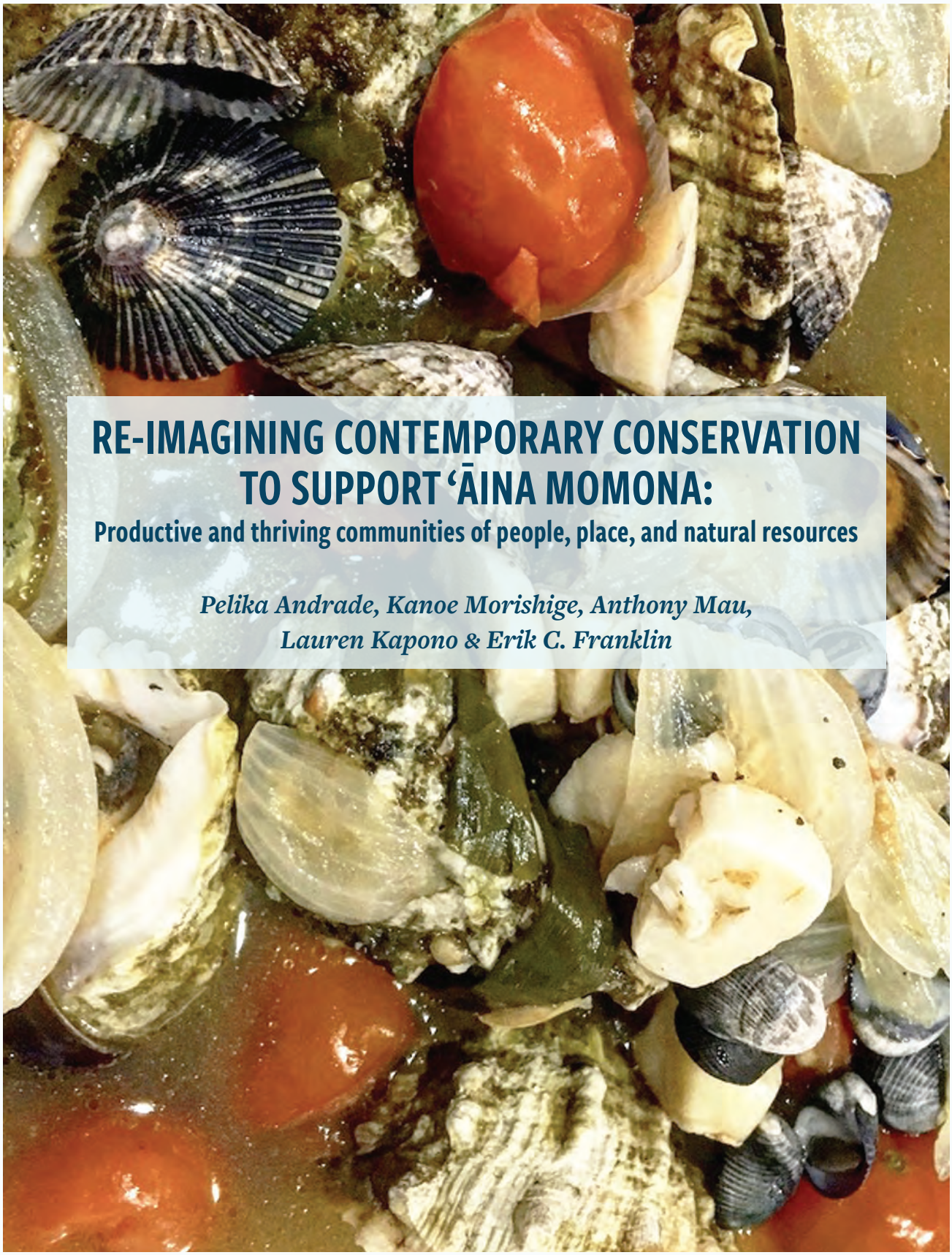
WE ARE OCEAN PEOPLE: INDIGENOUS LEADERSHIP IN MARINE CONSERVATION
CINDY BOYKO & ʻAULANI WILHELM, GUEST EDITORS



RE-IMAGINING CONTEMPORARY CONSERVATION TO SUPPORT ʻĀINA MOMONA:

Productive and thriving communities of people, place, and natural resources

Pelika Andrade, Kanoe Morishige, Anthony Mau, Lauren Kapono & Erik C. Franklin

ABSTRACT

The integration of multiple knowledge systems is being used more frequently to inform research and management. However, the end goal of management is sometimes limited to the narratives and values of the status quo of Western fisheries management and in many cases is disconnected from the holistic goals and objectives that other Indigenous cultures strive to achieve. Indigenous cultures are based on an intimate understanding of the driving factors of health and productivity of the natural environment. Rather than thinking about preserving resources as they are through Western approaches to designing and implementing marine protected areas, Indigenous communities have the power to drive biocultural research and monitoring towards addressing aspects of the environment that drive production and support and enhance productivity. Na Maka Onaona (Na Maka), an ʻōiwi (Native Hawaiian) non-profit organization, has been on a 14-year journey of reimagining contemporary research to support ʻĀina Momona: thriving and productive communities of people, place, and natural resources. Na Maka provides culturally grounded programs and partnerships to support the health of our Hawaiian Islands. Our story takes us to the dynamic rocky intertidal fishery of Hawaiʻi, an endless slew of lessons learned, and a nascent management plan that weave the narratives and values of the status quo within the fundamental vision of ʻĀina Momona.

