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Australian inquiry into climate-related marine invasive species

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Giant Kelp
Giant Kelp are the largest and fastest growing marine plants, growing at up to 40 cm per day. They grow from the seabed to the water surface (in depths of up to 30 m), and create a complex, forest-like habitat that is highly significant for a raft of marine fauna and flora, increasing local marine biodiversity. An estimated 77% of seaweed species (565 species) in southern Australia are found nowhere else on earth. Australia's temperate reefs dominated by kelp forests are also extremely important for high-value fisheries including abalone and rock lobster, as well as supporting ~730 species of fish. The large biomass and productivity of the Giant Kelp Forests also provides a range of other ecosystem services to the coastal environment, including protection from coastal erosion, removal of nutrients and being one of the biggest carbon sequestration sources on Earth.

In a recent study published in Scientific Reports, Filbee-Dexter and Wernberg of the University of Western Australia highlight the vital role of kelp forests in mitigating climate change. Their study combined arial extent mapping, biomass calculations, and productivity measures across the entire Great Southern Reef to quantify the total blue carbon sequestered in Australia.

Their study revealed that kelp forests in Australia sequester approximately 1.3-2.8 teragrams of carbon per year. Thus, kelp forests account for 30% of the total blue carbon sequestered annually in Australia, and about 3% of the total global blue carbon budget.

Problem
Climate change through rising sea surface temperatures and overfishing of predatory species like lobsters, crabs and cod from the world's oceans have unleashed a population explosion of sea urchins, spiny invertebrates that have decimated some of the world's most productive kelp forests including those found in Australia's East coast.

After destroying the kelp forests and collapsing its dependent food chain, urchins draw down on their energy reserves stored in their roe sacs, and starve until a new food source grows or floats by. As a result of years of starvation, the urchins have little or no roe in them, making them unattractive for predators to eat or for humans to catch and make into sea urchin roe, one of the world´s most exclusive seafood products also known as 'Uni'.

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Without an intervention to address this phenonmenon, urchins will occupy once productive kelp forests, keep them barren for decades or even centuries, and likely expand to new kelp forests.

Solution

Established in 2017, Urchinomics is a Norwegian based company that has developed an approach that is turning the kelp forest destruction by urchins into an economic, social and environmental opportunity. Through our approach, we engage fishers, ecologists and scientists to identify and remove empty, unproductive urchins that hinder kelp forests from recovering.

Our business model helps restore kelp forests, which in turn supports greater marine biomass, biodiversity, and capacity to sequester CO2, all while creating meaningful, full-time employment in rural, coastal communities around Australia.

Once urchins are removed, nature takes over and kelp begins to grow. In as short as 5 days, juvenile kelp will begin to settle on the substrate, with some species then growing as fast as 18 inches per day until reaching the surface.

The restoration of the kelp marks the beginning of the recovery of an entire ecosystem.

The kelp blades attract microscopic organisms that feast on, amongst others, sea urchin larvae. This helps to keep urchin numbers in balance and prevents destructive population explosions in the future.

In turn, these organisms become prey to small fish, which prefer to hide in 3 dimensional habitats like kelp forests. Later, these small fish become prey to the larger fish, which settle in kelp forests to lay their eggs.

In a short period, as seen in Japan, the desert-like urchin barren returns to its original state as a dynamic kelp forest, significantly increasing the biomass and biodiversity of marine life.

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Urchin Ranching

The removed, empty urchins from the barrens are then re-homed into Urchinomics' sea or land based ranching facilities, where they are fed nutritionally balanced, plant-based (soy and corn-free) natural feed to grow their roe. After 6 to 10 weeks of feeding, the urchins become plump and full of roe for discerning foodies to enjoy whilst providing job opportunities to rural areas that have deep expertise in aquaculture.

Results

Since 2021, Urchinomics has been converting overgrazing, empty sea urchins into premium sea urchin roe at commercial scale at their site in Kunisaki, Oita Prefecture, Japan and continue to achieve premium pricing. Pilot operations in Stavanger, Norway and California, USA have also begun commercial sales. The Norwegian urchins are served at Norway´s 2 Michelin star restaurant RENAA, and have been nominated as a finalist for "Seafood of the Year" in Norway. Californian urchins are being served in collaboration with Sushi Kaneyoshi and Sushi Inaba, a Michelin star sushi restaurant in Los Angeles.

