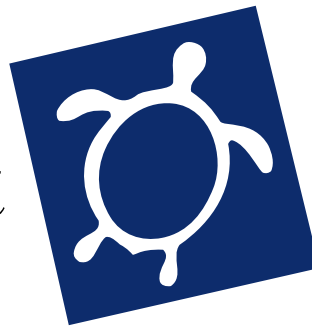


Environment



Hawai'i

a monthly newsletter

Weak Links In the Food Chain

Big fish eat smaller fish, which eat even smaller ones, which eat even smaller critters, which eat ...

That's the trophic chain, which extends down to the tiniest microbes. When disrupted, the consequences can be devastating. As our cover story points out, climate change, warming oceans, and the direct impacts of fishing on top ocean predators have all contributed to shifts in the roles of various species in this network.

In the final analysis, it is nearly impossible to weaken one element in this intricate chain of dependency without compromising the health of the remaining ones. The system ultimately adjusts, but not always in a way that supports conditions favorable to all species.

Acknowledging the impacts that human actions have on these creatures is vital to addressing these threats. The presentations made in May to the Marine Mammal Commission – which the Trump administration would like to disband – were a good, if depressing, start in this direction.

Changes in Ocean, Climate Portend A Dire Future for Marine Mammals

How does the middle of the Pacific Ocean, an area that's practically a desert when it comes to the nutrients that lie at the very heart of the marine food chain, manage to support some of the largest life forms on Earth?

"It's an enigma," says Jeff Polovina, who, though recently retired, was for years chief of the Ecosystem and Oceanography Division at the Pacific Islands Fisheries Science Center in Honolulu, an agency of the National Oceanic and Atmospheric Administration (NOAA).

"Even though there's little productivity, some foraging hotspots allow deep nutrients to come to the surface," supporting whales, sharks, dolphins, and large bony fish, including those species targeted by the Honolulu-based fleet of longline vessels, with revenues of around \$100 million a year, he said.

But that critical link in the trophic chain is weakening. Modeling done by Polovina and his colleagues predicts dire changes in ocean productivity by the end of the century, he said in a talk that opened

the annual meeting of the federal Marine Mammal Commission, held in May at the Keauhou Sheraton.

"Zooplankton densities will decline by 20 to 40 percent. There will be fewer nutrients and lower productivity of zooplankton. The carrying capacities of many organisms will decline 40 to 50 percent around the subtropical gyre by the end of the century," he said.

Ten years ago, Polovina addressed the same body when it held its annual meeting in Honolulu. At the time, he warned that areas of extremely low productivity in the ocean – called oligotrophic zones – were expanding, with the zone in the North Pacific having expanded at an average annual rate of around 2.2 percent over the previous nine years. Should the trend continue, he said, it could significantly affect populations of important commercial fish, but also disrupt the oceanic food chain, affecting everything from seabirds to sea turtles to marine mammals.

In the decade since, the trend has neither

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PHOTO: NOAA

Hawaiian monk seals.

Environment

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Hawai'i

June 2019

NEW AND NOTEWORTHY

Hu Honua in the News: On June 6, Judge Greg K. Nakamura of the 3rd Circuit Court in Hilo denied several motions to dismiss a lawsuit against Hu Honua and state agencies brought by Claudia Rohr, owner of a Hilo bed-and-breakfast. Last September, Nakamura had thrown out a similar lawsuit filed by Rohr, but this day, speaking from the bench, Nakamura said there was now a trend to "stricter enforcement of environmental laws" and that the courts should exercise restraint in resolving matters of environmental importance on a summary basis.

He also took note of the state Supreme Court's May 10 remand of Hu Honua's power-purchase agreement with the Big Island utility back to the Public Utilities Commission with instructions to take greenhouse-gas emissions into account.

Rohr's lawsuit seeks to force Hu Honua to comply with Chapter 343 of

Hawai'i Revised Statutes – the state's environmental policy law – by preparing an environmental impact statement or environmental assessment for the power plant it is building about 10 miles north of Hilo.

In addition to Hu Honua, defendants are the state departments of Health and Land and Natural Resources and several county agencies.

(More details on the hearing are available in our EH-xtra item of June 6, available on our website, environment-hawaii.org.)

On June 20, the Public Utilities Commission reopened the Hu Honua docket. The first deadline in the PUC schedule is July 8, when Hawaiian Electric and Hu Honua are to file an updated power-purchase agreement.

Lawsuit over Hawk, Hoary Bat: Sandra Demoruelle, a longtime resident of Na'alehu, has sued several Hawai'i County officials over the construction of a transfer station in the Ka'u community of Ocean View. The lawsuit was filed on May 29 in federal court in Honolulu.

Work began on the project in March, and, at the time the lawsuit was filed work continued.

Under conditions set forth in the 2008 final environmental impact statement for the project, however, no land clearing was to be done from April 1 through April 31, so as to avoid interfering with the pupping season of the endangered Hawaiian hoary bat, *ope'ape'a*. In addition, to protect breeding of the Hawaiian hawk, or 'io, if any clearing was to be done in March, the county was to hire a qualified ornithologist to conduct a pre-construction nest search, and if 'io are present, no land clearing was to be allowed until at least September.

Land clearing actually began in March, Demoruelle says in her complaint, and the contractor was not required by the county's Department of Environmental Management to have the survey for 'io done beforehand.

Named as defendants are William Kucharski, director of the county Department of Environmental Management, Allan Simeon, the department's deputy director, and Gregory Goodale, county Public Works Department director. Also named was David Bernhardt, secretary of Interior. He has since been dismissed.

A scheduling hearing is set for July 29. A request for comment to Kucharski's office was unanswered by press time.

Save the Date: On November 8, Jeff Polovina will be the featured speaker at *Environment Hawai'i's* annual benefit dinner. Until his retirement, Polovina was senior scientist and chief of the Ecosystem and Oceanography Division of the Pacific Islands Fisheries Science Center in Honolulu, an agency of the National Oceanic and Atmospheric Administration. Last year, he received the Distinguished Career award from NOAA in recognition of his many pathbreaking contributions to climate and marine ecosystem research.

As in past years, the dinner will be held at the Imiloa Astronomy Center. Details to come.

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Patricia Tummons, Editor
Teresa Dawson, Managing Editor

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Environment Hawai'i
190 Keawe Street, Suite 29, Hilo, Hawai'i 96720.
Telephone: 808 934-0115.
E-mail: ptummons@gmail.com
Web page: <http://www.environment-hawaii.org>
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Directors

Patricia Tummons, President and Treasurer

Deborah Chang Teresa Dawson
Vice President Secretary

Valerie Monson, Director

Quote of the Month

"[T]here are so many caveats when we try to project climate impacts. ... We have more tools, and we're making more projections, but we're also aware there's so much uncertainty. There'll be surprises."

— Jeff Polovina

Scientists, Resource Managers Seek To Understand, Halt Spread of ROD

So you want to stop rapid 'ohi'a death in its tracks?

Probably the very best thing you can do is to remove goats, pigs, cows, deer, and sheep from the area you want to protect – and fence that land to keep them out.

