



A giant statue of a pufferfish is displayed at Karato fish market in Shimonoseki, southern Japan. REUTERS/Mari Saito

# Asia's undersea crisis

BY MARI SAITO AND MATTHEW GREEN

OCTOBER 30 - DECEMBER 10 HAKODATE/PURU NI TIMBUL/SHIMONOSEKI

# Disappearing act

In the land of sushi, a favourite squid snack moves out of reach

BY MARI SAITO

OCTOBER 30 HAKODATE

**T**akashi Odajima picked up a cracked and faded photograph and dusted it off with his sleeve. He smiled a little sadly at the image from long ago, back when he was a baby boy.

In the photo, he sits on his uncle's lap as his family poses at a nearby dock, squid heaped in the background. In another, his uncle dries rows of squid, carefully folded like shirts over a clothesline on the roof of their house.

Odajima's family has lived for generations in Hakodate, on Japan's northern island of Hokkaido. It's a city steeped in squid, a place where restaurants outside the local fish market advertise the start of the squid-fishing season with colourful banners.

When Odajima's father returned home from World War II, he supported his family by driving a truck for a local seafood company. He was paid in salt, a valuable commodity at the time.

Using the salt, his family began making and selling shio-kara, a fermented squid dish that derives its name from its taste: "salty-spicy." Because it keeps for days without refrigeration, it was an important source of protein for Japan's starving population after the war.

Seven decades later, most Japanese bars still serve it as an appetiser, and small bottles are sold in supermarkets as a condiment to be eaten with rice.

"Someone once asked me what squid means to people in Hakodate, and I told him that it



Takashi Odajima makes 'shio-kara', a traditional fermented squid dish, at his family's factory in Hakodate, Japan. REUTERS/Issei Kato

was our soul. I was half-joking at the time," Odajima, 66, said. "But squid was always the main dish, long before we started eating rice."

Out of more than a dozen types of squid eaten here, the Japanese flying squid, or *Todarodes pacificus*, is so central to the national cuisine, it's sometimes referred to as maika, or the true squid.

But now, fluctuations in ocean temperatures and years of overfishing and lax regulatory oversight have drastically depleted populations of the translucent squid in waters around Japan. As recently as 2011, fishermen in Japan were hauling in more than 200,000 tons of flying squid a year. That number had fallen by three-quarters to 53,000 tons last year, the lowest harvest since Japan's national fisheries cooperative started keeping records more than 30 years ago. Japanese researchers say they expect catches of flying squid to be



Takashi Odajima, who runs a seafood company manufacturing 'shio-kara', a traditional fermented squid dish, and other seafood, is seen as a baby in a family photo, at his family's factory in Hakodate, on Japan's northern island of Hokkaido. REUTERS/Issei Kato

even smaller this year.

That such a ubiquitous creature could disappear has shaken a country whose identity is intertwined with fish and fishing, a nation where sushi chefs are treated like rock stars and fishermen are the heroes of countless TV shows. The shortage of flying squid, an icon of the working and middle classes, has dealt a hard blow to the livelihoods of not only fishermen, but everyone from suppliers to traders at Tokyo's famous fish market.

The fate of the flying squid is a microcosm of a global phenomenon that has seen marine life fleeing waters that have undergone the fastest warming on record. Reuters has spent more than a year scouring decades of maritime temperature readings, fishery records and other little-used data to create a portrait of the planet's hidden climate change – in the rarely explored depths of the seas that cover more

than 70% of the Earth's surface.

Fish have always followed changing conditions, sometimes with devastating effects for people, as the starvation in Norwegian fishing villages in past centuries when the herring failed to appear one season will attest. But what is happening today is different: The accelerating rise in sea temperatures, which scientists primarily attribute to the burning of fossil fuels, is causing a lasting shift in fisheries.

In Japan, average market prices of the once-humble squid have nearly doubled in the past two years, quickly putting the dish out of reach for many blue-collar and middle-class Japanese families that grew up eating it.

#### **A TOWN'S IDENTITY IS THREATENED**

Here in Hakodate, the squid shortage threatens the very culture and shared history of the town. One of the country's first ports to

open for trade with the outside world in the 19th century, it has the look of a Japanese San Francisco, with gingerbread Victorians and tram lines that slope down to the waterfront.

Odajima's earliest memory is of his mother buying squid from a neighbour's cart piled high with the morning's catch. Now, fishermen barely have enough squid to sell to traders, much less to neighbours. A festival celebrating the start of the squid season in a nearby town has been cancelled two years in a row.

Odajima still works in the family compound, a collection of deteriorating buildings near the Hakodate docks. Walking through a cluttered storage shed, he shows off the factory floor where he keeps his family

huddle of men at the docks for one of the first squid auctions for the season.

They looked over three neat piles of white Styrofoam boxes, comforting one another that it was still early in the squid season.

"Shit, they're all tiny," one buyer said. His friend walked away without waiting for the bidding to start.

At exactly 6.20 a.m., men in green jackets tipped their hats and began the auction. Once an event that used to attract dozens of buyers and take as long as an hour, this one took less than two minutes.

A gruff buyer supplying local restaurants that cater mostly to tourists strode to the front of the pack and bought all 11 boxes without looking. The rest of the group, including Odajima, hung back and shook their heads.

In the month of June, just 31 tons of fresh squid ended up at Hakodate's main market, 70 percent less than the previous year. A typical squid caught in the Sea of Japan now weighs a third less than it did 10 years ago, according to surveys by Takafumi Shikata, a researcher at the Ishikawa Prefecture Fisheries Research Center.

### AN EARLY WARNING ON SQUID

The squid shortage has become so dire, anxious bankers with outstanding loans to those in the industry have started showing up at the annual seminars held by Yasunori Sakurai, one of Japan's foremost experts on cephalopods.

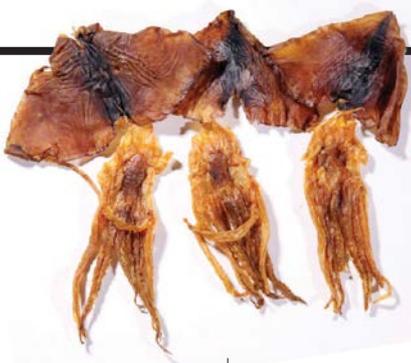
Sakurai, the chair of the Hakodate Cephalopod Research Center, began warning fishermen and other researchers about the effects of climate change on Japan's squid population nearly two decades ago.

