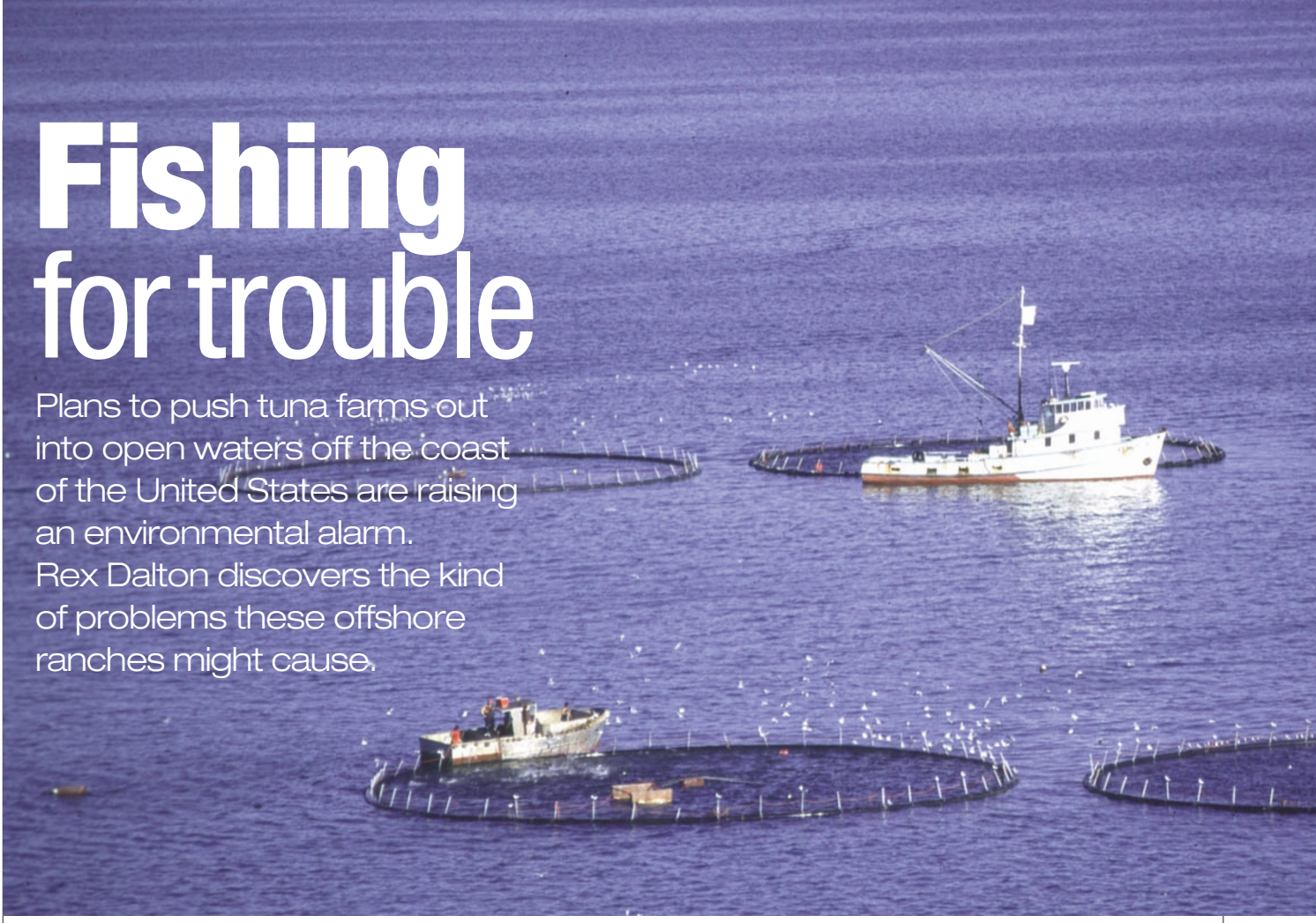

R. SEITRE/STILL PICTURES

Fishing for trouble

Plans to push tuna farms out into open waters off the coast of the United States are raising an environmental alarm. Rex Dalton discovers the kind of problems these offshore ranches might cause.