At a two-day scientific symposium held in late May, dozens of experts who have been studying the disease that threatens hundreds of thousands of acres of Hawaiian forests came together to discuss all that they have learned in the four years since the disease was given a name.

Many of the practices that have been recommended to prevent the spread of the two fungi that cause the 'ohi'a to die are all-round sensible hygiene, good to do regardless of what impact they might have in curbing the spread of rapid 'ohi'a death. Yes, clean boots before going on that trail. Do hose off trucks and scrub other equipment before moving them from one forested area to another. By all means, don't mark trails or other landmarks into trees with your hatchets. Never take any part of an 'ohi'a tree – flowers, stems, wood, whatever – from one island to another without clearing it with state agricultural inspectors.

But their utility in stopping the spread of rapid 'ohi'a death isn't entirely clear.

What is clear is the important role fences play – not that they keep out the

fungi that cause ROD, but that they keep out the animals that wound the trees, thereby opening pathways for the airborne spores of the fungi to invade otherwise healthy trees.

Some of the most dramatic slides presented at the symposium were aerial shots that showed fenced areas immediately adjacent to unfenced ones, with dead 'ohi'a highlighted. Inside the fenced areas, there may have been a few infected trees, but nowhere near the numbers seen in the forests outside the fence. As Flint Hughes, of the U.S. Forest Services Institute of Pacific Islands Forestry put it, describing one such area in the Big Island district of Ka'u, "a huge blob of death" was seen outside the fenced area, while inside, "we have yet to find a [ROD-]positive tree."

WUD and ROD

Driving home the same point was the presentation of Emma Yuen, native ecosystems protection and management manager at the state Department of Land and Natural Resources.

Yuen linked rapid 'ohi'a death to an even older and more widespread problem she called WUD, or widespread ungulate damage.

"We have millions of trees that have died because of WUD for more than two centuries now. More than 100 studies have

been done showing how damaging WUD is in over two million acres of 'ohi'a and other native forests," she said. Today, even though on the Big Island, 160,000 acres are free of hooved animals, that number is dwarfed by the more than 2 million acres that are still unfenced, she added.

Now the DLNR is attempting to have some of the funds allocated to fight rapid 'ohi'a death used to fence and remove ungulates from forested areas.

Despite the clear link between WUD and ROD, Yuen said, there's a need to be strategic in identifying areas that should be prioritized for fencing. Also, given the objections that Hawai'i's vocal community of hunters is likely to raise against additional fencing, Yuen asked how it might be possible "to translate the community's 'ohi'a love into support for actions needed to protect forests?"

Finally, she threw down a challenge to the state's conservation community to use the data on the link between ungulates and rapid 'ohi'a death "to fence and protect areas with a renewed urgency."

In the Air

The two different species of *Ceratocystis* implicated in ROD result in the same event – the death of the tree – but by different mechanisms and over different time spans. *C. lukuohia* causes death by quickly spreading through the tree's vascular system, while *C. huliohia* is slower, causing cankers to form inside the tree. Death is almost certain, but it may take months or even longer.

Thomas Harrington, a professor at Iowa State University who has extensively studied fungal diseases of trees, described the different ways in which he suspects the fungi are spread. *C. lukuohia*, he said, was most associated with wind, while *C. huliohia* is found in trees that are more protected.

To support the notion that the more devastating fungus is carried by wind and not, for example, by insects, Harrington showed two aerial photos of the same area, Wao Kele o Puna, before and after Hurricane Iselle, which hit Puna in August 2014.

In 2008, there's no sign of any diseased trees, but 18 months after Iselle, "the forest is transformed."

Continued on next page



In the Agricultural Research Service lab in Hilo, sections of 'ohi'a trunks infected with the *Ceratocystis* fungus are placed in fabric cages to see what insects emerge from them.

Near Hakalau Forest National Wildlife Refuge, *C. lukuohia* hit an area that, Harrington said, is undisturbed and has no ambrosia beetles, a type of insect that's suspected of carrying spores of the fungus from infected trees to uninfected ones, thereby spreading the disease. This, he said, "could not be human-associated inoculation. It had to be the wind."

Genetic analysis of the *C. lukuohia* found in infected Kaua'i trees showed it to be close to strains found on the Big Island and is very likely to have come from there, "probably in a wind event," Harrington said.

"Trees that are exposed to the wind, trees above the canopy, seem to be the most susceptible" to infection with this species, he said.

Why are those taller trees more likely to be infected with *C. lukuohia*?

Harrington has a theory. "I suspect it's because of the upright architecture of the tree. In between the stems that grow together is old bark. In the wind, they'll open up the tree where the included bark is," he said. "The heaviest stain" – which is symptomatic of infection by *C. lukuohia* – "is often in the included bark."

Wade Heller, with the U.S. Department of Agriculture's Pacific Basin Agricultural Research Center in Hilo, noted that air samples from more than 20 sites had tested positive for either or both species of fungus as far as 20 miles from the closest known infected tree. DNA was present in trace amounts – although he cautioned that the mere presence of DNA did not indicate that the fungus was viable.

Sheri Mann, Kaua'i manager for the state Division of Forestry and Wildlife, said she, too, suspects that wind has been a big factor in the spread of *Ceratocystis* on that island, where both species have been found.

Are Beetles to Blame?

Ambrosia beetles, sometimes called "fungus farmers," have also come under suspicion as a means of infection. Kylie Roy and Kelly Jaenecke, researchers with the U.S. Geological Survey's Pacific Island Ecosystem Research Center, described the research they had done on the possibility that the beetles' frass – the sawdust-like

waste the beetles produce – might carry the fungus from one tree to another.

Less than 10 percent of the frass samples they collected contained *Ceratocystis* DNA, but no spores were detected.

The beetles themselves may be able to carry the fungus from one tree to another. Roy and Jaenecke are just starting to test this possibility.

Franny Brewer, communication director with the Big Island Invasive Species Committee, reported on a study she conducted last year at trailheads on the Big Island that revealed the presence of *Ceratocystis* DNA in dirt.

She and co-workers collected dirt from boot brushes and nearby areas, tested that for the presence of *Ceratocystis* DNA, and then attempted to grow it out on carrots, the culture medium used most frequently to determine fungal viability.

Trace amounts of DNA from both species were present in every sample, although most of it was not able to be cultured.

"The surprising thing is where we actually were able to culture *Ceratocystis* from samples – neither of them came from places where there's a lot of ROD-infected trees nearby," she said, adding that the inoculum probably came from far away on someone's boot.

Brewer added that she had tested a limited number of samples from off-island. "All have been negative so far," she reported.

Harrington spelled out what he sees as the long-term future of Hawai'i forests: "There's DNA floating around everywhere, just looking for a wound. I think it's eventually going to spread through all 'ohi'a forests on the Big Island, although the percentage of trees dying is actually small."

He defined success as "a low level of infected trees. You're not going to get rid of it on the Big Island."

Eventually, he added, "it may take decades, but the fungus will be in 'ohi'a forests all around the islands. Maybe five to ten percent may go out over a decade."

