AOTEAROA
fisheries limited

PĀUA AS TAONGA

Understanding Pāua's Place in Aotearoa

A Qualitative Ecosystem Service
Review of New Zealand Pāua (Abalone)

FOREWORD

As kaitiaki (stewards) of significant iwi (Māori) fisheries assets, Aotearoa Fisheries has begun a sustainability journey to safeguard the future of our premium wild and farmed seafood. We believe in courageous innovation and in carefully testing best practice in order to understand the deeper implications of future proofing our business. Believing that we also don't have all the answers, we joined the New Zealand Sustainable Business Council (SBC) to give us access to leading edge tools.

In 2014, SBC piloted the application of a new approach to analysing our resource base called ecosystem service review. Ecosystem services link ecosystem processes and human well-being in terms of the direct and indirect benefits people obtain from ecosystems. Māori deeply understand this interconnectedness and that humans are also core parts of these ecosystems. We chose to focus on pāua as a taonga, because it is a prized product, yet changes to the ecosystem could have significant impacts on the fishery in years to come. The review has indeed identified some issues we need to deeply consider and potentially address, including the loss of kelp habitat for pāua in the Marlborough Sounds.

This work would not have been possible without meaningful partners. We would like to thank SBC and Landcare Research for guidance and Department of Conservation (DOC) for sponsoring this project. Our technical contributors were National Institute of Water and Atmospheric Research (NIWA), DOC, the Pāua Industry Council (PIC) and Otago University Department of Marine Science. Terra Moana Ltd facilitated, guided and technically contributed to its delivery.

We invite you to read this summary of much detailed research and consider how you might join us in extending the use of ecosystem service review to other important primary products in New Zealand, as well as to collaboratively address the issues that this pāua review has identified.

Carl Carrington

CEO – Aotearoa Fisheries

Published: November 2014

The compendium is based on a Qualitative Ecosystem Service Review of New Zealand Pāua (ESR) that was commissioned by Aotearoa Fisheries Limited. This compendium summarises detailed reviews of six priority ecosystem services.

This was one of five ESRs led by Landcare Research under the auspices of the New Zealand Sustainable Business Council Business and Biodiversity project.

For more information, the detailed review, or a list of references contact Katherine Short at katherine@terramoana.co.nz

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Pāua – our taonga, our responsibility

As the largest Māori-owned seafood company, Aotearoa Fisheries Limited stewards the commercial fisheries assets Māori regained as part of our Treaty of Waitangi Fisheries Settlement with the Crown, the Government of New Zealand.

Pāua, the Māori name for abalone, is one of the most important components of Aotearoa Fisheries' business. Prepared Foods (a division of Aotearoa Fisheries) operates as the largest processor of pāua in New Zealand and Aotearoa Fisheries' company OceaNZ Blue. Between our wild catch and farmed business, Aotearoa Fisheries has seen continued sales growth among existing and new customers.

Traditionally, Aotearoa Fisheries used the prime pāua meat for canning, sent the trimmings to the nutraceutical sector, and sent the shells to the ornamental trade. This picture is changing, however, with increasing interest in live export. Our pāua markets are China, Malaysia, Singapore and Hong Kong.

Our tikanga, or value structure, underpins everything we do and includes our responsibility as kaitiaki, or guardians, of the domain of Tangaroa (the God of the Sea) and all its gifts and our commitment to protecting the environment for this, and future generations. As kaitiaki, we have embarked on a journey to ensure our fishing and business practices are sustainable and aligned with the values of our community.

As part of this journey, with support from Terra Moana Limited (TML) (our sustainability advisers), Aotearoa Fisheries conducted a Qualitative Ecosystem Service Review (ESR) of New Zealand Pāua. The Pāua Industry Council (PIC), the National Institute of Water and Atmospheric Research (NIWA) and Otago University School of Marine Science were core technical partners. This was one of five ESRs led by Landcare Research under the auspices of the New Zealand Sustainable Business Council Business and Biodiversity project.[1]

For the ESR, Ocean Ranch, the pāua harvest managers, provided technical advice about the daily business realities and issues pāua divers face in harvesting a wild resource. The ESR involved all relevant pāua industry and Aotearoa Fisheries corporate leaders, including the management of the pāua processing division, Prepared Foods.

The ESR has enabled Aotearoa Fisheries to holistically evaluate both its dependence and impact on ecosystem services and to identify the resulting business risks and opportunities. Aotearoa Fisheries pāua ESR is a first for the New Zealand seafood industry and potentially internationally, and represents a step change in fisheries management.

1 Summaries of the SBC Projects can be viewed at http://www.sbc.org.nz/projects/biodiversity-and-business.

Aotearoa Fisheries Sustainability Strategy and the pāua ESR – part of the journey

Aotearoa Fisheries wants to ensure we give customers and shareholders confidence that our seafood products come from responsible, environmentally safe and sustainably managed seafood production systems. This is articulated in our corporate sustainability policy for Conscious Stewardship.

We also recognise that operating sustainably just makes good business sense. This can be seen in the increasing international consumer demand around food safety and for food sourced from verifiably sustainable, environmentally responsible suppliers, as well as in daily operational efficiencies. Major supermarket, hotel and restaurant chains are also adopting sustainability and environmentally friendly product sourcing policies to drive change across supply chains and producers. To maintain access to these important markets and reach new ones, we have to know any associated environmental issues and develop action programmes to address them.

The sustainability journey builds in risk management and is also a way to ensure we maintain our social licence to operate. Our ability to farm and harvest seafood faces increasing pressure from resource sustainability challenges and from public concern about the state of the oceans and social desires for different uses of marine space. We recognise that without a strong ecosystem-based management framework, it will become increasingly difficult to attract investment and to ensure that our young people have a future in fishing. We have to change.

Part of this change includes working in collaboration with other seafood companies and the wider seafood industry. No single company can turn the situation around and with some issues industry must move towards cooperative and collaborative models. That's why we're investing in the industry, building partnerships within the community, participating in industry and government working groups and improving our own operations. It is our hope that beyond charting a course for Aotearoa Fisheries to navigate, the pāua ESR will also assist the pāua industry more broadly to develop a deeper approach to sustainably managing our pāua populations and the ecosystem that supports them.


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Why an ecosystem service review?

The future security of the Māori fisheries assets are contingent on wise stewardship of marine natural resources.

Aotearoa Fisheries seafood products are inherently dependent on ecosystems for the goods and services they provide, including:

- healthy coastal and offshore marine ecosystems,
- sustainably managed wild-capture fisheries,
- social licence to operate for access to both marine space and resources, and
- to underpin a product provenance story in premium markets.

For Aotearoa Fisheries, the ESR was a core project for its pāua division as part of the new company-wide Sustainability Strategy. Climate change and erosion present risks to pāua populations, and therefore Aotearoa Fisheries pāua business, however, the company is well-positioned to capitalise on significant opportunities that can be gained through better environmental and ecosystem management.

