Restoration Notes

Restoration Notes have been a distinguishing feature of *Ecological Restoration* for more than 25 years. This section is geared toward introducing innovative research, tools, technologies, programs, and ideas, as well as providing short-term research results and updates on ongoing efforts. Please direct submissions and inquiries to the editorial staff (ERjournal@sebs.rutgers.edu).

Chiixuu Tll iinasdll: Indigenous Ethics and Values Lead to Ecological Restoration for People and Place in Gwaii Haanas

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Indigenous societies worldwide recognize people as inherent parts of ecosystems (e.g., Council of the Haida Nation 2007, Brown and Brown 2009). Indigenous governance systems are based on relationships, knowledge, and practices that reflect a deep history of interdependence between people and the places they live, sustaining biological and cultural diversity over millennia (e.g., Trosper 2009, Atleo 2011, Brondizio and Le Tourneau 2016). A rapprochement with Indigenous peoples' worldviews, governance, and knowledge systems offers a transformative path forward for ecological restoration and conservation (sensu Menzies 2013). Here, we present a case study of Chiixuu Tll iinasdll (Nurturing Seafood to Grow), a kelp forest restoration project in Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site (hereafter Gwaii Haanas) on Xaayda Gwaay (Haida Gwaii), a remote archipelago in northern British Columbia, Canada (Figure 1). We demonstrate how Indigenous leadership can restore balance in social-ecological relationships while advancing ecological conservation and restoration for and by local communities.

The Haida First Nation are re-asserting governance authority over their traditional territory—the land, sea, and air of Xaayda Gwaay—following over a century of colonial governance (e.g., Fisher 1992). Accompanied by conflict and contestation with federal and provincial governments and industry, the Haida Nation is shifting power towards cooperative management through court challenges, civil disobedience, land and marine use planning processes, and governance and reconciliation discussions (Takeda and Røpke 2010, Takeda 2015, Jisgang Collison 2018). Guided by Haida worldviews, ethics and values that evolved over their millennia-long relationship with Xaayda Gwaay, the Haida Nation is continuing to transform land and sea management in a resurgence of governance over their traditional territory (sensu Corntassel 2012).

This political seascape shaped the formation of Gwaii Haanas, a 5000-km² land and sea protected area encompassing the southern third of Xaayda Gwaay, in 1985 (Figure 1). Gwaii Haanas is now cooperatively managed through consensus-based decisions by the Gwaii Haanas Archipelago Management Board (AMB), comprised of

