PHOTO DIARY

Conserving Rockfishes: Barotrauma and Descending Devices in the Northeast Pacific

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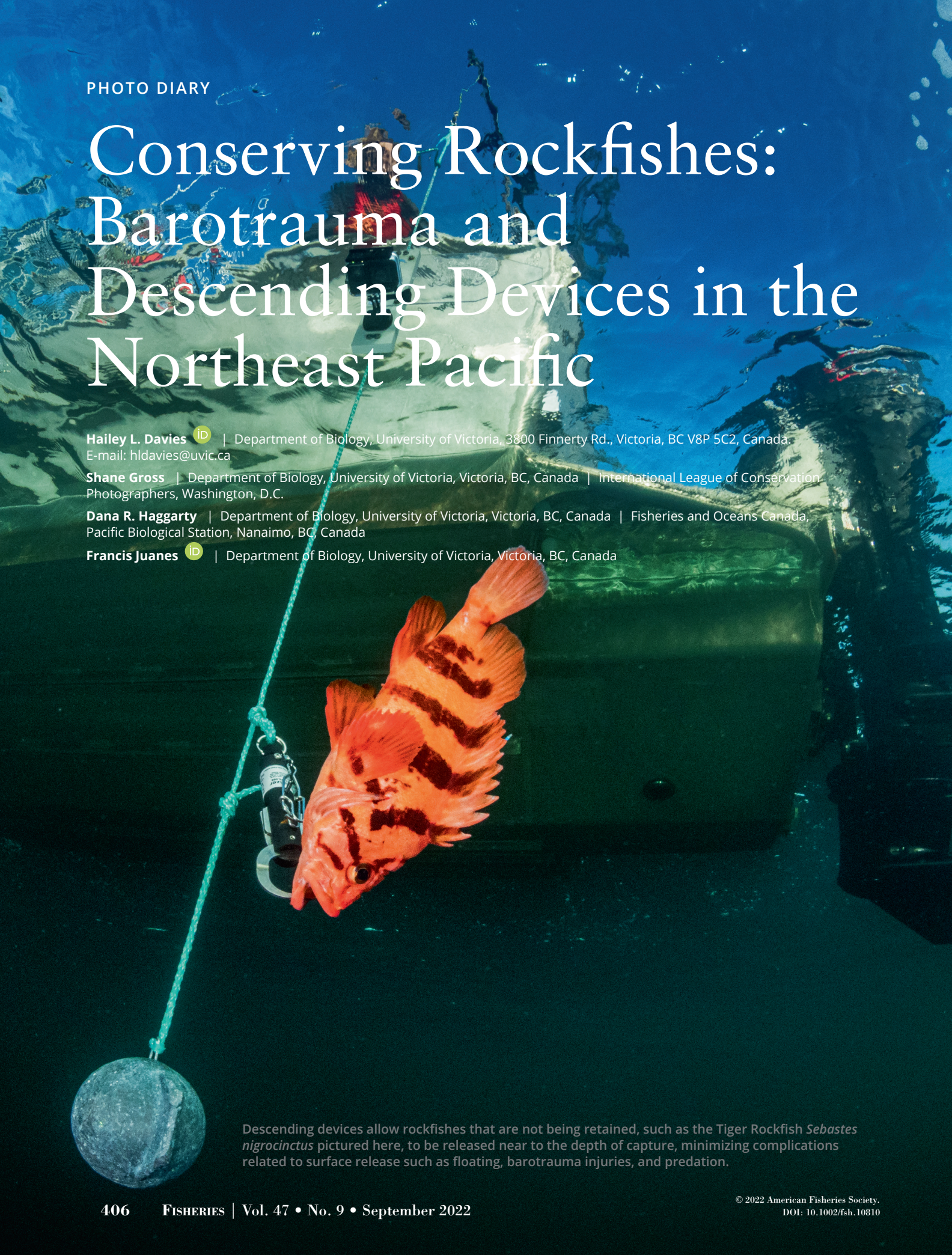

Descending devices allow rockfishes that are not being retained, such as the Tiger Rockfish *Sebastes nigrocinctus* pictured here, to be released near to the depth of capture, minimizing complications related to surface release such as floating, barotrauma injuries, and predation.