One positive aspect: "It doesn't spread rapidly from one tree to the next. That's what is different about this disease as opposed to, for example, chestnut blight or oak wilt. ... We're not seeing it wipe out the whole forest. I'm more hopeful than most, but I think we have to accept some level of disease." — **Patricia Tummons**

A Short History of a Devastating Disease

A decade ago, people in Puna began to notice that 'ohi'a trees, so abundant in their district, in residential and forested areas alike, were dying. The leaves on the trees would suddenly wilt, then turn brown, and within a matter of weeks from the first signs of a problem, the trees would be dead.

As more and more trees died and the area of infected trees grew, foresters, land managers, researchers and scientists with a host of public agencies and private nonprofits began to suspect that the problem might soon become a threat to the 'ohi'a tree across broad swaths of the Big Island, but also statewide. The 'ohi'a, *Metrosideros polymorpha*, is a keystone species in nearly all native ecosystems, from wettest rainforest to driest shrublands, and practically everything in between.

In early 2015, Lisa Keith, a plant pathologist with the U.S. Department of Agriculture's Pacific Basin Agricultural Research Center in Hilo, tentatively identified the source of the problem: a strain of *Ceratocystis fimbriata*, a fungus, that interferes with the trees' vascular system, blocking the lifelines that deliver nutrients and water to the branches and leaves.

Further work by Keith and colleagues determined in 2017 that there were actually two different species of *Ceratocystis* that were showing up in dead trees. There was *C. lukuohia* – the destroyer of 'ohi'a – that causes a tree's crown to wither all at once, and also *C. huliobia* – the turning of 'ohi'a – that causes cankers to grow beneath the bark, nearly always resulting in death, but at a slower rate than *C. lukuohia*.

The two fungi also differ phylogenetically. *C. lukuohia* is most similar to strains of *Ceratocystis* traced to Latin America. *C. huliobia* falls within the Asian-Australian clade.

Ceratocystis fimbriata, which used to be considered a single species with multiple diverse strains, is now considered its own genus, with 39 different species. "There have been tremendous changes in taxonomy," noted *Ceratocystis* expert Tom Harrington of Iowa State University.

Take Reduction Plan Goes Awry For Insular False Killer Whales

Nearly nine years ago, responding to a petition from the Center for Biological Diversity, the National Marine Fisheries Service determined that the insular population of false killer whales around the Main Hawaiian Islands constituted a distinct population segment and merited protection under the Endangered Species Act.

A take reduction plan was developed, with the expectation that, within six months of its implementation, fewer animals from both the pelagic and insular stocks would be injured or killed as a result of interactions with longline gear. For the insular stock, the target was to hold mortality or serious injury (M&SI) to 0.3 animals per year – or about one animal every three years. For the pelagic stock, whose range overlaps the insular stock's and extends to the high seas, it was expected that the M&SI rate would be held to less than nine animals a year.

Longer term, the measures proposed in the plan were to reduce within five years the M&SI rate of both populations to insignificant levels approaching zero.

So how has that worked out?

"Those goals have not been met," said Ann Garrett, protected resources supervisor at NMFS' Pacific Islands Regional Office, in her presentation to the federal Marine Mammal Commission. The commission held its annual meeting in Kona last May.

The plan had specified certain gear changes: weaker hooks that could be more easily straightened and stronger branch lines that wouldn't break off and end up causing further injury to false killer whales incidentally caught by the longliners. Also, captains were to be notified whenever a false killer whale was hooked and were to receive training in how to release them.

From 2013 through 2018, Garrett said, "the vast majority of times, the line was cut or broke." On just four occasions in that five-year period did the crew manage to straighten a hook; one time, the hook itself broke. Overall, 39 percent of interactions terminated when the line was cut, while the line broke in 29 percent. Nearly three quarters of the interactions – 73 percent – resulted in mortalities or serious injuries, Garrett said.

How many times was an animal released free of gear?

Just once.

"We determined that the plan isn't meeting all its goals and objectives," Garrett said, mastering the understatement. The take reduction team (TRT) began drafting new recommendations to amend the take reduction plan, she said, noting that the number of meetings the team has had is "unusual." Most of the teams set up for other endangered species may have just one annual meeting. The team dealing with the Hawai'i insular population of false killer whales "continues to have regular calls instead of just an annual meeting."

Brendan Cummings of the Center for Biological Diversity, the group that originally petitioned to have the insular stock listed as endangered, is also a member of the take reduction team. He told the commission that the reason the original plan didn't work was because it simply wasn't implemented. "We were to have a 4.0 (mm) hook, according to the criteria set out by the team, and NMFS proposed that as a regulation. But the final regulation proposed a 4.5 hook, which was status quo for much of the fishery," he said.

"The fact that the plan didn't work was masked by the fact that new abundance estimates" were developed, he said. But in fact, the actual M&SI didn't go down.

"It's taken a decade for people to recognize that, ... and now we're at a point where we agree there's a need to move to a weaker hook. The sticking point is, what trade-offs need to happen."

Eric Kingma, formerly with the Western Pacific Fisheries Management Council (Wespac), is now executive director of the Hawai'i Longline Association, which represents owners of most of the longline vessels that interact with the Hawai'i false killer whales. He defended his members' efforts to reduce interactions, blaming the failure to adopt the weaker hook on NMFS: "We understand there was an initiative to get the necessary research done," he said. "The proposal wasn't done in time. NMFS didn't finish that process."

As to increasing the strength of the branch line, "We understand that suppliers are looking into getting this available," he said.

He also praised the Hawai'i fleet for the

level of observer coverage, which is around 20 percent on the deep-set longline vessels. Elsewhere in the Pacific, "foreign fleets ... are subject to five percent observer coverage, and many fleets don't reach that at all ... No other fleet is even close."

Asuka Ishizaki, Wespac's protected resources coordinator, said that Wespac was looking at ways to minimize depredation on the longliners' bait by the false killer whales. "Until we can address depredation," she said, "we can't address interaction issues," adding that the council has been looking at a device that might prevent this. "There are operational challenges" to deploying it, however, she noted.

In addition, Ishizaki said the council had concerns with the way in which a hooking is determined to be a mortality or serious injury. "Most interactions result in the animal being released alive, but because of the gear remaining around the head, it's considered to be a serious injury. But this is NMFS policy, not statute".

The council, she said, "wants more research."

Erin Oleson, a research ecologist with NOAA's Pacific Islands Fisheries Science Center, addressed the issue of how mortality and serious injury is determined. "What we draw on quite a lot is the long-term prognosis of bottlenose dolphins with hooks," she said. "That is still for us the best available data."

She added, though, that NMFS is just now beginning to re-evaluate the criteria for serious injury and has set up a national working group.

Ann Garrett spoke to the need for changes in the take reduction plan. "About November, December of last year, the [take reduction] team was making considerable progress. I thought we were close to consensus recommendations. Then we ended up with the government shutdown, which put things behind schedule," she said.

Following that, there were "additional takes" – reported hookings of false killer whales earlier this year that resulted in NMFS closing off a large swath of the ocean south of the Hawaiian Islands to longliners, as called for in the take reduction plan.