The flying squid gains its name from the way it can spread its mantle like a parachute to draw in and eject water, using propulsion to fly above the waves. The squid spend their short life – just over a year – migrating thousands of miles between the Sea of Japan and the Pacific Ocean, mating, then returning to lay eggs in the same area where they were born.

Sakurai blames climate change for recent fluctuations in ocean temperatures – a cold snap in waters where the squid spawn and

Someone once asked me what squid means to people in Hakodate, and I told him that it was our soul. I was half-joking at the time.

Takashi Odajima, whose family has made and sold shio-kara for generations



treasure: dozens of 60-year-old barrels made of Japanese cedar. He's one of the last local manufacturers still using wooden barrels to ferment and age his product.

Odajima also refuses to use cheaper imported squid, saying it would harm the brand's locally sourced appeal.

But with costs skyrocketing, he isn't sure about the future of his family business. His 30-year-old son quit his office job to help out after Odajima failed to find new workers. "I wanted to be able to hand it to him in better shape," he said, "but now..."

One morning in June, Odajima joined a



Fishing boat flags called 'tairyo-bata' used to indicate a large catch are seen hoisted on the squid fishing ship Wakashio-Maru No.85 before its departure from a port in Sakata, Japan. REUTERS/Issei Kato

steadily warming waters in the Sea of Japan where they migrate. These changes mean that fewer eggs laid in the colder-than-average waters in the East China Sea survive, and those that do hatch are swimming northward to avoid unnaturally warm waters in the Sea of Japan.

The Sea of Japan has warmed 1.7 degrees Celsius (around 3 degrees Fahrenheit) in the past century, making it one of the fastest-warming areas in the seas surrounding the archipelago. Based on predictions by Sakurai's former students now at Japan's Fisheries Research and Education Agency, surface temperatures in these waters may rise an additional 3.7 degrees Celsius over the next century.

These changes have taken a toll on squid.

"It's something that's always been eaten on the side, and now it's just gone. Everyone is asking why," Sakurai said.

Others, like retired regulator and researcher Masayuki Komatsu, argue that although Japanese officials and fishermen are loath to admit it, the country's rampant overfishing and lax regulatory oversight are also to blame for the shortage.

"They all blame it on climate change, and that's the end of the discussion for them," said Komatsu, who served as a senior official in

Japan's fisheries agency until 2004.

Since Japan started setting catch limits for the flying squid 20 years ago, fishermen have never come close to hitting the limit of the quotas. This year, the fisheries agency said it will allow fishermen to catch 97,000 tons of squid, a third less than the government's limit for last year, but nearly double what fishermen actually caught during the same period.

The ministry acknowledges that flying squid, particularly those born in winter months, are rapidly declining. But officials say the catch limits are appropriate given the scientific evidence available. They say it is especially hard to study the elusive creature, which travels long distances over a short lifespan and is more susceptible to environmental changes than many other marine species.

"It isn't scientific to simply say that because squid isn't being caught, we need to lower the catch limits, when we don't have the scientific backing to justify that," said Yujiro Akatsuka, assistant director of the agency's resources management promotion office.

## A FISHING TOWN ON THE ROCKS

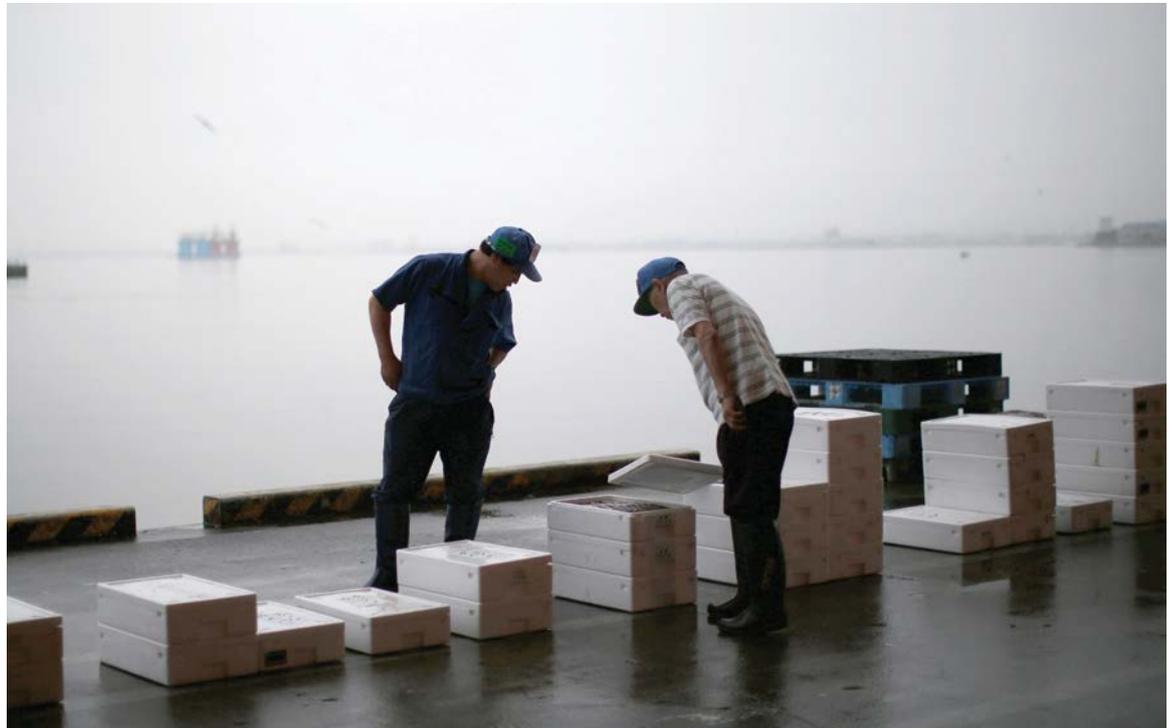
Ripped curtains and fraying bits of cardboard cover windows of the empty storefronts along the main shopping street in Sakata, a town on the northwestern coast of Japan that once thrived as a major trading hub for rice and later as a fishing port. Old signs for grocery stores, camera shops and beauty parlours are barely visible through a thicket of vines.

Wooden warehouses that once stored the region's rice are one of the few reminders of the town's prosperous past. They were turned into souvenir stores after the buildings were featured in a popular television drama series.

