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coral reef paper

Women managers, local wisdom, and customary practice in marine conservation, Raja Ampat, Papua

[1] YKAN (Yayasan Konservasi Alam Nusantara), South Jakarta, Indonesia

[2] Yayasan Rekam Nusantara, Jawa Barat, Indonesia

[3] University of Queensland, Brisbane, Australia

* Corresponding author email: <hilda.lionata@ykan.or.id>

Hilda Lionata [1] *
Arisetiarso Soemodinoto [2]
Awaludinnoer [1]
Salomina Tjoe [1]
Lukas Rumetna [1]
Nathalie Butt [3]

ABSTRACT.—The critical role of women in natural resource management is becoming increasingly recognized globally. In many Pacific communities, women are highly dependent on natural resources to feed and support their families, and their lives are closely entwined with the quality and quantity of these resources. However, in traditional patriarchal systems, women face multiple challenges related to traditional gender dynamics, including unequal access to natural resources, and lack of decision-making power. "Sasi," a customary practice to manage the continuous supply of forest or marine resources by applying temporary harvest closures, has been practiced for more than 400 years in the eastern part of Indonesia, historically by men. In a world-first initiative, a women's group in West Papua, Waifuna, undertook management of a sasi in 2008, with their rights fully acknowledged by the subvillage government, church, and customary holders. Here, we describe and discuss the group's management of sea cucumbers and lobsters. We found that, despite the challenges they faced, through sasi management women increased their capacity to participate in conservation activities and decision-making, as well as contribute to marine conservation efforts. In addition, the whole community benefitted from changing perspectives on women's abilities to manage natural resources because of the deconstruction of the prohibitive social norms that restricted women's participation in the past.

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Although not previously well recognized or quantified, the role of women in natural resource management around the world is significant (James et al. 2021), including making critical contributions to knowledge preservation and transfer (Razafindratsima and Dunham 2015). This is a particular concern in the marine context, where sociopolitical and sociocultural settings in many developing and

less-developed countries has often put women in disadvantageous situations (Frangoudes et al. 2019). Their contribution of gleaning and nearshore fishing for home consumption and to generate income for their families has not been recognized or properly accounted for, even though their estimated involvement in small-scale fisheries in all regions of the world is approximately 11% (Lentisco and Lee 2015, Pravalprukskul and Resurreccion 2018, Harper et al. 2020). In addition to this lack of representation and acknowledgement, women are unlikely to benefit from positive conservation management outcomes in traditional hierarchies because of many factors affecting women's meaningful engagement in conservation, such as race, ethnicity, age, religion, poverty, and disability (James et al. 2021). Furthermore, despite policies, international agreements, and increasing requirements of donors, gender in terms of women's role and involvement is still often viewed as an "add-on" rather than as a fundamental element of effective conservation (Westerman and Senbow 2013, James et al. 2021). Approaches or interventions that enable and recognize the crucial roles of women in the conservation and management of natural resources in coastal and marine settings are therefore urgently needed.

The conservation and protection of biological resources should be combined with their sustainable use, which can in turn generate funds to finance management that ensures resources supply (Bennett 2004, FAO 2014). With this objective as a key principle, involving women in efforts to balance the sustainable use of coastal and marine resources with conservation and protection of those resources has multiple demonstrated benefits (Westerman and Senbow 2013, James et al. 2021). First, there are benefits to women, by increasing their capacity to participate in conservation activities and decision-making. Second, there are benefits for conservation and protection efforts and outcomes. Third, whole communities benefit from changing perspectives over time, through deconstructing the prohibitive and unjust social norms that restrict women (Westerman and Senbow 2013, James et al. 2021, Harper et al. 2024).

Women's access to natural resources is often hampered by asymmetric gendered power relations; in many areas men are the sole managers and decision-makers, and women are excluded from these processes. In this paper we describe the process by which this gender-normative situation was overturned through the actions of local women in establishing a group to practice a traditional natural resource management system, "sasi," in Papua, Indonesia. We present and analyze the contribution of citizen science to conservation goals, detailing the collaboration between Yayasan Konservasi Alam Nusantara (YKAN)—an affiliate of The Nature Conservancy—which is a national nongovernment organization (NGO) in Indonesia and the women-led management group, Waifuna, to train women practitioners in ecological monitoring and assessment.