What are natural capital and ecosystem services?

Our health and well-being depend upon the services provided by ecosystems and their components: water, soil, nutrients and biodiversity such as trees and fish. These are the stocks of natural capital that underpin human well-being and which were catalogued in the Millennium Ecosystem Assessment (2005). Ecosystem services can be defined in various ways. The UN's Millennium Ecosystem Assessment classified ecosystem services as follows:

Supporting services: The services that are necessary for the production of all other ecosystem services including soil formation, photosynthesis, primary production and nutrient and water cycling.

Provisioning services: The products obtained from ecosystems, including food, fibre, fuel, genetic resources, biochemicals, natural medicines, pharmaceuticals, ornamental resources and fresh water.

Regulating services: The benefits obtained including regulating air quality, climate, water, erosion, disease, pests and natural hazards, pollination and water purification.

Cultural services: The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences – thereby taking account of landscape values.

Using an ecosystem approach for business decisions and management

Around the world, identifying ecosystem services, and then assessing and responsibly managing a company's impacts and dependencies on those ecosystem services is recognised as best practice. An ESR provides the road map for this management approach, and informs an ecosystem approach which generally includes the following principles:

- managing within natural limits;
- managing for the long term;
- managing at micro and macro scales with an understanding that ecosystems exist on many scales and are interconnected;
- accounting for true value which means looking beyond simple economic valuation;
- making trade-offs clear; and
- involving stakeholders in decisions.[2]

If effectively applied and operationalised, this can also be consistent with ecosystem-based management of fisheries. New Zealand's Quota Management System (QMS) is an important foundation for managing fisheries sustainably. Increasingly however, as ecosystem-based management (EBM) approaches are gaining traction internationally, the QMS and EBM can be integrated to deliver more comprehensive management.

2 Source: UNEP/GRID-Arendal.

The four steps for an ESR

The ESR was conducted using internationally accepted best practice and the World Resources Institute Corporate Ecosystem Service Review methodology. Landcare Research technically supported the application of the ESR in New Zealand.

An overview of the steps used is provided below.

1. Determine the scope of the assessment

The ESR was focused on the operational issues facing the production of wild pāua in the marine environment and its processing facility, although Prepared Foods had recently moved into a new high-sustainability specification facility and was already implementing efficiency programmes.

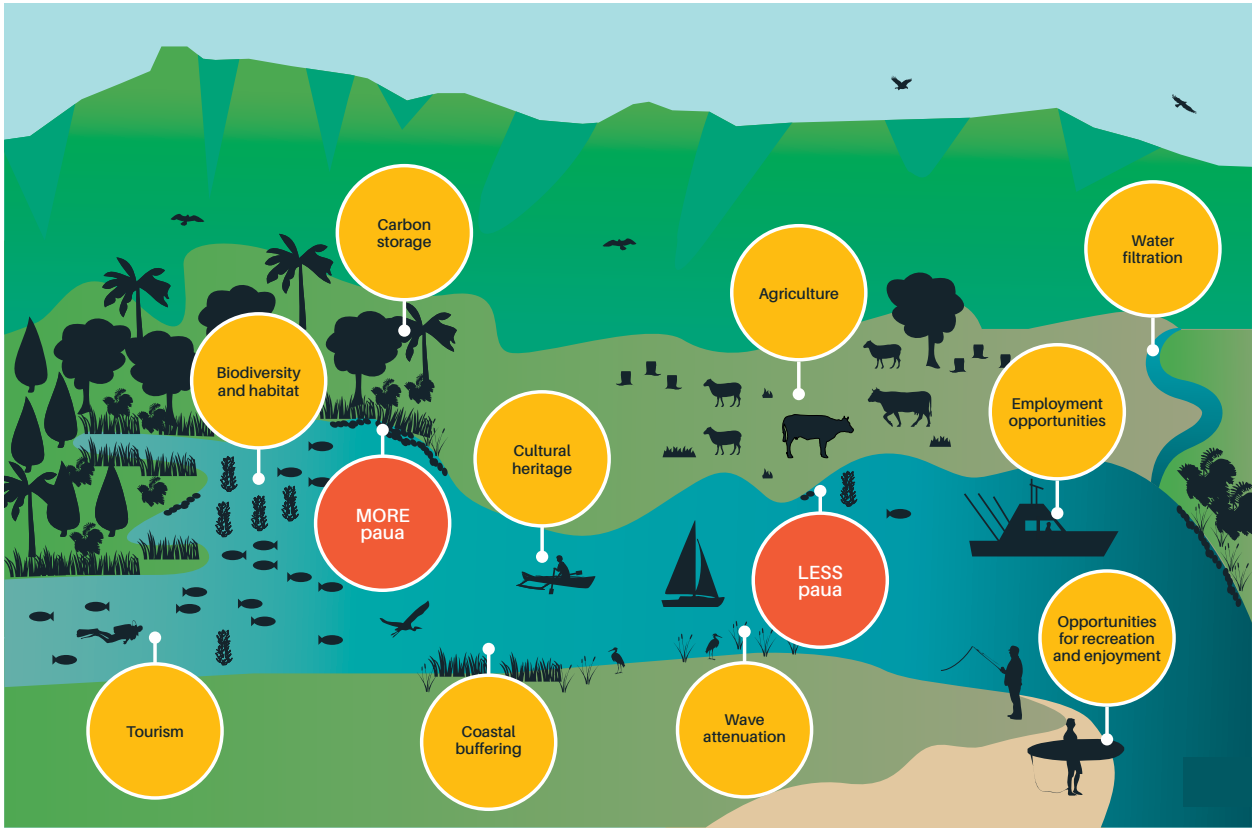
2. Identify the priority ecosystem services

The ESR enables the company to prioritise a few key ecosystem services by evaluating the degree of the company's dependence and impact on a range of ecosystem services. Six priority ecosystem services were identified:

Provisioning: (1) Wildfoods were selected as Aotearoa Fisheries pāua operations depend upon the provision of pāua as a wildfood.

Regulating: (2) Regional climate change and (3) erosion were selected as Aotearoa Fisheries pāua operations are dependent upon global and regional climate, freshwater timing and flows, erosion control, water purification and waste treatment, and natural hazard mitigation.

Cultural: Aotearoa Fisheries pāua operations are affected by (4) recreation and ecotourism, (5) education and inspiration and (6) ethical and spiritual values.



A conceptual illustration highlighting how interconnected human activities and pāua habitat and ecosystems are. This infographic used with permission from F.L.O.W. Collaborative Ltd and Terra Moana Ltd.

