healthy.

Survey Results: Reef Fish Biodiversity

- The biodiversity of reef fishes was assessed for 20 of the 22 survey sites using underwater visual census from 1-70m depth. A total of 741 species were recorded, representing 234 genera and 61 families. In addition, 40 species not recorded during the MRAP were noted by A.M. Ayling during a 2008 survey of the proposed Nino Konis Santana Marine Park and another 33 records were added by a September 2012 expedition from the Australian Museum. Therefore, the current known reef fish fauna of Timor-Leste includes 814 species.

- With the addition of historical records (123 additional species) from Timor-Leste and Indonesian West Timor, as well as Kupang market survey records (31 additional species) by B.C. Russell of the Northern Territory Museum, the resultant total is raised to 968 reef fish species belonging to 316 genera and 88 families. A total of 275 species recorded during the current MRAP represent new records for this region.

- A formula for predicting the total reef fish fauna based on the number of species in six key indicator families (Chaetodontidae, Pomacanthidae, Pomacentridae, Labridae, Scaridae, and Acanthuridae) indicates that at least 1232 species can be expected to occur in the region of Timor-Leste and West Timor.

- Wrasses (Labridae), Damselfishes (Pomacentridae), and gobies (Gobiidae) are the dominant groups in the region in both number of species (104, 94, and 89 respectively) and number of individuals.

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- Species numbers at visually sampled sites during the survey ranged from 66 to 294, with an average of 212 species per site. This is the second highest average for any survey region to date anywhere on the globe. The top 7 sites recorded for reef fish diversity in Timor-Leste included Site 19 (Belio Barrier Reef, Pulau Atauro; 294 species); Site 4 (Loikere; 270 species); Site 11 (Ete Asa Lepek; 260 species); Site 9 (West Jako Island; 249 species); Site 16 (Tenu; 243 species); Site 13 (Com Deep Cave; 238 species); and Site 10 (Djonu Twin Rocks Tutuala; 237 species).

- 200 or more species per site is considered the benchmark for an excellent fish count. This total was achieved at 70 percent of the 2012 Timor-Leste MRAP sites - the highest percentage yet recorded by the authors anywhere in the world.

- During the course of the survey, we photographed and collected three definite undescribed species (a damselfish in the genus Chromis, a goby in the genus Vanderhorstia, and a jawfish in the genus Stalix - noting that each of these have also been previously photographed in Indonesia) and three species that are potentially new (a dottyback in the genus Labracinus, another damselfish in the genus Chromis, and a damselfish in the genus Chrysiptera) but are currently being investigated with genetic techniques to determine if they do indeed represent distinct taxa. Moreover, we recorded at least 16 important range extensions of species previously not known or expected to occur in Timor-Leste - some having only been previously known from Brunei and the South China Sea. Included in these extensions are the following species: Luzonichthys taeniatus, Pseudochromis pictus, Cirrhilabrus humanni, Cirrhilabrus tonozukai, Hoplolatilus chlupatyi, Chlorurus capistratoides, Pterapsaron longipinnis, Synchiropus tudorjonesi, Pseudanthias charlenae, Pomacentrus cheraphilus, Meiacanthus cyanopterus, Parapercis flavolineatus, and Trimma papayum.

- Sharks, coral trout (Plectropomus species), and the highly threatened Napoleon Wrasse (Cheilinus undulatus) were rarely seen during the survey, an indication of significant fishing pressure and the urgent need for implementation of no-take zones within Timor-Leste's national MPA network for the purposes of fisheries replenishment.

- In summary, we were impressed with the extremely high within-site diversity of Timor-Leste's reefs, as well as the overall high diversity recorded. We have no doubt that additional survey work focused on the south coast as well as Pulau Atauro and other habitats not yet thoroughly sampled on the present MRAP would yield even more impressive diversity numbers (and likely new species and range extensions) for Timor-Leste. In the meantime, we recommend an initial focus on setting up well-enforced no-take zones and a broader zonation system with clear rules within the NKS National Park, as well as an initiative to gazette a new MPA at Pulau Atauro. We moreover note that Timor-Leste has excellent potential for development of marine tourism as a synergistic economic driver along with MPA implementation, whilst noting that it is important to set clear regulations from the outset that insure that local communities derive meaningful benefits from tourism in a way that encourages even better stewardship of their reefs.

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Survey Results: Hard Coral Biodiversity

- A total of 39 sites (adjacent deep and shallow areas) at 20 stations (individual GPS locations) were surveyed along the NE coast of Timor-Leste inside and outside of Nino Konis Santana National Park and on Atuaro Island. Coral communities were assessed in a range of wave exposure, current and sea temperature regimes, and included most habitat types of the NE coast. Coral communities of the S coast, known to be of differing structure because of the different environmental regime, were not assessed due to weather and logistic constraints.