Australian Context

In 2012, the Giant Kelp (*Macrocystis pyrifera*) Marine Forests of South-east Australia ecological community ('Giant Kelp Forests') were listed as endangered under the EPBC Act, a first for a marine community in Australia. Giant Kelp Forests were once common across Australia's south- eastern coastline, but over the last half century have undergone a dramatic decline of 95%. Today, only small, isolated pockets of these Giant Kelp Forests remain in Tasmania.

Commercial Opportunity - Global Supply

Global sea urchin landings increased from 18,250 tons in 1960 to a peak of 109,736 tons in 1995 and steadily declined to 68,052 tons by 2018 (FAO FishStat). Aside from a limited amount of sea-based urchin aquaculture in China and Russia, virtually all urchins are harvested from the wild, and historically

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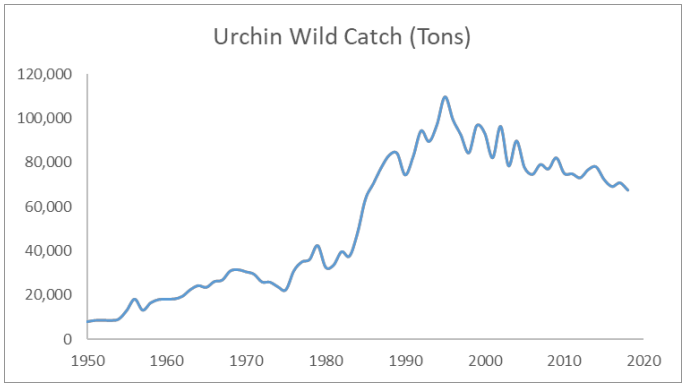
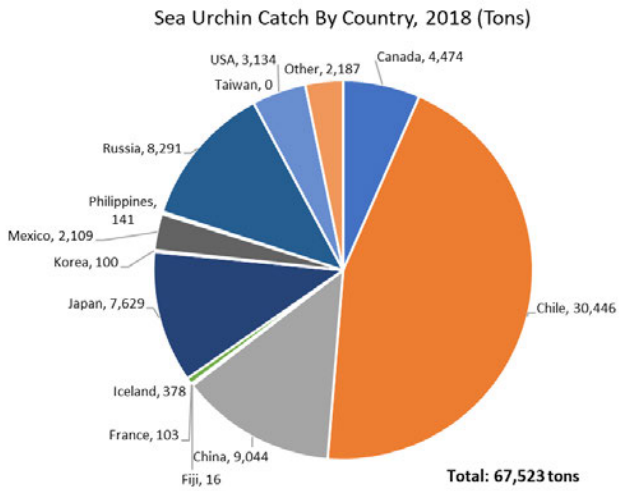
plentiful fishing grounds are being depleted due to overexploitation of the fisheries and expansion of urchin barrens. Based on the lack of new countries producing sea urchin despite strong price growth, there is likely little prospect of new fisheries entering the market and increasing wild catch supply. Sea urchins are primarily hand harvested by divers, processed, sold to intermediaries, and ultimately to restaurants.





Source: FAO FishStat

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Chile produces 45% of global sea urchin supply and is focused primarily on export of frozen uni with minimal domestic consumption. Japan is by far Chile's largest customer, with approximately 72% of Chilean uni being sent to Japan and Chile making up 37% of the Japanese import market by trade value (FAO FishStat, Minato Shimbun). Due to distance from Asia and the highly seasonal nature of urchin fisheries globally, Chilean uni is mainly processed, preserved, frozen, and sent to major markets during the summer low season, when it can command up to 3x the price (Mouzakitis).

Like Chile, Russia is focused on fishing and export to Japan with no significant domestic consumption. Russia differs from Chile in that it sends its whole, live urchins - 8,291 tons, or 12% of global supply in 2018 - to Japan for processing in Hokkaido (Minato Shimbun, FAO FishStat, Japan Ministry of Agriculture, Forestry and Fisheries).

