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Community Engagement: An Integral Component of a Multifaceted Conservation Approach for the Transboundary Western Pacific Leatherback

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Bycatch in fisheries is one of the greatest threats to marine megafauna such as sea turtles, and the Biodiversity Impact Mitigation Hierarchy (BIMH) has been proposed as an improved and holistic approach for integrating fisheries management with sea turtle conservation. The first three BIMH steps – avoid, minimize, and remediate – take place at sea where fishing activity is taking place. However, these at-sea measures are costly and difficult to effectively implement across the vast range of a highly migratory species. As such, some level of mortality continues, even when the first three steps of the BIMH are implemented as extensively as possible. These remaining negative impacts need to be addressed by compensatory conservation actions elsewhere, e.g., at sea turtle nesting beaches. As a case study, we use the critically endangered leatherback sea turtle nesting population in Papua Barat, Indonesia, to illustrate the opportunity for conservatory offsets to fisheries bycatch across the Pacific. We describe the community empowerment and nest protection programs that have been enhanced by the voluntary offsets from the tuna industry. While improved nest protection measures have helped optimize hatchling production, the engagement of the local communities, through activities that empower and enhance quality of life, has been a critical component to the successful increase in hatchlings. This momentum needs to be sustained and scaled-up to protect the majority of threatened nests over a consistent number of years to successfully provide the recruitment boost needed at the population level. These compensatory off-site conservation measures are also the most cost-effective means of achieving increases in leatherback populations, and perhaps one of the most critical components of the recovery strategy for Pacific leatherbacks.

Keywords: Papua Barat, Indonesia, leatherbacks, community engagement, hatchling production

INTRODUCTION

The conservation of critically endangered populations is a complex, multi-disciplinary and multi-faceted undertaking (Bennett et al., 2017). This requires consistent and reliable monitoring of the population, effective control of threats across all life history stages, long-term engagement with local communities and relevant government authorities, and the development of sustainable, creative, and flexible management strategies. The life history of sea turtles makes conservation of their populations particularly challenging. They spend most of their life at sea, often traversing the waters of many countries, while coming ashore only to lay eggs that incubate in the sand for approximately 2 months before the hatchlings emerge. Despite the need for a holistic conservation strategy, which addresses all sources of mortality across life history stages (Bellagio Blueprint for Action on Pacific Sea Turtles, 2011; Dutton and Squires, 2011; NOAA-NMFS, 2016), efforts to mitigate sea turtle bycatch continue to be enacted in a piecemeal manner in individual fisheries, typically under the assumption that nesting beach conservation is being effectively carried out. Furthermore, at-sea and nesting beach management tend to operate independently under different regulatory frameworks and funding initiatives. Therefore, to consolidate these various conservation efforts more effectively, the Biodiversity Impact Mitigation Hierarchy (BIMH) has recently been proposed as an improved, holistic and integrative approach for fisheries management and biodiversity conservation (Arlidge et al., 2018; Milner-Gulland et al., 2018; Squires and Garcia, 2018) because it considers a broader suite of actions to reduce anthropogenic mortality across a bycaught species' entire life cycle and range of habitat use (Squires et al., 2018). In the BIMH, the primary approach is mitigating bycatch at sea where fishing is taking place. However, at sea measures, such as gear modification, time-area closures, and best fishing practices, are costly and difficult to effectively implement in multiple countries across the vast range of a highly migratory species. Therefore negative impacts from fishing remain, despite these bycatch impact reduction measures. This mitigation deficit needs to be addressed by the last component of the BIMH, which are compensatory conservation measures at sea turtle nesting beaches (Squires et al., 2018).

As an example, we use the critically endangered leatherback turtle (*Dermochelys coriacea*) nesting population on the beaches of Jamursba-Medi and Wermon in the Bird's Head Abun region of Papua Barat, Indonesia, in the Western Pacific to illustrate the opportunity for conservatory offsets to fisheries bycatch within the BIMH framework. We describe the implementation of multi-level conservatory offsets within the BIMH strategy for this population through nesting beach protection and optimization of reproductive output, innovative approaches to engage local communities in the nesting beach conservation effort, identification of metrics for quantifying conservation gain, and review of elements necessary for success from three decades of conservation effort.

