Protecting the Pacific's endangered marine species using artificial intelligence

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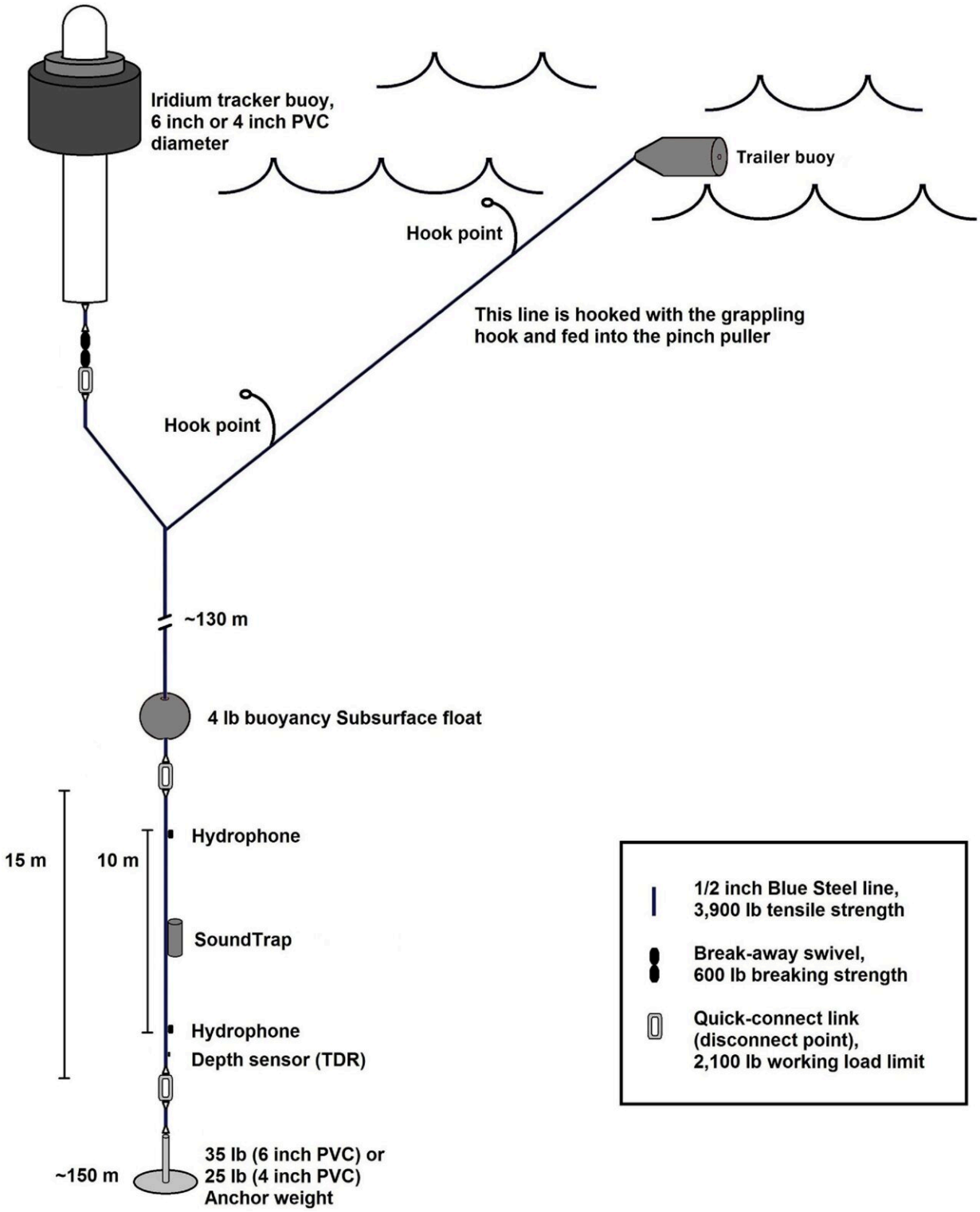

Schematic design of Pacific Island Fisheries Science Center—Drifting Acoustic Spar Buoy Recorder (PIFSC DASBR). Credit: DOI: 10.3389/fmars.2021.664292

The pelagic ocean covers over 50 percent of the planet's surface and many of the species that call it home travel thousands of miles each year, seeking food and suitable nursery grounds. Some of these species end up in your favorite sushi—like Bigeye tuna—while others are some of the most imperiled on the planet, like leatherback sea turtles. Catching one without catching the other has challenged commercial fishers, scientists and fisheries managers to develop innovative solutions.

"In the last several decades, we have seen major improvements to bycatch reduction," said T. Todd Jones, Fisheries Research and Monitoring Division director for the National Oceanic and Atmospheric Administration's Pacific Islands Fisheries Science Center. "We see as much as a 60 to 90 percent reduction in bycatch rates for endangered marine turtles due to gear improvement, for example. The goal is to refine that further."