Sasi Natural Resource Management.—Sasi, which is a customary practice to manage the ongoing supply of forest or marine resources by applying spatial and temporal close-and-open harvesting seasons, has been practiced for more than 400 yrs in the Maluku Archipelago (Novaczek et al. 2001, Harkes and Novaczek 2002), and by local, traditional communities in Papua, Indonesia (McLeod et al. 2009).

As a practice, sasi typically includes (1) an area, either land or water and the resources therein that will be managed, and (2) a dependent community that will manage the resources, that is in many cases represented by a triumvirate of "adat"

(customary group or leaders), the local religious institution (such as the church), and the village government (Novaczek et al. 2001, Harkes and Novaczek 2002, Purnomo 2003). The management decisions, including the decision to open or close a sasi area for harvesting, are said to be made "by the community", which often means "by a prominent person of the community": e.g., a man in a leadership position. In marine settings, the voices of fishers may or may not be considered, and women are excluded (Novaczek et al. 2001). The participation of women in sasi management is restricted to prescribed activity during a specific time period—during harvesting, for example, to gather sessile species such as sea cucumbers and trochus sea snails during low tide, or to collect fish caught by their husband or male members of the family, in the case of sasi for fish (Novaczek et al. 2001).

After being neglected for decades, there has recently been widespread interest from the community, nongovernment organizations (NGOs), and the Indonesian government in revitalizing or strengthening sasi in many parts of Maluku and Papua (*see*, for example, Mony et al. 2017, Soselisa 2019, to support fisheries in Maluku, and Boli et al. 2014, Lestari and Satria 2015, to support the management of marine conservation areas in Papua). However, it is not known whether this interest has led to an increasing role for women in many facets of sasi management. The Indonesian government's growing interest in customary community matters provides a good opportunity to examine women's role in sasi practice, and most importantly, to facilitate proper recognition and promotion of women's role in the management of renewable natural resources.

Formation of Waifuna and a Sasi in Kapatcol Village, Southwest Papua.—Waifuna is the first sasi group in Papua that was formed and led by women. It was created by Betsina Hay, the Kapatcol village leader's wife, who leveraged her influence to create the group. Given the historic nature of this group, it was important that Waifuna had the tools to demonstrate success and instill confidence among community members in the women's ability to manage local marine resources—particularly marine species such as lobster and sea cucumber that are slow moving and easy to overexploit. The chairperson, treasurer, and secretary formed the leadership of the group, and management tasks were divided into monitoring, documentation/marketing, postharvest handling, and harvesting (carried out by free divers). Fifteen years after its inception, most women with family responsibility (70%) in the village are now members of Waifuna.

Waifuna's experience in sasi implementation faced frequent challenges. Starting in 2008, their attempts in the first few years were unsuccessful, with negligible harvests. However, with persistence and more integration of ecological and biological knowledge, their efforts led to improved harvests in 2011. Waifuna identified a more suitable area covering 32 ha to be managed for their sasi species, and their success resulted in the village government giving them access to a larger area of 181 ha in 2019. The group now manages an area of 213 ha (Fig. 1). The ecosystems in the sasi area include shallow water seagrass habitat of varying density, coral reefs, and mangrove. Tropical sea cucumbers usually spend three months as juveniles, reaching maturity and a body length of ≥15 cm by one year (Azari et al. 2010), while female painted spiny lobsters (*Panulirus versicolor*) are not functionally mature until they reach 7.8 cm carapace length after 2–3 yrs (SeaLifeBase 2024). The rationale for setting up harvest size limits and frequency of opening sasi is based on the species' biology.