LEATHERBACK NESTING IN PAPUA BARAT, INDONESIA

Leatherback sea turtle populations are classified as critically endangered in the Pacific by the IUCN Red List (Tiwari et al., 2013), and the severe decline of over 90% is due to egg harvesting, exploitation for meat and fat, habitat destruction, and bycatch in artisanal and commercial fisheries. In the eastern Pacific, leatherback populations in Mexico, Nicaragua and Costa Rica have declined dramatically (Ábrego et al., 2020). In the western Pacific, the once large nesting population in Malaysia is now considered functionally extinct (Chan and Liew, 1996) and although the key leatherback populations remaining in the western Pacific, in Indonesia, Papua New Guinea, and the Solomon Islands are severely depleted, they offer the best prospects for recovery (Dutton et al., 2007). Approximately 75% of this nesting takes place along the north coast of the Bird's Head peninsula in the Abun region of Papua Barat, Indonesia (Dutton et al., 2007).

Two index beaches in the Abun region of Papua Barat, Indonesia – Jamursba-Medi (18 km) and Wermon (6 km) – support the last, largest leatherback nesting population remaining in the Pacific (**Figure 1**). Nesting occurs year round; April to September (boreal summer) and October to March (austral summer; Hitipeuw et al., 2007). Leatherbacks from this population forage widely – boreal summer nesters head to the South China Sea, western USA, the equatorial eastern Pacific, and the Kuroshio Extension region whereas boreal winter nesters travel toward southeastern Australia and Tasmania (Benson et al., 2011); fisheries bycatch on these migratory routes and foraging grounds is speculated to have considerably impeded the recovery of this population (Roe et al., 2015).

Despite the alarming decline observed in this nesting population since the 1980s (Tiwari, *unpublished data*; Tapilatu et al., 2013), it is considered the most robust nesting population remaining in the Pacific that has not yet collapsed to the point of being functionally extinct. Hope for the recovery of this population persists as long as holistic and effective conservation and management measures are consistently implemented throughout the population's range and critical life history stages (Dutton and Squires, 2011).

Within the BIMH framework, the at-sea conservation strategies for leatherbacks in the North Pacific include technology standards, time-area closures (e.g., in California/Oregon drift gillnet fishery), gear and effort restrictions such as hard caps on bycatch (e.g., the Hawaii-based longline fishery), and best practices that together comprise a strategy designed to reduce bycatch and decrease mortality of turtles. However, at-sea measures are challenging to implement across the entire migration range and do not address the large cumulative impact of artisanal fisheries in many developing countries that impact leatherbacks on their migratory routes and in coastal foraging areas on both sides of the Pacific (Arlidge et al., 2020). Given that preventing turtle bycatch completely is both challenging and costly, residual negative impacts on turtle populations continue to take place. Therefore, compensating for this, and achieving