In the blue waters off the coast of Baja California, Mexico, circular nets are buffeted by the teeming mass of tuna inside. Every day boats pull up to these ocean 'ranches' and workers toss sardines into the churning water, fattening their investments while keeping an eye out for predatory sea lions.

The bluefin tuna being tended in these pens are destined for the sushi markets of Japan, which last year paid Mexican ranchers about US$50 million for the prized fish. Such ranches are turning into big business around the world. Some countries in the Mediterranean farm the fish. And off the coast of southern Australia, more than 100 pens operated by a dozen firms are harvesting even bigger sales. Now, in the United States, legislation is quietly being drawn up to facilitate such fish-farming operations in offshore waters — beyond the environmental control of coastal states, in waters difficult for anyone to police.

This expansion has some people worried, as the history of tuna farms from Mexico to Australia shows that these ranches can cause damage to the marine environment. Coastal residents near Ensenada, Mexico, have complained in the past that some ranch operators have shot sea lions to protect their fish. And scientists are still trying to determine whether fish-food imported to Australian tuna farms was the source of a virus that wiped out the sardine fishery along that continent's southern coast in the late 1990s. Seabirds were starved by that disaster, and fishermen left idle.

Some fear similar losses if ranches start to sprout in deep waters far from the US coast. "The opportunity for large-scale environmental disasters is enormous," says John Volpe, a fisheries ecologist at the University of Alberta in Edmonton. Volpe was one of the first scientists to issue warnings about potential environmental damage from salmon pens off British Columbia in the mid-1990s. Such farms are now blamed for spreading disease and lice into wild populations, and polluting the local environment. "We are one season from having wild salmon wiped out by lice," says Volpe. Now that similar warnings are being sounded for offshore tuna farms, he hopes someone will listen.

Offshore investments

But administrators at the US National Marine Fisheries Service (NMFS), an agency within the Department of Commerce's National Oceanic and Atmospheric Administration, are enthusiastically backing the concept. NMFS officials have been drawing up legislation and formulating plans for offshore aquaculture for years, as a way to provide more home-grown fish and aid the local economy.

In recent months, the NMFS has circulated draft legislation to federal agencies for comment. The bill is designed to permit aquaculture in waters outside the 5.5-km boundary of state control, but within the 370-km Exclusive Economic Zone of the United States.

However, details of the proposal are tightly guarded: even the NMFS's own Marine Fisheries Advisory Committee (MAFAC) was given only a verbal summary of the legislation when it was asked to provide guidance on the concept in August. Environmental organizations have been trying to provide input for more than a year, but say they have been given the brush-off. The draft legislation is reportedly now close to being presented to Congress, and environmentalists fear it will slip through in the final weeks before the election.

With legislation pending, a research–business consortium is making plans for a tuna ranch in the Santa Barbara Channel off California. The consortium, led by the Hubbs–SeaWorld Research Institute of San Diego, hopes to anchor two square kilometres of nets on a former Chevron oil-drilling platform, about 20 km off the coast, and fill the nets with tuna and other deep-water fish.

The project would begin as a research facility, examining the capability of offshore farms and their environmental impact. The non-profit institute says it also has plans to extend operations to a commercial venture, using millions of dollars from fish sales to support the facility and its research. Chevron is funding the institute's start-up costs, and offering $10 million to run the operation for three years. The oil company hopes to avoid the substantial expense of removing the oil platform completely.

B. BARBEY/MAGNUM

Down on the farm: critics condemn the ranching of bluefin tuna, which goes to Japan's markets (above).

California, like other US states, only controls waters up to 5.5 km from the shore, so the consortium has only needed to apply for federal permits. But environmentalists and officials in California are worried about the plans and threaten legal action if the state gets no say on the project. "They are making a big mistake trying to circumvent our jurisdiction," says Peter Douglas, executive director of the California Coastal Commission, which monitors coastal development. "We will go to court."