Global Demand

Lack of supply globally and growing demand outside of Japan are realigning supply relationships for premium quality urchins. While Japan remains the world's largest urchin importer today, there is growing evidence that it is not the dominant consumer of premium roe it once was. Rather, Japan seems to be the major clearinghouse for premium roe for other countries in addition to being a smaller consumer itself. It is more likely that Japan is a high volume, reasonably priced market serviced mainly by "discount" producer Chile while the high potential, premium priced markets where brand and perceived quality matter, are outside of Japan (e.g. Hong Kong, Singapore, New York City, Los Angeles, San Francisco, London, Paris, etc.).

The explosive popularity of Japanese cuisine and sushi globally combined with supply shortages and macroeconomic forces have driven urchin prices to new record highs each year since 2019 and could support this premium pricing as a new normal for the urchin market. Average sea urchin prices at Toyosu have grown at a CAGR of 12.4% over the last decade, but the last few years have seen record prices (GDFreak!). Recent developments include COVID driving

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prices up 40-70% in 2020, Hokkaido red algae bloom die offs resulting in prices as high as AUD $977,000/kg in 2021, and the Russia Ukraine war and consequent sanctions on Japan's predominant live urchin supplier causing new record highs in 2022 (Suisan Keizai Shimbun July 14 2021, ANN News, Sankei Biz March 26 2022).

12 Month Rolling Average Sea Urchin Price Growth (Toyosu)			
CAGR Since	**Domestic**	**Imported**	**Average**
2010	9.1%	12.2%	10.4%
2012	10.7%	14.9%	12.4%
2017	10.8%	10.2%	10.6%
2018	15.4%	12.7%	14.1%
2019	14.6%	14.9%	14.7%
2020	22.1%	20.7%	21.4%

Domestically in Japan, average urchin prices have risen 53% from AUD$160/kg in 2018 to AUD$245/kg between March 2021 and February 2022. Export prices seem to have risen in lockstep, having doubled between 2015 and 2018, with the average price of urchin exported from Japan reaching approximately AUD$326/kg in 2018 (GDFreak!, Minato Shimbun). Using the 2018-2022 domestic price growth rate and 2018 export prices to interpolate today's export prices results in an average 2022 export price of AUD$498/kg.

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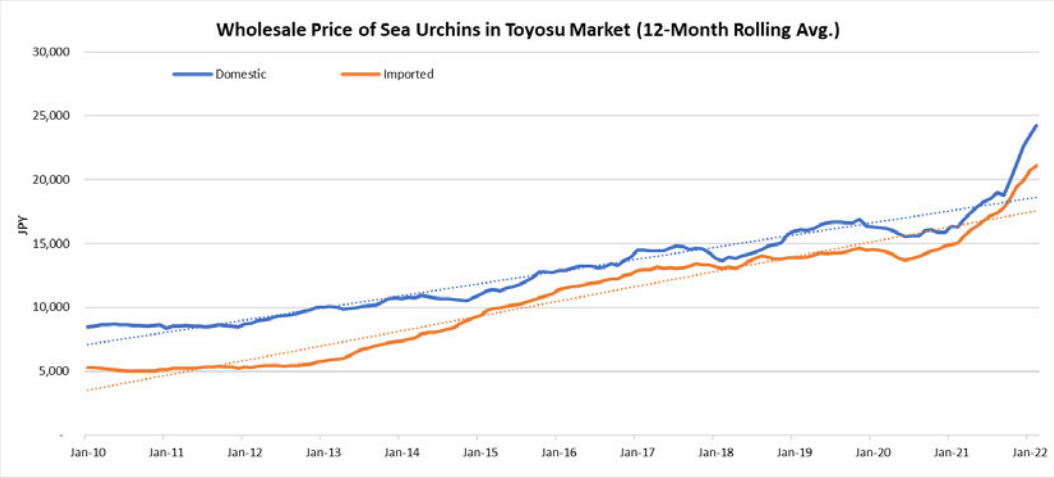

Market Size and Projection

The global sea urchin market is estimated to be AUD $495 million based on 2018 global production and Japanese import data, with Japan importing approximately 70% of this total.