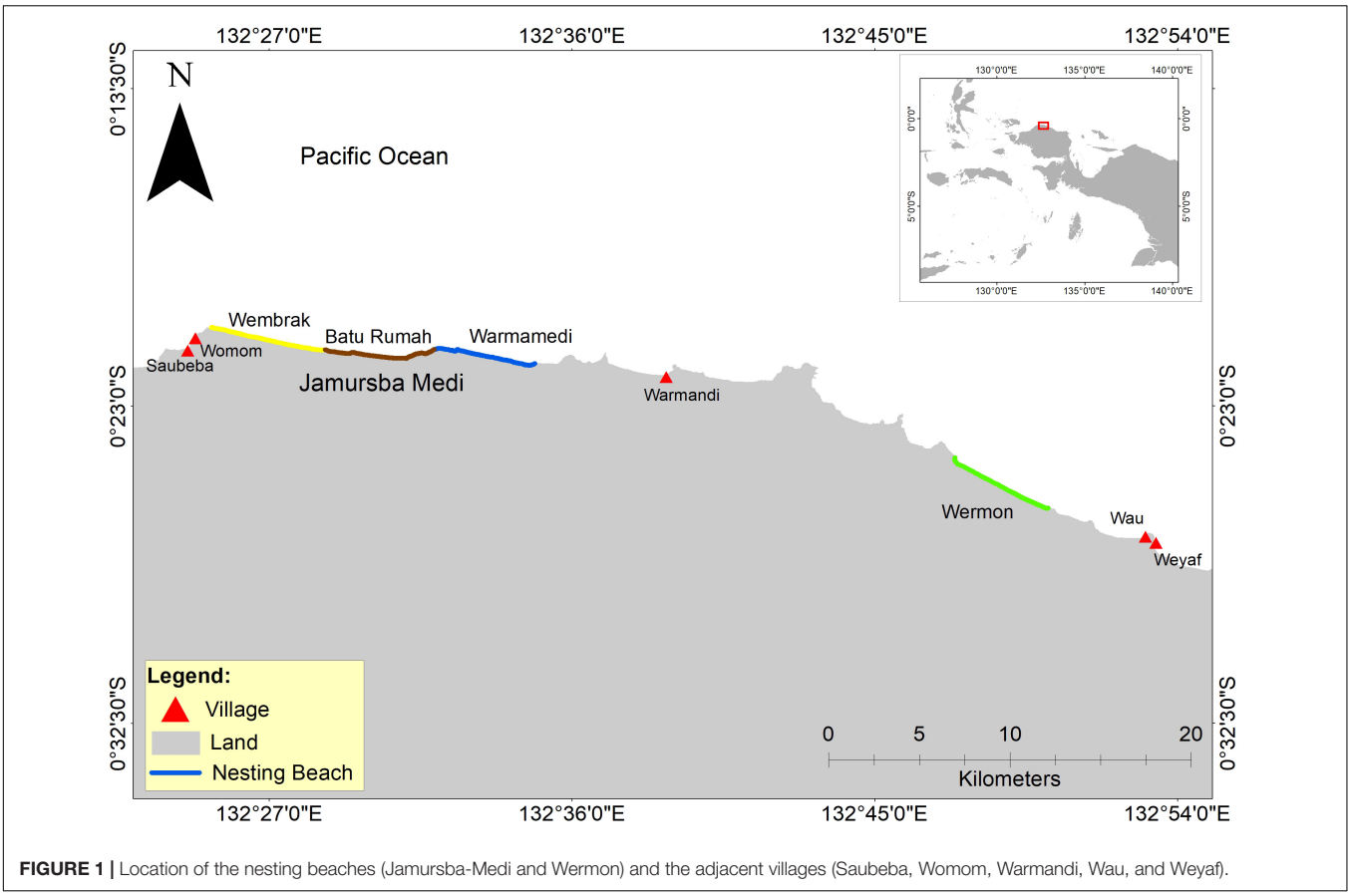

FIGURE 1 | Location of the nesting beaches (Jamursba-Medi and Wermon) and the adjacent villages (Saubeba, Womom, Warmandi, Wau, and Weyaf).

population recovery, depend on effective conservation of nesting populations. This conservatory offset to mitigating bycatch is perhaps the most critical component of the recovery strategy for Pacific leatherbacks. It also satisfies the criteria of the BIMH framework by addressing mortality at a different (and critically important) part of life cycle of the same population that is impacted by high seas and coastal fisheries. Conservatory offsets for sea turtles have yet to be formally incorporated under fisheries management and regulatory frameworks. However, Squires et al. (2018) describe a voluntary program where processors assess a tax each year on tuna landings from longline fisheries (known to impact sea turtles) to fund conservatory offsets at nesting sites, including the Abun Leatherback Project (ALP), through the International Seafood Sustainability Foundation (ISSF). We further describe how conservation outcomes at the Abun leatherback nesting beaches have been enhanced by the local community engagement.