On an early summer day, the docks were deserted except for a group of young Indonesian men living in shared rooms next to the port. They're Japan's answer to an ageing industry, part of an army of young foreign men brought into the country to take fishing jobs spurned by Japanese men.

Shigeru Saito was 15 when he boarded

Fish traders check squid before an auction at Hakodate wholesale market in Hakodate, Japan.  
REUTERS/  
Issei Kato



his first fishing boat. By the time he was 27, he was at the helm of his own ship. He never questioned his path. Both his father and grandfather, born on a small island off Sakata's coast, had been fishermen.

Now 60, Saito has steered dozens of ships all over Japan. When Saito started fishing, Japan had a fleet of more than 400 ships harvesting squid. He now captains one of the 65 remaining ships specially kitted with powerful light bulbs that lure squid from dark waters.

Until recently, his crew could return to port in two weeks after the start of the squid-fishing season in early June with their ship's hold full of flying squid. Now, it takes them almost 50 days to catch that much.

"We're having to travel farther and farther north to chase squid, but there are limits," he said, pausing his round of checks to sit in the captain's room of his ship, the *Hoseimaru No. 58*, where he sleeps in a tiny cot under boxes of equipment.

As competition intensifies for an ever-dwindling catch, fishermen have begun blaming trawlers from China, South Korea and

Taiwan for overfishing in nearby waters. In recent years, fishermen from North Korea have also joined the competition. Japan says North Koreans are illegally poaching squid in the Yamato Shallows, a particularly abundant area in the Sea of Japan.

Saito's fishing lines got tangled in a net set by a North Korean boat there last year. Cautious about any confrontation with North Koreans, he and other Japanese fishermen abandoned the area early in the squid season.

"We can't fish in these conditions," he said.

Young Japanese men like Saito's son are reluctant to join the industry, with its long months away from home and physically gruelling labour. His crew is already half Indonesian. Soon, he said, only the captain will need to be Japanese.

In the last decade, the number of fishermen in Japan has declined by more than a third to fewer than 160,000. Of those left, an average fisherman earns about \$20,000, not even half of Japan's national median income.

"My son is a salaryman in the city," Saito said. "I couldn't recommend this to him – how

could I? We're away a third of the year," and, with North Korean poachers on the prowl, "the waters are more dangerous now."

The next day, men set up folding chairs and tents on Sakata's dock for a ceremony marking the start of the fishing season. Saito joined other captains in the front row, bowing his head with his baseball cap in his hands. Young Indonesian men fidgeted in the back of the crowd. Melodic chants of Buddhist monks filled the salty air.

"We know we are powerless before the might of nature," one monk said as the captains fixed their eyes on the ground. "We cannot go against the power of the sea. But we pray for a bountiful harvest and safe passage over the seas."



Our culture surrounding fishing is disappearing, and our culinary culture is also fading.

Kazuo Nagayama  
chef at sushi bar in Nihonbashi district of Tokyo

## ANXIETY IN TOKYO

Several weeks had passed since Japan's squid-fishing fleet left port. But in Tokyo, near the Tsukiji fish market, Atsushi Kobayashi was waiting anxiously. The specialist wholesaler still hadn't received a single shipment of flying squid from northern Japan. His driver sat on the concrete curb next to Kobayashi's truck smoking in the midday sun.

In the past, each week Kobayashi would unload three to four shipments of 1,200 squid, to be dispatched to high-end sushi restaurants around Tokyo.

"Last year, the fishing season ended in November because the squid disappeared" – two months earlier than usual. He unlocked his phone to message another customer that he had nothing to sell that day.

Elsewhere in Tsukiji, the largest wholesale seafood exchange in the world, hundreds of other family-run fish traders were also awaiting this season's catch. But by the time cases of squid finally began to arrive later in the summer, many of the traders were preparing to close their stalls to abandon the 80-year-old market.

In October, hundreds of fishmongers moved to a gleaming new market on the waterfront that cost more than \$5 billion. But others, their businesses already failing from a drop in consumer demand, higher operational costs and a lack of interest from the families' younger generation, didn't make the move.

Those who left felt a powerful sense of loss about a place that has been a colourful symbol of the country's fishing industry.

Masako Arai was one of them. Her husband's family started their wholesale fish trading business 95 years ago, first in Nihonbashi, where the previous market was destroyed in a massive earthquake and fire in 1923, and later in Tsukiji.

"Our families have lived here and protected this place for generations," the 75-year-old grandmother said.

Near Arai's store were empty spaces where families had tended shop for generations; more than a hundred businesses have closed in the past five years. Nearly a third of the remaining 500 fish traders at the market were losing money.

"It feels like we're always on shifting sand, and we don't know what the future holds," Arai said.

Nor do the chefs who create Japan's signature cuisine.

Kazuo Nagayama has visited Tsukiji most mornings for the past 50 years to buy fresh fish. Once back at his sushi bar in the Nihonbashi district, he changes into his white uniform to write out the day's menu with an ink brush. For the past few years, the 76-year-old chef has found it harder to list local fish he deems decent enough to serve to his customers. On this summer day, the first item on his handwritten menu was yellowfin tuna

National Cooperative Association of Squid Processors Managing Director Hiroshi Nonoyama poses for a photograph at the association's office in Tokyo. REUTERS/ Issei Kato



shipped from Boston.

“I’m worried that people won’t know what it’s like to taste truly delicious fish,” he said. “Fishermen feel they have no future, and fisherfolk are disappearing. Our culture surrounding fishing is disappearing, and our culinary culture is also fading.”

Nagayama doesn’t allow anyone else to handle fish behind the counter, where customers pay up to \$300 each for the chef’s nightly omakase course. Although his tiny bar is usually fully booked, he doesn’t see a future for it – he has no children and no heir.

“We’ll have to close in the next four to five years,” he said. “I’ll be the last one here.”

**‘EVERYONE’S RAISING PRICES’**

At Nabaya, a dark bar across the street from his Tokyo office, Hiroshi Nonoyama sipped a beer after another long day at work.

“It’s all depressing news, not a great topic of conversation over drinks,” he said. Nonoyama manages a trade group overseeing 79 companies that manufacture everything from

squid-flavoured potato chips to squid jerky. They’ve been some of the hardest hit by the recent run of poor harvests, Nonoyama said.

“A lot of these guys are old school. They haven’t diversified beyond using flying squid, you see? And when that becomes too expensive? Boom!” he said, crashing his hand on the bar counter.