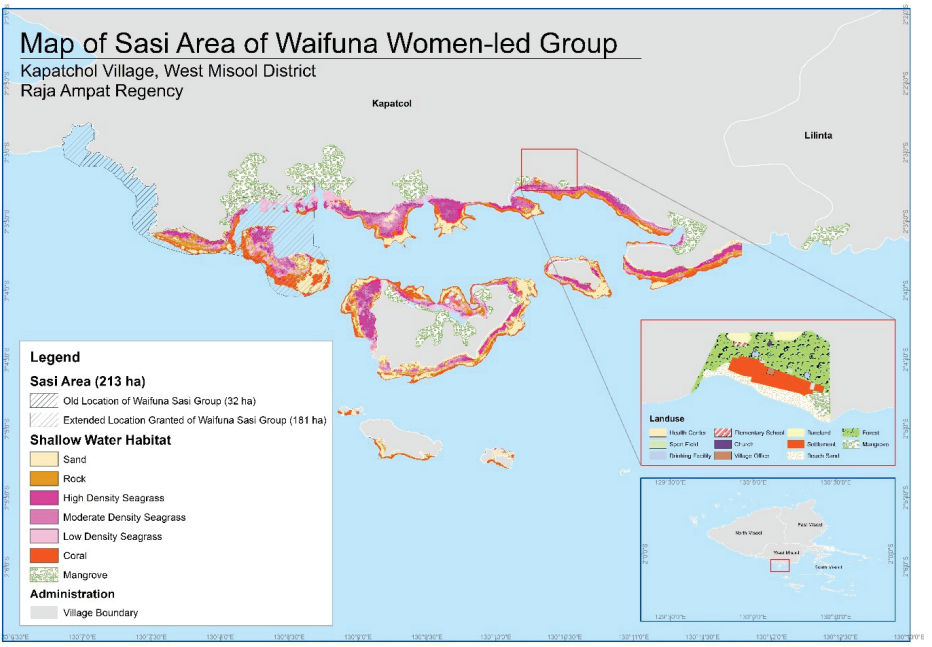

Figure 1. Map of Waifuna Sasi Area in Kapatcol Village, Misool Island, Raja Ampat Regency, Southwest Papua Province, Indonesia. The area contains a mix of shallow water habitats: rock, high to moderate density seagrass, and coral reef. The rock and reef provide suitable habitat for painted spiny lobsters, and the seagrass and reef are most important for sea cucumbers.

Collaboration with NGOs.—Yayasan Konservasi Alam Nusantara (YKAN) partnered with Waifuna to provide training around ecological assessments, species' ecology, and monitoring to ensure successful management of the sasi. It provided support in the initial phases from 2008 and continues to work with the women in an advisory capacity. YKAN has worked in the Bird's Head Seascape, especially in Southwest Papua Province, since 2002 to facilitate the development of marine conservation, through establishment and management of marine protected areas (MPAs) and the promotion of conservation-supportive sustainable livelihoods by local communities.

After the initial unsuccessful harvest, Waifuna and YKAN carried out suitability assessments to establish whether the area was suitable for the species they managed under the sasi system. For example, shallow tropical waters in coral reef ecosystems at depths up to 15 m, with rocky areas and sandy substrate, are suitable for lobster habitat, while sea cucumbers prefer sandy seagrass and reef habitat. Regular monitoring commenced to check whether the abundance of the species was increasing, and to assess the best time for harvest. Visual censuses were introduced as the most appropriate monitoring method, carried out through freediving and snorkeling. Abundance was assessed using the expert judgement of the local monitoring team (2–5 team members per monitoring trip). The team monitored three points located along the two edges and in the middle of the sasi area. Each survey point covered 200 m^2. Stocks were assessed as suitable for harvest when more than 30 mature sea cucumbers were counted during one dive/snorkel at one survey point.

New sasi practices were developed by Waifuna in collaboration with YKAN to ensure a healthy, regenerative ecosystem. These practices include harvesting gear restrictions and species catch size requirements to exclude juveniles and to avoid overexploitation. Within the patriarchal culture, women were often excluded from leadership roles and there was little emphasis on administrative or record-keeping tasks. To close this gap, YKAN provided guidance on project and people management (such as assigning specific group members to free-dive and harvest, oversee buyers, and manage transactions), as well as record-keeping to generate year-on-year data on the types and total weights of the catch.