"That," Garrett said, "changed the tenor of the discussion in the team to some degree."

However, NMFS has already begun to look into some of these recommendations, especially with regard to research. "We've allocated funds for that, to take a look at

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new gear configuration, run trials with longline vessels.”

“Also,” she added, “internally, we’re talking about handling and training, which seems like a fairly easy thing to overcome. It’s not without complexity, due to language barriers But we’re talking about revamping training to reach the crews and not just captains.”

Kristy Long of NOAA’s Office of Protected Resources reported that a draft recovery plan for the insular false killer whale population is expected to be released for public comment in late summer or early fall.

The plan has been a long time coming.

In October 2013, Long said, NOAA published a notice of its intent to prepare a recovery plan. Three years later, it developed a 23-page “recovery outline.” In October 2017, it held a four-day recovery workshop. Only in April of this year did it submit a draft species status assessment and draft recovery plan for peer review.

“We hope to finish the recovery plan by next summer,” she said.

As to the cost of implementing the plan, Long said, “We estimate the cost out over 50 years plus inflation [to] be between \$75

and \$100 million, but who knows if that’s what it’ll actually cost.”

Closer to Home

The longline fleet rarely interacts with the insular population of false killer whales, since most of the range of that population is closer to the Main Hawaiian Islands than the longliners are allowed to fish.

Not so with respect to other gear types.

Robin Baird of the Cascadia Research Collective drove home this point in his presentation to the commission. Baird pioneered research into false killer whales with his extensive survey and tagging program, begun more than two decades ago.

In Hawai‘i, he noted, there are more than 3,000 commercial marine license holders, and the retained catch of pelagic species by this sector amounts to between four million and five million pounds a year.

The haul from the unlicensed recreational fishers is even greater, he noted, estimated at between 11 million and 17 million pounds per year.

In addition, there are 567 licenses for bottomfish fishers in the main Hawaiian islands, 459 licenses for tuna handline fisheries, and more than 100 licenses for charter fishers.

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slowed nor reversed.

“What is the biggest change since 2009?” The question was the first one lobbed to Polovina after he had concluded his talk.

“We have another decade of data, of continuing trends – and we’re more aware that climate impacts are happening earlier than we thought,” he answered.

And, he said, “We’re more aware of the impacts of the longline fishery,” he said.

“The fishery started in the core area” – around the Main Hawaiian islands – “in the late 1980s,” Polovina said. “Around 2005, its effort increased and expanded to the north and the east,” to the point where now some 13 million square kilometers are commercially fished around Hawai‘i.

With that increasing effort has come declining catch rates, between 2 and 7 percent a year. The size of the fish caught is shrinking as well, while the proportion of smaller fish in the catch shows substantial increases, he told the commission members, its scientific advisors, staff, and the several dozen interested members of the public in attendance.

“The catch rates of small fish” – those with a mean weight of less than 15 kilograms

– “have increased 25 percent since 1996,” Polovina said, while those for the larger fish have declined more than 50 percent. More and more of the catch is made up of fish having no commercial value, such as lancetfish and snake mackerel.

Overall, “the fisheries yield is expected to decline by as much as 50 percent, and the size structure of the catch will also decline,” he said.

The change does seem to be a “top-down response: as you remove large animals, the population of smaller animals increases,” he said. While this may be bad news for commercial fishers, he added, “there may be some benefit for marine mammals. Maybe more mahi and ono for false killer whales.”

But the benefit may be fleeting.

“Marine mammals and fisheries will be impacted,” he said, with insular populations, such as Hawai‘i’s insular false killer whale population, being hard hit, while pelagic stocks may be able to find areas of higher productivity.

The average rate of annual decline in fishery yields that he had observed in 2009 now is predicted to be as high as 5 percent. “As fishing and climate change impacts

“And there’s no observer program in any of these fisheries,” he said.

Yet almost certainly, these fisheries interact with the insular false killer whales.

In addition to broadening the discussions to include fisheries other than the longline vessels, Baird also expanded it to address interactions between all fisheries and other species of marine mammals, including bottlenose dolphins, pilot whales, pygmy killer whales, short-finned pilot whales, and monk seals.

“Of the eleven species where there is evidence of insular populations,” Baird said, “only five have had recognized insular stocks designated by NMFS” – even though the “evidence for others is quite conclusive.”

Of the pygmy killer whales, he said, 43 percent have evidence of interactions with fisheries. “It’s baffling for us,” he noted. “In all our encounters with pygmy killer whales, we’ve never seen them feeding during the day. They interact with gear at night.”

In addition, he said, the pygmy killer whales seen “represent individuals that have survived fishery interactions, and thus indicate the extent of depredation behavior rather than how many may be seriously injured or killed” as a result of the interactions.

—P.T.

combine to shift the size and trophic structure to smaller sizes and lower trophic levels, the subtropics will lose resources that migrate out,” Polovina said. “And it’s not clear anything will migrate in.”

So while the rate of change in the central Pacific Ocean north of the equator may not be as fast as that predicted for northern latitudes, “the impact to ecosystem services may be much greater,” he said.

He cautioned, however, “there are so many caveats when we try to project climate impacts. We’re unsure how parts of the ecosystem will change as chemistry changes. ... We have more tools, and we’re making more projections, but we’re also aware there’s so much uncertainty. There’ll be surprises.”

But probably not pleasant ones.



Swim-With-Dolphin Rule Still a Work in Progress

Dolphin tours are big business—very big business—in Hawai‘i. Along the Kona Coast of the Big Island and off Wai‘anae,

Continued on next page

on O'ahu, dozens of companies hold out to their paying guests the prospect of swimming with pods of spinner dolphins.

Lars Bejder, director of marine mammal research at the University of Hawai'i's Hawai'i Institute of Marine Biology, told the commissioners that on O'ahu alone, the annual revenue of dolphin tours amounted to \$58 million, while the figure for Kona-based tours came to \$44 million a year.

But while snorkelers may pay a premium to enjoy getting up close and personal with the animals, the price the dolphins pay is to their health. The animals feed in the open ocean at night and come in to protected bays during the day to rest. When their rest is interrupted by human activity, their ability to forage, to protect their young, and to successfully reproduce suffers.

Nearly three years ago, in August 2016, NOAA proposed a rule intended to beef up protections for the spinner dolphins. Under the federal Marine Mammal Protection Act, it is already illegal to harass, injure, or kill all dolphins, seals, whales, and other marine mammals without specific authority to do so. But in the absence of rules, enforcement of the MMPA is difficult and uncertain.

The rule would bar vessels or individuals approaching closer than 50 yards to spinner dolphins, would prohibit swimming with the dolphins, and would also ban the practice of "leapfrogging," or placing a boat or person in the path of a dolphin.

Ann Garrett, supervisor for protected resources in the Pacific Islands Regional Office of the National Marine Fisheries Service, said that NMFS was "still in the process of finalizing the rule" and had only recently completed its review of all 2,294 unique comments. A final rule was still months away at the earliest, she said.

But at the MMC meeting, several of those present voiced their concerns that the proposed rule did not do enough to protect dolphins.