Other states that are nervous about the environmental impact of offshore farms, such as Alaska, have sought a moratorium on development plans. In early August, MAFAC heard a spirited debate about the offshore aquaculture legislative proposal at a meeting in Juneau, Alaska. Environmental groups and state officials called for more study, and the advisory panel agreed with them. But they won't necessarily get what they want: top NMFS officials in Washington DC would only say that they are taking the group's suggestion into consideration.

High stakes

A look to the south provides a picture of the environmental issues at stake. Along the 1,600 km of Mexico's Baja California Peninsula, there are already more than a dozen offshore fish farms. The Mexican government continues to grant permits for more, even though some businesses have shut down after setting up their nets, leaving empty pens that are a hazard for migrating sea-turtles and whales.

To stock the Mexican ranch, boats travel some 600 km down the coast to catch migrating bluefin tuna. The 35-kg fish are herded into a circular net, then slowly towed north to be anchored in deep water near Ensenada. The tow can take up to a month, during which time about 10% of the wild fish die or are lost from the nets.

Once the nets are anchored in the Pacific, farmers bring in food to fatten the tuna by about 25% before selling them, typically to Japan. Like most farmed fish, tuna are carnivorous. They are also quite picky, preferring sardines, and they are warm-blooded, which means that they require more food than cooler-blooded fish, such as salmon.

Tuna ranchers insist that their sardine-harvesting operations do not remove enough fish from the region to adversely affect the food chain. But some scientists are less sure, particularly given Mexico's patchy record for controlling its aggressive fishermen.

> "The ranchers are making a big mistake in trying to circumvent California's jurisdiction. We will go to court."
> — Peter Douglas

Near the tip of the peninsula lies Magdalena Bay, a warm-water basin that is thought to be the spawning area for much of the sardine population of the west coast of North America. After years of good management in the United States and positive climate conditions, that sardine population is at its highest in decades. But this might not last. Mexican sardine fishermen are already taking 40,000 to 60,000 tonnes of sardines a year out of Magdalena Bay, according to Mexican fishing reports. If tuna farms increase demand for sardines, the population may not withstand the pressure. "If the industry grows unchecked, it may pose a threat," says Axayacatl Rocha Olivares, an ecologist at the oceanographic research agency CICESE, Mexico's centre for higher education and scientific investigation in Ensenada.

Death in the water

Another problem may arise when local wildlife comes into conflict with the commercial interests of a ranch. It seems a few wayward ranch-workers have been known to take extreme measures to protect their tuna. With each hefty fish worth $400 to $700, a single bite from a hungry sea lion can spell a huge loss. So some took to shooting the beasts — known as *los lobos*, or wolves — that dared nip at their charges.

Residents of the coastal hamlet of Salsipuedes, for example, have complained that riflemen in skiffs regularly shot sea lions at nearby pens. Haksong Lee, the manager of pens operated by Aquaculture of Baja California, acknowledges that some shooting has happened in the past but says the practice was halted after higher nets were installed to thwart the pesky mammals. The Mexican environmental protection agency launched an investigation of the practice after enquiries by *Nature*, but so far it has not made a case against anyone.

A third concern about the tuna ranches has become apparent, thanks to farms in Australia: disease.

Back in 1995, a herpes virus hit southern Australian waters close to some tuna farms. The virus whipped across the ocean like a brushfire front, moving at 30 km a day and leaving behind it a sea of dead fish. Eventually, it was estimated that 75% of pilchards in the region died. Seabirds, from Australasian gannets to penguins, starved in the wake of the disaster[1,2]. In 1998, another virus attack knocked out many of the remaining pilchards.

Although no one has been able to prove which factors unleashed this virus, some say it came from frozen sardines or pilchards

imported for the farms. "In 1995, the source of pilchards was wherever the deal was cheap," says Brian Jones, senior pathologist with Western Australia's Department of Fisheries. "They were coming from all over the world." And it was a largely unregulated trade, he says.

Tim Ward and his colleagues at the South Australian Research and Development Institute in Adelaide say the practice may have "facilitated the range shifts of pathogens that have been associated with the increased frequency of mass mortalities due to disease"[3].

But no one has been able to prove where the offending 1995 virus came from. Jones and his colleagues have isolated and characterized the herpes virus from the dead pilchards. So far, the sequence matches no known herpes virus in fish elsewhere in the world.