3. Identify and analyse trends, risks and opportunities

The ESR guides an analysis of the conditions and trends in the ecosystem services prioritised, as well as drivers of environmental change that significantly influence those trends. The ESR then helps evaluate how those trends can impact the company.

The ESR identified a range of trends, risks and opportunities across the selected priority ecosystem services. These included risks from sedimentation and ocean acidification, to pressures from other sectors affecting both the health of pāua populations, to commercial access to the fishery.

4. Develop strategies and next steps for minimising the risks and maximising opportunities

The ESR tool enables new business strategies to be created to address the risks and opportunities identified in the previous step. The ESR identified the critical national pāua fishery management challenges as:

- integrating kaitiaki and community management;
- developing a well-managed recreational sector;
- ensuring the QMS is fit for purpose;
- addressing poaching; and
- using an ecosystem-based management approach.

As discussed in section 7 (page 30), a series of priority actions to address these challenges are being considered by Aotearoa Fisheries and the wider pāua industry. Experts and potential partners have also expressed interest in supporting Aotearoa Fisheries to develop responses to risks and include DOC, PIC and experts from Otago University Marine Science Department, NIWA and the Cawthron Institute.

Aotearoa Fisheries is considering the lessons from this ESR and whether to apply this approach to other priority business areas. Aotearoa Fisheries supports the uptake and use of ecosystem service approaches in resource management in New Zealand through, for example, the Sustainable Seas Science Challenge and the Natural Resource Sector Natural Capital Project with the Sustainable Business Council.

Pāua – a biological overview

Blackfoot pāua ***(Haliotis iris)*** is one of three species of pāua that occurs naturally in New Zealand.

Larger than the two other species (yellowfoot and whitefoot), blackfoot pāua is the only pāua currently commercially harvested and farmed in New Zealand. Blackfoot pāua can grow to about 190mm in shell length. Growth is significantly influenced by wave exposure, (which is correlated with food availability). Size can also be affected by sea surface temperature with decreased size at maturity being associated with warmer waters.

In the wild, pāua is most commonly found in shallow waters at depths of 0.5 to 7 m, although it may be found as deep as 15 m. Pāua can be found all around the coastline of mainland New Zealand, Stewart Island and the Chatham Islands. It is a relatively sedentary animal and often lives in large groups.

Within the inshore ecosystem, pāua is an important herbivore that feeds mainly on drifting seaweed fragments. Immature pāua is preyed on by a number of species, including blue cod, wrasses, octopus, and rock lobsters. Starfish and rock cod prey on pāua of all sizes.

Pāua are broadcast spawners, meaning they release eggs and sperm directly into the water column. Spawning time and number of spawning events appears to vary across locations and years. Breeding success and recruitment is based on the size of the groups of spawning animals. Spawning success is reduced when a group's size falls below a minimum threshold level.

For juveniles, rock-hard calcareous red algae (crustose coralline) are the favoured habitat for about eight weeks. They then seek out a cryptic habitat, such as under rocks or in crevices, where their diet is comprised of benthic diatoms. Variation in post settlement survival has been attributed to sedimentation, depth, predation, wave exposure, and grazing by adult pāua.

International fishing trends

Abalone is considered a delicacy and is socially, cultural and economically significant both where it is fished and consumed, making it an important fisheries product worldwide. The global abalone fishery is spread over seven countries and comprises 14 commercially relevant species.

Many of the world's abalone fisheries have experienced massive declines as a result of over-exploitation. In many species, production has dropped by 50 per cent or more between the 1970s and the 1990s and two of the world's biggest abalone fisheries in the United States and South Africa, were closed during this period. In 2010, the total wild-caught abalone globally was 8656 t, with the three largest contributors to this total being Australia (4525 t), Japan (1500 t), and New Zealand (1115 t). Asian countries import the majority of abalone products. In the past five years there has been a rapid expansion of abalone farming in China; however there are major concerns around product quality and food safety. This result has been a greater focus on wild caught abalone as a premium product.

Abalone's susceptibility to over-fishing can be attributed to its sedentary nature and tendency to be found in groups. The depletion of mature adults can result in low natural recruitment, which limits population recovery. While commercial fishing is the primary reason for the worldwide decline in abalone populations, the high-market value and relative accessibility to all fishers exposes them to significant illegal, unreported and unregulated fishing.

Customary fishing officers Maadi Te Kahu and Renee Randall - Photograph taken by Craig Simcox. Further negatives of the Evening Post newspaper. Ref: EP/1999/3746/35. Alexander Turnbull Library, Wellington, New Zealand.

Pāua – an essential part of our way of life

As a wild fishery

Customary fishing

In pre-European times and before the onset of large-scale commercial fishing, pāua was a significant kaimoana (seafood) for Māori, and is still considered a taonga (treasured) species. The meat is an important part of the traditional diet and the shell is an iconic feature of carving and jewellery. Pāua remains a significant customary kaimoana species, especially in manaakitanga ki nga manuhiri (the hosting of visitors).

For Māori, tapu (sacred code) surrounds almost every aspect of fishing and successful expeditions depend on strict adherence to the religious restrictions that ensure the favour of gods. The tapu remains until it is removed by a tohunga (spiritual leader) back on shore. This comes in different forms including rahui (periods when shellfish must not be taken), mataitai (self-management areas) and taipure (Māori monitored sites).

The Matauranga Māori notion of balance has meant that when one area is harvested, another area is not.

The knowledge of the ocean kept by each coastal iwi (tribe) and after hapū (family) through its kaitiaki and passed down through generations has been a way of managing resources.

Inconsistent interpretation of information on volume and size of pāua for customary catch is an issue in some parts of New Zealand and can differ according to a given marae and kaitiaki.

Commercial fishing

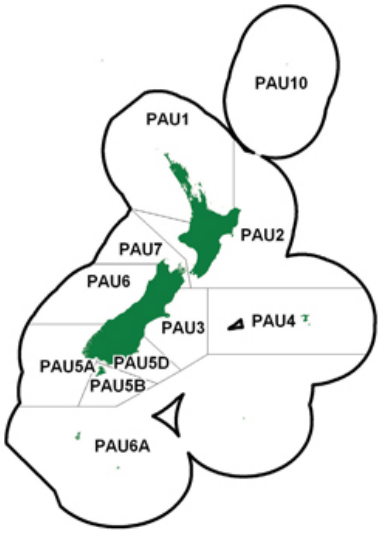
Commercial pāua fishing began in New Zealand in 1940 initially for the shells, and increased steadily until the early 1980s driven by market demand and technological developments to create an exportable product. Based on overfishing concerns, catches were reduced after peaking at 2000 t in 1981. New Zealand's pāua fishery is one of the few sustainably managed wild sources of abalone remaining internationally.

Pāua was introduced into the QMS in 1986 with an initial total allowable commercial catch (TACC) of 1250 t.