Prominent among them was Bejder, who cited research that emphasized the importance of the sheltered bays where the spinner dolphins rest. Sites along the Kona Coast were studied by an Australian researcher, Julian Tyne, who, Bejder said, determined that the spinner dolphins there had "the highest human exposure rates of anywhere in the world."

"Eighty-three percent of the time the dolphins spent in resting bays had humans within 100 meters," Bejder said, referring to Tyne's work. "That's 25 percent higher than what has been reported for any other cetacean species. And the average time between exposure events was just 9.6 minutes."

Up until 2015, he said, NOAA's preferred approach to managing human-dolphin interactions was through time-and-area closures. But in 2016, that changed to the 50-yard standoff. That, he said, "is a good start ... but the resting bays need greater protection."

"Also, the 50-yard rule doesn't consider vessel noise," he added, noting, "Acoustic exposure propagates over hundreds to thousands of yards."

"It's clear that if you have a vessel just outside 50 yards, it will be audible," he said. "A 50-yard approach limit is good outside bays, but in the bays, it's very inadequate. I'm afraid that we've spent 25 years to get a rule in place, but if we put a rule in place now that we already know is not protective, we'll spend another 25 years to get another rule, while we know that the pressure on dolphins is increasing."

Addressing Bejder's concerns, Garrett said that NOAA had "considered closed areas, but we got feedback from our partners that that wasn't a preferred option."

In any case, she noted that her agency was already working with operators and others in the affected communities: "As the rule hasn't been in place, we have been doing other things to help the spinner dolphins. We've engaged in outreach with commercial operators and the tourism industry to help them understand the issues. And as far as recreational viewing goes, we've engaged in outreach on beaches and bays. And we have a growing social media presence."

When the public attending the meeting was invited to comment, the testimony was scathing.

Rick Wilson of Kona, identifying himself as a "50-year user of oceans," said, "First, I suggest each of you here go down to Kailua Bay at 7:30, 8 in the morning. Watch what happens. It's absurd. We will have between 10 and 15 tour boats in the bay, following the dolphins. They surround them. I live right above Lyman's. I watch every day as they're just harassing the hell out of the dolphins. ... You need to get this under control. It's a joke, and it's been going on for 25 years."

The tour operators themselves weighed in with complaints about their own industry's behaviors. One captain said that for years, the company he worked for resisted, but, "we ended up swimming with dolphins five years ago. You can't beat 'em, so join 'em." Another tour operator, whose boat carries just six passengers, complained about the other 56 operators who can drop "up to 60 people in the water at a time."

Whatever the final rule is, it might not

be coming anytime soon. Timing, Garrett said, "is difficult to predict, especially as we move across administrations. Certain rules that aren't administratively required have been slowed down."



Monk Seal Recovery Threatened by Disease

"Under the Endangered Species Act, we have downlisting criteria," Jason Baker, a marine biologist with NOAA's Pacific Islands Fisheries Science Center, reminded the MMC members. "For the Hawaiian monk seal to be listed as threatened instead of endangered, it will take 31 years at the current rate of growth for the population to meet downlisting criteria." That current growth rate is about 2 percent a year.

"And I can tell you, the population won't grow at current rates for 31 years in a row."

Still, Baker did report that throughout the range of the species, monk seal counts were increasing. "There's a lot of variation over time," he said, "but at most sites, we're seeing stable or rising populations."

Past threats – especially predation on seal pups from Galapagos sharks – remain. Last year, he said, at French Frigate Shoals, deaths of pups due to shark predation was the worst ever seen.

And the population is still suffering from low pup survival rates at French Frigate Shoals. Overall, though, Baker said, "we're happy to see the population is growing."

"In 1998, I was pretty depressed," Baker said. "From the time I took over" as head of the monk seal research group, "the population kept going down and down."

"But, despite the fact that we have a long way to go, we're seeing positive trends since 2013, and myself and others in the program are pretty excited about it."

Angela Amlin, the monk seal recovery team coordinator for NMFS' Pacific Islands Region Office (PIRO), had a more sobering assessment in her overview of threats to the species.

Seals in the Northwestern Hawaiian Islands face multiple threats, including food limitation, entanglement and entrapment in abandoned facilities, male aggression, and habitat loss – in addition to the shark predation mentioned by Baker.

In the Main Hawaiian Islands, there's the ever-present threat of interaction with fishing gear (and sometimes fishermen):

Continued on next page

"As of 2017," Amlin said, "there have been 18 seal mortalities from fishery interaction. Seven from hook ingestion, with the rest suspected of dying in nets. All but one of the confirmed cases involved laynet gear, which is illegal." One mortality, she noted, was associated with an aquaculture pen.

There have been 14 intentional killings of monk seals in the Main Hawaiian Islands, with another four or five deaths from trauma where the intent could not be determined, she said.

To mitigate the threats in the North-western Hawaiian Islands, juveniles that are malnourished – especially females – are translocated or transferred to the seal rehab hospital in Kona.

Entanglement with nets remains a serious threat, with the NWHI seeing one of the highest entanglement rates for seals anywhere, Amlin reported, as a result of ocean currents dumping debris on the beaches of the archipelago. "We have disentangled 379 seals since 1982," she said. As for entrapment: "Since 2015, we've released 23 monk seals from behind the Tern Island sea wall."

Male aggression occurs when a male or group of males mobs female or juvenile monk seals, which can lead to death or serious injury and the skewing of the population's sex ratio. This, Amlin said, "was a significant cause of mortality in the 1980s and 1990s, but because of mitigation – hazing, wound treatment, translocation, or permanent captivity for males only – it has gone down."

About one third of the monk seals today, Amlin said, "are alive because of direct interventions. Either they were saved directly, or they're descendants of seals that were saved in the past."

Yet even as past actions have helped the population recover, new threats have arisen.

There's the loss of habitat due to a changing climate. Whale-Skate Island, in the French Frigate Shoals, sank out of sight in the 1990s. More recently, East Island, the second-largest land mass in the same atoll, disappeared after Hurricane Walaka tore through the area last fall, while Trig Island was overrun by wave action. French Frigate Shoals is one of the most important nesting areas for green sea turtles as well as a haul-out for the seals.

"After Whale-Skate," Amlin said, "the seals relocated on their own. It remains to be seen what happens when you lose one after another island. It could be significantly more damaging."

In addition to losing land, the seals also face the threat of disease.

Starting last summer, hundreds of harbor seals and gray seals along the eastern seaboard of the United States began to die in what NOAA called an "unusual mortality event." The cause of most deaths was eventually determined to be a morbillivirus – phocine distemper virus, much like canine distemper.

To protect against this, NMFS has launched a vaccination program, now in its fourth year. Michelle Barbieri, a veterinarian with the Pacific Islands Fisheries Science Center, said the seals are vaccinated with a syringe at the end of a hand-held pole. Two injections are needed, three to five weeks apart.

So far, in the Main Hawaiian Islands, 63 seals have been vaccinated to date accounting for about a fifth of the population. In the Northwestern Hawaiian Islands, the percentage is 57 percent, or 634 seals out of a total of roughly 1,100.

"We're not aiming to vaccinate every seal," she said, "but enough to establish herd immunity."