INTRODUCTION

As multiple knowledge systems are being used more frequently to inform research that then drives management, there is a benefit to taking the next steps in letting multiple knowledge systems also inform the destination of where the research and management will take us. The destination of ʻĀina Momona—thriving and productive communities of people, place, and natural resources—is defined differently depending on the culture and/or community being asked. However, the common thread is that we are more frequently engaging in conversations of holistic health and abundance that are inclusive of other value systems and relationships that have historically proven successful. ʻĀina Momona represents the essence of Indigenous relationships connecting our holistic world and how to maintain it. This major shift to integrate multiple knowledge systems in management outcomes allows us to focus on ecosystem health and abundance while including the healing journey of humanity as well (Morishige et al. 2018).

The following narrative is our journey of rediscovery and reconnections to each other, to our communities, to our history, and to our future through a lens of healing, production, and abundance.

LESSONS LEARNED

In 2009, through various opportunities and partnerships provided by the Keaholoa STEM Scholars Program (KSSP), a group of University of Hawaiʻi at Hilo (UHH) students, UHH faculty/staff, and community members began a journey to understand traditional resource management in North Kona on the Island of Hawaiʻi. The project at the time was called Pilinakai and was based on the idea of re-setting and building our pilina (relationships) to the ocean and exploring how to grow and nurture them. Through this journey, we began to better understand what our places need to thrive and our role in shifting behaviors to tend our ocean gardens which, as we have grown our understanding and experience, have come to fall under the umbrella of ʻĀina Momona.

At the time, integration of Indigenous Knowledge systems into Western/Institutional systems was just gaining momentum within our resource management and educational institutions. It became an ideal time for us to explore what integration could look like, how it was implemented, and what it meant to us as Kānaka ʻŌiwi (Native Hawaiian) scholars, researchers, community members, while setting foundations for the framework and expectations of what it could achieve.

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As we delved into inquiry, data collection, and building relationships with some specific shorelines across the Hawaiian Archipelago, we were introduced to the work of Dr. Chris Bird of the Hawai'i Institute of Marine Biology and his studies of 'opihi (*Cellana* spp.), which are species of small shellfish. We adopted his methodology to build our understanding of the intertidal communities and 'opihi habitat. At first we used his chain transect method, which later evolved into a modified rapid assessment protocol to assess populations on a larger scale. Both methods served as valuable lessons for our team in understanding how these very dynamic places changed over time as well as repeatedly returning to permanent transects focusing on the intricate details of a defined space. We also created a protocol to understand 'opihi reproductive cycles and capacity through Gonad Index work. Paired with Huli'ia, a process based on Indigenous Knowledge to document qualitative observations tracking seasonal events and cycles over time, these survey tools provided us with a vehicle to expand our learning across a diverse and wide range of rocky shorelines across our Hawaiian Archipelago, build upon our relationships to place, and both purposefully and consciously transform the *who, what, how,* and *why* of research and management implementation.

Over the course of eight years, we collectively trained hundreds of students and community members in various monitoring protocols, while participating in numerous workshops and think tanks focusing on community research, integration of knowledge systems, and community-based management initiatives. Throughout this journey and broad array of experiences, we were also asking questions and reflecting on the work we were doing to ensure we were still relevant within our goals as our consciousness and conversations were evolving; and, as any good scientist should do, we continued to step back from our research and reflect on how our initial hypotheses could be wrong, if we were asking the right set of questions, and if our research still aligned with supporting 'Āina Momona.

Let's take a step back before we get into that very important question! Our interests ... the driving intent, the end goal for us is 'Āina Momona … productive communities that feed us. So the end goal isn't the singular importance of biodiversity, biomass, habitat health, or reproduction. The end goal for us was a productive system that included the importance of all of these things collectively for the purpose of feeding our communities. So, as an example, preserving biodiversity isn't our end goal, but rather the success of a productive system demands that biodiversity succeed as well.