Already this year, two of his companies had gone out of business because of the rising cost of squid.

“I only heard about one of them because I got a call from the tax office about unpaid taxes,” he said, sighing. The owner, who had employed 70 workers for half a century, was now on the run from his creditors.

“Everyone’s raising prices, but how much are customers willing to pay?” Nonoyama asked.

It’s the same question that Odajima, the Hakodate squid merchant, asks himself every day. He has nearly doubled prices in the past two years to 700 yen per bottle.

“Buyers are telling me that if I raise prices



Squid fishing equipment is seen on the Hosei-Maru No.58 squid fishing ship at a port in Sakata, Japan. REUTERS/Issei Kato

again, they won't be able to sell it as a side dish or condiment – consumers just won't buy it," he said.

His factory's yearly output is almost half of what it was 10 years ago. Looking for ways to survive, Odajima is now courting boutique supermarkets and upscale restaurants.

Recently, Odajima flew to Tokyo to pitch his product. By the time he arrived at Ginza Six, a shimmering luxury mall in the city's posh shopping district, he was already sweating in his oversized pinstripe suit. He adjusted his tie and patted down his freshly cut hair in front of Imadeya, a premium liquor store on the basement floor of the mall.

Two Chinese women sampled glasses of Japanese wine under a pair of Edison bulbs at the shop counter. Shohei Okawa, the store's 36-year-old manager, waited patiently as Odajima pulled several jars of shio-kara out of a cooler he had carried on the plane from Hakodate. Folded copies of Tokyo's subway

map peeked out of his large duffel bag.

"As you know, prices are getting higher, particularly for squid," he said, suddenly sounding formal and looking anxious. "Which is part of the reason why we'd love to sell in a higher-end store like yours."

"What other stores carry this in Tokyo?" Okawa asked. "And is this rare? Is it authentic?"

Odajima quickly added that his product was handmade with no artificial colouring.

Satisfied, Okawa said he would send in orders for a few cases.

Outside, leaning against the mall's glass façade, Odajima was happy – for the moment, at least.

"I wonder what my father would think, selling it at a place like this," he said. "It's a little unbelievable. We had so much squid we didn't know what to do with it. Now, it's become a delicacy." 

Editing by Kari Howard

# Ocean Shock

## Big aquaculture bulldozes Borneo

BY MATTHEW GREEN

OCTOBER 30 PURUNI TIMBUL, MALAYSIA

**S**winging his machete with an economy of movement that only the jungle can teach, Matakin Bondien lopped a stray branch from the path of his boat. He hopped barefoot from the prow, climbed a muddy slope and stared once more at what he'd lost.

Not long ago, the clearing had been home

to mangroves, saltwater-loving trees that anchor a web of life stretching from fish larvae hatching in the cradle of their underwater roots to the hornbills squawking at their crown. Now the trees' benevolent presence was gone, in their place a swath of stripped soil littered with felled trunks as gray as loss.

"Do you think we can find any food in this place now?" asked Bondien, a village leader of the Tombonuo people. "The company thinks it can do anything it wants – that we don't count."

The company is Sunlight Inno Seafood. Owned by Cedric Wong King Ti, a Malaysian businessman known as "King Wong," it

Village leader Matakin Bondien inspects a stream of wastewater discharged from the Sunlight Seafood shrimp farm in Pitas, Sabah, Malaysia.  
REUTERS/  
Edgar Su



has bulldozed swaths of mangroves in the Tombonuo's homeland in northern Borneo to make space for plastic-lined ponds filled with millions of king prawns. The shrimp are destined to be fattened for three months, scooped up in nets, quick frozen, packed into 40-foot refrigerated containers and loaded onto cargo ships bound for distant ports.

Gargantuan as it may seem to Bondien and his relatives, the project represents only a speck in the global aquaculture industry, one of the world's fastest-growing sources of protein. Unfolding across Asia and around the world, this revolution in farming could help mitigate the impacts of climate change – or



The sea cucumbers  
are my treasure chest.

Astinah Binti Jamari  
Sea-cucumber farmer



make them even worse.

As the buildup of heat-trapping greenhouse gases causes the world's oceans to warm, ecosystems that formed hundreds of thousands of years ago are being upended in less than a human lifespan. Across the planet, fish and other marine creatures are being forced into a desperate search for cooler waters. Even coral is on the move: Some Japanese reefs are expanding northward at up to nearly nine miles per year, researchers have found.

Tropical seas may be the hardest hit. Species in the once-stable conditions near the equator could find it much harder to tolerate even mild temperature increases than hardier cousins at higher latitudes, which are used to coping with the contrast between summer and winter.

“If you ask me what is the No. 1 concern that I have on climate change effects on fisheries, it is on these tropical, developing countries,” said William Cheung, director of science at the Nippon Foundation-University of British Columbia Nereus Program. “The sheer speed of the change will make it that much harder for marine life to adapt.”

Coral reefs, as vital to tropical fish as trees are to birds, are becoming more vulnerable to a process called “bleaching,” which occurs when a spike in water temperatures causes coral to expel the algae that provide their kaleidoscope colours, leaving them prone to starvation or disease. Today, swaths of the once-psychedelic Great Barrier Reef in Australia have turned boneyard white and largely devoid of life.

Scientists fear a similar fate could await the Coral Triangle, a huge underwater wonderland east of Borneo endowed with a trove of biodiversity comparable to the rainforests of the Amazon Basin. Millions of people depend on its bounty to survive, a large share of them Malaysians, who eat an average of 125 pounds of fish each a year – more than double the world average.

With climate change bearing down on the tropics, the search is on for a more sustainable way of getting food from the sea, one that doesn't take more than nature can give.

Farther to the north on Borneo, an island



Farmer Astinah Binti Jamari holds a sea cucumber in Mapan Mapan, Sabah, Malaysia.

REUTERS/Edgar Su

divided among Malaysia, Indonesia and Brunei, villagers are raising sea cucumbers: curious-looking creatures resembling giant slugs that are typically braised and served with oysters, mushrooms and spring onions, or – if you're in Japan – thinly sliced, flavoured with wasabi and eaten raw.

These echinoderms, close relatives of sea urchins and starfish, may not appeal to every palate. But farming them has one of the lightest footprints of any form of food production, a reminder of the vast untapped global potential for harvesting oysters, mussels, clams and many other types of filter-feeders.