- Timor-Leste hosts diverse reef coral fauna, with a confirmed total of 367 reef-building (hermatypic) coral species. An additional 27 species were unconfirmed, requiring further taxonomic study. Three species (Echinophyllia, Goniopora and Montipora spp.) show significant morphological differences from their closest congeners, and are likely new to science, though requiring additional taxonomic study. In total, there are likely to be ca. 400 hermatypic Scleractinia present in Timor-Leste waters.

- Using cluster analysis at the station level, four coral community types were identified. Each of the communities was characterized by a more-or-less distinctive suite of species and benthic attributes. Two communities occurred predominantly in NKSNP, one of which at Jako Island and the other along the NE coast. The other two communities were most common further west and at Atuaro Island.

- The above impacts notwithstanding, corals exhibited relatively low levels of recent injury overall, other than at Lamsana Inlet, where an active crown-of-thorns seastar outbreak was occurring. There was no evidence of past or recent major coral bleaching-related mortality, as typically triggered by elevated or depressed sea temperatures.

- There was no evidence or reports of past (1998) or recent (2010) large-scale high temperature bleaching-induced coral mortality around Timor-Leste. This is consistent with the presence of cool waters in most sites, which were typically 25-27° C at the time of the survey in August. This is three to four degrees cooler than many neighbouring locations, where sea surface temperatures consistently average 29-31°C, inter-seasonal and inter-annual variability notwithstanding.

- Waters to the north and south of Timor-Leste are major corridors of the Indonesia ThroughFlow (ITF), itself influenced by the cooling effects of mixing in the Banda Sea. If these cooling influences remain consistent, reliable features, Timor-Leste's oceanography may provide a cool water buffer and refuge against the increasing sea temperatures predicted from climate change over coming decades.

- Timor-Leste has shown great initiative in declaring Nino Konis Santana National Park, which, with effective management, can play a very important role in conservation and replenishment locally and regionally and serves as an outstanding anchor for Timor-Leste's nascent MPA Network. NKSNP has high quality reefs and forms an important link in the regional MPA network being developed in the Lesser Sunda marine ecoregion and the broader Coral Triangle Reefs of high conservation value were widespread in NKSNP and also at Atuaro Island.

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- Those reefs with the highest conservation value (taking into consideration indices of replenishment value, rarity, species richness, and hard coral cover) include sites 7 (Jako Island SW), 14 (Djonu East), 4 (Loikere), 6 (Jako Island NW), 15 (Tutuala 3 Terraces), and 19 (Belio Barrier Reef on Atauro Island).

- Most of the high quality reefs we recorded (including 5 of the 6 highest conservation value reefs noted above) are located within the NKSNP, and thus are already afforded a degree of protection and will soon be the focus of strong management, monitoring and enforcement. Reefs at Atuaro Island are also of high conservation value for a number of different criteria, including the presence of two coral community types generally not well represented in NKSNP. As such, Atauro is strongly recommended for development into a new MPA, or even as an extension to NKSNP.

Survey Recommendations

- **Recommendation 1: There are four areas – the Com coastline, Tutuala coastline, Jako Island and Atauro Island – which are strongly deserving of special management attention.** Taking into account the results of both reef fish and coral surveys, the following sites rank amongst the highest in conservation value (based on diversity, biomass/cover, rarity, and replenishment potential): sites 4 (Loikere), 6 (Jako Island NW), 7 (Jako Island SW), 9 (West Jako Island), 10 (Djonu Twin Rocks), 11 (Ete Asa Lepek), 13 (Com Deep Cave), 14 (Djonu East), 15 (Tutuala 3 Terraces), and 19 (Belio Barrier Reef on Atauro Island). Importantly, these top sites group into four main areas: the Com coastline, Tutuala coastline, and Jako Island areas of NKSNP, and Atauro Island. These four areas are strongly deserving of special management attention, as described in the below recommendations.

- **Recommendation 2: That the top priority action for the Timor-Leste Government with regard to marine management, is establishing improved management of the NKSNP.** It is clear from the MRAP survey results that NKSNP is exceedingly well-sited and encompasses the majority of the high conservation value reefs in Timor-Leste, as well as generally good representation of the main coral and reef fish community types. As such, we strongly recommend that the top priority action for the Timor-Leste government at this critical juncture is to continue the strong community engagement already started by the CTSP program and aim to finalize a management plan with a clear and effective zonation system (and its associated rules) that has the strong support of local communities and that provides for strong enforcement (preferably involving local communities as well).