The women's group acquired and developed a range of skill sets during sasi implementation. These included technical skills such as carrying out species monitoring, and species and habitat identification, data, managerial, and financial skills around coordinating the annual sasi closure and opening, recording data, and managing transactions, and leadership and organizational skills in the group. This allowed the women in the group to participate in the decision-making processes around when to open the sasi, the profit proportion for every stakeholder, and the use of the profits made by the group.

Methods

Data Collection.—This research was conducted at Kapatcol Village, Misool Island, by YKAN using qualitative descriptive methods. Data collection was done by observation, in-depth interviews, and focused group discussion (FGD) annually during the periods of sasi opening. Observational data collection was carried out mainly to monitor harvest levels and to ensure that the harvesters and the group complied with the harvest management rules (e.g., applying the size limit for sea cucumbers, carapace length for lobsters). YKAN staff acted as observers at the landing sites on the beach for all the harvested species. Although annual catch numbers were derived from the data collected on sea cucumbers and lobster caught during sasi open days since 2014, systematic recording began in 2018 (*see* Table 1).

In-depth interviews or FGDs took place in the community house in Kapatcol Village; one or two respondents took part in the in-depth interviews, and 16–20 participants were recorded in the FGDs (*see* Online Table S1 for survey questions and discussion topics). The village comprised 47 households and 212 people.

Sasi Enactment.—When the group initiated sasi, they had to first ask the customary leader who owned the area for a mandate to manage the area. Once this was secured, the Waifuna core team was established. This group then asked the church leaders and elders to arrange services and a customary (adat) ceremony to confirm the area as a sasi area. Once it was declared as a sasi area in line with both adat and church systems, then regulations—and the consequences for breaking

Table 1. The duration of sasi opening in Kapatcol Sasi Area, 2018–2023 (in days). The sasi openings were held in March, outside the monsoon season, when wind activity, sea turbulence, and water turbidity are lower, and conditions are more favourable for harvesting.

Year	2018	2019	2020	2021	2023
Duration of sasi opening (days)	14	7	4	3	14
Month of sasi opening	March	March	March	March	March

them—were applied. In 2018, Waifuna went through the formal registration and village decree process.

To notify others, including people from other villages, that the area was under sasi management, signage was installed in three different locations along the coast, one at each end and one in the middle of the sasi area. People within the same clans or tribes upheld the sasi arrangements that were set up by Waifuna. In the event of a violation of the restrictions, there is a local belief that perpetrators coming in from other areas will be punished by God or a supernatural entity. Monitoring was initially conducted monthly/bimonthly to prevent community members from other villages from using the area.

Results

Waifuna prohibited the extraction of sea cucumber and lobster over a 200-ha area when the sasi was closed. The sasi was opened based on the group's decision, with the duration depending on the needs of the group members, and the timings decided by group consensus. For the women, economic gain for their family livelihoods was primarily for investment in the next generations, the education of children; the health and welfare of their families, and the village more widely. The number of days of opening varied each year and was informed by the group's ecological monitoring. At least six months of closure were required: sea cucumber stocks ideally need a year to be replenished. However, in some cases the group decided to open the sasi before a year had passed due to urgent economic need.

Sasi open periods can last from three days to 14 days and take place annually, usually in March when the sea is calmer, thus making harvest easier because there is clear water and minimal wind. May–September is the southern monsoon season when the waves are rough, and the wind is strong; managers avoid opening sasi during these months (Table 1).

Data from 2018 to 2023 showed that the lobster harvest increased overall, leading to greater earnings per day of harvest (Fig. 2). For sea cucumbers, the harvest and earnings increased until 2020, and then decreased in 2021–2023. This was not due to a decrease in the sea cucumber population, because the harvesters frequently saw sea cucumbers, rather that the group preferentially harvested lobsters which provided a more immediate financial return as the catch could be sold directly to a buyer or middlemen coming to the village (Almina Kacili, Waifuna member, pers comm).

The sale prices of these two commodities were competitive: as of 2023, the price paid by the middleman for lobster was 180,000 IDR kg^{-1} (IDR = Indonesian rupiah) or approximately 12 USD kg^{-1}; Almina Kacili, Waifuna memeber, pers comm. 2023), whereas the price of dried sea cucumbers ranged from 40,000-1,200,000 IDR kg^{-1} (3–80 USD kg^{-1}; Lionata 2023), depending on the species. Even though sea cucumbers were more profitable, they require postharvest handling, including drying for at least a week before they can be sold. Therefore, the turnaround time for profit from sea cucumbers is longer, and they are more labor intensive to process than lobsters (Almina Kacili, Waifuna memeber, pers comm).

