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Summary

Innovating aquaculture to improve social and economic well-being in coastal communities

Merging Indigenous wisdom with modern aquaculture techniques could usher in a more inclusive and sustainable blue economy, that could benefit coastal communities socially and economically and safeguard the environment.

This paper summarises a project that explored the potential of innovative pātiki aquaculture to generate income and empower communities to reclaim control over their resources.

The blue economy has economic, social, and cultural benefits

The 'blue economy' is a global initiative that seeks to redefine our relationship with the marine environment — recognising its immense value to human societies and its need for protection. The Sustainable Seas National Science Challenge defines the blue economy as *Marine activities that generate economic value and contribute positively to ecological, cultural and social well-being.*

Traditionally, coastal communities have relied on marine resources for sustenance and livelihoods. However, Indigenous communities, whose cultural and economic ties to the sea span generations, often face barriers to accessing these resources. Aquaculture presents an opportunity to address these challenges while promoting economic growth, cultural preservation, and environmental stewardship.

Pātiki aquaculture could generate income and empower communities

Pātiki tōtara, or yellowbelly flounder, holds cultural significance for many coastal Māori communities in New Zealand. As stocks decline, these communities view aquaculture as a means to uphold kaitiakitanga (guardianship) and preserve traditional food-gathering practices. Partnering with Bay of Plenty hapū and iwi, our Sustainable Seas National Science Challenge and University of Waikato study explored the potential of pātiki aquaculture to generate income and empower communities to reclaim control over their resources.

Central to this endeavour is the concept of stock enhancement, where hatchery-reared juveniles are released to the wild to bolster customary fisheries. While this approach is novel in New Zealand, it draws from global precedents, including historical Māori practices with shellfish and, more recently, pāua and salmonid fish, as well as international trials with flatfish species. For stock enhancement to be successful, challenges such as post-release mortality and genetic dilution would need to be addressed through small-scale trials and careful management.

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Opportunities for employment and self-determination

In the broader context of global aquaculture, flatfish farming represents a lucrative market driven by consumer demand and waning capture fisheries. Despite New Zealand's ambitious aquaculture goals, native flatfish species like pātiki remain largely untapped. Local coastal communities are interested in the prospects of land-based pātiki aquaculture. This could provide employment opportunities, enabling whānau to move back to their ancestral land and improve self-determination. However, more work needs to be done around the hatchery technology and economics of production before either stock enhancement or commercial aquaculture could be seriously considered.

Pātiki tōtara yolk-sac larvae

Pātiki tōtara embryo

Gravid female pātiki tōtara

Images: B Ellis-Smith and S Muncaster

Partnering for progress in Māori aquaculture research

With hapū from Matakana and Rangiwaea islands and Whakatōhea, our objective was to explore the feasibility of small-scale Māori aquaculture economies, with a particular focus on the pātiki tōtara. Our initial steps involved a preliminary economic analysis and investigating the reproduction of this species to advance the current hatchery technology.

Economic viability is promising, but needs an innovative approach

Initially, the outlook for pātiki aquaculture seems promising, given its ability to fetch premium prices in domestic and export markets, compared to average seafood. A preliminary economic assessment hints at potentially lucrative returns, estimating that land-based pātiki aquaculture could yield revenue from 10 to 30 times that of gold and green kiwifruit per hectare, respectively. However, the cost analysis presents a more 'bearish' perspective. Establishment costs are projected to be approximately double that of kiwifruit, with operational expenses forecast to soar to nearly 200 times the kiwifruit's production cost per hectare. Notably, the largest single portion of these expenses is tied to the production of juveniles. With no available data on juvenile pātiki production, the analysis relies on figures from European flatfish farming, converted using current exchange rates. This approach raises critical questions about the true cost of rearing pātiki tōtara in New Zealand and the feasibility of making pātiki farming economically viable.

Out-of-the-box thinking is needed to tackle the formidable challenge posed by the high estimated costs of juvenile production. Contemporary larval culture techniques tend to focus on intensive methods, which, while effective, come at a significant cost for labour and resources. However, an alternative approach lies in low-intensity production methods. This approach entails establishing a small-scale 'ecosystem' or mesocosm conducive to fish rearing. In this arrangement, a pool or pond is enriched to sustain continuous phytoplankton growth and then populated with zooplankton and, in this instance, pātiki larvae. While this method may not generate as many juvenile fish and demands more space than its intensive counterpart, international studies suggest that it could potentially yield high-quality juveniles at a fraction of the cost. Exploring these innovative methods could significantly alter the economic outlook of pātiki aquaculture.

Controlling broodstock reproduction is a crucial first step

Aside from the obvious need to confirm economic viability, venturing into aquaculture presents its own set of challenges. One major hurdle lies in ensuring a steady supply of juvenile fish for grow-out, a common constraint faced by new aquaculture ventures. This bottleneck often arises from difficulties with broodstock reproduction or larval survival and quality. Controlling broodstock reproduction emerges as a pivotal first step toward securing a consistent supply of offspring for further industry development.

Understanding the reproductive biology of pātiki tōtara is essential for effective broodstock management. Spawning patterns in northern New Zealand suggest a breeding season spanning approximately six months, from June to December, with the main spawning peak in spring. A smaller spawning peak may occur in early winter. Contrary to previous assumptions of single-clutch spawning, our observations suggest that females likely spawn several batches of eggs per breeding season.

Hormone treatment is pivotal to overcoming reproductive challenges

A significant concern with wild-caught broodstock is their vulnerability to reproductive failure. Stressors such as capture and the confines of captivity can disrupt the delicate balance of the reproductive endocrine system, impairing normal reproductive processes and resulting in decreased egg production. However, a promising strategy to mitigate this issue involves the use of gonadotropin-releasing hormone agonists (GnRHa). These crucial hormones, which are produced in the brain, indirectly stimulate ovarian development, facilitating the maturation of developing oocytes (egg cells) and promoting ovulation. In essence, GnRHa treatment plays a pivotal role in restoring reproductive function in stressed broodstock, to improve breeding outcomes.

Our study demonstrated the efficacy of GnRHa treatments for inducing ovulation and egg production in wild-caught pātiki tōtara. Although variable, fertilisation rates exceeding 80% were achieved, indicating that good quality eggs could be obtained using this method. Control fish, which only received a ‘sham’ saline treatment, did not ovulate, and instead showed signs of arrested oocyte development, typical of reproductive failure.

While hormone treatments are not our long-term solution, they're currently invaluable for overcoming reproductive challenges in wild-caught pātiki broodstock to help address the immediate need for larval supply. Interestingly, we've observed that after about 12 months in captivity, pātiki can become naturally reproductive without hormonal intervention.

Accurate data on juvenile production costs is essential for economic assessment

Our next step is to gather precise data on juvenile production costs, which will be essential for a more accurate economic assessment and then work to reduce the highest-cost aspects of juvenile production. Only time will reveal if the numbers align. If successful, this merging of Indigenous wisdom with modern aquaculture techniques could usher in a more inclusive and sustainable blue economy for all.

Report

A novel approach to aquaculture in Aotearoa New Zealand: growing community wellbeing with pātiki tōtara

Image: Andre / Unsplash