The QMS is based on the two key concepts of total allowable catch (TAC) and individual transferable quotas (ITQs). Under the QMS, a TAC is allocated to each commercial species governed by the QMS, which is the maximum amount of that species which may be taken per year. From the TAC, the TACC is derived after allowances for recreational and customary take are deducted. The TACC is then allocated to quota holders within quota management areas (QMAs). There are 11 pāua QMAs; however, significant catches are taken from only seven of these areas.

The primary driver of commercial pāua catches has been the setting of a TACC in each of the main QMAs. These were initially set based on catch histories of fishers and have subsequently been reduced in some areas to maintain an estimated biomass that is believed to achieve maximum sustainable yield. This has been achieved by reductions in TACC by the Ministry for Primary Industries (MPI) and through voluntary management initiatives at the industry level, such as spreading catch effort, shelving (voluntary reductions in TACC for a season), and voluntary minimum harvest sizes.

In 1990, quota owners established the New Zealand Pāua Quota Holders Association, which evolved into the New Zealand Pāua Management Company



Ltd (1998). Some QMAs also then formed their own regional associations. In 2004, a broader industry structure was introduced which disbanded the New Zealand Pāua Management Company in favour of regional, QMA-based PāuaMACs (management advisory committees) who collectively own the Pāua Industry Council Ltd.

The TACC for pāua was set at 1250 t from 1986 to about 1999. Since 1999, reductions of up to 40 per cent have occurred in PAU7 (Nelson/Marlborough) and PAU5 (Southland), which caused an 18 per cent decrease across the whole of New Zealand to 950 t. The current TACC is 1056 t which includes voluntary management initiatives.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Recreational fishing

Pāua recreational fishing is an important way of life in New Zealand for different ethnic groups, most notably and historically Māori, then Pakeha and now increasingly with new migrants, including Chinese New Zealanders.

The New Zealand government sets a size and daily bag limit for pāua recreational fishing. While there are penalties for harvesting undersize pāua or taking more than the daily bag limit, recreational fishers appear to have a poor understanding of the rules and the sector does not regulate itself. A lack of information is also an issue for tourists and migrants who may not necessarily know there are fishing rules and for those for whom English is not their first language.

Of particular concern is that there is no systematic reporting or information about recreational catch. Periodic surveys do occur at boat ramps and aerial photos are also used and extrapolated to build a picture of overall recreational fishing effort. There is, however, no verification that the assumptions are valid. This blind spot in our understanding of the recreational take of pāua has implications for pāua and its ecosystem, as well as other stakeholders.

Illegal fishing

Illegal fishing pressures are of significant concern in this fishery. One of the drivers for illegal fishing is the increasing numbers of visitors who are able to afford a holiday meal that is a prized and very expensive delicacy in their native country.

It is believed pāua poaching is declining among recreational fishers, but not among the more serious black market criminals. Wellington's coastline appears to be the most vulnerable to these criminals, and was the site of 413 of the 985 prosecutions between 2010 and 2013. MPI figures show the number of times people were caught taking pāua illegally decreased nationwide from 1824 t in 2010 to 1185 t in 2013. The most serious black market offending, involving large numbers of pāua, however, has remained fairly stable over the years, with about 80 prosecutions each year.

There appears to be a geographical correlation between commercial fishing occurring and noticeably reduced black market fishing. Further research into this correlation would be helpful to better understand and manage pāua populations.

A few overarching observations

While levels of commercial catch can be monitored and regulated, there is great uncertainty about levels of recreational and illegal catch. The reality is that pāua is expensive as a commercial product and, as such, is attractive to catch for "free" whether through customary, recreational, or illegal fishing. As noted above with recreational fishing, more accurate data would enable a better understanding of pāua populations and would support better management and decision-making.

Across all types of fishing (customary, commercial, recreational, and illegal) continued changes in technology, such as global positioning systems (GPS), which allows fishers to pinpoint and return to prime locations, could have major implications for pāua populations. Any management planning will need to address the issues associated with existing and emerging technologies.

Mrs Raewyn Te Patu diving for paua and kina at Pukerua Bay - Photograph taken by Stuart Ramson. Further negatives of the Evening Post newspaper. Ref: EP/1985/0619/7a-F. Alexander Turnbull Library, Wellington, New Zealand.

Recreation and tourism

Recreation

Pāua is important recreationally. For example, pāua shells are collected for their beauty, for amateur jewellery making, and for games.

In addition to direct uses, many coastal communities provide leisure, relaxation, and an opportunity to unplug from our fast-paced lives. These communities depend on species such as pāua to provide this experience.

Coastal areas are also places where people enjoy recreational pursuits, including walking, kayaking, swimming, and photography. These activities produce benefits ranging from relaxation, to socialising, to learning new skills.

At a collective level, recreation provides communities with improvements in physical and mental health, builds social capital and contributes to local identity and economies.

Tourism

Pāua supports more general tourism and ecotourism as it is:

- represented in local art and displays;
- used by restaurants and others to showcase New Zealand cuisine;
- served as a delicacy, with many cultures valuing abalone highly as a seafood and which commands high prices, for example in New Zealand's Asian restaurants it can sell for as much as $150.00 per portion;
- purchased by tourists as souvenirs, art and jewellery; and
- used to create a destination location, such as the Wairarapa shell factory for jewellery and souvenirs.

Ecotourism includes recreational pāua fishing and other coastal-based sports, along with wildlife watching, tramping and other coastal activities.

The benefits

There are a range of market and non-market economic aspects to tourism, ecotourism and recreation associated with pāua. Non-market values are often difficult to quantify, for example, if people recreate and become healthier, this can reduce national health costs and which is currently not accounted for. Another example is when the value of a day's recreational fishing is significantly greater than the price of buying the same fish.

Especially when in market economic terms, the value of recreation, tourism, and ecotourism can be measured through the consumption of fuel, tackle, bait, boat sales and charters, accommodation, food, and hospitality.

Associated problems

While there are positive economic and cultural benefits associated with recreation and tourism, there are also increased pressures. These pressures range from an unsustainable demand for pāua (either as a food or as a fishing activity), to displacing other user groups, to impacting on other resources.

Finding the balance

Like all activities, recreation and tourism can impact on other pāua user groups, which can lead to complex marine management challenges. For example, a public campaign by the recreational pāua fishing advocacy group "Pāua to the People" has sought to make the Otago Peninsula closed to commercial pāua fishing. Local recreational pāua fishers and Dunedin City Council also support the closure in a bid to protect wildlife tourism.

There are also often indirect consequences when behaviours or uses change within an ecosystem. For example, in recent years there has been an increase in shark tourism operators who often use food to attract sharks near to their tour vessels. The practice, known as chumming, has modified shark behaviour by building a strong association between food and vessels with divers in the water albeit in shark dive cages. This change in the ecosystem has put pāua divers at greater risk of shark attacks .