	Japanese Market Whole Urchin Quantity (Tons)	Value (JPY 000)
Total Imported	41,019	20,908,000
Total Domestic	7,629	12,858,000
Total Exported	1,000	3,000,000
Total Japan	**47,648**	**30,766,000**

Japanese Global Market Share	70%
Japanese Market Value (JPY)	30,766,000,000
Global Market Value (JPY)	¥43,941,175,721
Global Market Value (EUR)	€ 320,770,583
Global Market Value (USD)	$ 347,135,288

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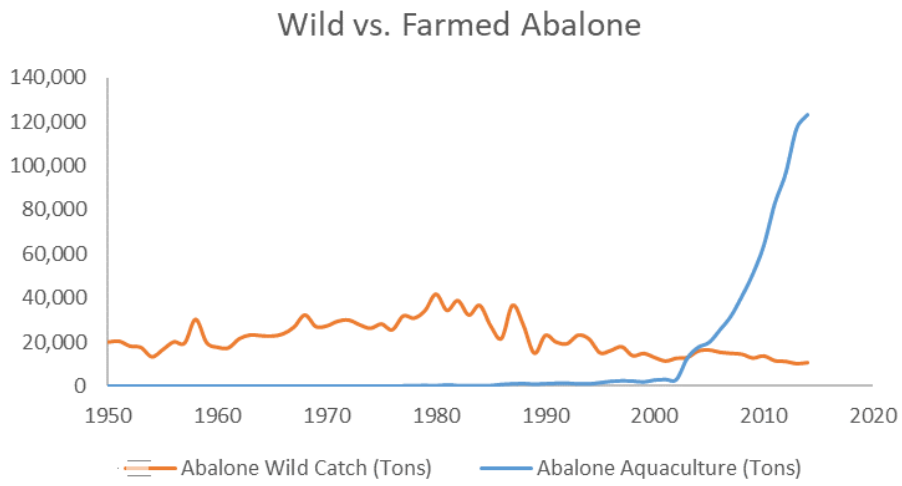
Due to the unstable yet consistently rising prices of sea urchin roe, many food service operators have been unable to keep uni on their menus. With prices breaking records year after year, urchin aquaculture is gaining interest again as a way to increase supply. Observing two similar aquaculture industry developments, when aquaculture is introduced to a new premium shellfish market, farmed supply outpaces wild caught dramatically as the market grows. Using this data, we can estimate what the market potential could be for sea urchins once aquaculture is firmly established.

For example, in the abalone industry, when aquaculture production began in earnest in the 1990s, farmed abalone outpaced wild abalone production by 10:1, a ratio that has since grown to 23:1 in 2018 with wild stocks in continued decline (FAO FishStat). Although the laws of supply and demand would suggest that increased supply should result in lower prices, this has not yet been the experience in the world abalone market. Prices did fall by as much as 30% between about 2008 and 2012, but the Global Financial Crisis was posited as the main reason for this, rather than an over-supply of product (Cook).



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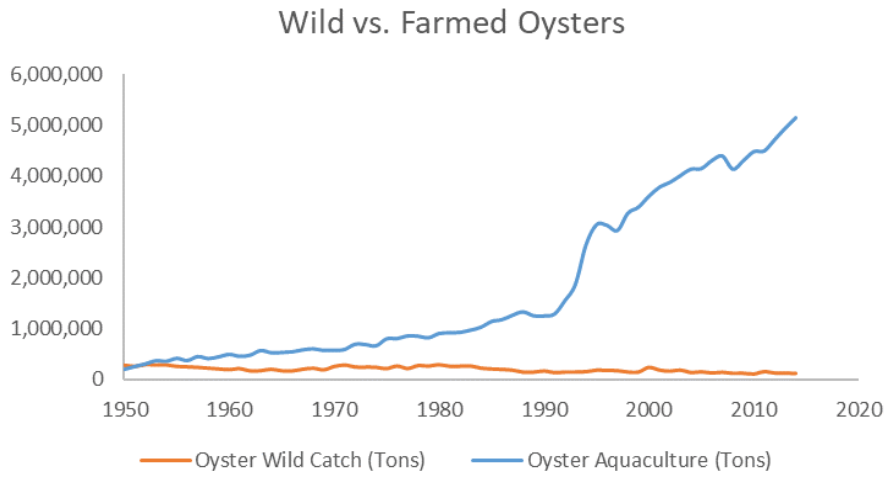
In the oyster industry, wild production has remained stable at 200K tons for decades; however, with the introduction of aquaculture, farmed supply eclipsed wild caught oyster production and outweighed wild supply by a factor of 39:1 in 2014 (FAO FishStat).