You see, when we talk about relationships, and traditional relationships, the function of 'āina was to feed, and more importantly, to feed in reciprocity, making all of our places, people included, important

contributors that feed one another. When we took a good, hard look at management outcomes and management strategies, we were finding that though they focused on improving fish stocks and protecting habitat, the function of ʻāina … the meat and essence of ʻāina … of reciprocal feeding, wasn't included in the conversation, and in turn, wasn't included in the solution. So, as we protected fish stocks and habitat, we erased and changed the relationship and function of ʻāina. That scared us! We now have members of our community (our lands and oceans) that no longer serve their fundamental role within our familial and genealogical relationships.

So back to the question. Is our research getting us to thriving communities? Is it supporting our communities in ʻĀina Momona? We weren't so sure any more. You see, we were finding out a lot of really great information, but there were missing pieces. We were witnessing and participating in conversations to implement management, but couldn't be in full support of strategies and initiatives because we could still see the changing relationship. We foresaw that, somewhere down the line, it would seem that all roads lead to marine protected areas that succeed in fish stock improvement and habitat protection, because that is what these initiatives are designed to do. However, we also knew that we would see a larger disconnect to, not only understanding, but maintaining an intimate relationship with ʻāina.

So we consciously dove into this concern and first asked questions about the research. What was this specific method set up to do? And as we reflected on our past understanding of research projects, we realized that most research projects are set up to get a grade, a degree, and/or a publication. They aren't created, administered, and critically looked at for the goal of productive systems. More recently, there are some amazing projects that are addressing productive systems, but 10 years ago, research wasn't driven by this very important end goal.

We've been monitoring the intertidal for the past 14 years now and have built a massive data repository on ʻopihi, including the ʻopihi Gonad index (which measures the annual timing of spawning windows and the sizes at which ʻopihi are the most productive). We also have counts of numerous shorelines telling us how many ʻopihi are at a specific location during certain times of the year. But in retrospect, population size gives us an idea of *what* and *how many*, but doesn't provide real insight into the health or the productive capacity of the system in terms of the seasonal environment.

We participated in the very skewed assumption that a lot of ʻopihi equated to *healthy* and a little equated to *unhealthy* or worse, to *overharvesting*. Those assumptions, unfortunately, are not helpful to support our relationship to ʻāina and to support productive systems. Those assumptions also, unfortunately, don't allow us to problem solve towards a productive system because we are so focused on a perceived villain, overharvesting, and a specific end goal, we forget that everything still needs to be braided together to make a strong and stable system.

In the summer of 2018, we had an amazing realization. We worked with interns at Hāʻena through the ʻōiwi non-profit organization, Hui Makaʻāinana o Makana, and students from Miloliʻi, Kauai, through Kawaikini Charter School. We hosted our own Nā Kilo ʻĀina field school that took us to Makalawena, Kalaemanō, Kawaihae, Kīholo, and Puanui on Hawaiʻi Island. We were also able to host a couple of workshops at Nohili and Polihale on Kauaʻi. During that same four-month time period, we surveyed the remote island of Nihoa, one of the Northwestern Hawaiian Islands in Papahānaumokuākea Marine National Monument. This marked the culmination of the 10 years of immersive experiences on the shoreline where every observation started to come together as the stars aligned.

Though it may sound simple, we had grown an extensive understanding of Hawaiiʻs shoreline ecosystems and could now articulate that not all rocky shorelines are created equal. This meant that we couldn't do a basic scan of shoreline maps and declare *X* miles of rocky shoreline should support *X* amount of ʻopihi and then use this information to guide and advise management. Through this approach, we would be able to ensure ʻopihi presence, and if we found a small population size, shut harvesting down to let them rebuild their numbers. If we find a large population size, shut it down to create a seed source or open it up so we can shut it down in the future when numbers get low again. This approach informs us of population size but doesn't address what that population size means in the context of health or production potential. So we switched gears as every good scientist does. We proved ourselves wrong, reassessed, and made adjustments to ask a better and more appropriate set of questions. We needed to figure out what we needed to know to understand the ʻopihi fishery, understand how production worked, understand the various driving factors of a productive ʻopihi fishery, and understand how harvest fit into supporting productivity, because, contrary to popular belief, the most productive systems are actively managed and harvested from. Ask any lei maker, lauhala weaver, or medicine gatherer. The best parts of the forest to harvest lei materials are from the areas we pick responsibly. Lauhala weavers tend to hala groves because the untended ones have more rubbish than is worth sorting through. Medicine gatherers have specific patches they return to because

these spots are tended over the years and sometimes over generations.

If we want our shorelines to be productive and continue to produce for us, we need to understand how to tend to them. But before we start tending, we need to understand the capacity of production and what environmental drivers contribute to that production. What is an ideal ʻopihi habitat? What makes it ideal and how do we now optimize those components to boost and ensure productivity? So we changed everything. We created a monitoring tool that we believe is helping us understand that. Understand the productivity of our intertidal shoreline and ʻopihi fishery to retain our shorelines as a contributing part of our community, as ʻāina.