China – an emerging tourism market

For the last few years China has been our fastest growing visitor market and current predictions are for Chinese visitor numbers to almost double by 2018 to around 400,000 visitors spending more than $1.1 billion annually[4].

Abalone is considered a delicacy in China and Chinese tourists often seek out pāua in Chinese restaurants as part of their New Zealand experience. Hypothetically, what this means in terms of volume is that if just 5 per cent of existing Chinese visitors (240,000[5]) were to have one pāua meal within a seven-day visit, this would equate to 12,000 meals at 335 grams greenweight per pāua or 4.02 t of pāua consumed this way. In value terms, at $150 per serve (declared restaurant menu prices), then the relative figures for 5 per cent retail value would equal $1.8 million per year.

With increasing numbers of increasingly affluent Chinese visitors coming to New Zealand, there is thus the potential for an improving domestic market for pāua, particularly if provenance and sustainability labelling are incorporated. This approach may also reduce interest in poaching by putting a premium on legally harvested pāua.

4 Retrieved from: http://www.chinatoolkit.co.nz/.
5 Retrieved from: http://www.tourismnewzealand.com/markets-and-stats/china/.

Instilling the true value of pāua

Understanding the tension between commercial interests and recreational and tourism interests is essential for the sustainable management of pāua and its ecosystem. This includes ensuring better public accountability and that information systems are in place.

In New Zealand, the ocean and fishing for kaimoana (seafood), including pāua is a way of life and people naturally want to protect the resource. Education has an important role to play, for example, programmes could be established at border entry to promote recreational fishing rules and conservation.

In education and inspiration

Ecosystems influence the types of knowledge systems developed by different cultures, both formal and traditional. Pāua and its ecosystem also provide a rich source of inspiration for art, folklore, national symbols, architecture, and advertising.

Formal education and research

The coasts are used in both formal and informal education. Formal education about pāua and the coastal environment occurs through marine studies in universities, high school education, and marine exploration programmes, such as the Island Bay Marine Education Centre, along with nationwide programmes, such as Seaweek.

Research and studies are often linked to finding ways to sustainably manage the oceans. For pāua there are a number of industry research initiatives currently underway, for example, reseeding, translocation and monitoring of other biological indicators. Pāua is also being studied to determine its health benefits to humans.

In tradition

Māori have a rich knowledge base, Matauranga Māori which is the Māori world view of the natural order to the universe, that there is a balance or equilibrium and believe that when part of this system shifts, the entire system is unbalanced. This knowledge system includes how to steward the ocean and its inhabitants, including pāua and its ecosystem.

Knowledge is often handed down through generations, including fishing methods or the location of fishing areas. Māori traditional harvesting includes karakia (prayer) before and after going into the sea to gather food.

As inspiration

Coastal environments are a source of inspiration for artists and others who are drawn to our coasts for aesthetic reasons. One only needs to consider the many ways the pāua shell, for example, is represented across all types of mediums – from indigenous art, to fine jewellery, to greeting cards, to entrances to marae – to realise the aesthetic draw of this species.

People who have a positive aesthetic connection with aspects of an ecosystem are more likely to support it or protect it from degradation and loss.

Threats to education and inspiration

An increase in human activity and related pollution in coastal areas not only increases pressure on pāua populations, it also contributes to an overall degradation of the "beauty" of the coasts through overcrowding. Balancing the needs of the environment and ecosystems with societal pursuits in and around the coast will become increasingly challenging and require more sophisticated resource management approaches, such as ecosystem service analysis.

Terrestrially based activity resulting in erosion and run-off also causes turbid, murky water and disrupts the clear blue of the ocean that provides aesthetic value to visitors.

Spiritual and ethical

The ESR looked at belonging in terms of a geographical sense of place, along with personal, community and national identity. The ESR also considered belief systems and cultural practices associated with pāua and its ecosystem.

Sense of place

As an island nation, our coastal environment provides a sense of place for many New Zealanders. This sense of place can affect how pāua and its ecosystem are managed.

For example, at the PāuaMAC 2 executive committee meetings, discussions occur where committee members who are Māori often speak with pride about their tribal area. This sense of place extends to pāua populations in the area, with an expectation that activities, such as reseeding, should be genetically consistent with the existing populations.

Personal, community and national identity

Studies have shown that fishing is not just an occupation, but also defines fishers as individuals, as well as defining their households and communities. In addition, the nature of small coastal towns inherently generates a strong sense of community with locals and commercial fishers working together to protect resources, such as pāua, that they depend on for their livelihood and overall way of life.

For Māori, pāua is identified as a highly esteemed taonga, as food, as a component of arts and traditional crafts, and for the role it plays within its ecosystem. Pāua is frequently used to represent the eyes in Māori carvings and traditionally is associated with the stars or whetū – the symbolic eyes of ancestors who gaze down from the night sky.

At a national level, most New Zealanders have a strong affinity with the ocean. This affinity is reflected in how we manage resources, how we work, how we recreate, and how we celebrate.

Our belief systems and cultural practices

Traditionally, Māori performed various rituals including reciting karakia of thanks to Tangaroa before and after fishing. Historically, iwi and hapū have had special sites on shore where they performed these rituals and placed their offerings of fish to Tangaroa. At sea, such rituals also included releasing the first fish to Tangaroa. A better understanding of each iwi and hapū's rituals and whether aspects of those rituals are maintained today would be useful for providing context for fisheries management.

With changes in our demographics new traditions and rituals will likely be introduced. For example in Chinese culture, pāua is a representation of good fortune that is due, and is often consumed during special occasions such as Chinese New Year.

Changing the Crown-Māori relationship

The Waitangi Tribunal report into the Wai 262 Claim recommends the Crown-Māori relationship move beyond grievance to a new era based on partnership. As the Tribunal notes, "Over the next decade or so, the Crown–Māori relationship, still currently fixed on Māori grievances, must shift to a less negative and more future focused relationship at all levels."

The ecosystem services approach aligns with this shift. Specifically, using the pāua ESR as a starting point for discussion with its more subtle incorporation of social and cultural perspectives and issues may serve as a blueprint for how this new era can benefit all of New Zealand.

Pāua – regulating services

Regional climate change and erosion were prioritised as regulating services.

They were chosen because Aotearoa Fisheries pāua operations are dependent upon global and regional climate, freshwater timing and flows, erosion control, water purification and waste treatment, and natural hazard mitigation.

Effects of regional climate change

Future climate change (ocean acidification and ocean warming) has the potential to have detrimental effects on pāua populations and their ecosystems.

Globally, ocean temperature is predicted to increase in the order of 2-4°C by 2100. Elevations in surface ocean CO_2 is altering seawater chemistry thereby reducing seawater pH, the availability of carbonate ions, and the saturation states of calcium carbonate minerals used in the formation of skeletal and shell material.