Recent efforts by UF/IFAS researchers attempt to do just that by drawing imaginary lines in the vast, open ocean, a seemingly impossible task. But using artificial intelligence, scientists are making progress toward protecting endangered species that are not meant to be caught.

Building on his species-distribution modeling expertise developed as a doctoral student, Zachary Siders, a UF/IFAS assistant research scientist, developed a new AI application. It estimates locations of endangered species where fisheries operate. This information helps commercial fishers avoid fishing those areas. It also helps managers explore whether to incentivize fishing avoidance through regulation.

Commercial fishing vessels provide wild-caught fish to consumers. Fishing in federal waters and the high-seas is managed through cooperation between NOAA and the region's fisheries management

council. Strict regulations determine how many unintended animals, called bycatch, can be caught by fishers.

For the commercial pelagic longline fisheries operating from Hawaii, the primary target species are Bigeye tuna and swordfish. However, sometimes endangered species are incidentally caught. For these species, every animal can make a difference to the population's survival.

"Catching our own fish means that we have better control over the supply chain, can hold our fisheries to higher standards, manage them sustainably, and, generally, get a better product on the shelf," said Siders. "One of the biggest hurdles facing the Hawaii pelagic fisheries is the struggle between fishing enough to remain operating and profitable, and preventing protected species interactions. Whether you like seafood or love sea turtles, whales, dolphins and sharks, finding innovative ways to sustainably manage off-shore fisheries is essential for their continued operation and for reducing impacts on protected species."

The rarity of endangered species bycatch posed a tough challenge for using existing machine-learning algorithms—a type of artificial intelligence—that traditionally rely on big data to accurately predict areas of the ocean these animals prefer. While scientists and fishers know about thousands of locations where endangered species have not been caught, only a few hundred instances hold the information to what habitats endangered species like to use.

UF/IFAS researchers took an ensemble approach, blending predictions over many AI models, to make the most of the few instances of endangered species bycatch. The development and testing of this ensemble AI approach was published in the journal *Endangered Species Research* in late 2020.

"This project provides a tool to inform ecosystem-based fishery

management for the Hawaii longline fishery, which produces more than 80 percent of U.S.-caught bigeye tuna and about half of U.S.-caught swordfish," said Asuka Ishizaki, protected species coordinator for the Western Pacific Regional Fisheries Management Council, one of the primary funding partners of the project.

"This work helps fisheries become more efficient," Jones said. "Less time on the water, less time with hooks in the water and fewer overall hooks in the water all make a positive impact on the environment including to the carbon footprint. It's a success for everyone."

Applications of the UF/IFAS AI model have provided valuable information that guides conservation and management efforts for several species listed on the Endangered Species Act. Those include leatherback sea turtles, giant manta rays, oceanic whitetip sharks, and species such as the striped marlin where overfishing is taking place.

Recently, NOAA and UF/IFAS researchers applied the AI approach to define the habitat preferences of rare and cryptic beaked whale species in the Mariana Islands; published in *Frontiers in Marine Science*.

"One of the unique parts of the collaboration is that UF/IFAS is taking fisheries sciences into the future, NOAA has the data and the questions that need answered," Jones said. "Merging our big data sets and our understanding of fisheries science management issues with UF/IFAS' modeling and quantitative skillset—that's where the magic happens. Neither of us could do it on our own."

"This project began as one initial question and grew exponentially," Jones said. "This started due to the Fishery Council's concerns for sea turtles in a deep-set fishery after catch rates increased. Fast forward three years later, and we have a multispecies ecosystem-based fisheries management approach looking at target and non-target catch

improvement."

Recently, the UF/IFAS and NOAA collaboration was renewed with a multi-year award that funds the research through 2025. This next phase of the collaboration will aim to provide insight into the future of endangered species populations.

"If we could merge all the data we have into one platform, this would provide a gold standard for evaluating how well we are managing endangered species and impacts to their populations," Siders said.

Siders notes that this experience has inspired him to answer research questions that "move the needle." Even if that sometimes means identifying what does not work.

"AI is not a silver bullet to all of our problems," he said. "We have to keep in the front of our minds that the decisions we allow an AI system to make have real consequences for livelihoods of the fishing industry as well as irreplaceable species."

More information: Jennifer L. K. McCullough et al, An Acoustic Survey of Beaked Whales and Kogia spp. in the Mariana Archipelago Using Drifting Recorders, *Frontiers in Marine Science* (2021). DOI: 10.3389/fmars.2021.664292

ZA Siders et al, Ensemble Random Forests as a tool for modeling rare occurrences, *Endangered Species Research* (2020). DOI: 10.3354/esr01060

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