Of 29 species of sea cucumber recorded in Indonesia, nine of them are commonly found and harvested in Kapatchol. Three of the most commonly harvested are *Holothuria edulis, Holothuria atra*, and *Holothuria fuscogilva*. *Holothuria edulis* and *Holothuria atra* do not represent the highest economic value but are harvested the

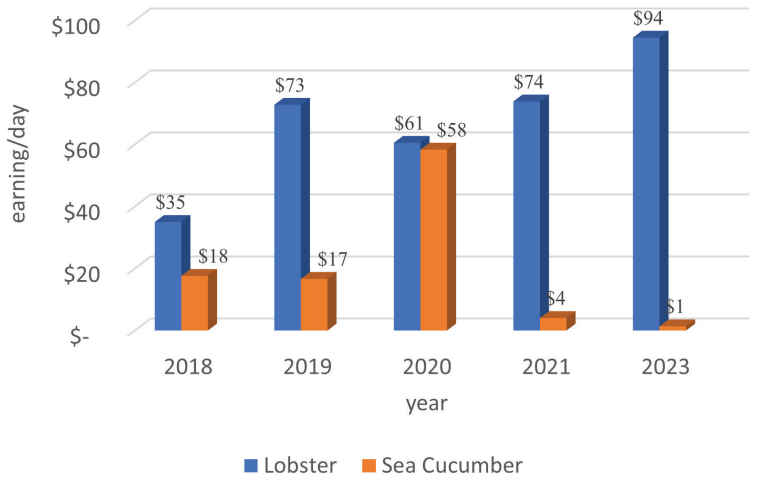

Figure 2. Earning/day in USD (1 USD is equivalent to 15,000 IDR) for the women-led sasi practice in Kapatcol, from 2018 to 2023. As a comparison, the minimum salary rate in Southwest Papua Province in 2023 was 3,864,696 IDR (257.6 USD; https://databoks.katadata.co.id; accessed 5 July, 2024). The minimum salary rate in the smaller administrative division of the Raja Ampat Regency is usually lower than in the Province of Southwest Papua overall, the larger administrative division. However, as with many communities in this sparsely populated island region, Kapatcol Village is a semisubsistent community where they can fulfill their basic primary needs (food, simple housing, alternative medicine) directly from their available natural resources. Money is mostly needed for education and modern health that is not available locally.

most because they are abundant and easily found in shallow waters (1–3 m) in seagrass habitats. Their market price, for dry weight per kg, ranged from 250,000–300,000 IDR and 40,000–100,000 IDR, respectively. *Holothuria fuscogilva* is commonly found in deeper water and it has thicker meat which is more highly valued by consumers. Its dry weight per kilo was 600,000 IDR (Table 2).

The demonstrated success of Waifuna's management of the sasi has resulted in a 60% increase in its membership, from 20 women in 2014 to 33 women in 2023, out of 47 households in the village. Encouragingly, there is interest and demand from young women in the village to join Waifuna, and they require training in basic and safe freediving skills, as well as the other skills necessary to participate in the sasi management.

Table 2. Sea cucumber species frequently harvested in Kapatcol Sasi Area and the estimated market price (2023) of the dried product in kg, in Indonesian rupiah (IDR); 100,000 IDR is equivalent to approximately 6.15 USD. The most frequently harvested species in Kapatcol were the three *Holothuria* species.