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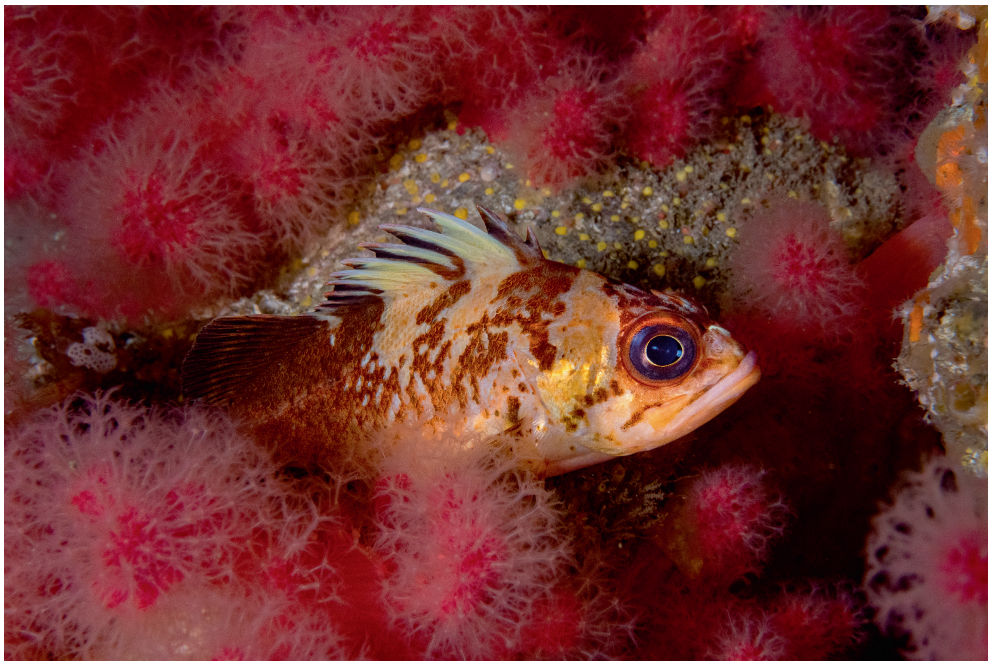


A juvenile Quillback Rockfish *Sebastes maliger* nestles among red soft coral *Gersemia rubiformis*. Substrate and habitat are very important to rockfishes of all life stages, particularly juveniles.

A Yelloweye Rockfish *Sebastes ruberrimus* captured using a hook and line exhibits external barotrauma symptoms including esophageal eversion, or a protruding esophagus, caused by the anterior expansion of gas in the swim bladder during rapid ascent which rolls the esophagus out of the fish's mouth. It is a common mistake for anglers to assume that this is the swim bladder protruding from the mouth, and detrimentally puncture the esophagus through their effort to vent the built-up gas. Pop eye (exophthalmia) is also highly visible.