TODAY'S CONSIDERATIONS

- What does a productive shoreline look like?
- What is the carrying capacity of a productive shoreline?
- What are the environmental factors that affect productivity?
- How does productivity change both spatially and temporally?
- How do we establish a baseline for assessing ʻopihi stocks considering *all* factors contributing to productivity?

How do we support healthy habitat? How do we support biodiversity? How do we support biomass? How do we support fish stocks? All these questions can be addressed by gearing our solutions towards the

question, How do we support productive systems? How do we support ʻĀina Momona and the reciprocal relationship of feeding and being fed in return?

PACC

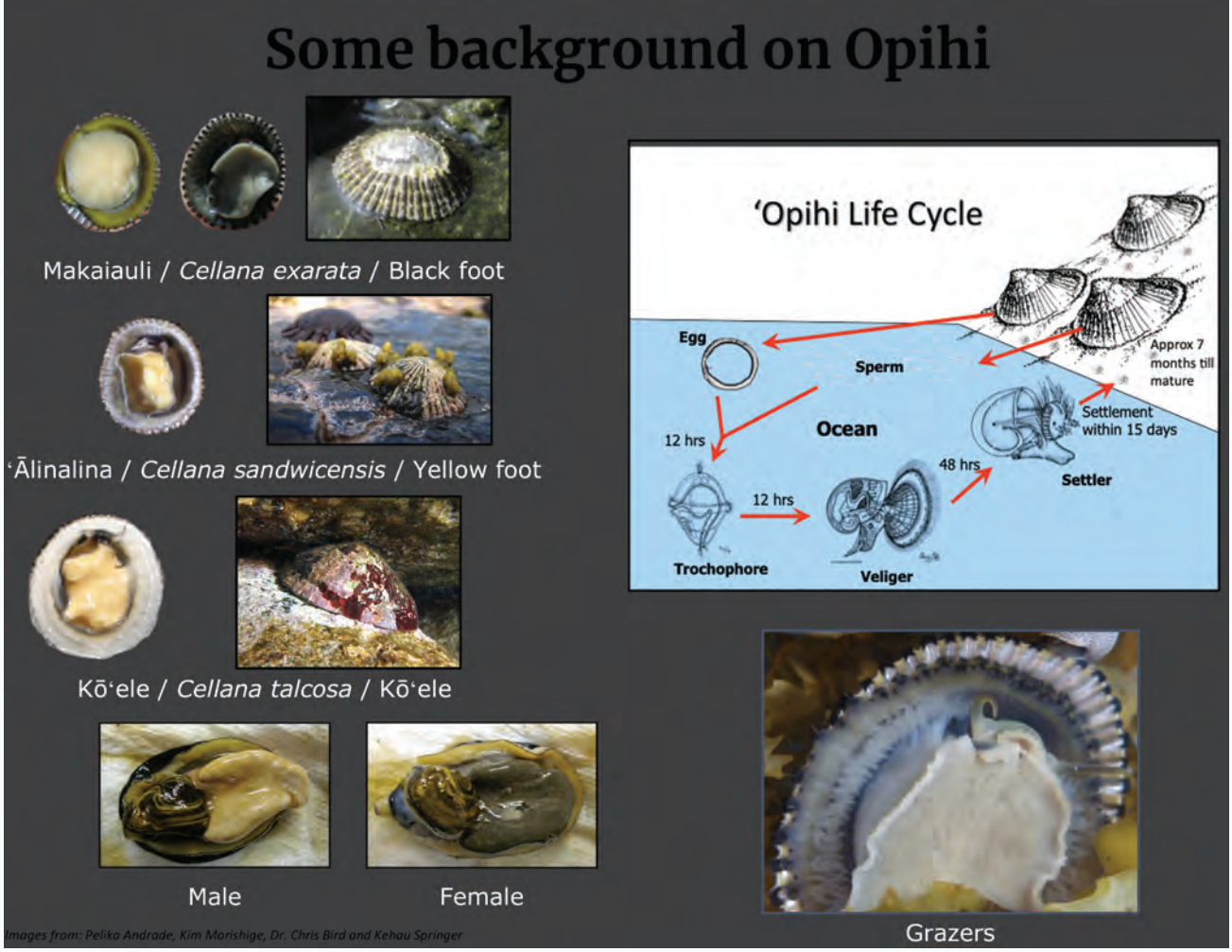
PACC, or Productivity and Carrying Capacity, is a monitoring/surveying tool created by our team based on our years of lessons learned as a way to pivot our focus on production. PACC was created to better understand the productivity of our intertidal fishery so we can better support ʻĀina Momona.

The goals of PACC are to:

- Develop a sustainable fishing model for ʻopihi based on the environmental carrying capacity across Hawaiʻi; and
- Adaptive management strategies that include sustainable harvesting and resting to compliment that cyclical productivity: ʻĀina Momona.