Abun Nesting Beach Program

Since the 1980s, some level of population monitoring has been conducted at Jamursba-Medi and Wermon Beaches, but it was inconsistent and at best reduced harvest of females and eggs (Hitipeuw et al., 2007). However, we now know that nest destruction from feral pigs and dogs, tidal inundation, erosion, and high sand temperatures have resulted in low hatchling productivity (Tapilatu and Tiwari, 2007), and these threats began to be addressed only in this past decade with at best 35% of threatened nests being protected (Tiwari, *unpublished data*). Since 2017, the ALP has adopted a more effective and consistent protect-as-many-nests-as-possible strategy to optimize hatchling output. This overarching goal of maximizing hatchling production has been demonstrated elsewhere to be critical for population recovery (Tiwari et al., 2011). In Papua, ALP's community engagement program has played a very important role in increasing the percentage of nest protected (≥50%) using all strategies. In high risk areas, individual nest enclosures are built to protect nests *in situ* from pig, dog and monitor lizard predation, and nests are shaded individually *in situ* with palm fronds to lower lethal sand temperatures. Local community members are also hired to trap feral pigs in the forest behind the beach to further reduce the intensity of predation. Nests highly vulnerable to erosion and inundation are relocated to hatcheries or stable sections of beach.

However, while the conservation actions needed on the nesting beach are clear, the establishment of a long-term sustainable program in this remote area has been much more challenging. Jamursba-Medi and Wermon Beaches are owned by families in five adjacent villages. These landowners determine access to the beach and what conservation and management activities can be conducted. Therefore, in order for conservation actions to effectively achieve the desired goal of maximizing

hatchling production, it is critical to have community support and involvement.

Abun Community Empowerment Program

Community-based conservation is a least-cost approach to turtle conservation especially in these remote areas with traditional land tenure and impoverished communities (Gjertsen et al., 2014). Local beach communities have strategic roles in conserving biodiversity and ecological functions, however, the historical approach of dealing with the local Abun communities within the conservation framework has been problematic. Community buy-in, welfare, and empowerment were overlooked because those trained in the biological-sciences focused more narrowly on more traditional community-based measures through obvious direct involvement in conservation (e.g., hiring villagers as patrollers, paying concession fees to landowners, and monetizing "eco-tourism"). In Papua, this sowed a sense of social/economic inequity among the village communities and a general discontent toward the leatherback project. A first social survey carried out in the villages adjacent to the beach in 2010 provided insights into local demographics, economy, education, health, and infrastructure available, but more importantly this survey revealed that community members believed that conservation projects functioning on their beaches since the 1980s had so far only prioritized the leatherbacks and a small group of community members, especially the landowners, with few benefits to the broader community (Gjertsen, 2011b). Therefore, integrating the local communities into the project was prioritized through carefully evaluated and targeted quality of life-enhancing activities (Pakiding et al., 2017) as described below, which benefit and empower the entire community (Waylen et al., 2010; Wright et al., 2015).

The community empowerment project was enhanced by the ISSF conservatory offset funding, and implemented through the placement of ALP staff or community workers, mostly fresh graduates from the State University of Papua, in the five villages for almost 10 months of the year since 2013. These community workers determine community needs by interviewing the local leaders every 6 months and guide the development of numerous projects desired by the community. The main livelihood of these communities is farming and hunting, therefore, ALP focused on the community's desire for increased skills and capacity in the agricultural and meat processing sector by introducing improved techniques, processing, and marketing of products. Over time some community members have adopted the introduced technology and were able to sell their products in nearby cities. For example, ALP's community worker introduced improved techniques to make coconut oil in 2013. This program grew from 5 households in 2017 to 38 households in 2019. In 2019, the community produced 2,200 liters of good quality coconut oil worth 4,250 USD. Local community members now make coconut oil during 3–4 months in a year when they cannot sell their agricultural products to nearby cities because of bad weather. Another livelihood-focused scheme introduced in 2018 was teaching the village women to knit traditional bags or "nokens." By 2019, 16 women were involved and had earned around 823 USD. Marketing of these products remains a big challenge, but an initiative by the Office of Cooperatives, Micro, Small, and Medium Enterprise of the Tambrauw District Government in 2019 to establish a marketing cooperative is expected to be one of the solutions.