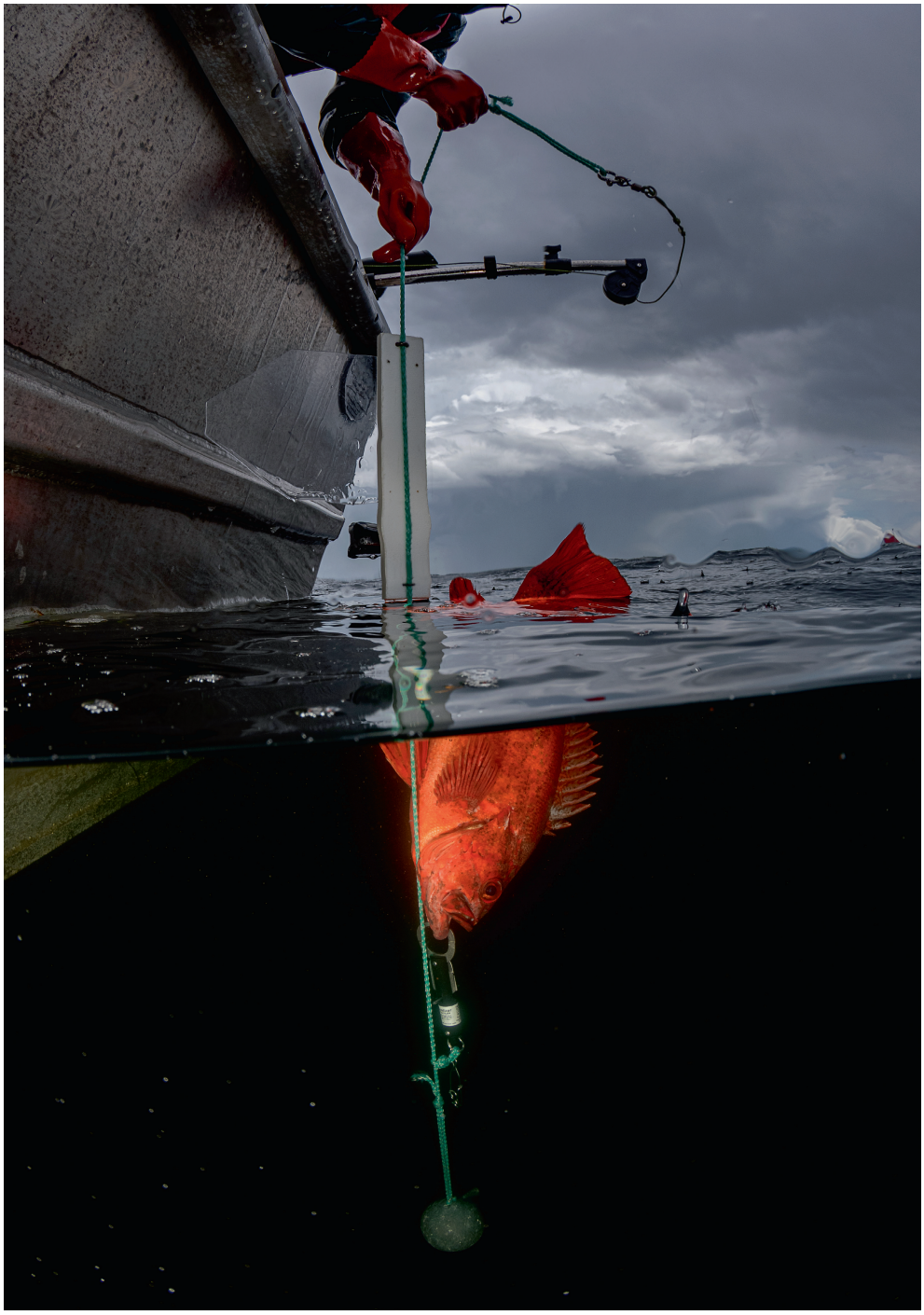
Rockfishes (*Sebastes* spp.) are a diverse group of fish in the order Scorpaeniformes that are distributed globally but concentrated in the North Pacific. Recognizable by their large eyes and distinct dorsal spines, the genus is united by shared characteristics including live births, head spines, a highly spinous dorsal fin succeeded by a soft-rayed portion, and musculature attached to a closed (physoclistous) swim bladder. Despite these similarities, there is an astonishing amount of morphological variation among species including highly streamlined bodies for active schooling in midwater environments and thick, heavily spined bodies for more sedentary, benthic lifestyles. Rockfishes can be found from extremely deep slope environments to shallow inshore rocky bottoms and favor complex substrates, including crevices and kelp

Rockfish eyes are often affected by barotrauma, including pop eye (exophthalmia), and bubbles within the eye (ocular emphysema), as shown in the left eye of this Quillback Rockfish *Sebastes maliger* (right side of photograph). Our field observations have revealed that these symptoms are not always symmetrical, and the presentation of ocular emphysema can be delayed.