In the South Pacific Ocean, pH levels in the surface of the open ocean are approximately 8.08 and are predicted to decline to 8.0 by 2025 and to 7.95 by 2050. There are no predictions available, however, for changes in coastal areas where abalone live. To better understand the potential effects of declining pH levels, a review and analysis of available data, including overlaying temperature, CO_2, and oceanographic information is necessary.

Both warming and acidification processes may impact on marine calcifying species including pāua, although the overall impact of these stressors are difficult to predict as research has shown the responses of calcifiers are diverse, species-specific and vary depending on life-stage. Abalone occupies coastal areas where seawater temperature and pH show high variability on a daily basis.

Of particular concern are juvenile abalone, which appears to be more susceptible to both changes in temperature and acidification. Adult abalone seems to tolerate these changes better, although studies have found negative effects of warming and acidification in adult abalone as well, for example, small reductions in growth rate in response to reduced seawater pH. Research has also shown a decrease in the reproductive abilities of mature male red abalone exposed to warm water conditions (2.5oC above ambient) for six months and complete reproductive failure over a 13-month exposure period.

Pāua habitat is also at risk. Research shows that coral structures – which are important habitat for juvenile pāua – are susceptible to ocean warming and ocean acidification. In terms of acidification, predicted changes include a reduction of carbonate ions. This change may affect coral distribution by reducing their ability to calcify. The change could also undermine the skeletal structure of existing corals and could affect their physiological processes.

Effects of warming – a closer look

Recent studies suggest warming may cause a reduction in fertilisation success, as demonstrated in the red abalone ***(H. rufescens)*** found along the west coast of North America. Fertilisation in the Japanese and Australian abalone species (***H. discus hannai and H. coccoradiata)*** appears robust to moderate ocean acidification levels. There is no published information on the effects of warming or acidification on fertilisation of New Zealand pāua.

Warm water has been shown to make red abalone more vulnerable to withering syndrome, which is caused by a rickettsial organism. Withering syndrome attacks the gut lining of abalone and inhibits digestion which can cause the abalone to consume its own body mass. The syndrome causes the affected individual's foot to wither making it more susceptible to predation and starvation. On the west coast of the United States, withering syndrome has been associated with increases in temperature, particularly during El Niño events.

Rickettsial organisms have been found in New Zealand pāua, although to date this has not been associated with any signs of withering syndrome. With ocean warming, however, rickettsial infections could emerge in wild and cultured pāua, along with other disease conditions, such as haemocytic neoplasia (a herpes-like disease).

Effects of acidification – a closer look

There is limited research on the biological responses of abalone to ocean acidification. Laboratory research that has been done suggests a sensitivity to seawater pH reductions of 0.2 to 0.5 units below ambient. This is characterised by malformation or complete loss of the larvae shell, smaller sizes of normally developed larvae, as well as reduced thermotolerance.

Previous studies suggest fertilisation and larval development of the New Zealand pāua may be vulnerable to the effects of acidification; however, research on New Zealand pāua fertilisation and larval responses to pH levels predicted for 2025, 2050 and 2100 would be required to be able to compare New Zealand pāua with overseas species.

Adaptation and acclimation

It is yet to be determined if marine organisms will be able to overcome the long-term and multigenerational exposure to future ocean warming and acidification.

Research indicates sea urchins have been able to acclimate to increased acidification, which suggests sensitive marine invertebrates may be able to adapt to moderate acidification predicted for the coming century.

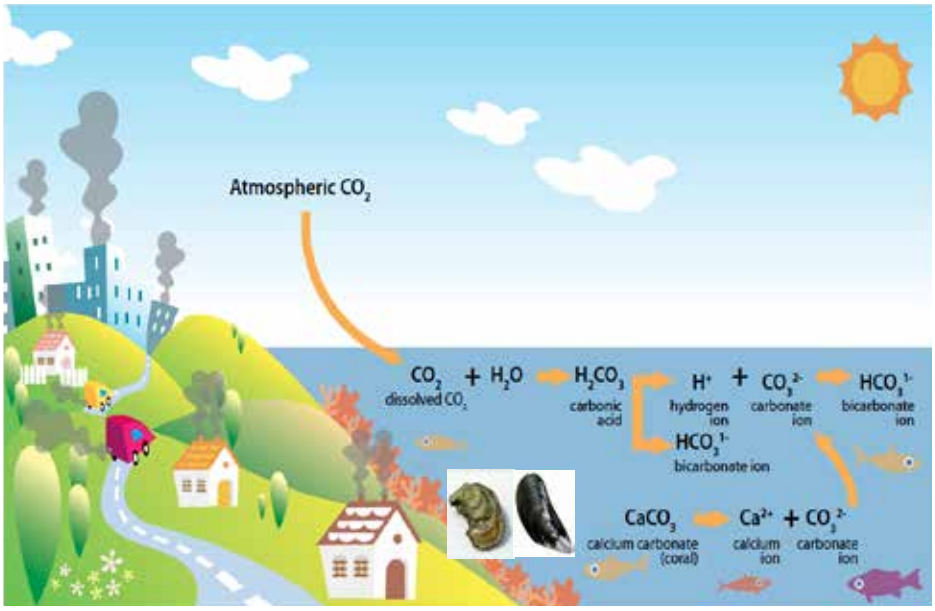
Additional research is required to determine the ability of New Zealand pāua to acclimate and adapt to rising temperatures and acidification.
The involvement of Aotearoa Fisheries and the pāua industry in collaboration with research providers could help to better monitor and assess the potential impact of environmental change on pāua populations.

Effects of erosion and sedimentation

Sedimentation is a natural phenomenon driven by geology, topography, active tectonics and rainfall. Sedimentation can be intensified by terrestrial activities, such as farming and forestry. Sedimentation can also intensify through benthic disturbances in the marine environment, such as mining, trawling and vessel propulsion wash. In New Zealand, for example, agriculture covers over half, and forestry 5 percent of our land surface. Levels of erosion and sedimentation in our coastal environment have increased steadily with human settlement and the associated changes in land use.

When Māori first arrived in New Zealand in about 1250 AD they cleared about half of the native vegetation, particularly around coastal plains, lakes and rivers. In about 1850, European settlers began further large-scale clearing of native vegetation for conversion into pasture that extended into the hill country. A major source of erosion is landslides occurring on open hill country combined with extreme rainfall events.

The chemistry of ocean acidification is straightforward and irrefutable



Harrould-Kolieb et al. 2009. Acid test: can we save the world's oceans from CO_2?, Oceana

The kelp-pāua connection

Kelp plays an important role in pāua ecosystems. Pāua growth is highest over the summer months, which coincides with kelp beds subsiding and being washed inshore, where they are broken up and make ideal drifting food for pāua.