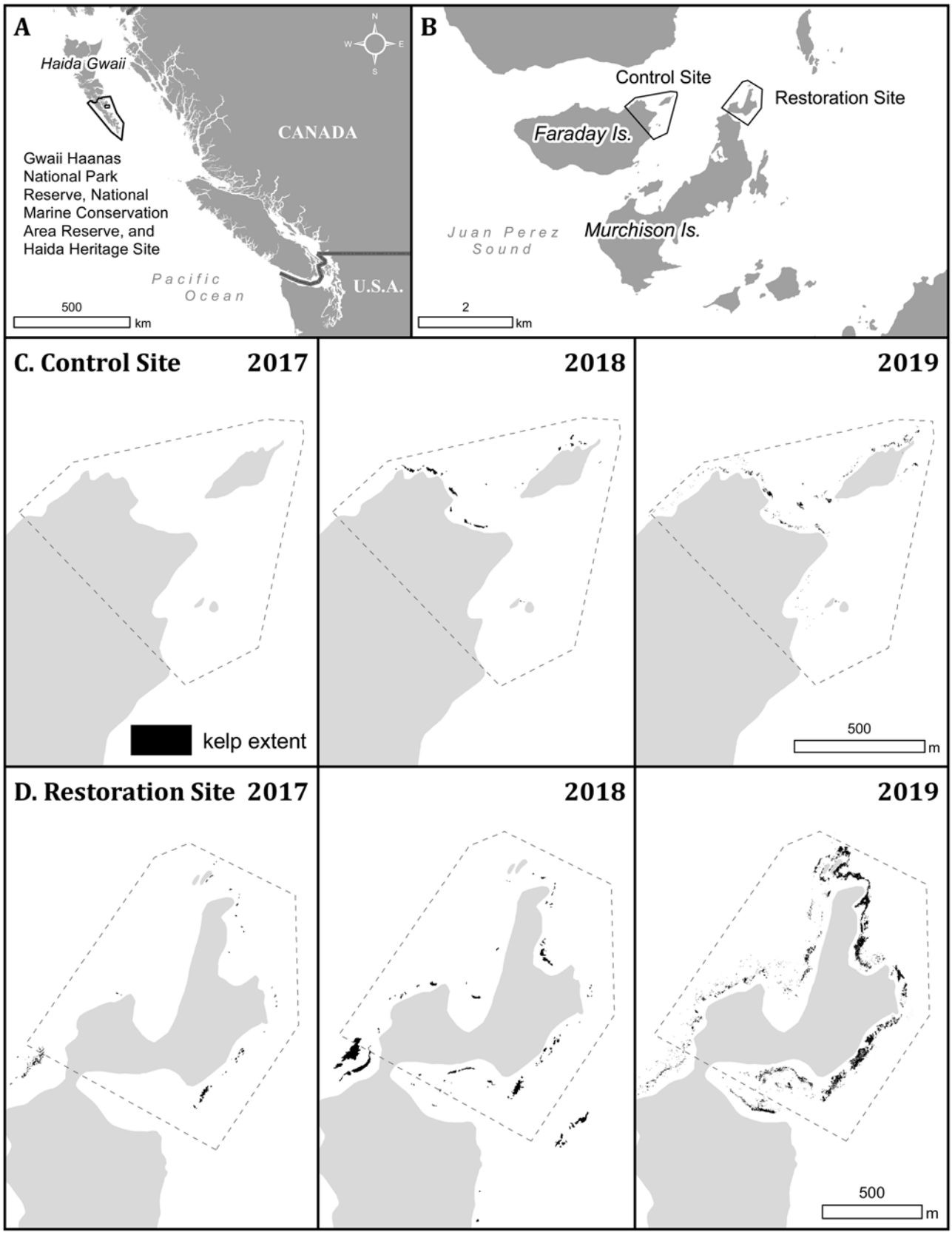

Figure 1. (A) Study area in Gwaii Haanas on Xaayda Gwaay (Haida Gwaii) in northern British Columbia, Canada (small rectangle inside Gwaii Haanas); (B) Inset of study area showing the control site at Faraday Island and restoration site at Murchison Island (black outlined polygons) in Gwaii Haanas; (C) Row panel showing extent of kelp canopy in summers 2017–2019 at the control site; (D) Row panel showing extent of kelp canopy pre-restoration in summers 2017 and 2018, and post-restoration in summer 2019.

three representatives from the Council of the Haida Nation (CHN), two from Parks Canada Agency (PC) and one from the Department of Fisheries and Oceans Canada (DFO). Conflict resolution arrangements help to resolve most, but not necessarily all, conflicts when they arise (e.g., Jones et al. 2017). In 2018, the AMB approved the Gwaii Haanas Gina 'Waadluxan KilGuhlGa (Talking about Everything) Land-Sea-People Management Plan (Council of the Haida Nation and Canada 2018), founded on six Haida ethics and values articulated by the Haida Nation in marine use planning and adapted for Gwaii Haanas (Jones et al. 2010, Bellis et al. 2019).

Chiixuu Tll iinasdll is a collaborative kelp forest restoration project among the Haida Nation, federal agencies, academia, research institutes and fishing industry, all represented by co-authors here (Figure 2). Initiated within the cooperative management context of Gwaii Haanas, the project aims to restore kelp forests along three-kilometers of coastline, covering approximately 20 ha from 0–20 m water depth. Our restoration strategy is to mimic kuu (sea otter, *Enhydra lutris*) predation on guuding.ngaay (red urchin, *Mesocentrotus franciscanus*), styuu (green urchin, *Strongylocentrotus droebachiensis*) and daws styuu (purple urchin, *S. purpuratus*), by removing or cracking 75–95% of the urchins in the area with SCUBA divers to reduce algal-grazing pressure and allow naturally-settled kelp spores to survive and grow. Kuu are an ecological and cultural keystone species that were ecologically extirpated from Xaayda Gwaay almost two centuries ago by the maritime fur trade. Their loss caused a cascade of social-ecological effects including reductions in kelp forest depth and size, hyperabundance of their shellfish prey, and disruption of cultural connections (e.g., Estes and Palmisano 1974, Lee et al. 2018). Pre-restoration surveys were conducted in summers 2017 and 2018, followed by restoration work in fall 2018 and spring 2019. Post-restoration surveys were conducted in summers 2019 and 2020 and are planned for summer 2021, as well as annual restoration maintenance in conjunction with the commercial guuding.ngaay fishery each spring. Haida Fisheries Program (HFP) and scientific divers conduct pre- and post-restoration monitoring and research, while HFP and the Pacific Urchin Harvesters Association (PUHA) divers conduct the restoration work. Urchins with sufficient quality gonads (roe) were fished for community food and commercial markets whenever possible, and the remaining urchins were cracked underwater to be cycled into coastal food webs.