Gas bubbles and bulging membrane are highly visible in the branchiostegal region (including the throat and gill coverings or opercula) of this Quillback Rockfish *Sebastes maliger*, just brought to the surface. Since these symptoms are exhibited on the underside of the rockfish and are not often fully exposed, they may go unnoticed by anglers. We observed that Quillback Rockfish often release gas bubbles from around the operculum when being brought to the surface, indicating that some gas may escape through membranes in this region.

forests. Whatever their preferred habitat, they tend to remain close to small home ranges throughout their relatively long lives; most rockfish species are late-maturing, and some can even live for hundreds of years. It is the older, larger females that contribute the most to population growth, although these individuals have become much less common due to decades of intense fishing pressure.

The establishment of industrial fishing methods has led to devastating declines in most rockfish populations along the northeastern Pacific coast, resulting in many species



A Vermilion Rockfish *Sebastes miniatus* is slowly lowered over the side of a small research vessel into the stormy Salish Sea and will be released at depth using the descending device attached to its lower lip, with the depth setting closest to that of the capture depth. Above it, a small camera has been set up to record the descent and release.

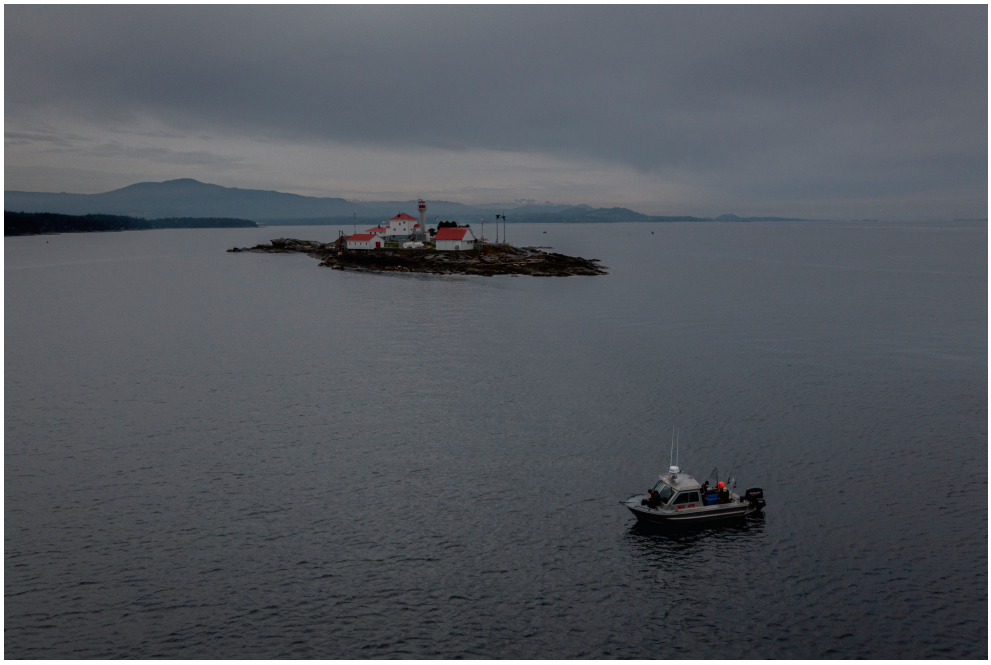
becoming threatened or endangered. In response, a network of Rockfish Conservation Areas (RCAs) was implemented in British Columbia (BC), prohibiting groundfish fishing in selected regions with suitable rockfish habitat. In addition to designating RCAs, Fisheries and Oceans Canada (DFO) applied inshore rockfish conservation measures such as increased catch accountability (including bycatch and discards), improved stock assessment techniques, and strategies to decrease angler-induced fishing mortality. Despite these efforts, many overfished rockfish populations have not recovered. The life history, reproductive, and physiological characteristics of rockfishes make them extremely susceptible to fishing pressure, particularly their closed swim bladders, which contribute substantially to high post-release mortality.