I have no words. It's like we've lost our whole world.

Samad Samayong  
A Tombonuo elder



A couple of hours' drive from the Sunlight Seafood shrimp farm, inhabitants of the stilted village of Mapan Mapan have created a maze of sunken enclosures fenced with a barnacle-covered mesh. Immersed waist-deep in one of these briny paddocks, sea-cucumber farmer Astinah Binti Jamari plucked one of the sandpaper-skinned creatures from the seabed. It responded by squirting her with a jet of saltwater – a defence normally used to scare away crabs.

### A REVOLUTION INFISH

Forty years ago, only 5 percent of the world's fish production was farmed. After decades of rapid growth, aquaculture reached a tipping point in 2013, according to the U.N. Food and Agriculture Organization, when the amount the industry raised in cages, tanks and ponds

outweighed the tonnage of freely swimming fish hauled from lakes, rivers and seas for people's plates.

In many respects, the industry has a good-news story to tell. Farmed salmon, for example, can convert feed into edible protein far more efficiently than cows or pigs, while producing fewer greenhouse gases. Now, almost all the salmon sold in restaurants and supermarkets is raised in captivity, with Norway, Chile and Scotland the biggest producers.

But this phenomenal expansion has come at a cost. The appetite for farmed species is so voracious, almost 20 percent of the annual catch from the world's seas is ground into fishmeal, a nutrient-rich powder that forms the basis of the feeds used from salmon cages in Scottish lochs to shrimp ponds on Borneo. Vast amounts of fish have been taken from poorer countries to feed species destined for the plates of wealthier consumers. In addition, shrimp farms, in particular, have made coastal communities in the tropics even more vulnerable by cutting down mangroves, their first line of defence against extreme weather and rising sea levels.

Since the mid-1970s, the aquaculture industry has led to the destruction of more than 1.3 million acres of mangroves spread across Indonesia, Thailand, Vietnam, India, Bangladesh, China, Brazil and Ecuador, according to a 2013 paper in the *Bulletin of Marine Science*. Untreated waste and epidemics of shrimp-killing diseases mean the gains can be short-lived: A study published this year identified more than half a million acres of abandoned shrimp ponds in Indonesia alone.

Nevertheless, some governments in Southeast Asia and Latin America have concluded that it's worth sacrificing more mangroves in return for the export earnings and employment the projects can generate. Among them is the Malaysian state of Sabah, which is a partner in King Wong's shrimp farm.

### HOPES OF A BETTER LIFE

In 2013, representatives of Sunlight Seafood

Villagers survey the Sunlight Seafood shrimp farm near their home in Pitas, Sabah, Malaysia.  
REUTERS/  
Edgar Su



 They cleared the mangroves with no proper consultation with the community.

Lanash Thanda  
President of the Sabah Environmental Protection Association

offered leaders of the Tombonuo and other indigenous communities a deal. In return for some of the land flanking the tidal creeks where their mangroves stood, locals recalled, the company would provide running water, electricity and much-needed employment for youths in the surrounding area, known as Pitas.

Five years since the bulldozers went to work, Tombonuo community leaders

say they've lost more than 2,000 acres of mangroves and that the jobs and infrastructure they were promised haven't materialised.

"I have no words. It's like we've lost our whole world," said Samad Samayong, a Tombonuo elder, surveying a sacred outcrop consecrated by his ancestors that is now encircled by shrimp ponds. "We only realised what was happening when it was too late."

On the other side of a fence, a lone worker trudged past carrying a large bag of Royal Dragon brand shrimp feed on his shoulder. He didn't seem to notice Samayong and other Tombonuo watching from the trees.

Sunlight Seafood didn't respond to Reuters requests for comment made by telephone, email and a letter hand-delivered to its office in Kota Kinabalu, the capital of Sabah. Reuters also contacted a law firm in Kuala Lumpur, the Malaysian capital, that had acted for the company in the past but received no reply.

A destroyed mangrove forest is seen outside the Sunlight Seafood shrimp farm in Pitas, Sabah, Malaysia.  
REUTERS/  
Edgar Su



Sunlight Seafood has issued statements to Borneo media saying the project was built on land long earmarked for aquaculture by government officials, and that it is boosting the economy in Pitas, one of the poorest districts in Sabah.

The sheer scale of the farm is only fully apparent from up close. In July, a Reuters reporter and photographer accompanied Samayong, Bondien and others on a three-boat party to various points where water from the ponds gushed from pipes, leaving foamy trails of scum in the creeks.

It took hours to trace even a portion of the fence enclosing the site. The barrier's stark edges cut a jarring contrast to the tangle of mangrove roots straddling saltwater and land, their branches home to proboscis monkeys, pig-tailed macaques, blue-eared kingfishers and storks.

The Sabah Environmental Protection Association, a non-governmental organisation, says Sunlight Seafood has already cut down 2,300 acres of mangroves, citing satellite

imagery. "They cleared the mangroves with no proper consultation with the community," said the group's president, Lanash Thanda. "They have to redress the wrong they have done."

Apart from losing more trees, Samayong and Bondien fear diggers will further encroach on their ancestral shrines, such as an eerie riverbank guarded by a spirit husband and wife. Visiting on his boat, Bondien dedicated a cigarette he had rolled from mangrove bark to the couple, placing it on an altar made of branches.

"It's not only the forest that's being destroyed," said Mastupang Somoi, another member of the Tombonuo. "It's our identity."

#### TREES PROVIDE BUFFER

With evidence mounting that mangroves represent an effective buffer against climate impacts, some tropical countries are starting to question the gusto with which they once felled the trees, which can take 15 years to mature.

Were it not for the way mangroves served as shields, the 2004 Indian Ocean tsunami could



The roots of mangrove trees are seen along a river in Pitas, Sabah, Malaysia. REUTERS/Edgar Su



It's not only the forest that's being destroyed. It's our identity.

Mastupang Somoi  
Another member of the Tombonuo



have taken many more than 220,000 lives. The trees can also help mitigate the impact of rising sea levels: Their multi-tiered rootsystems trap sediment to raise the land around them relative to the encroaching waves. Equally ingeniously, mangroves sequester more greenhouse gases than almost any other type of forest, as well as serving as natural larders of fish, birds, fruit and the kind of snails you can eat raw by snapping their conical shells and sucking out the innards.