Kelp beds also play an important role in buffering wave energy in exposed areas and stabilising critical habitats for juvenile pāua in the intertidal zone. Kelp may also play a role in determining larval dispersal patterns in pāua. Pāua larvae go through a period of positive buoyancy for five to nine days. In areas of high kelp biomass, larvae may be locally retained as water flow is dampened, and long-range dispersal of larvae may be inhibited. In the absence of kelp there is greater potential for long-range dispersal. Long-range dispersal is one of the factors that may actually decrease the likelihood of successful settlement and recruitment.

Regional climate change and sedimentation may both impact on kelp beds and that could have huge implications for pāua populations and other species that depend on kelp beds for part of all of their life cycles, such as blue cod.

Considering the effects

Sedimentation can impact on the composition, structure and dynamics of near shore ecosystems. These effects fall into three broad categories:

- smothering which can result in reduced light, oxygen and nutrients, or accumulation of waste products;
- abrasions caused by moving sediments damaging or removing organisms; and
- changes to the bottom surface and habitat by replacement of the hard sub-strata with unstable particles.

All of these effects can negatively impact on pāua populations; for example, high rates of sedimentation in the wild have been linked to direct mortality in adult pāua. There is also the direct physical impact of sedimentation on pāua. As grazers, pāua can ingest sediments which in laboratory conditions has been shown to stunt their growth.

Listening to those on the frontline

Senior Skipper and Maritime Advisor David Baker has lived in the Marlborough Sounds for most of his life. He received a Queen's Service Medal (QSM) in 2012 for his services to maritime safety and marine conservation. Currently he is the Senior Director of Saavid Fishing Ltd as a professional pāua diver, Duty Officer for Marlborough Harbours, and Maritime New Zealand's Marine Oil Spill Regional On-Scene Commander for Marlborough.

David started diving for pāua in 1966. He chaired a group of Area 7 pāua quota holders regarding concern raised by recreational fishers on the West Coast. Together they agreed to rotationally close areas (e.g. PAU7) on the West Coast and later voluntarily shelved 20 per cent of their quota limit in Area 7 to let stocks rebuild. He continued as interim chair through the formation of PāuaMAC 7. The group saw stocks rebuild by over 50 per cent.

As David told the ***Marlborough Express*** when interviewed after receiving his QSM, "It's an asset we are lucky to have and a privilege we have and need to protect for the future."

Over the past 40 years David has seen significant changes to pāua habitat in the Marlborough Sounds, including the dramatic loss of kelp beds. As a pāua fisher, he has also seen first-hand the link between loss of the kelp bed habitat and the decline of pāua.

Information such as David's is vital to fisheries management planning. Using an ecosystem services approach ensures that this type of information is accessed, validated and used to guide policies and practices.

This map shows the anecdotally reported extent of kelp loss in Queen Charlotte Sound (in the Marlborough Sounds).
Yellow = ~50%, Orange = ~90% and Red = 100%.

Shared fisheries

In 2013, the PāuaMAC 2 approved a set of Shared Fishery Engagement Principles that guide the work of the industry in the region that extends from East Cape to Tirau Point on the West Coast. These principles note the dependence of the industry on healthy pāua populations and their environment.

The principles include the industry's responsibilities to:

- operate within the QMS;
- collect and report data in a way that enables good management and monitoring of the resource;
- invest in research; and
- work with others to support where possible a shared fishery framework.

The principles also include the PāuaMAC 2's accountabilities to:

- acknowledge the importance of iwi as a Treaty partner;
- optimise the value to the economy;
- be aware of other resource users within the shared fishery environment; and
- leave "the resource in a better condition than we received it" for future generations.

Such principles, particularly the last, demand a shift in focus from the users' needs to the needs of a fishery and its ecosystem. This would be supported by more encompassing, ecosystem-based management alongside the QMS.

An overview of the sedimentation research

Research suggests that sedimentation events can restrict settlement of pāua larvae, cause larval mortality, and change behaviour in adult pāua making them more susceptible to predation and dislodgment. Sedimentation can also restrict the recruitment of kelp spores, cause mortality of settled pāua juveniles by smothering them, and restrict growth in juveniles by increasing water turbidity. Settlement of fine sediments on the blades of mature plants can also restrict their photosynthetic ability and nutrient exchange. These findings all suggest that sedimentation can adversely affect pāua populations.

While there is no published scientific evidence for direct links between increasing sedimentation, a reduction in kelp abundance and reduced pāua population productivity, there are consistent anecdotal reports that suggest that this pattern exists in some areas. For example, in the Marlborough Sounds (PAU7), it is believed that increased sedimentation from forestry has resulted in a dramatic decline in pāua food sources, such as giant kelp ***(Macrocystis pyrifera)*** and is also linked with a decline in the productivity of the pāua populations in these coastal areas. Conversely, on the Wairarapa coast where the native forest remains intact the pāua fishery is highly productive.

More direct measures to combat ocean acidification are also being researched. To date, two studies have found that the return of crushed shell material to an area can increase alkalinity and pH acting as a potential buffer to regional climate change, a mitigating strategy that could be an area of interest to the pāua fishery at a local scale.

Rethinking our management strategies

An assumption in fisheries stock assessment models is that fishing pressure is the only stressor in the fishery, and that environmental stressors remain constant, despite dramatic ongoing changes in coastal ecosystems over the last 100 years.

Management initiatives are currently based on altering fishing pressure (changing size limits or the TACC); however, the ongoing cumulative effects of environmental stressors on the ecosystem are poorly understood and rarely effectively factored into fisheries management. This ESR has highlighted the fact that there is a need to give greater consideration to environmental effects in managing the resource. For example, in areas where reseeding is routinely undertaken, care should be taken to reseed in areas where there is intact native vegetation or where forestry is present and logging will not occur in the near future, or to avoid reseeding during seasons where high rainfall is expected.

There could also be a move towards using new indicators to monitor fishery health. For example, in particularly susceptible areas, metrics such as measures of land-use change, forestry harvest timeframes, frequency of storm events or levels of turbidity may be able to be used to predict the status of specific populations. This is an area where there is potential for further research.

Creating new regulatory mechanisms and multi-sectoral financial relationships may enable restoration of coastal habitats, land and water, to buffer the impacts of sedimentation and to address pH imbalances.

A tale of two QMAs

To illustrate the potential environmental effects, such as sedimentation, on pāua populations a recent study compared PAU5B (Stewart Island) to PAU7 (Nelson/Marlborough).

These two fisheries have undergone similar histories of over-exploitation followed by exploitation-based management controls, yet PAU7 has not experienced the same rebounding of its pāua populations. While there is no hard evidence to suggest this is due to changing environmental effects, the literature and anecdotal observations suggest that certain drivers of sedimentation may impact on pāua and its ecosystem.