Given the lack of public awareness about the importance of education, shortage of teaching staff, and limited school facilities and infrastructure, ALP has improved formal education opportunities at the elementary school level in the villages through government and private entities. An informal education program was also established for children not in school at ALP's learning houses. An important goal of the informal education program is to increase the children's awareness and respect for the wealth and importance of their natural resources. Therefore, ALP hosts a Turtle Camp every year and takes village children to the beach to see nesting leatherbacks, to release hatchlings, and to learn about turtle biology and conservation, while they also learn basic hygiene (brushing their teeth, showering, washing hands and feet), and the importance of garbage management. Even village adults are taught about proper garbage disposal and cleanliness in the village and homes. The educational programs, both formal and informal, have been successful and the community respects ALP's efforts. The Tambrauw District Education Office has even used ALP to assist with national examinations for elementary school students.

The lack of medical equipment and medical personnel is one of the biggest problems in these remote villages, and villagers rely on traditional medicines to cure their illnesses. ALP has collaborated with the Provincial and the Tambrauw Regency Health offices to conduct a health program for these communities. This collaboration is an opportunity for the Regional Government to evaluate the health of the community, provide health education, health checks, and free treatment. Meanwhile, medical team visits are organized by ALP to provide regular community health support. The local government is expected to follow up on these activities with better health programs for the communities.

An increasing number of community members are also hired for nesting beach work. Those who have customary rights to the beach work with ALP to monitor the beaches, identify additional community members to help ALP monitor the beaches, and prevent illegal activities. Community members without customary rights are hired by ALP for beach monitoring, nest relocation, hatchery construction, pig-trapping and other project-related activities with the approval of landowners. All community members benefit from the ALP community programs in the villages. Overall, ALP is bringing more income and improved living-conditions to the community.

Conservation Benefits

ALP has gained the trust and goodwill of community members largely because of the community empowerment project, which is showing promise toward enhancing the sense of "ownership" or the intangible "value" of leatherbacks' existence on their beaches. Now as a result of several years of ALP's presence in the community, their flexible and adaptive response to community

feedback, needs and interests, and their consistent messaging that the ALP community and nesting beach team members belong to the same project, the local communities have started to understand and appreciate that they are benefiting because of the leatherbacks.

The benefits of this change in attitude are evident also on the nesting beach. Between 2013 and 2016, community members used to openly offer turtles eggs to ALP staff, but today this no longer occurs; local children report that turtle eggs are not served at home, and they are ashamed if caught consuming turtle eggs. Furthermore, since access to the nesting beaches is controlled by several families in Abun who also decide what activities can be undertaken, stabilizing beach access has been at the forefront of ALP's achievements. With secure access starting in 2017, ALP with community support has been able to protect a larger percentage of leatherback nests and increase hatchling production. It should be noted that the increase in hatchling production corresponds to the increased number of community members working with ALP's nesting beach staff.

Conservation Equivalency

Since the conservation benefit to the population of protecting (e.g., producing) a sea turtle hatchling is much lower than protecting a larger juvenile or reproductive female, it is important to account for the relative equivalency when evaluating conservatory offsets targeting different stages of life history. A better understanding of population dynamics (survival rates, age to maturity, sex ratios), as well as bycatch mortality, is needed to develop robust equivalency models, however for our purposes, we can consider some broad equivalencies with the available information for leatherbacks. Note that nest protection, and the resulting increase in hatchling production, is one component of a holistic conservation strategy that includes protection of nesting females on the beaches, the highest level of offset in terms of reproductive value to the population (Gjertsen et al., 2014).