Preliminary data from permanent plots established at the restoration and an adjacent control site for monitoring surveys showed that we reduced guuding.ngaay densities from 49.36 ± 4.38 (± se, unless otherwise noted) individuals/10 m^2 in summer 2018 pre-restoration surveys to 5.76 ± 1.22 individuals/10 m^2 post-restoration in summer 2019. Over the same pre- and post-restoration surveys, we increased hlkyama (bull kelp, *Nereocystis luetkeana*) from 0.83 ± 0.78 stipes/60 m^2 to 56.33 ± 32.26 stipes/60 m^2, and observed a four-fold increase in area of canopy kelp cover from 3107 m^2 in 2018 to 11960 m^2 in 2019 (Figure 1). Kelps and other algae re-established in 2019 were mostly annual species, along with some perennial species including ngaal (giant kelp, *Macrocystis pyrifera*), the latter only on the more sheltered side of the restoration site. Continued monitoring in future will be required to track the rate of urchin movement into the site from deeper and adjacent untreated areas, and the persistence of kelp forest gains. Additionally, we are investigating guuding.ngaay and Gaal-Gahlyan (northern abalone, *Haliotis kamtschatkana*) diet, growth and respiration rates associated with habitat and algal community composition pre- and post-restoration work, and tracking the fate of cracked urchins underwater.

In this note, we focus on the positive outcomes and conservation gains made possible through many decades of persistent relationship-building among management partners, interest groups, academia and local communities that continues today. These foundational relationships facilitate the application of Haida ethics and values to guide this restoration project for and by local Indigenous communities in partnership with others. By working together, we magnify positive outcomes for coastal ecosystems beyond ecological gains to foster cultural and social well-being, informed by the best-available traditional and Western scientific knowledge.

Haida Ethics and Values in Chiixuu Tll iinasdll

Definitions for the six principles below are from the Gwaii Haanas Gina 'Waadluxan KilGuhlGa Land-Sea-People Management Plan (Council of the Haida Nation and Canada 2018), followed by how they relate to the Chiixuu Tll iinasdll kelp restoration project.

Yahguudang—Respect. We respect each other and all living things. We take only what we need, we give thanks, and we acknowledge those who behave accordingly.

Respect guides conduct of the diverse project partners working together towards co-developed and shared social-ecological objectives. The restoration site lies within a larger community-driven Abalone Stewardship Area that is also within a strict protection zone closed to commercial urchin fishing. Therefore, the project required respectful collaboration between management partners and PUHA to consider different perspectives and agree on a shared path forward to allow a limited commercial fishery that would support the restoration goals. The AMB approved this fishery, which was facilitated by DFO management, and contingent on fisheries monitoring by Haida Fisheries and Gwaii Haanas personnel. Respecting Haida values to ". . . take just what you need. Don't waste any. And share it with your neighbours . . ." (Haida Marine

Figure 2. (A) The diverse interdisciplinary and multi-organizational partnership Chiixuu Tll iinasdll field crew work from a remote float camp in Gwaii Haanas; (B) Haida Fisheries and other scientific divers conduct monitoring surveys together; (C) Commercial fishing vessel loads guuding.ngaay onto transport vessel for delivery to Xaayda Gwaay communities for learning in the schools (left inset) and community food (right inset); (D) Commercial urchin packer and smaller dive fishing vessels (left), dive tender with bags of fished urchins aboard (right), and high quality guuding.ngaay roe (inset); (E) Kelp forests provide important habitat for many species including these GaalGahlyan and juvenile copper rockfish; and (F) Academic researchers sample abalone epipodia, and measure respiration rates of red urchins (inset), assisted by project partners. *Photo credits: Ryan Miller (A, B, E); PC/Charlotte Houston (C); PC/Gwaii Haanas (C insets); PC/Lynn Lee (D, F insets); PC/Nadine Wilson (D inset); Emily Adamczyk (F).*

Traditional Knowledge Study participant Percy Williams, 2011), urchins with sufficient quality roe were brought into Xaayda Gwaay communities for food and fished for commercial markets whenever possible (Figure 2).

'Laa guu ga kanhllns—Responsibility. We accept the responsibility to manage and care for the land and sea together. We work with others to ensure that the natural and cultural heritage of Gwaii Haanas is passed on to future generations.