Brian Jeffries, director of the Tuna Boat Owners Association of South Australia, a trade group for a dozen tuna-ranching groups, denies that imported fish had anything to do with the pilchard die-off. Since the 1995 outbreak, he says, bait-fish are regularly tested, and none has been found to carry a virus. Tuna ranches prefer to blame other sources, such as leaks from the water used as ballast in passing ships.

If the bait was the origin of the virus, then there is cause to worry. More than 55,000 tonnes of bait-fish were fed to Australian farmed tuna last year; about 20% of this was imported from California, says Jeffries, and another 10% imported from elsewhere. Scientists on both sides of the Pacific are watching the California sardine imports closely, because of a disease in those waters.

Mexican virus

A haemorrhagic septicaemia fish virus seems to be spreading up the west coast of North America, as the expanding sardine population migrates north from Mexican waters in search of food. Ronald Hedrick, who studies fish health at the University of California, Davis, has tracked this virus and says it appears to thrive in colder waters, where fish may be stressed from the low temperatures. There was a 58% prevalence of infection during a massive sardine die-off in the cold waters of Vancouver over 1998–99, for example[4]. "Under the right conditions, this haemorrhagic virus can contribute significantly to marine mortalities," says Hedrick.

Disturbingly, Hedrick notes, the virus is being found in more and more species: in Alaska, the virus has been linked to a die-off of Pacific herring[5]. It is unclear how fast or how far such a virus is capable of spreading, he says, emphasizing the need to keep track of international shipments of frozen bait-fish.

Jones thinks Australia has managed to dodge the haemorrhagic virus so far because the waters there are too warm. But he remains worried. "A mass die-off can happen again," he says. And if viruses can travel one way, they can travel the other — opening more offshore farms in the United States will only open more opportunities for unregulated trade to spread disease.

N. WU/MINDEN/FLPA

Nip and tuck: ranchers have been accused of shooting sea lions for taking bites out of valuable tuna.

N. WU/PHOTOLIBRARY.COM

B. BARBEY/MAGNUM

Vast quantities of sardines (top) are frozen and shipped to farms to satisfy the picky bluefin.

Not everyone suspects that offshore aquaculture will end with mass disease and environmental problems. Some point out that, with the nets anchored out in open water, pollution will neither accumulate nor harm sensitive coastal systems. Others go so far as to say that even coastal fish farms do not do as much harm as some people claim. Although many scientists see fish pens as a source of disease for wild species, marine ecologist Donald Kent is not so sure. "Maybe the wild fish gave lice to the penned fish," says Kent. "That is just as likely a scenario."

Kent's view is held by a minority in the scientific community. But his opinions are being heard at high levels: he is chairman of MAFAC's aquaculture subcommittee, which advises the NMFS on policies such as the proposed offshore farming legislation. Kent is also president of the Hubbs institute, which is playing such a major part in the proposed farm on the disused oil platform. Kent sees his institute's programme as a way to meet national economic goals for farm-raised fish. "The detractors are missing the point," says Kent. "The demand for seafood is increasing; it's not going to go away."

Any experience with offshore farms in the United States is limited. There have been a few marine demonstration projects, but most were close to shore and raised fish on a small scale, making them poor tests for offshore ranches. The one pilot programme that did take place in waters far out in the Exclusive Economic Zone, in the Gulf of Mexico off Alabama, was wiped out by a storm.

This leaves proponents unable to convince critics that offshore farms would be environmentally benign. They can only point to the economic successes of other tuna farms, and emphasize that an expansion into deep waters should help the United States compete in the global fish market.

The lack of experience likewise leaves critics unable to convince the authorities that deep-water fish farms will be a disaster. But environmental watchdogs, such as the Institute for Agriculture and Trade Policy, based in Minnesota, continue to argue that these dreams of economic success court environmental trouble. If others make money out of such farms, they point out, perhaps this is because of lax rules that allow for short cuts in their management — which is precisely the sort of situation that creates environmental fall-out. ■

Rex Dalton is *Nature*'s US West Coast correspondent.

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