No	Vernacular name	Scientific name	Estimated market price of dried product in kg in IDR
1	Teripang dada merah	*Holothuria edulis*	250,000–300,000
2	Susu	*Holothuria fuscogilva*	600,000
3	Minyak/hitam	*Holothuria atra*	40,000–100,000
4	Benang Bintik	*Bohadschia argus*	200,000
5	Balok	*Thelenota anax*	500,000
6	Sepatu	*Actinopyga echinites*	400,000
7	Kucing	*Pearsonothuria graeffei*	40,000–100,000
8	Teripang malam	*Actinopyga lecanora*	400,000
9	Nenas	*Thelenota ananas*	550,000

Discussion

Revisiting the objectives and principles laid out in the Introduction, our study demonstrated the multiple benefits of the program, which revolved around: (1) increasing women's capacity to participate in conservation activities and decision-making; (2) conservation and protection efforts and outcomes; and (3) whole communities benefitting from changing perspectives over time, through deconstructing the prohibitive and unjust social norms that restrict women's participation in the management of their natural resources.

Sasi for Promoting Women's Access to Conservation Activities and Decision-making.—Sasi was previously seen as "a government/customary elder affair" by women, and they had no voice in decision-making regarding sasi management (Novaczek et al. 2001). This was especially so regarding marine sasi, because women infrequently access the reef area where most of the sasi areas are located. Women are mostly gleaners, gathering shellfish—especially oysters, clams, mussels, lobsters, and crabs—that are harvested in nearshore areas with no boats and no need for freediving skills to harvest the biota. In Kapatcol Village, and generally in Papuan society, women traditionally gained no direct economic or livelihood benefits from marine sasi. However, with this women-led sasi group, the practice has been transformed. The management rights given to the women's group mean they can decide when to open and close the sasi, the harvest duration, the profit allocation and who gets the chance to harvest in their area.

As in other places, such as Malawi, owning boats and fishing gear means the ability to earn and have control over money, which leads to an increase in self-determination, or personal empowerment for women (Frangoudes et al. 2019): gaining management rights had the same outcome for women in Kapatcol. They have been able to exercise their project and people management, negotiation, resource-mobilization, and decision-making skills. They have mobilized men, young people (girls and boys), and the group's members in preparing boats to be used to harvest and decided who does what, within and outside of Waifuna. They document and monitor the catch, and they make decisions concerning their share of their harvest's profit. The allocation of profit from the sasi harvest is decided by consensus in group meetings. Members are allowed to suggest profit allocation, whether it is for their children's education, for sick members of the community, or for other necessities. During this process, the group may assess the needs of those potentially requiring medical support, and the capacity of the potential students to seek higher education. The group then discusses and sets priorities for profit sharing. The tendency of women to allocate profit for community-level purposes and for the next generation reflects attitudes in Fiji and Salomon Island (Harper et al. 2024).

There are many practical skills that imbue a sense of pride in those working in fisheries, such as knowing how to swim, free dive, spearfish, or operate a boat. These skills are a source of personal pride and a sense of belonging to the ocean (Allison et al. 2020). Similarly, in Kapatcol, women freedivers are proud of themselves; because of the capacity building provided by YKAN they have been trained to free dive with fins and goggles so they can see better, swim faster, and reach greater depths safely.

Sasi as a Strategy for Conservation.—The potential of customary marine management systems such as sasi to support sustainable livelihood and conservation objectives is generating wider research interest (Novaczek et al. 2001, McLeod et al. 2009, Boli et al. 2014). In general, there is no specific institution or individual that oversees sasi regulations in Indonesia. People from the same clan or tribe are very observant of the regulations because of the still innate (spiritual) belief of terrible consequences for those who break the rules. Kapatcol Village is like other locations in Indonesia that still adhere to supernatural sanctions such as sickness or even death (Boli et al. 2014 in Awalluddinoer et al. 2018). With regular monitoring, the use of the area by outsiders was also hindered. Currently, monitoring was only required once or twice per year, as most people are aware of the sasi area boundaries, and they stay away. The regular monitoring and the sasi routines managed by the women's group are a crucial part of their sense of sasi ownership and engagement in sustainable marine resource management. Conversely, when this decreases, respect for and governance of the sasi will also be affected.

The important conservation and ecological outcomes from sasi areas are confirmed by our work and by other studies. For example, annual observation data from 2013-2017 indicated an increased number of sea cucumber species in sasi areas in Folley Village, Misool, from 6 species in 2013, to 13 species in 2016 (Awalluddinoer et al. 2018). An increased average of total harvest from 191 individuals per day in 2013, to 681 individuals per day in 2016, leading to higher income for the people in Folley sasi area was also recorded (Awalluddinoer et al. 2018). The biodiversity of sea cucumbers in Kapatchol was relatively stable, unlike in the sasi in Folley Village. However, the fact that the lobster harvest was relatively stable, and even increased (Table 2), indicates the success of the sasi area management.