ʻOpihi are a food source here in Hawaiʻi. A delicacy and prized meal for many. They are found mostly in the intertidal zone of the shoreline. They are grazers primarily eating small or microscopic algae or limu. They are broadcast spawners that release their eggs/sperm within two common windows of the year, fall and spring. Males are identified by a yellow-creme color gonad, and females by a greenish-brown gonad. We have arguably three species of ʻopihi. Makaiauli is our blackfoot ʻopihi and found highest on the rocks in the splash zone. ʻĀlinalina or yellowfoot ʻopihi is found in the mid-zone and highest impact area of the shoreline. Koʻele is found more commonly at the lowest part of the intertidal, submerged or in shallow water. We distinguish between two major habitats within the intertidal, the black zone (upper splash zone) and the pink zone (lower, more wave action and submerged) with Makaiauli mostly found in the black zone and ʻĀlinalina and Koʻele mostly found in the pink zone. There are some crossovers but that's normally what we'll see.

PACC was born out of the evolution of our intertidal research over the past 14 years. As we began to understand the shoreline a bit more intimately, as we



began to ask questions about research in general, we realized our considerations, our inquiries, weren't addressing our much larger intention of supporting productive communities and productive systems; ʻĀina Momona. We were looking at ʻopihi population sizes across various stretches of shoreline but not really collecting any other information to compare those numbers to … as if population size alone was enough to guide management. It was like us randomly popping into a theater to see how many people were there regardless if there was a movie playing or not.

We realized that population size alone really didn't tell us anything about improving and supporting an ʻopihi fishery. It just told us if there were ʻopihi to harvest or not. It supported the ability to harvest (if there are ʻopihi, we take; if there are no ʻopihi, we don't take) but it didn't support the ability to ensure always having ʻopihi so we could always harvest. Two very different end goals. So we relooked at our research and focused on how we understand the productivity of our shorelines to boost and encourage the condition of always having ʻopihi. What is the natural carrying capacity of our shorelines? What environmental factors and drivers affect the productivity of our shorelines? How do they change through time and space? We figured, if we could understand that, we could differentiate management and harvest activities between a shoreline that could only naturally support 2–4 ʻopihi per m^2 and a shoreline that could naturally support 30–40 per m^2.

We wanted to develop a sustainable fishing model based on environmental carrying capacity as well as implement adaptive management strategies that were inclusive of sustainable harvesting and resting to complement that cyclical productivity. Developing PACC, we had to sort through our many years of being on a broad range of shorelines and tease out what we considered important drivers or factors that contribute to a productive system.

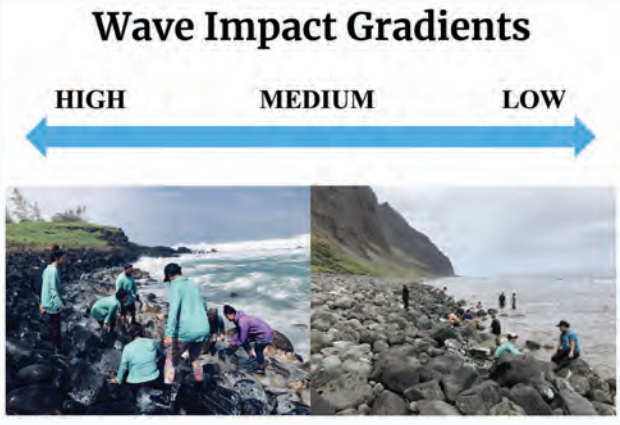
The biggest take away was that *not* all shorelines are created equal. You laugh … I laugh … at the simplicity of it … but for years we counted populations across all different types of shorelines and just reported that shoreline *A* had this population size and species distribution, which differed from shoreline *B*, which had double the population size of shoreline *A* and similar distribution. With that information alone

what do we assume? People must have harvested! Oh no, we need to stop this. But in some instances, shoreline *A* only had the natural capacity to carry half the population of shoreline *B*. Possibly it only has half the habitat size? Which equates to half of the food source? … So let's factor that into our considerations.

So let's talk about different shorelines. We have got differences in substrate and coastal morphology such as cliffs, benches, boulders, fingers, bowls, etc. And believe it or not, they are all rocky but not created equal. Cliffs have this vertical habitat that is limited in size because wash goes up and straight back down. So the horizontal width is close to zero. Benches and boulders are more extensive, as the wash is able to move horizontally up, creating a larger habitat. Though benches provide larger habitats than cliffs, we find more habitat in boulder shorelines, because of the larger surface area of each rock. We see relatively the same width of the bench and boulder intertidal zones, but viable habitat within the boulder shoreline increases in comparison to bench shorelines.