"If you catch a fish in the open sea or off a coral reef, it may well have spent part of its life in the mangroves," said Dan Friess, an associate professor of geography at the

National University of Singapore.

Sabah's government says it is committed to striking a balance between economic development and preserving Borneo's extraordinary natural heritage, including by designating extensive areas of forest as nature reserves for threatened orangutans and creating Malaysia's largest marine protected area.

Earlier this month, Junz Wong, Sabah's agriculture minister, toured the Sunlight Seafood farm and said the company had operated "quite professionally" and created nearly 400 jobs. On his Facebook page, Wong said he had rejected a company request to cut down an additional 1,000 acres of mangroves. "I told them NO," he wrote. "No more destroying of mangroves."

In July, a Reuters reporter visited Sunlight Seafood's offices in a suburb of Kota Kinabalu and hand-delivered a letter summarising the Tombonuo community's grievances and requesting an interview with owner Wong or another company representative.

While the reporter was explaining the purpose of the letter to a worker who had been sent to meet him at the door, a security guard cut their conversation short and escorted the reporter off the premises. The guard then closed the gate to the driveway. It bore a large sign in red letters warning that trespassers would be prosecuted.

## FOOD WITHOUT A FACE

Nestled in sea-cucumber farmer Jamari's palm, the specimen she had fished from the seabed convulsed with a slow-motion shudder. Once a struggling single parent, Jamari says the creatures came to her rescue, earning her enough money to put her five children through school and build a new house.

"The sea cucumbers are my treasure chest," she said. "I can't even imagine what life would be like without them."

Mapan Mapan has earned so much money from its sunken farms that it has declared an annual sea cucumber "birthday" festival, at which villagers give thanks by stewing a share of their harvest in a communal meal.



Sea-cucumber farmer Astinah Binti Jamari reaches for sea cucumbers on the seabed at her farm in Mapan Mapan, Sabah, Malaysia. REUTERS/Edgar Su

Chinese traders have been importing sea cucumbers for more than a thousand years. Served at royal banquets, they were considered both a status symbol and an aphrodisiac. A Ming Dynasty book published in 1602 called “Miscellanies of Five Items” lists them as “sea ginseng.”

This mystique drives much of the appetite today. In the decade that ended in 2016, global production of sea cucumbers more than doubled to nearly 275,000 tons, according to the FAO. At top Chinese restaurants, the

echinoderms are used to make one of the world’s most expensive soups, a broth called Buddha Jumps Over the Wall that can sell for \$400 and needs to be ordered five days in advance.

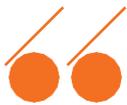
Irwin Wong is a manager at Oceandrive, a Malaysian seafood company that buys the sea cucumbers for export. He served as an advisor when Mapan Mapan started cultivating the creatures eight years ago in a 20-farmer pilot project backed by the local government. He says the scheme is harvesting wild sea

cucumbers at a sustainable rate, but that even better management could help Borneo produce many more.

“Perhaps this is the lowest impact of all aquaculture activities,” Wong said, standing on a platform overlooking a planned new phase, to be built with barnacle-proof mesh and more durable epoxy-coated stakes. “It can seriously go very big.”

Researchers believe there is enormous potential to scale up global production of plankton-eaters such as scallops, clams, oysters, cockles and other bivalves – and, of course, sea cucumbers.

“The current way of feeding ourselves is simply not sustainable,” said Sebastian Ferse, an ecologist at the Leibniz Centre for Tropical Marine Research in Bremen, Germany.



The current way of feeding ourselves is simply not sustainable.

Sebastian Ferse  
Ecologist at the Leibniz Centre for Tropical Marine Research in Bremen, Germany



“I think on a global level we have to start thinking about the lower levels of the marine food chain, such as bivalves, when it comes to supplying our proteins.”

Scientific advisers to the European Union agree. They concluded last year that it should be possible to harvest a combined 165 million tons annually of bivalves and seaweed – almost double the world’s annual landings of wild-caught fish.

The beauty of these creatures is that, unlike farmed fish or prawns, they don’t require any feed apart from the nutrients they absorb from the sea. No mangroves have to be felled to culture them. Neither do they spew tons of fish

waste or chemical pollutants. In fact, bivalves actually remove toxins from the water; a single oyster filters 50 gallons of seawater a day.

Yet even as the risks posed by climate change bring the potential of shellfish, seaweed and sea cucumbers into sharper focus, it is also putting them in danger. As oceans absorb carbon dioxide released by burning fossil fuels, seawater is rapidly becoming more acidic. There is already evidence that acidification can make mussels’ shells more brittle, or weaken their grip on rocks, leaving them at greater risk of being swept away by advancing waves.

### ‘WE NEED TO PRESERVE EVERY SPECIES’

Life has been kind to the prize specimens at the Borneo Marine Research Institute: mammoth tropical fish known as giant grouper, which can weigh as much as a person, and in some cases have been swimming in spirals in silo-like tanks for almost 20 years. The only drama happens at feeding time. When fresh sardines hit the surface, the fish dart through the water with torpedo force.

Their wild relatives will have to work a lot harder to survive. In experiments to simulate the effects of more acidic waters, the institute has found that grouper – a staple in the Coral Triangle – find it harder to reproduce, and their young don’t develop properly. The findings have sharpened concerns about what climate change will mean for the region’s marine life, already struggling with plastic pollution, runoff from oil palm plantations, damage to reefs by dynamite fishing and the loss of mangroves.

Shek Qin, a research assistant, visits the busy fish-landing quay at Kota Kinabalu two nights a week to monitor catches of sharks and rays. In the early hours of a July morning, she picked up a newly landed shark by its tail, plonked it onto the dock and cheerfully inserted her forefinger into its mouth, peering inside to inspect the teeth – a trick for classifying a specimen more accurately, especially if fishermen have lopped off the fins.

“It’s a whole food web: If one species



A worker feeds giant groupers at the Borneo Marine Research Institute hatchery in Kota Kinabalu, Sabah, Malaysia. REUTERS/Edgar Su

is declining, others will get affected too,” Qin said, cradling a recently deceased hammerhead. “That’s why we need to preserve every species of fish.”

Near the fence surrounding the Sunlight Seafood shrimp farm, villagers Bondien and Samayong moored their flotilla under some mangrove trees and cast lead-weighted hooks. Samayong’s daughter Ida remembered her grandfather regaling her with tales of the monster fish of his youth: notably, a ray he once caught that was bigger than his boat. But

that day, nothing came to nibble.