Diversity and partnerships promote social-ecological conservation gains, enriched by multiple perspectives, capacity-building, knowledge-sharing and in-kind contributions from project partners. Ecological research facilitated through academic partnerships leveraged the restoration work to investigate both visible and invisible changes in kelp forest communities. Visible structural changes from urchin removal transforming urchin barrens into kelp forests include diversity and abundance of algae, fish, and benthic invertebrates tracked in monitoring surveys. Invisible process changes include metabolism, growth rates, and food sources for guuding.ngaay and GaalGuuhlkyan, tracked using expertise and specialized equipment available through academic partners. Partnering with urchin commercial fishing industry allows us to pilot creative solutions to maintain long-term restoration gains that can also benefit local communities, commercial fisheries, and inform future fisheries management. An important yet often overlooked logistical consideration for working together among organizations is potential for bureaucratic hurdles when different policies and regulations guide operational activities, such as those governing academic and commercial SCUBA divers. Yet rewards from the hard work of navigating institutional and inherent challenges to diverse collaborations allow all partners to share stewardship responsibilities (Figure 2).

Gina 'waadluxan gud ad kwaagid—Interconnectedness. Everything depends on everything else. Healthy ecosystems sustain culture, communities and an abundant diversity of life, for generations to come.

Respecting interconnectedness between people and place achieves ecological, cultural and socio-economic outcomes. We conducted two weeks of subtidal urchin removals and cracking in fall 2018 with a crew of five Haida Fisheries divers and one Haida-owned commercial vessel and crew (two divers), followed by ten days of restoration work with the Haida Fisheries dive crew and five commercial fishing vessels and their crews in spring 2019, two of which were Haida-owned (Figure 2). This restoration work reduced guuding.ngaay densities by 90% and hlkyama stipe density increased 67.6 times between pre-restoration surveys in 2018 and post-restoration surveys in 2019. Increased hlkyama stipe density at one shallow transect in the control site in 2019 indicated generally higher hlkyama recruitment that summer. Subsequent years of maintenance work and monitoring will be required to track whether we have restored balance over the longer-term. Monitoring of the guuding.ngaay fishery by Haida Fisheries fosters Haida stewardship of their traditional territory and allows a limited commercial fishery to occur in an otherwise-closed area, creating socio-economic benefits. Provision of guuding.ngaay to local communities and associated education and outreach provides cultural benefits by sharing lessons on the cultural importance of guuding.ngaay and significance of Gina 'waadluxan gud ad kwaagid.

Giid tlljuus—Balance. The world is as sharp as the edge of a knife. Balance is needed in our interactions with the natural world. Care must be taken to avoid reaching a point of no return and to restore balance where it has been lost. All practices in Gwaii Haanas must be sustainable.

The AMB logo is a kuu holding guuding.ngaay prey, reflecting how balance was lost when kuu, an ecological and cultural keystone predator, were extirpated. Learning from areas with kuu (e.g., Watson and Estes 2011, Lee et al. 2016, 2018), we reduced urchin densities by 75–95% to decrease grazing and facilitate kelp growth. Larger, deeper kelp forests are expected to improve habitat for species of cultural, ecological and commercial importance, including endangered GaalGuuhlkyan, and rockfishes (Figure 2), salmon and herring. Enhancing habitat for culturally important GaalGuuhlkyan supports Haida goals to foster self-sustaining GaalGuuhlkyan populations that can support future food fisheries. Extensive kelp forests can also increase shoreline protection, carbon sequestration, dissolved oxygen levels, and mitigate ocean acidification, to increase coastal ecological resilience.

Gina k'aadang.nga gii uu tll k'anguudang—Seeking Wise Counsel. Haida elders teach about traditional ways and how to work in harmony with the natural world. Like the forests, the roots of all people are intertwined. Together we consider new ideas, traditional knowledge and scientific information that allow us to respond to change in keeping with culture, values and laws.

Cooperative management of Gwaii Haanas inherently considers traditional and Western scientific knowledge systems with equal legitimacy (sensu Peltier 2018). Partnerships with HFP, PUHA and multiple academic institutions bring together traditional, local, experiential and Western scientific knowledge (sensu Tengo et al. 2014). Wise counsel for the project from a steering committee with members from the Gwaii Haanas AMB, management partners and an external expert provide higher-level guidance, while a technical committee with leads from all partners coordinates implementation. A technical lead links both committees and coordinates project logistics and activities. As team members from the Haida Nation and diverse partners work together from project initiation to

Table 1. Haida ethics and values apply across multiple interdisciplinary academic frameworks that include people as part of ecosystems, including ecosystem-based management (Jones et al. 2010), biocultural conservation (Gavin et al. 2018) and social-ecological resilience (Biggs et al. 2012).