We have got shorelines facing dominant weather and swell … our windward shorelines. And we have got shorelines that are much more protected throughout the year and have a smaller window of exposure to consistent weather and swell … our leeward shorelines. This is important because ʻopihi are grazers … their food source is limu … and what do we need for limu to grow? We need some splashing, among other things, but a wet shoreline makes good grounds for limu growth. Wave exposure dominates the dynamics of rocky intertidal habitats in the Hawaiian Islands (Bird et al. 2013). Windward shores have larger windows of swell exposure *and* larger swells, while leeward shores have smaller windows of swell exposure. They still get huge swells as well, but not as often as windward. So which side of the island do you think has more limu growth? *Yes*, our windward sides.

Along the same lines, there is also a gradient of wave impact on any shoreline. We've broken it into High, Medium, and Low. High is completely open to wave action … no barrier between the open ocean and the shoreline. No reef, no breakwall, etc. Low is a shoreline that is behind one of these barriers. Waves first hit reef, sandbar, and breakwall, and then lose their strength before hitting the shoreline. Medium was thrown in there because we do have the in-between from not exactly heavy impact but not completely protected as well. Mediums are usually found behind a barrier, but the barrier is close or only half protective. As you can see in the picture to the left in the "Wave Impact Gradients" figure, our team is in a high-impact area … lots of white water, everyone's on alert and ready to move when a wave is coming through. The picture on



the right is at a low-impact area … super-calm water … everybody is sitting around … no worries in the world.

Those are the big components but there are also other contributors and considerations we know are important to productivity. We have salinity. Again, we are dealing with limu grazers and know that some limus, especially the greens, need some freshwater mixing to do well. Not too much freshwater, just a little. So we've noticed that small streams like Milolii on Kauai have a very productive rivermouth habitat for ʻopihi. Not too much freshwater coming out of that stream and enough openness to the ocean to disperse, unlike the rivers of Hanalei which have a much larger volume of fresh-water and a protective bay that holds the freshwater with slower disbursement. So we are trying to find that ideal sweet spot of salinity to encourage ideal limu growth.

We also had this epiphany when it came to sunlight and shadow. We are very fortunate to survey places like Nihoa that have this huge northern facing cliff … but very little ʻopihi on it. It always baffled us … windward shoreline … pali, not the most extensive habitat but hard substrate … should have a decent population but it doesn't. You see, there is a practice in Haena, Kauai, at the base of Makana, which is their famous mountain, to rest taro patches running along the northern base during winter months. Why is that? Well, for 3–4 months of winter, when the sun moves south, the sun doesn't reach these patches so nothing really grows well. *Oh my gods …* brilliant. No sun for part of the year = no limu growth for part of the year = a very limited ability for that space to provide food = a very limited carrying capacity. And then we saw it again at Hoolulu on Na Pali, Kauai, which is a vertical half-crater-ish cliff. This beautifully exposed shoreline that gets hammered by waves during winter months has very little ʻopihi. *Why?* No sun for part of the year and thus no limu.

We also had a hypothesis from one of our colleagues that species found on different shorelines will have a different maximum size. We have an idea of the potential size each species can grow to, but he hypothesized that regardless of a species' potential, each shoreline differed in that maximum size. Some shorelines supported Makaiauli that grew to 6–7 centimeters, while on other shorelines they grew to a maximum of 5–6 centimeters. *And* of course, what is the reproduction contribution of each size class? Again, productive systems: which is most productive? If we ensure those individuals that are most productive remain within the system to reproduce, then we enhance production.

