Development Story Of An Innovative Device To Mitigate Depredation

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Background
Depredation is defined as the damage or removal of fish or bait from fishing gear by predators. The Reunion Island pelagic longline fishery targeting tuna and swordfish is particularly impacted by toothed whale depredation. This issue can lead to substantial economic loss for fishers and raise conservation concerns for the involved predators. So far, various depredation mitigation techniques were tested, including acoustic and operational ones. However, none of them was identified as effective in the long-term.

Method
To prevent depredation on pelagic longlines, captured fish have to be protected as soon as they are hooked. Field observations suggest that fish entangled with fishing gear are less likely to be depredated because toothed whales may associate tangled device with danger. Physically protecting the fish may therefore be a solution to depredation. The PARADEP project intends to develop a depredation mitigation device designed to protect the fish. It is made of two protection nets simulating a cast net wrapping the capture. Nets are stored inside a case attached on top of each branchline. The device is triggered when biting. The fish pulls on the branchline, the case unlocks, the cast net is released, slides down towards the captured fish and covers it to create a physical and visual barrier.
Five versions of the device were designed since the beginning of the project. Various case designs and net materials were tested, until validation of the final prototype. For each version, a few prototypes were tested by divers in shallow waters to have a close look at their behaviour, the net deployment and the case usability.
Experimental branchlines were deployed, with a device attached on top of each of them and a dummy simulating a fish on the other extremity. Diver #1 pulled on the branchline to simulate a capture and to trigger the device. Diver #2 recorded a close up shot of the device triggering and followed the descent of the cast net along the branchline. Diver #3 recorded a wide shot of the whole experiment. Data related to the device behaviour was collected and analysed when viewing the recorded shots: case handling, safety of use, net deployment, useful volume, size and weight… This experimental step is essential before validating and mass producing the device for trials onboard professional longliners.

Results
Devices #1 and #2 were made up of 4 linen veils stored inside a metallic case. Similar issues were observed for both devices: they were too heavy and too big (14*9*9 cm and 600g for the parallelepipedal device #1, 16*8.5cm and 690g for the cylindrical device #2), several entanglement issues were observed and linen was not

suitable for use in marine environment.
Device #3 was designed with a monofilament net stored inside a metallic case. This version raised similar issues: the case dimension was not optimal (18*16cm and 325g) and the monofilament net got entangled with the case, deployed badly, was stretchy and did not hide the capture.
Device #4 was designed with a HDPE (High-Density PolyEthylene) net, a cheap, resistant and rotproof material. The case design was modified and a rectangular carabiner was used as both the net attachment and the triggering system. However, the net behaviour was still an important issue. The HDPE net was too bulky and too rigid, it did not come out of the case easily and did not deploy as expected. The use of a carabiner met some of our expectations, but its rectangular design increased entanglement issues. Finally, the device size and dimension decreased, but were not optimal yet (17*7*8cm and 550g).
Device #5 was designed with the previous case, but a HDPE net with a lower density was tested and a circular carabiner was developed to prevent entanglements. Better results were observed with the circular carabiner, but the net deployment was still disappointing. The weight of the device was improved (420g). However, the case handling and the safety of use were not satisfying, a recurring issue for all five devices.
After having considered 15 different net materials and 5 case designs, the net providing the best trade-off between volume, deployment and coverage skills was eventually obtained: a low-density polyester net reducing the useful volume by more than half (compared to the previous net materials tested). The decrease of the cast net volume allowed a drastic reduction of the case dimension. The final device (device #6) is now designed as a plastic cylindric case of 5 cm in height and an external diameter of 8 cm, allowing an essential optimization of its ergonomic regarding both handling and safety of use.

Conclusion

This three-year story was extremely instructive to come up with the development process of an innovation for end-user. Whatever the materials to be used, whatever functioning mechanisms to be involved in relation to the goal of the innovation, the group to be contacted in the first place is end-user, fishers in our case. They must be the first ones to express their feelings about the design of an innovation aiming to reach a given goal, depredation mitigation in our case. The constraints raised by fishers will be paramount to shape the first model of the innovation. The choices of both materials and mechanisms will be decided afterwards as plenty of solutions will be available to satisfy motivations (economy, environment, ecology and conservation, consumers).