Similarly, the implementation of sasi rules in an area in Raja Ampat that was previously overfished has increased production and improved stocks of sea cucumber, trochus, and lobster, as well as protected marine biota (Boli et al. 2014). In another South Pacific Island, Vanuatu, closed areas have resulted in a threefold fish biomass increase, and there was a twofold increase in the Solomon Islands, compared with areas that were not closed (Aswani and Sabetian 2010 in Boli et al. 2014). Besides improved abundance and diversity, the sasi also provides protection to other species living in the same area, including globally threatened and protected biota, such as sharks and turtles (Boli et al. 2014). These species were seen very infrequently before the establishment of sasi but afterwards were often encountered by fishermen and residents. This indicates that sasi management, which provides protection during closed periods, can be an effective tool to prevent overfishing, support marine conservation, and help towards international biodiversity goals (Novaczek et al. 2001, McLeod et al. 2009, Boli et al. 2014).

Sasi for Shifting Perspectives around Gender Norms.—Waifuna strategically distributes their harvest open days equally among their own groups, the church, and other community members. For example, if they open the sasi for a week, they are entitled to the harvest of the first three days, the following two days are for other community members, and the final two days are for church needs. Thus, all stakeholders in the village benefited. This led the village government to grant a larger sasi area to the group; from 32 ha in 2008 to 213 ha in 2019 (Fig. 1), demonstrating

a key change in the perception of *women* managers, and importantly, acceptance of their competence and effectiveness as natural resource managers.

Based on the interviews conducted with the head of the village and the religious leader who is also an adat leader, the Waifuna women have benefitted greatly from this process in a range of areas. They observed changes in women's involvement in the public sphere, as well as increases in men's openness to women's involvement. Having worked in the area since early 2000, YKAN noted that the women were rarely invited to community meetings and were not vocal at meetings or when decisions were made, probably due to their cultural outlook on gender roles. They are now always invited to village meetings because they are registered as one of the formal groups within the village. They are starting to speak with authority in conversations dealing with village matters and have gained confidence in their own knowledge and opinions derived from experience. Their formal registration, and related financial and administrative elements, will enable them to apply for opportunities for training and grants from different government or ministerial agencies present in the village. This demonstrated that organizing women into an official group supported their involvement in the wider aspects of the community and its decision making (Westerman and Senbow 2013, Frangoudes et al. 2019).

Conclusion

Sasi has proven to be a dynamic customary practice. In our research area, women overcame multiple barriers and issues to successfully manage and lead a sasi group—an arena where traditional culture dictates that women are generally excluded from decision-making and natural resource management activities. If supported by related stakeholders such as churches, NGOs, village governments, and customary elders, sasi can shift these power structures, provide economic opportunities, and enhance community values. Women take care of the next generation by making sure that they have access to better education, and thus the profit from their sasi often goes to sending the best students in the villages into higher education. The economic returns from sasi can also act as a social security net for vulnerable community members who need better medical treatment and contribute to civic development by supporting the renovation of public buildings, such as churches.

By involving women in sasi management, gender equity and sustainable harvests can go hand in hand, providing mutual benefit and supporting marine conservation. Women are valuable contributors to informing effective management planning in similar ecosystems and sociocultural contexts. The enthusiasm of the Waifuna group has inspired the formation of other women's groups to lead sasi practice in other villages in Misool. To replicate the success of this women-led initiative in the area, YKAN is currently engaged in an ongoing project to implement similar initiatives.

Using increased species biodiversity and economic profits as proxies of abundance, we can infer that best practice sasi management can contribute positively to marine ecosystem health as well as sustainable livelihoods. We strongly believe that such women-led conservation will lead to the increased participation of women in marine conservation and sustainable marine resource harvests as well as to a shift of gender norms in natural resource management. The continuation of these initiatives will ensure women can both benefit from and influence conservation to the same extent as men.

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