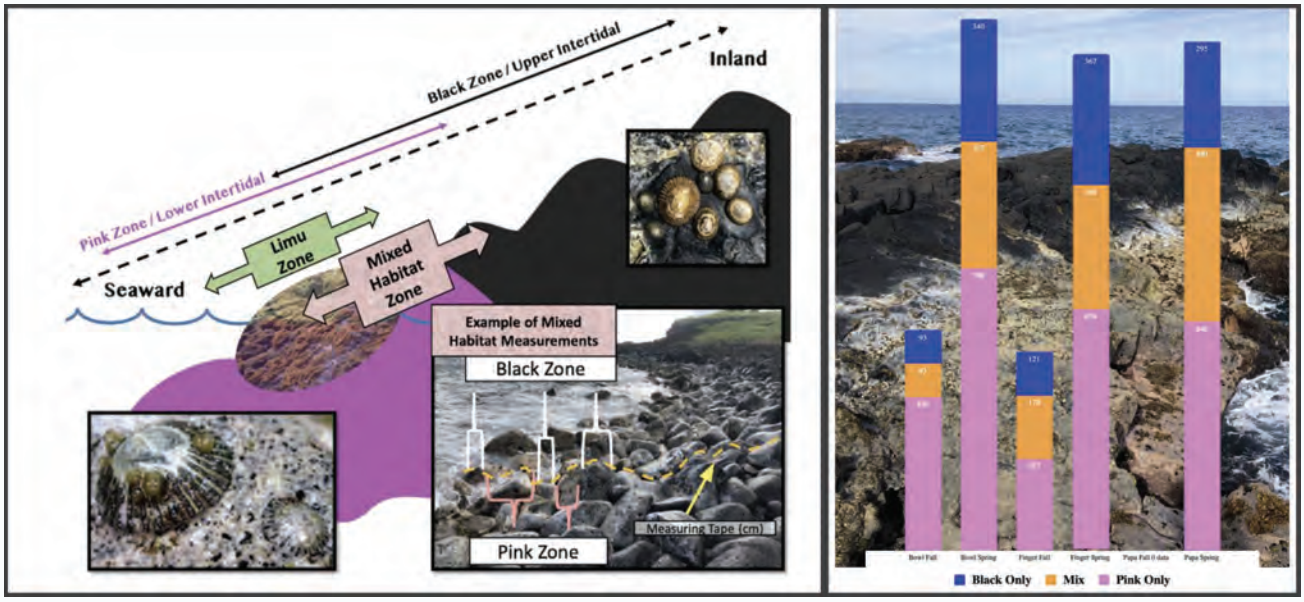
So all of these components contribute to productivity of the shoreline. We have swell exposure, wave intensity, sunlight, salinity, growth rate, reproduction capacity, etc., but we can't forget to factor in seasonal growth and shrinkage. You see, our shorelines have this amazing cycle of habitat growth and shrinkage. Every shoreline goes through it, but differs in the range of growth and shrinkage … and the timeline … there's some staggering of events over time…. *But* usually we see a peak growth in spring and a peak shrinkage in fall.

So what does this mean? In simplest terms, if we look at our shoreline in acreage, let's say at peak shrinkage, we might only have 1 acre of 'opihi habitat. An acre theoretically can only support, let's say, 100 'opihi. During peak growth, that acre potentially grows to 20 acres on a windward coastline. So now we have the acreage over this window of time to support 2,000 'opihi ... and guess what, this growth overlaps with a spawning cycle. So now we have a huge area that is open to recruitment, 19 extra acres. So thousands of baby 'opihi settle in and enjoy a rather fabulous buffet of grazing, but when we hit peak growth and now our habitat is shrinking and because we know that it'll shrink back down to 1 acre with a carrying capacity of 100 … hmmmm what's gonna happen to all those 2,000 'opihi? Can the little ones compete? Probably not? So we have this huge recruitment (what we've termed a *pseudo recruitment*) and a natural die-off to follow. What do we do with that information?

So first things first, let's get to understanding habitat zones and sizes, seasonal growth and shrinkage. We have a horizontal tight measurement to document the width of each zone; then we measure the curvature through rugosity so we can get the area of each zone. We do this over time so we can see how small and how large our 'opihi habitat gets.

We also show a change in habitat size in correlation with wave impact type. Various sections across shoreline, same day … just 20 meters apart as we moved from a heavily exposed high-impact location into a protected section of the shoreline behind a fringing reef.

We also count 'opihi by size class within each zone. Our interests here have to do with understanding carrying capacity. Not only how many 'opihi we find in each zone, but what is the combination of sizes.

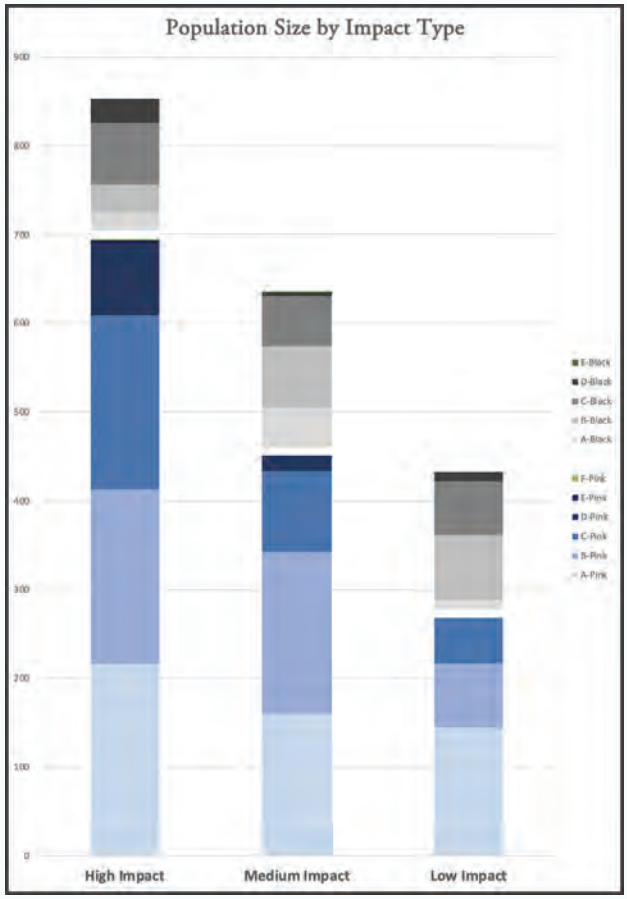


We are still figuring out how to measure it, but we are looking at consumption values: bigger ‘opihi should need more food, so, similar to reproductive capacity, each size class has a food consumption need (one really big ‘opihi eats as many as five small ‘opihi) further supporting the need to factor in more information than population size alone.