The virus itself, she said, has never been detected in a Hawaiian monk seal, but to prepare for a day when an animal is suspected of having the disease, "we've been identifying sites where quarantined seals could be held."

No vaccine is available to prevent toxoplasmosis, however, which Barbieri described as the leading disease-related cause of mortality in Hawaiian monk seals.

"Cats are the only definitive hosts," shedding the oocysts in their feces. Those oocysts can survive for months and do not die even when they are washed into the ocean.

Toxoplasmosis was first detected in monk seals in 2011, and since then, a total of 11 seal deaths have been attributed to the disease. "It mostly hits females, including many of productive age," Barbieri said.

Further strengthening the linkage between the disease and cat populations is the fact that almost all the seal deaths from toxoplasmosis have occurred in the Main Hawaiian Islands. Just one seal outside the MHI is known to have died from toxoplasmosis – a seal at Laysan Island.

"There's no way to easily prevent exposure," Barbieri said. "Most seals found with this disease end up dead."



Dramatic Fluctuations In Humpback Numbers

In 2012, Phil Fernandez was named volunteer of the year by the Hawai'i Humpback

Whale National Marine Sanctuary. Less than a year later, he was one of the organizers of a group called Hawai'i Fishermen's Alliance for Conservation and Tradition (HIFACT), many of whose directors are closely allied with the Western Pacific Fisheries Management Council. Within two weeks of HIFACT's official founding, it petitioned the National Oceanic and Atmospheric Administration, asking that it define the North Pacific humpback whale population as a distinct population segment and then remove it from the list of federal endangered and threatened species.

That year, as it turned out, marked the high point for the humpbacks that winter in Hawai'i and summer in Alaska. In 2016, based on population growth estimates of 6 to 7 percent a year, the humpback whales that frequent Hawai'i waters in winter were found to be so abundant that they lost their status as endangered. The Hawai'i distinct population segment of the Northern Pacific population was taken off the list of animals protected by the Endangered Species Act – although it still enjoys more limited protection under the Marine Mammal Protection Act.

Was it too soon?

"Three to four years ago," says Marc Lammers, researcher coordinator at the Hawaiian Islands Humpback Whale National Marine Sanctuary, "something unusual began to happen here and in Alaska."

"The 2015-2016 whale season started normally enough, with the first sighting off Molokini in October. But in January, people started to notice the whales were slow to arrive... People got worried. Headlines read: 'Whales have gone missing.'"

The annual whale count conducted by the Pacific Whale Foundation in 2016 counted just 732 animals, less than half the number seen the year before (1,488), Lammers said.

Also, acoustic monitoring of whale activity showed a decrease. "In December 2015, the sounds were about the same as the previous year. But then, for the rest of the year, they never reached the level of the year before. Also, there was an earlier departure" from the islands, Lammers noted.

"A change of six decibels is equal to a 50 percent drop in acoustic energy," he said, adding that there was a difference of between six and seven decibels over the three seasons from 2014-15 to 2017-18.

Other evidence of change, Lammers said, came in from the sanctuary's ocean count, which takes place on Kaua'i, Oahu, and the Big Island. "It's held three times

Continued on next page

in the whale season" (January-March), and at all locations, we've seen a steady decrease in the number of whales people see and count."

The alarming trends led Lammers and others to hold a workshop last November that brought together more than 30 experts and resource managers from 17 different agencies and institutions in both Hawai'i and Alaska.

At the end of the workshop, there was general agreement that whale counts from Southeast Alaska, Prince William Sound, Hawai'i island, and Maui "all show strong decreases in sighting rates over the last four-to-five years," Lammers said. And this included both adults and calves.

The consensus of those at the workshop was that changes in prey abundance and distribution played a role. But they also identified "unknowns:"

Do the decreasing numbers reflect changes in habitat use or an actual decline in the population?

Is this limited to the Hawai'i population or does it reflect a broader trend across all Central North Pacific humpback populations?

And are these changes linked to declines in other species or changes in the ocean itself?

As an outcome of the gathering, eight different working groups were formed to pursue a number of different research efforts. But in addition, Lammers said, "some interesting information has come out" since the workshop.

"In the time period beginning in 2013 to 2016, some really major ecosystem-wide changes took place in the North Pacific," he said. This included "ocean heat waves" that led to the collapse of the cod fishery and seabird die-offs.

In the 2018-19 whale season, Lammers said, whale numbers in Hawai'i jumped up. "This season, actually, was a pretty good whale season, by most accounts. Operators were happy," he noted.

Acoustic data confirmed the increase, with levels that were almost up to those of 2015 at one site, Lammers said, with a "definite improvement" at a second site.

One of the benefits of the government shutdown in January was that a NOAA research cruise was reprogrammed to look for humpbacks in the Northwestern Hawaiian Islands.

"We only had a week to spend in the [Papahānaumokuākea Marine National] monument," Lammers said. "The cruise hit a number of islands about halfway up the chain. We all were quite surprised



PHOTO: PACIFIC ISLANDS FISHERIES SCIENCE CENTER

On the bow of the research vessel Oscar Elton Sette, Susan Yi prepares to take a tissue sample from a humpback during the spring 2019 whale survey of the Northwestern Hawaiian Islands.

that we found whales everywhere we looked.

"In total, we saw approximately 180 whales, including at least 13 calves. The area appears to be quite important for humpbacks. They're breeding there."

Christine Gabriele, with Glacier Bay National Park in Alaska, described the decline of humpbacks in Glacier Bay, one of the areas where the Hawai'i humpbacks spend summer months.

From 2014 through 2015, she said, "a huge patch of unusually warm water" spread over the North Pacific. The "blob," as it came to be called, was characterized by water that was up to 2.5 degrees C higher than average, resulting in "lots of ecological consequences," she said.

From 1985 to 2013, the humpback population in Southeast Alaska increased at a rate of 5 percent a year, with a peak in 2013 of 239 whales.

"Then the downhill slide began," she said. By 2017, the number of humpbacks dropped by more than 40 percent.

"Eleven whales were seen every year for 30 years," she said. "From 2013 on, all were missing." In 2018, finally, three were resighted – though just one of them was seen in Glacier Bay.

The number of missing "regulars" has been increasing every year, with the fate of most of these unknown, she added.

Calving success also declined dramatically. In 2013, the birth rate was 9.3 percent. "After 2014, it was 2.8 percent. The first thing we knew was wrong was in 2014. Half of the calves were missing from their mothers after the end of summer in 2014. The calves were presumed dead, since they were not old enough to be weaned.

"In 2018, there was just one calf, which died. It was total reproductive failure – the

first time in the 34 years we've been studying the whales," she said.

Many of the whales that make it back to Glacier Bay are in poor shape. In 2016, 13 percent were judged to be "skinny," while in 2017, that had increased to 24 percent, she reported.

Gabriele noted that strandings had also increased after 2014, with many of the stranded whales being emaciated. Also, she and her colleagues were noticing an increasing prevalence of unusual skin conditions, including bleeding from flippers, patchy dermatitis, blotchy, rough skin, and bumps, or nodular dermatitis.