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- **Recommendation 3: Establishment of significant 'no-take' zones in key areas will be important 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**. The NKSNP (and any other MPAs gazetted as part of the Timor-Leste MPA network) should include significant "no-take" zones (NTZ's) 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 Timor-Leste and eventually providing increased catches to fishers operating outside of these no-take areas. To be optimally effective, these NTZ's need to cover minimally 20-30% of the important reef habitats of Timor-Leste, and should generally aim to have a minimum size of 10 hectares per no-take zone - with larger NTZ's providing more rapid and significant results. Our results show that the NTZ's previously suggested by local communities are very well sited and should be implemented as soon as possible. We moreover note that there are 3 areas in particular which currently have NTZ's agreed to by communities that in the future should be considered for possible expansion: the stretch of reef just east of Com (Ete Asa Lepek to Loikere); the Tutuala coastline, and Jako Island. While we understand that it may not be possible to include the entirety of each of these areas in NTZ's, we strongly urge a phased approach in implementation of NTZ's in NKSNP, whereby the community-suggested areas are implemented and enforced immediately, after which time the communities can be encouraged to consider expanding the NTZs in these 3 areas to cover larger sections of optimal reef fish habitat. Creating several larger fisheries replenishment areas using NTZ designation will have a larger beneficial result to local communities than having a large number of small community NTZs.

- **Recommendation 4: Establish improved protective mechanisms for Atauro Island. Importantly, the team unanimously identified Atauro Island** as the top priority area for further MPA development due to its extremely high biodiversity and highly strategic oceanographic setting in the center of the Ombai Strait (bathing these reefs with strong currents and frequent cool upwellings and thus affording it both outstanding connectivity with other reefs of the Lesser Sunda marine ecoregion and also likely strong climate change resilience). Atauro moreover has excellent potential for marine tourism development (due to its scenic nature, proximity to Dili, and excellent reefs and water clarity), and adding this as either a second MPA in the Timor-Leste network or even as an extension of NKSNP (if that is considered preferable for logistic or administrative reasons) would also ensure better representation of coral community types C and D, which are otherwise only minimally represented within the present boundaries of NKSNP.

- **Recommendation 5: Recognize that effective management will require long term government commitment and resources, and initiate steps to secure this.** It is imperative that the Timor-Leste 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

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those already working effectively in MPAs like Bunaken and Raja Ampat in neighboring Indonesia) that could contribute significantly to the costs of enforcement and MPA management. Importantly, management and enforcement in the NKSNP and any other MPAs to be gazetted should strive to involve local communities as much as possible; while this will undoubtedly require significant investment in local capacity building, in the long run having community-led enforcement and management provides the strongest likelihood of long term sustainability and effectiveness of the MPA(s). It is moreover important to note that with effective implementation of the NKSNP management plan, a significant buildup in fish biomass is to be expected within a relatively short time frame of 3-5 years. Recovering fish stocks will likely make the area a target for illegal foreign fishing boats, which may require national level enforcement efforts beyond what can reasonably be expected of NKSNP park rangers.

- **Recommendation 6: Consider drafting a marine tourism master plan.** Timor-Leste has excellent potential to further develop its marine tourism industry. While the current marine tourism hub for the nation is focused around Dili, the smaller-scale tourism development now focusing on the reef areas around Com and Pulau Jako within the NKSNP and on Atauro Island should be nurtured by the government and provided clear direction and incentives to ensure that they develop in an environmentally-sustainable manner that provides clear benefits to local communities. The government should strongly consider drafting a marine tourism master plan that provides clear regulations on environmentally-friendly accommodation construction and waste management, as well as stipulations to ensure that local communities derive clear benefits (by requiring, for instance, a minimum percentage of resort staff to be hired from local communities, etc). The master plan should carefully consider and strive to harmonize development of both community-run homestays as well as more capital-intensive dive resorts, and should set a clear "tourism carrying capacity" that limits the number of operating licenses. As noted previously, the master plan should also include the development of a marine tourism entrance fee system that is used to fund both MPA management and community improvement programs as has been done effectively in a number of well-established Coral Triangle MPAs.

- **Recommendation 7: Improve watershed management for catchments leading to Hera and Lamsana.** As many of the coastal reef areas closer to Dili (particularly Hera and Lamsana) are showing strong signs of sedimentation stress from erosion within the hinterlands, we strongly urge the Timor-Leste government to take urgent action to improve watershed management and especially to provide/rehabilitate riparian buffer zones that prevent further erosion of Timor-Leste's thin soil in agricultural areas. This will be important not only to improving the long-term sustainability of agriculture, but also for ensuring the food security which Timor-Leste's reefs have long provided for coastal communities and also preserving future marine tourism potential for these coastal reefs.

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