We also needed to learn about the growth rates of ‘opihi to better understand their productivity. To estimate rates of growth, we coupled secondary ion mass spectrometry analysis of oxygen isotopes with sclerochronology of the cross-sections of ‘opihi shells (Mau et al. 2021). From this we learned that longevity was 5 years and age-at-maturity for ‘Ālinalina ‘opihi was 8–9 months (approximately 21 mm shell length) (Mau et al. 2018).

The carrying capacity of the same shoreline also can drastically differ within different wave impact types, as shown by the “Population Size by Impact Type” graph. Moving from high (completely exposed to swell) to low (completely protected from swell) we find double the carrying capacity. Again, it’s not as simple as this conceptual model, but it’s a great reminder that within the same geographic stretch of shoreline, population size will drastically change just based on wave intensity.

As we look at seasonal growth and shrinkage, wave impact gradients, and factor in consumption and reproduction capacity by size class, we are inundated



with lots and lots of information, which leaves us with lots to consider, but the potential of putting in the work … thinking broadly about systematic productivity … oh, the possibilities! We can have our cake and eat it too. We can be proud of our

biodiversity, proud of biomass, proud of habitat health … and still be able to feed our people. Still be able to have ʻĀina Momona.

This journey has been one full of twists and turns, failures, and successes, with multiple contributors who were with us for a second, popping in and out, or walking every step along the way. This story feeds into a collective vision honoring the essence of Indigenous relationships with a major shift to integrating our multiple knowledge systems and values addressing productivity and abundance while including humanity on this healing journey. We will continue to push forward to learn more about the intertidal environment and translate that knowledge into guidance for sustainable ʻopihi harvests.

I hope you enjoyed our story and journey as we integrate multiple knowledge systems to reimagine contemporary management to support productive and thriving communities of people, place, and natural resources: ʻĀina Momona. Ola!

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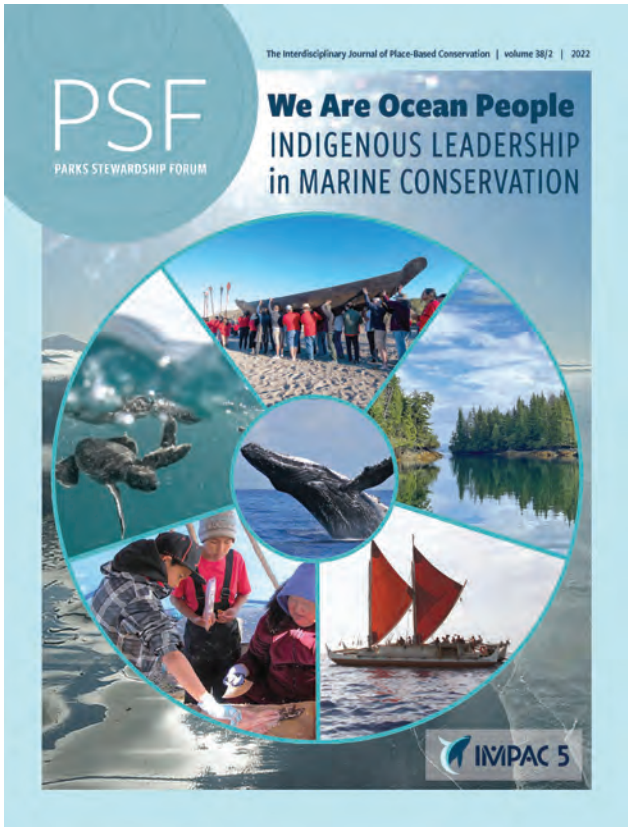

On the cover of this issue

CIRCLE DESIGN, clockwise from top:
- Northern Chumash ceremony | ROBERT SCHWEMMER
- Haida Gwaii | CINDY BOYKO
- The Polynesian Voyaging Society's voyaging canoe Hōkūleʻa | NOAA
- Elder teaching youths, northern Alaska | US FISH AND WILDLIFE SERVICE
- Baby Honu (sea turtles), Papahānaumokuākea Marine National Monument | NOAA
- Center: Humpback whale, Papahānaumokuākea Marine National Monument | NOAA

Background: Pacific Rim National Park Reserve | PARKS CANADA

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