What had happened?

"The carrying capacity of the ocean had changed in a heartbeat," she said. The herring fishery had collapsed, with none harvested at all in 2018 and no harvest in 2019. "These fish are not of marketable size – and these are prey for the humpbacks," she noted. The same held true for other fish species, including capelin, lampfish, and pollock. Not least, the zooplankton itself had become "skinny," with a reduced lipid content.

As to whether the delisting decision was premature, Angela Somma, chief of NMFS's Protected Resources Division at its headquarters in Silver Spring, Maryland, said this:

"When NMFS makes a listing decision under the Endangered Species Act it makes that determination, as it did in 2016 with respect to the Hawai'i DPS of humpback whales, based upon the best available scientific and commercial data available. We can't speculate, without conducting a full analysis of the data available and assessing all of the listing factors what the outcome of an ESA status review for this DPS would be today."

—Patricia Tummons

Invertebrates, Sharks May Suffer Most From Climate Changes in the Pacific

A recent rapid assessment of 83 marine species from throughout the Pacific found that sharks — including the threatened oceanic whitetip — sea cucumbers, urchins and clams are highly vulnerable to expected climate change effects over the next few decades. Limpets, such as opihi, and the tiny Palolo worm are likely to suffer the most, it found.

The assessment, called the Pacific Islands Vulnerability Analysis (PIVA), was conducted by a team consisting mainly of local federally funded scientists and is similar to one done in 2016 for the Northeast continental shelf.

The National Oceanic and Atmospheric Administration's Fisheries Climate Science Strategy calls for regions across the country to conduct such assessments to help determine which species are the most vulnerable and where science and management should focus their efforts to reduce risk.

The work in the Northeast covered 82 fish and marine invertebrate species and examined their vulnerability to seven climate change factors, including ocean surface temperature, ocean surface salinity, surface air temperature, precipitation, surface pH, currents, and sea-level rise.

The scientists found that bay scallops and Atlantic salmon were the most vulnerable, scoring "very high" in both their exposure and their sensitivity to those factors.

More than half of the species would likely to be negatively affected by climate change, about two dozen species would experience neutral effects, and 14 species, including butterfish, black sea bass, and anchovies, were expected to benefit.

For the Hawai'i project, the scientists expanded their analysis to include 18 climate change factors, including changes in oxygen levels and sea bottom temperature.

Last month, Pacific Islands Fisheries Science Center fishery biologist Don Kobayashi, who worked on the assessment with colleagues Jonatha Giddens and Mark Nelson, provided the Western Pacific Fishery Management Council's Scientific and Statistical Committee with an overview of the project and its results.

He explained that the team took the best estimates of the species' distribution and combined that with NOAA forecasts of climate change effects (such as changes in ocean pH) to produce more than 5,200 exposure maps that "basically show you how

much climate change will be happening over a species' range."

The group assessed how sensitive each species was to each of those environmental changes. It then combined their exposure and sensitivity scores to produce an overall vulnerability score.

The Pacific project did not analyze corals or protected species (other than the oceanic whitetip shark), because those are being handled by a different group, Kobayashi said.

Lower surface oxygen, high sea surface temperature, and ocean acidification turned out to be the three factors that had the most impact. Those factors "bumped exposure into the very high range for nearly all of our taxa," Kobayashi said.

The species covered six functional groups: deep slope, coastal, coral reef, pelagics, sharks, and invertebrates.

"Coastal was clustered toward the moderate [vulnerability realm]. Sharks were inching up into the high and very high," he said.

Oceanic whitetip, scalloped hammerhead, pelagic thresher, and silky sharks all were determined to face very high exposure to climate change factors and to be highly sensitive to them. Whitetip reef and gray reef sharks also faced very high exposure, but their sensitivity was assessed as moderate and low, respectively.

"The invertebrate group ranked as most vulnerable and pelagic and coastal groups ranked as least vulnerable. . . . The sensitivity of many coral reef fishes ranged between Low and Moderate, which is likely an underestimate given that reef species depend on a biogenic habitat that is itself extremely threatened by climate change," a summary of the assessment states.

"Within its limitations, this project advances our understanding of the research needs and the management options to sustain both marine life and seafood security in the Pacific Ocean and beyond," it states.

'Ecosystem Context'

The assessment's results regarding pelagic fish species such as bigeye tuna suggest that while their exposure to climate change effects may be very high, the fish are only moderately or minimally sensitive to them.

But that assessment covers climate effects only through 2055, and compares only two time blocks — 1956-2005 vs. 2006-2055

— to determine the relative changes in the environment.

Research by other current and former NOAA scientists suggests that by the end of the century, a large drop in primary productivity in the North Pacific will lead to a corresponding drop in the ability of the region around the subtropical gyre to support many species, including the pelagic species that the Hawai'i longline fleet targets. (See the cover story for more on this topic.)

Such studies, Kobayashi explained in an email to *Environment Hawai'i*, evaluate environmental changes that occur out to 2100, "and might do a more extreme comparison which will accentuate the small predicted changes over time. Neither approach is flawed."

For PIVA, he said the team followed the same approach as the Northeast for consistency, adding that the assessment can be viewed as "not presenting endpoint extremes, but more like the immediate, contemporary-human-lifespan-scale experience of climate change impacts."

At the SSC meeting, Pacific Island Fisheries Science Center director Mike Seki asked Kobayashi whether the assessment team had given any thought to conducting an ecosystem vulnerability analysis that takes into account climate change effects on lower trophic levels.

"A lot of expected impacts are coming through the trophic relationships. It's hard to look at climate impacts without looking at the community," especially with regard to pelagic species, Seki said, adding, "The agencies tend to not look at the system as whole."

"I totally agree looking at an ecosystem context is the way to go," Kobayashi replied. He explained that in trying to assess potential ecological impacts, the assessment team looked not just at species of harvest interest, but also "any species that could potentially serve as a big player in the ecosystem in some aspect."

"This is certainly a first crack at it," he said.

In his email, Kobayashi added that lower trophic level measurements of both productivity and chlorophyll were among the exposure variables analyzed by PIVA.

And in the sensitivity scoring, the team also took productivity and ecosystem responses into account, he said. (Sensitivity attributes included habitat and prey specificity, sensitivity to ocean acidification and temperature, stock size/status, adult mobility, spawning cycle, complexity in reproduction, early life history survival

Continued on next page

and settlement requirements, population growth rate, dispersal of early life stages, and other stressors.)

"So short answer, I don't think any ecosystem responses slip through the cracks of PIVA, even though we don't directly talk about my favorite group of plankton," he said.

Other Applications

At the SSC meeting, chair Jim Lynch asked Kobayashi whether the assessment could be applied to the ongoing consultations that the National Marine Fisheries Service is conducting in accordance with Section 7 of the Endangered Species Act.

For example, the agency is in the midst of consultations for longline and purse seine fleets in the Western Pacific, which incidentally catch and kill oceanic whitetip sharks.

Kobayashi said he didn't know about Section 7 applications, but thought PIVA could be useful in stock assessments, which he said often don't consider environmental factors enough. SSC member Milani Chaloupka agreed, noting that the exposure maps the team produced would be especially helpful.