“You used to be able to catch a fish here in 10 minutes,” said Bondien, his line slack in the water. “Now, even if you have good bait, you can wait an hour and get only one – maybe nothing.” Around a bend in the river, an empty bag of Royal Dragon feed had become snagged in some mangrove branches. It was emblazoned with an image of a shrimp. 

Editing by Kari Howard

# Climate change creates mutant fugu, a deadly Japanese delicacy

BY MARISAITO

DECEMBER 10 SHIMONOSEKI

**T**he road, hemmed in on one side by empty warehouses and the other by a concrete seawall, ends abruptly in a desolate parking lot. Men step out of their cars and into the darkness, then slip behind the sliding doors of a warehouse. Inside, they huddle under floodlights and wait. A clock on the wall ticks to ten past three in the morning.

“Ready? Ready? Ready?” shouts a man whose arm is covered to the elbow by a black nylon bag. One by one, the men step forward and their hands disappear into the bag.

And so begins a surreal auction in this port city in southwestern Japan. The buyers grip the dealer’s hand, and after a few seconds of secret gesturing felt only by the auctioneer, he yells out the winning bid.

“13,000!” Thirteen thousand yen, or \$114, a kilo.

The furtive bidding, a relic of a time when fish traders wore kimonos whose sleeves obscured their hands as they signalled their bids, is part of the insular world of Japanese pufferfish, or fugu, a fish best known for its ability to kill a person in as little as a few hours.

Although deaths are extremely rare, the whiff of danger associated with the fish’s poison is a significant element of the delicacy’s

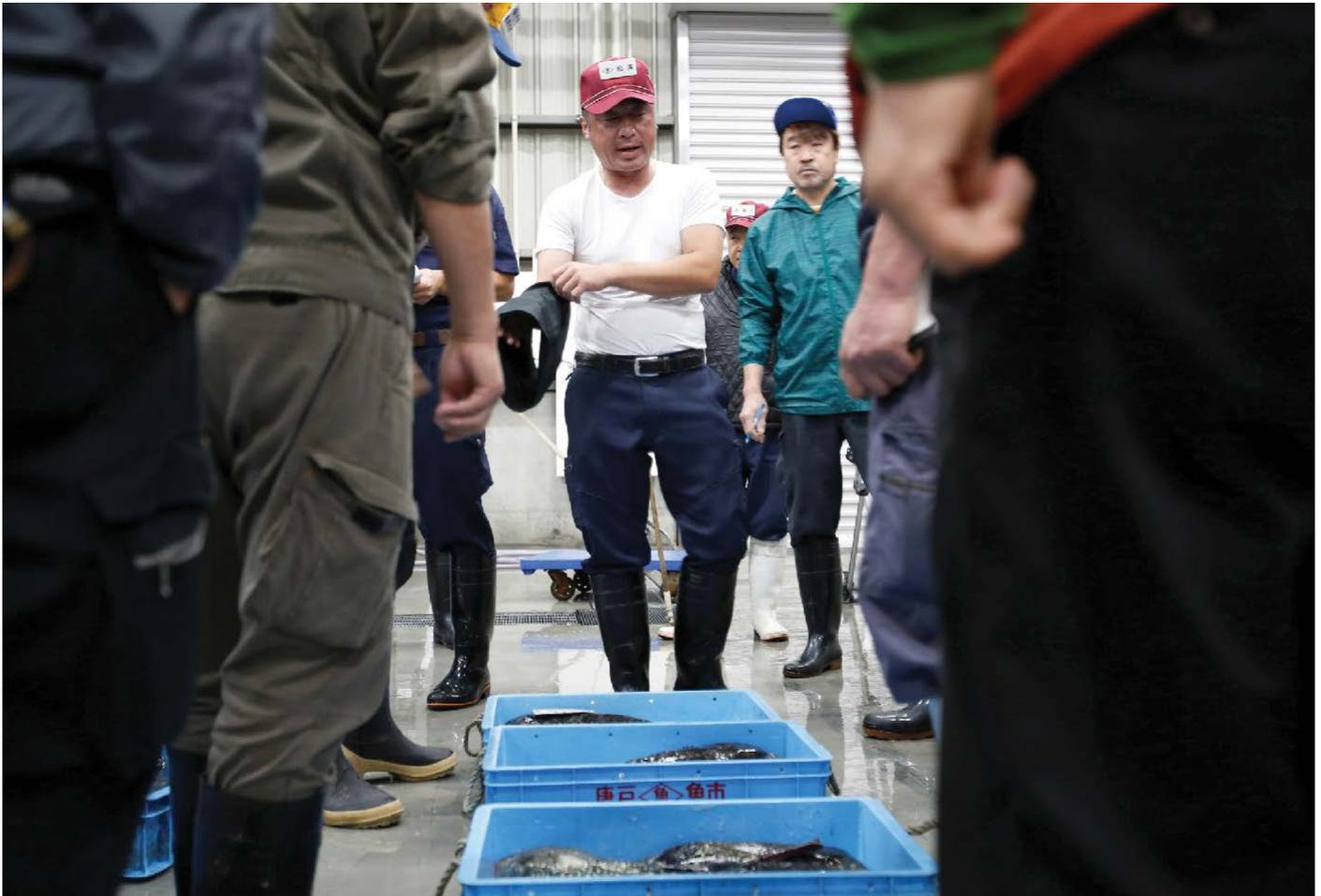
enduring allure in Japanese culture. A kilogram fetches as much as 30,000 yen at the market here, and in the December holiday season, when fugu is particularly popular, a luxury fishmonger in Tokyo can sell up to \$88,000 worth of the fish on any given day.

News of poisonings elicits fevered national coverage. When a supermarket in western Japan accidentally sold five packets of the fish without its poisonous liver removed in January, the town used its missile alert system to warn residents.

And now, climate change is adding a new element of risk: Fishermen are discovering an unprecedented number of hybrid species in their catch as seas surrounding the archipelago – particularly off the northeastern coast – see some of the fastest rates of warming in the world.

With pufferfish heading north to seek cooler waters, sibling species of the fish have begun to inter-breed, triggering a sudden increase in the number of hybrid fish. Hybrids are no more dangerous than your average lethal pufferfish. The problem is that they can be hard to distinguish from established species. To avoid accidental poisonings, Japan prohibits their sale and distribution. With the rise of these unclassifiable hybrids, fishermen and fish traders are having to discard a sizable share of their catch.