Haida Ethics and Values	Ecosystem-based Management Principles	Biocultural Conservation Principles	Social-ecological Resilience Principles
Yahguudang—Respect	Precautionary Approach	• Respect and incorporate different worldviews and knowledge systems • Tailor interventions to social-ecological context	• Foster an understanding of social-ecological systems as complex adaptive systems
'Laa guu ga kanhllns—Responsibility	Inclusive and participatory	• Incorporate distinct rights and responsibilities of all parties	• Broaden participation
Gina 'waadluxan gud ad kwaagid—Interconnectedness	Integrated management	• Prioritize partnerships and relation building • Devise novel, diverse, and nested institutional frameworks	• Manage connectivity • Promote polycentric governance systems
Giid tlljuus—Balance	Sustainable use	• Recognize that cultural dynamics shape conservation	• Maintain diversity and redundancy
Gina k'aadang.nga gii uu tll k'anguudang—Seeking Wise Counsel	Adaptive management	• Use intergenerational planning and institutions for long-term adaptive management and governance	• Encourage learning and experimentation
Isda ad dii gii isda—Giving and Receiving	Equitable sharing	• Acknowledge multiple stakeholders and objectives	• Manage slow variables and feedbacks

implementation and monitoring in an adaptive and flexible way, we inherently share knowledge across different systems and worldviews to foster more fulsome understanding of the social-ecological system.

Isda ad dii gii isda—Giving and Receiving. Reciprocity is an essential practice for interactions with each other and the natural and spiritual worlds. We continually give thanks for the gifts that we receive.

On Xaayda Gwaay, relationships, reciprocity, and learning often occur around sharing of food; therefore sharing ocean gifts of guuding.ngaay, styuu and daws styuu with the people of HlGaagilda (Skidegate), Gaw Tlagee (Old Massett) and other island communities is an integral part of the project. Gwaii Haanas and CHN personnel conduct interactive outreach events in elementary schools and at community events, providing hands-on opportunities for participants to extract roe from guuding.ngaay while learning about its role in the ecosystem and importance as a traditional food (Figure 2). Partners also share project perspectives, insights, and results at workshops, conferences and speaker series events hosted on- and off-island, as well as engage with other groups working on kelp forest research and restoration. In collaboration with the Haida Gwaii Marine Stewardship Group, another successful partnership on Xaayda Gwaay that works on marine species at risk, we are incorporating kelp forest ecosystem content into Gaal-Guuhlkyan conservation lessons that have been delivered in elementary and high schools on-island by Haida and other local educators for almost two decades. Informal yet important interactions between collaborators over meals while conducting remote field work also foster reciprocal learning, exchange of knowledge, personal connections and trust, which in turn help build understanding of different perspectives and respectful relationships.

An Indigenous Framework for Ecological Restoration

Gina 'Waadluxan KilGuhlGa (talking about everything) and Gina 'waadluxan gud ad kwaagid (interconnectedness) between people and place can lead to improved long-term conservation and restoration success. Indigenous management or cooperative management of projects and active inclusion of other local communities should shape objectives and implementation of restoration projects from the outset to foster local cultural, social, and ecological benefits. Local Indigenous worldviews and values can be respectfully applied as core elements of any framework for ecological restoration within their traditional territories (Table 1). A foundation of Indigenous values provides a place to build rapprochement and sow the seeds of decolonization in ecological restoration and other conservation projects (sensu Corntassel 2012, Menzies 2013).

In this case, Haida-Canada cooperative management of Gwaii Haanas ensures that cultural and socio-economic outcomes for Haida and coastal communities are as important as ecological outcomes. As a recognized cooperative management success story (e.g., Stephenson et al. 2014), Gwaii Haanas contributes to Parks Canada's policies to increase Indigenous knowledge and engagement in managing Canada's Protected Heritage Places. Implementation of the Gwaii Haanas Gina 'Waadluxan KilGuhlGa Land-Sea-People Management Plan and Chiixuu Tll iinasdll are demonstrating how conservation and ecological restoration for and by Indigenous people in collaboration with

others can lead to social-ecological system benefits for local people and place that extend broadly through diverse and strong partnerships. Learning highlighted here is broadly applicable to ecological restoration initiatives throughout the world, and in particular across the Northeast Pacific in light of recent kelp forest declines (e.g., Rogers-Bennett and Catton 2019). Most critical in pursuing ecological restoration and conservation projects with Indigenous peoples on their traditional territories and with local communities is the need to establish enduring working relationships that are respectful of the social and ecological context of each place.

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