Whether or how the Western Pacific Fishery Management Council will incorporate the assessment results into its annual recommendations on catch limits for those species that fall under NMFS management jurisdiction remains to be seen. And Kobayashi did not suggest that any such incorporation start now.

"I'm not suggesting the next step is a management strategy evaluation on bigeye tuna or oceanic whitetips. [We're just] trying to get an idea of what species we should look at and bring them into the PIVA scoring," he said.



Shifting Distributions, Changing Productivity

Where will the bigeye tuna that the Hawai'i longline fleet targets be in the coming decades as the ocean warms? And will there continue to be enough of them to support a robust commercial fishery?

Last November, recognizing that climate change may shift the distribution of harvested species and affect their productivity — be it through rising ocean temperatures, ocean acidification or some other factor — the National Marine Fisheries Service issued a technical memorandum describing a six-step process to help



PHOTO: NOAA

Limpets at Gardner Pinnacles in the Papahānaumokuākea Marine National Monument

regions deal with the myriad scenarios they're likely to encounter. The service recommended they 1) detect and anticipate changes, 2) understand mechanisms of change, 3) evaluate risks and priorities, 4) conduct assessments and develop forecasts, 5) communicate advice to manager and stakeholders, and 6) manage fisheries under changing conditions. To achieve each of those, the memo recommended a total of 20 specific actions.

The Northeast and Pacific vulnerability assessments are the kind of research the memo recommends be done under step 3. The Northeast study found that 55 of the 82 species were highly or very highly vulnerable to changes in their distribution. The Pacific study found that the distribution of pelagic species, most of the sharks,

coastal scads and the giant trevally were apt to shift.

To detect the kinds of changes that might influence productivity or distribution of key species (step 1), the annual Stock Assessment and Fishery Evaluation (SAFE) reports released by the Western Pacific Fishery Management Council have in recent years been tracking several indicators, such as ocean pH, phytoplankton size and abundance, and sea temperatures at the surface and at depth, among other things.

"Bigeye have preferred thermal habitat, generally staying within temperatures ranging from 8 – 14 °C while they are at depth. Changes in ocean temperature at depth will impact tuna, and in turn, potentially impact their catchability," according to

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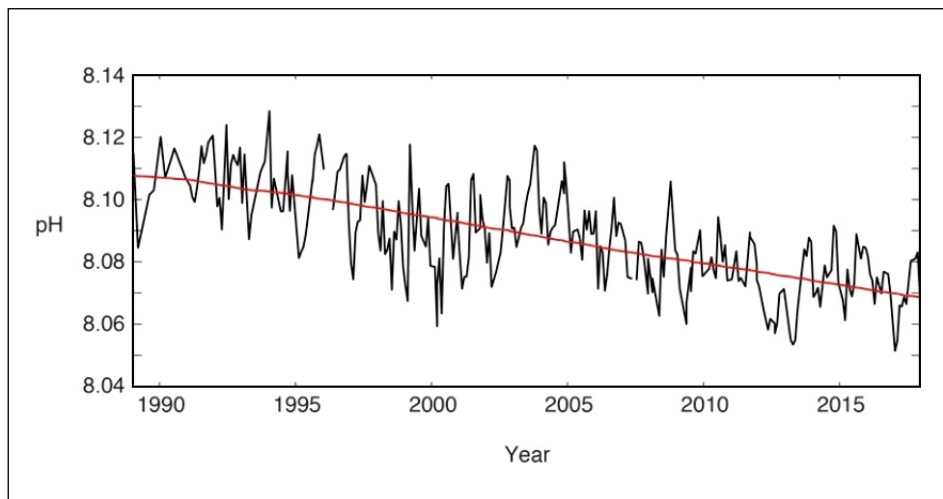
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Trend in oceanic pH (black) at Station ALOHA from 1989-2017.

the council's 2018 SAFE report for pelagic fisheries.

Last year, temperatures 200 – 300 m deep were “within the range of temperatures experienced over the past several decades (10.87 – 11.58 °C) and are within the bounds of bigeye tuna’s preferred deep daytime thermal habitat (8 – 14 °C),” the report states.

The data on ocean acidity — which can affect the ability of fish and their prey to build bones or other calcareous structures — was not so benign.

“The ocean is roughly 9.4 percent more acidic than it was nearly 30 years ago at the start of this time series,” the report states. “[S]mall variations seen over the course of the year are now outside the range seen in the first year of the time series [1990]. The highest pH value reported for the most recent year (8.0831) is lower than the lowest pH value reported in the first year of the time series (8.0845),” it continued.

Management Implications

At the council's Scientific and Statistical Committee meeting last month, Melissa Karp, of ECS Federal, LLC, on behalf of NMFS' Office of Science and Technology,

detailed the various step-related recommendations included in the memo. None of them amounted to a “silver bullet,” but they might allow regional fisheries to be “robust to climate change,” she said.

She recommended that regions capitalize on advancements in models, citing the Alaska Climate Change Integrated Modeling (ACLIM) project that looks to predict climate-driven changes in the Bering Sea.

“ACLIM uses global climate models and climate enhanced biological models, as well as economic models that give the big picture,” she said.

With regard to management, she said regions need to plan for future scenarios using results from risk assessments. “Some species may be crossing jurisdictional boundaries. Plan for emerging fisheries if new species enter your regions [and] run scenarios with adjacent jurisdictions,” she said.

She also recommended the use of near-real-time data that fishermen can use to avoid areas with predicted high abundance of protected resources and, therefore, lower bycatch and “allow for smaller area closures that are more dynamic.”

SSC member Ray Hilborn, an outspoken skeptic of large marine protected areas,

said he was really happy with the memo's recommendations.

“It's very clear stocks are subject to directional change and distribution and fluctuating ... higher and lower productivity. It's time to move beyond everything is stationary,” he said.

Given the unpredictability of stock performance, he said, “I'd be concerned if NOAA was to spend a lot of resources to predict what changes will take place. ... It's more important to adapt to the changes that take place.”

SSC member Kurt Schaefer of the Inter-American Tropical Tuna Commission added that trying to determine shifts in species distributions will be a monumental and expensive undertaking.

Even so, NMFS plans to start compiling species distribution information across the nation. “I agree that's a big effort, but that's an important effort,” Karp said.

SSC member Erik Franklin of the University of Hawai'i's School of Ocean and Earth Science and Technology said he was more concerned with potential declines in productivity, and maybe shifts in species composition, as a result of nearshore habitat loss.

He asked Karp whether NMFS was planning to issue a similar memorandum for insular areas. Karp replied that she'd not thought about it, beyond what's already been done in the PIVA.

Marlowe Sabater, the council's marine ecosystem scientist, asked Karp what NMFS's next step will be policy-wise. “Is this something headquarters is going to recommend to each region to start adopting ... for any kind of management decisions?”

Patrick Lynch, also with the service's science and technology office, said Sabater shouldn't expect anything too formal. “We released the tech memo as a guidance framework. ... It's up to the regions to do what they will with these recommendations.”

—T.D.