Kaniya, a seafood-processing company here in Shimonoseki, is one of many in the industry frustrated by the government’s rule to discard such hybrids, considering that most subspecies of pufferfish frequently found in Japan’s northeastern waters have poison in the



An auctioneer wearing a black nylon bag on his arm starts an early morning auction for pufferfish at Haedomari wholesale market in Shimonoseki, southern Japan. REUTERS/Mari Saito

same organs and can be safely eaten if handled correctly.

“But we have to follow the rules, because if there’s any problems it leads to hysteria,” says Naoto Itou, the gruff patriarch of the company.

Out of 50 or so species of pufferfish found around Japan, 22 of them are approved as edible by the government. Chefs and fish butchers handling pufferfish are specially trained and licensed to remove its liver and reproductive organs, which contain tetrodotoxin, a potent neurotoxin. Confusingly, the location of the deadly neurotoxin differs in certain types of pufferfish; it can sometimes be found in its skin or muscle, as well as its reproductive organs.

Every morning at 8 a.m., Kaniya receives boxes of pufferfish from fishermen in northern

Japan. By 9, an experienced fish handler is at his post in an apron and hairnet, sorting as many as seven or eight different groupings of pufferfish at a metal counter.

His bare hands moving quickly, the man picks up one slippery fish after another, holding it up for several seconds, examining its fins and checking for prickles. He pauses on one, turns it to the side, traces its back with his finger, then throws it into the discard pile.

The entire process has a hazmat feel: Workers in latex gloves, white masks and plastic aprons gut the fish and take away the toxic parts and dump them into a lock box. The waste is then collected and incinerated.

Asked why he would continue handling such inherently dangerous fish despite all the headaches surrounding hybrids, Itou points to

Fish handlers sort pufferfish before an early morning auction at Haedomari wholesale market in Shimonoseki, southern Japan.  
REUTERS/  
Mari Saito



two of his salesmen hovering nearby, fielding calls from buyers.

“Isn’t it a blessing to be able to handle something customers love and want so much? There aren’t many other fish out there like this.”

### **SWEEPING IMPACT OF CLIMATE CHANGE**

The rise in hybrid species is yet another example of the sweeping impact of climate change on marine creatures, which have undergone a mass migration as water temperatures increase.

Hiroshi Takahashi, an associate professor at the National Fisheries University, first noticed the increase in hybrid pufferfish six years ago. He started receiving calls from a scientific facility on the northeastern coast of Japan’s main island that had buckets of pufferfish it couldn’t identify. In the fall of 2012, nearly 40 percent pufferfish caught in

the area were unidentifiable, compared to less than 1 percent studied previously.

“It wasn’t one out of a thousand as it had been in the past; this was on a completely different scale,” he says. To an untrained eye, hybrids are barely discernible. Even veterans in the industry say it’s nearly impossible to tell apart “quarters,” or second-generation offspring of hybrid fish. At the end of June, more than 20 percent of pufferfish caught in a single day off the Pacific coast of Miyagi prefecture, 460 kilometres northeast of Tokyo, were hybrids.

Genetic tests found that the unidentifiable pufferfish were a hybrid of *Takifugu stictonotus* and *Takifugu snyderi*. Although they’re close relatives, the *T. stictonotus* usually swim around the Sea of Japan and the *T. snyderi* in the Pacific Ocean. Takahashi believes that the *T. stictonotus* escaped their gradually warming habitat by riding the Tsushima current north and crossing the



Shikishima-maru fishing boat captain Yukio Yamamoto, 49, peels the skin of a pufferfish caught by anglers near Ohara port in Isumi, east of Tokyo, Japan.

REUTERS/Issei Kato

strait just below Japan's northern island of Hokkaido to emerge in the Pacific Ocean. There, they bred with their sibling species and multiplied. The resulting hybrid, which has fine spots and yellow-white fins, could pass for either one of its parent species.

A division of Japan's health ministry in charge of food safety said it began collecting information about the reported increase in hybrid pufferfish in September. Each prefecture has its own tests for issuing licenses to chefs and others, and an industry group has pushed the government to standardise those tests.

Before dawn on a recent weekday, dozens of hobby fishermen throng a deserted dock in the Ohara port, a two-hour drive from Tokyo, to get a chance to catch the creature. They return on the Shikishima-maru around noon, sunburnt and tipsy, carrying white buckets filled with pufferfish.

While the anglers smoke cigarettes and hunch over noodles, Yoko Yamamoto grabs a knife and sits down on a low plastic stool. She works quickly, first striking the fish's spinal cord, then peeling back its skin to remove its poisonous outer layer. Her son, who captained

the boat, then takes over and slashes the fish to its gills to remove its liver and intestines as a moored fishing boat with pastel pink bench seats blasts "Bohemian Rhapsody" from its speakers.

We have to go a bit further now to find them," says Yukio Yamamoto, 49, crouching next to his mother. "You see all kinds of hybrids now; it's been this way for the past few years."

Toshiharu Enomoto, a 71-year-old hobby fisherman, walks over after his lunch and ties a knot in a plastic bag filled with ice and a few pufferfish. Laughing, he talks about the little thrill of the poison. "Some people like it when they feel a bit of tingling on their lips," he says.

The Japanese have eaten the fish for thousands of years. After it was outlawed by Toyotomi Hideyoshi, a samurai general who unified Japan in the 16th century, peasants continued to eat it in secret and died in droves. The ban on fugu was finally lifted after World War II following years of petitioning by avid fans.

Despite its deadly nature, the fish has an almost comical face and, with its puffed cheeks and open mouth, looks as though it's perpetually surprised to be so sought after for special occasions.

In Tokyo, high-end restaurants serving pufferfish rely on Otsubo Suisan, a luxury wholesaler at the Toyosu fish market. At the company's wide stall, Koichi Kushida taps his smartwatch and answers calls on his silver Sony Bluetooth. In the span of an hour, the 34-year-old sells thousands of dollars worth of pufferfish.

"It's tasty, isn't it? It's a luxury and has class; that definitely attracts people," he says, deftly packing an airtight bag of gutted pufferfish into a golden box. With more hybrids appearing on the market, Kushida personally checks all the fish himself.

"When we hand it to our customers, we have to be sure it's absolutely safe," he says. "We can't have any problems." 

Editing by Kari Howard