The sea urchin market is theoretically at a similar inflection point where, once aquaculture is introduced at meaningful volume, farmed/ranched urchins have the potential to outproduce wild urchins by a ratio of at least 10:1, which is less than half that of abalone and almost a quarter of oysters. This suggests a projected global market size of AUD $4.93 billion and a corresponding production volume of 680,520 tons. Of this 680,520 tons, the new supply of 612,468 tons must come from aquaculture, as wild stocks have consistently declined for almost 30 years.

Australian Trials

In south-eastern Australia, urchin barrens caused by the sea urchin *Centrostephanus rodgersii* are a major feature of the coastline and are expanding in some areas. Urchins from barrens are not harvested commercially, as they

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have smaller, lower quality gonads due to food-limitation. However, feeding barrens urchins in aquaculture facilities can rapidly increase gonads to a commercial size and quality. A land-based feeding trial was conducted by the University of New South Wales (UNSW) in Sydney, to compare the effect of a formulated feed against fresh *Ecklonia radiata* (the dominant kelp in the region) and pellets made from dried *E. radiata* and *E. radiata* wrack on the gonad index and colour of *C. rodgersii* collected from barrens.

The researchers found that the gonad index of urchins fed a commercial diet increased significantly to 3.63 ± 0.49% by six weeks, and to 3.93 ± 0.30% by ten weeks. At six and ten weeks, gonad index was significantly higher in urchins fed a formulated feed compared to other treatments and compared to wild urchins collected at the start and end of the experiment. Gonad index did not differ significantly between fresh kelp, kelp pellets or wrack pellet treatments at any of the dissection times. This knowledge could help to develop a profitable aquaculture industry for *C. rodgersii* in south-eastern Australia, with the added advantage of kelp restoration.

Australian Operations

Australia has an international reputation as a producer of safe, sustainable and high quality seafood products. While there are over forty species commercially produced in Australia, most of the value of Australian aquaculture production comes from high value species such as pearls, salmonids, tuna and oysters .

Tasmania’s abalone fishery is an example of a successful seafood product based on sustainable aquaculture infrastructure - Australia is the world’s largest abalone resource supplying over 25% of total annual global production. The abalone industry is Tasmania’s most valuable wild harvested marine resource and one of the state's largest export earners.

Similarly, Australia can become a thriving example of kelp reforestation through sea urchin ranching that can lead to greater environmental sustainability and job creation, while attracting investment and national brand recognition.

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We have collected a number of recommendations of how Australia can support kelp reforestation and grow a nascent sea urchin industry to a global market:

- Whilst already in place, subsidies to harvest urchins are limited in the number of urchins that can be harvested in Australia. This could reduce supply of urchins for ranching and the capacity to achieve commercial scale
- Subsidies to support novel IP translation such as the Urchinomics ranching process in Tasmania could help incentivise the significant infrastructure investment required to grow operations in Australia
- Co-investing in sea urchin ranching could facilitate opportunities for further commercialisation, providing access to farming facilities and co-investing in scaling operations
- Urchinomics is anticipated to be the world's first company to receive blue carbon credits for its kelp restoration work it is doing in Japan. If Australia recognises kelp reforestation in a similar way to how it recognises terrestrial reforestation as a carbon and biodiversity credit opportunity, this could create additional pathways for financing kelp restoration.

We would welcome the opportunity to work with you and explore kelp restoration in Australia.

Best

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