With the initiation of nest protection measures, mean hatchling production was estimated at 21,996 between 2005 and 2013 at Jamursba-Medi during the boreal summer and at 9,490 at Wermon between 2005 and 2011 during the austral summer (Tapilatu, 2014); prior to this almost all the nests were destroyed (Hitipeuw et al., 2007). In the recent years of stable beach access and community engagement (2017–2019), hatchling production in Jamursba-Medi and Wermon increased to 32,000–50,000 hatchlings between April and September alone (Tiwari, *unpublished data*). Therefore, if the estimated reproductive value of 426 hatchlings = 1 adult reproductive female in Papua (Gjertsen, 2011a), then the hatchling production in Jamursba-Medi and Wermon during April to September results in 75–117 adult females. Lewison et al. (2015) estimated that between 1990 and 2011, 678 leatherbacks were taken by longlines and 93 in nets representing 771 leatherbacks taken in 21 years or on average 37 leatherbacks/year in the Western Pacific Regional Management Unit (RMU; Wallace et al., 2010). It appears that hatchlings produced in Jamursba Medi and Wermon in recent years (equivalent to 75–117 adult females a year) would offset the estimated 37 leatherbacks/year taken by these fisheries.

Peatman et al. (2018), however, estimated a median interaction with 24,006 leatherbacks between 2003 and 2017 in longline gear alone in the Western and Central Pacific Fisheries Commission's Convention Area suggesting that take and mortality levels would be much higher than those estimated by Lewison et al. (2015). Given the uncertainty in bycatch estimates and mortality rates across all fisheries in the western Pacific RMU (Wallace et al., 2013; Lewison et al., 2015; Peatman et al., 2018) and the serious declines observed in the nesting population, maximizing hatchling production will be critical for population recovery. A similar approach was emphasized for the eastern Pacific leatherback populations, whose situation is more dire and extirpation is expected in less than 60 years if urgent measures are not implemented to save 200–260 adult and subadult leatherbacks and produce 7,000–8,000 more hatchlings annually (Ábrego et al., 2020).

CONCLUSION

There is an increasing body of research on advancing conservation by influencing human behavior (e.g., Reddy et al., 2016) as well as calls for multi-stakeholder dialogues by the United Nations to build partnerships and identify solutions that are aligned with sustainability objectives (UNEA-4, 2019). Recognizing that local communities and their welfare are an integral component of the conservation equation is fundamental to the success of biodiversity conservation. Additionally, social and natural science professionals need to understand that communities have their own legitimate perspectives on conservation in order to be effective (Berkes, 2007; Bennett et al., 2017). In Jamursba-Medi and Wermon, prioritization and empowerment of the local communities are having a positive impact on the ability to protect leatherback nesters and produce increased numbers of hatchlings. This momentum needs to be sustained and scaled-up to protect the majority of threatened nests over a consistent number of years to successfully provide the recruitment boost needed at the population level. This effort will be greatly enhanced by the creation of the Jeen Womom Coastal Park at Jamursba-Medi and Wermon by the local Tambrauw government and its legalization by the Ministry of Fisheries and Marine Affairs in 2018. The newly formed Technical Implementation Unit of the government (UPTD), trained by ALP, will be responsible for all aspects of Park governance, protection, and sustainability.

Within the BIMH framework, the challenges of Pacific-wide at-sea bycatch mitigation necessitate dynamic and persistent conservation measures on the nesting beaches to optimize hatchling production. Further work is needed to develop mechanisms for determining the residual bycatch cost of specific fisheries, and to develop demographic models to quantify the conservation benefits. Meanwhile, compensatory off-site conservation measures remain the

most cost-effective means of achieving increases in leatherback populations (Gjertsen et al., 2014), and a critical component in Pacific leatherback recovery.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved, in accordance with local requirements in Papua Barat, Indonesia, by the Regent of the Tambrauw Regency; Abun District Head, Tambrauw Regency; and Department of Marine and Fisheries (DKP) of West Papua Province. The animal study was reviewed and approved, in accordance with local requirements in Papua Barat, Indonesia, by the Regent of the Tambrauw Regency; the West Papua Provincial Government Office of Maritime Affairs and Fisheries; and all the local landowners who decided what studies can be conducted on their beaches.

AUTHOR CONTRIBUTIONS

FP was the project leader. KZ, AA, and SK implemented the community components of the project. DL implemented the nesting beach component of the project. MT was the scientific and technical advisor to the leatherback project. MT, PD, FP, and DL were co-leads of manuscript preparation. All authors contributed to the article and approved the submitted version.

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