Kaitiaki in a contemporary context

As the ESR suggests, there are major challenges facing our pāua populations. The ESR also serves as a map to guide the journey we must take if we are to maintain our pāua populations. Through more active kaitiaki, taking an ecosystem-based approach and meaningfully and collaboratively working together, we believe these challenges are surmountable.

To support a sustainable pāua resource there are five overarching strategies to consider as discussed below.

Integrating kaitiaki and community management

As the largest Māori-owned seafood company, Aotearoa Fisheries is well placed to support giving effect to Kaitiakitanga (guardianship), Kāwanatanga (governance), and Tino rangatiratanga (sovereignty). Through our large stake in the pāua fishery, greater Māori participation is occurring at the local PāuaMAC level. This participation is helping to build working relationships across the PāuaMACs, which in turn, could create a more collaborative approach to pāua fishery management. These relationships support better sharing of information and resources, as well as the consideration of traditional fisheries management practices as a response to some of the issues facing the fishery.

By integrating kaitiaki in every aspect of our work and being more strategic in our support of an holistic approach to fishery management, including marine restoration projects where necessary, Aotearoa Fisheries has a vital role to play.

Developing a well-managed recreational sector

The current fisheries management framework is political, competitive and adversarial. This is fuelled by a lack of information on the impacts of recreational fishing and a lack of explicit definition of recreational responsibilities and accountabilities in a shared fishery environment.

There is an urgent need to develop better monitoring approaches and systematic recreational catch reporting or information about recreational catch. As noted in the ESR, this blind spot in our understanding of the recreational take of pāua has implications for pāua and its ecosystem, as well as other stakeholders.

One way to encourage and support a shared fisheries approach could be through Māori customary and commercial interests leading by example in ecosystem service assessment, analysis, and management. This may shift the current emphasis on competition and illustrate how the pāua fishery and its habitat and related species can be shared. A challenge could still lie with the definition of recreational responsibilities and accountabilities, but examples such as Te Korowai, Guardians of Fiordland and the emerging Otago Coastal Protection Forum could provide guidance on building a more collaborative approach.

Ensuring a fit-for-purpose QMS

When the QMS was introduced in 1986 it received well-earned international recognition as a way of addressing the Tragedy of the Commons. But nearly 30 years on new information is available and there is a fuller understanding that fish populations (and therefore quota) need to be in considered in relation to the wider ecosystem.

Beyond the constraints of the current framework in terms of considering the wider ecosystem, the QMS promotes an adversarial and competitive relationship between the sectors. Under this framework, the commercial sector is expected to invest in improving the fishery and increasing national economic returns while other sectors remain relatively unconstrained in their access to the marine environment.

The QMS is also often a blunt and rigid instrument that frequently limits innovation and collaboration. In the case of the pāua fishery, for example, this means that options that could support more explicit spatial and temporal sharing and allow modern tools, technologies and innovations such as the use of underwater breathing apparatus and pāua ocean ranching, which are currently not possible.

Comparing the QMS with ecosystem-based management and filling any gaps will allow New Zealand to once again be a world leader in fisheries management. Ensuring a fit-for-purpose framework has positive implications for our fisheries, the wider ecosystem, our social licence to operate both here in New Zealand and overseas, and our economic capital.

Addressing poaching

Poaching is a national problem that requires national ownership by all sectors. As noted in the ESR, this connection between legal activities and a decrease in illegal activities needs to be both better understood and communicated to inform fisheries management.

The significant scale of high financial rewards versus the low penalty deterrence by the judiciary will continue to encourage poachers who currently factor penalties (such as fines and the forfeiture of vehicles and boats), into the cost of doing business. The sometimes subtle difference between someone exceeding recreational limits and poaching also needs to be considered.

In the longer term, we also need to incorporate provenance and sustainability labelling in marketing pāua. This approach may help reduce interest in poaching by putting a premium on legally harvested pāua. To complement this work, it's crucial to build public awareness around the impacts of poaching to make it less lucrative and socially unacceptable.

Marine ecosystem-based management

Holistically informed fisheries management – based on sound scientific research and local knowledge – will ensure the sustainability of pāua and its ecosystem. There's also a need to create a stronger sense of kaitiaki and collaboration across marine sectors and more considered management across both land and sea, such as the full extent of the coast.

Charting our course

The ESR produced 42 potential actions for Aotearoa Fisheries and partners to consider across the priority ecosystem services. Some can be addressed in interrelated projects and some require further scoping and development.

Priority short-term actions that have been identified fall into four main categories: information needs, internal changes, public policy engagement, and collaborative ecosystem restoration.

Information needs

To better understand pāua and its environment, data gathered on land use, sedimentation, and state of pāua populations needs to be collated, overlaid and analysed. This work should include identifying hot spots for regional climate change and developing a vulnerability index for pāua to help determine where mitigation interventions would be most appropriate. There's also a need to develop financial models to evaluate Aotearoa Fisheries pāua business exposure to the risks identified in this ESR and to guide prioritisation of our programme of work.

Internal changes

Our priorities include developing internal best practice corporate reporting using ecosystem service analysis, such as Global Reporting Initiative or Integrated Reporting. We are also considering ways to apply the ESR approach to other Aotearoa Fisheries priority businesses, such as snapper.

Public policy engagement

We will support the use of ecosystem services in resource management in New Zealand through natural capital assessment and initiatives, such as the Natural Resource Sector Capturing Nature in Decisions and the Sustainable Seas Science Challenge.

Collaborative ecosystem restoration

As the research suggests, there are restoration activities that could benefit pāua, their wider ecosystem, and the communities that depend and care about them. Aotearoa Fisheries recognises that collaboration is key for success and will identify a collaborative ecosystem restoration project that can be undertaken, for example, PAU7 in the Marlborough Sounds where there could be a focus on restoring kelp beds that would support both blue cod and pāua populations.

What next?

For Aotearoa Fisheries, considering the ecosystem services underpinning our seafood business requires the courage to step back from daily market, operational and management demands and look at how best to manage our resource base. For iwi, this approach requires a high level of engagement and support to balance Aotearoa Fisheries commercial returns with undertaking any required shifts. The approach will need to be fully transparent and methodical to ensure iwi are able to reflect, document, analyse and act to give effect to kaitiakitanga in today's fisheries management context.

Taking the approach outlined above may well raise the value of the entire social capital attributed to Aotearoa Fisheries in New Zealand and internationally. It can and should underpin any brand and provenance stories developed to raise the market value of New Zealand seafood, as well as foster social licence to operate.

Collaboration with other seafood companies and the wider seafood industry will be crucial if we are to succeed. We can play a leadership role, however, which is why we will look for additional ways to invest in the industry and to research and build partnerships within the community with science and non-government organisations, as well as participate in industry and government working groups to find and implement solutions to today's marine resource management challenges.

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