Rockfish swim bladders function in both buoyancy control and sound production. Since there is no external connection to

University of Victoria and Fisheries and Oceans Canada (DFO) researchers performing a mark–recapture study to investigate the long-term impacts of descending devices on rockfish survival. Top: A Copper Rockfish *Sebastes caurinus* has just been tagged and will soon be released using a descending device. Bottom: A tagged Yelloweye Rockfish *S. ruberrimus* will be attached to a descending device and released, following the collection of valuable data including depth of capture, length, and external barotrauma symptoms.

allow for uptake and release of gases, they are limited to gradual adjustments in buoyancy that are controlled by the passive diffusion of gases into and out of the bloodstream and the surrounding water through the gills. While this is a functional mechanism for typical in situ depth adjustments, problems arise when rockfishes are captured, inevitably subjecting them to a rapid change in pressure as they are brought to the surface. When gas enclosed in a swim bladder is brought from high pressure (deep water) to low pressure (shallow water), expansion occurs, causing decompression injuries referred to as barotrauma.

External symptoms of barotrauma include those easily noticeable by anglers: an extended esophagus (esophageal eversion), which can roll out of the mouth and is commonly mistaken for the swim bladder, as well as bulging eyes (pop eye or exophthalmia). Less obvious external signs include a tight or swollen abdomen, bulging branchiostegal membrane (near the throat and operculum), and gas bubbles within the branchiostegal membrane and eyes (membrane and ocular emphysema, respectively). Internal damage can also occur in the form of tears, ruptures and hemorrhaging of various



This field work was conducted on a small research vessel in the Salish Sea, off the coast of Nanaimo, British Columbia, Canada, where an impressive diversity of rockfish species can be found.

internal organs. Many of these barotraumatic injuries can be subtle and may go unseen when rockfish discards are released by anglers. In addition to physiological injuries from barotrauma, released rockfishes are sometimes unable to recompress and return to depth, causing them to float at the surface and contend with temperature shock as well as seabird and marine mammal predation. Consequently, a catch-and-release approach is ineffective at reducing mortality rates of most rockfish species, and valid management strategies such as RCAs and bycatch records need to consider both mortality and sublethal effects of barotrauma to be effective.

In recent years, deepwater release mechanisms (DRMs) such as descending devices are becoming more widely used in the recreational angling community as a method of recompressing rockfishes and increasing survival rates following capture and release. Weighted, inverted hooks, inverted milk crates, and commercially available descending devices are the main types of DRMs currently in use. Various U.S. jurisdictions have recommended or required the use of DRMs to release rockfishes that cannot be retained, and DFO introduced this condition of license in 2019. Despite these novel requirements, compliance rates remain unknown in many regions. Additionally, while DRMs may increase survival of some species as compared to near certain mortality from surface release, the degree to which survivorship may be bolstered is unknown. Since morphology can vary so widely among species, severity and symptoms of barotrauma can differ as well, therefore, species-specific research cannot always be extrapolated to the entire genus. While studies have been done on the short-term survival of many species, investigations of long-term effects (i.e., months, years) are very limited, and significant research gaps exist for species in BC.

The Salish Sea, encompassing the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound, is an ideal location to study the effects of barotrauma on rockfishes. This temperate coastal region is home to vast amounts of preferred rockfish habitat, including rocky outcrops and kelp forests, as well as an active groundfish angling community. The Strait of Georgia off the coast of BC features an incredible diversity of 41 species of rockfishes. Rockfishes are valued and at risk to such an extent that they are one of the few groups of organisms to have their own protected regions in BC, many of which exist in the Salish Sea. Despite this, several local species are still threatened or endangered and showing few signs of recovery, highlighting an urgent need to explore further conservation efforts.

We embarked on a field study to investigate the long-term effectiveness of descending devices at increasing rockfish survival, and the differences in barotrauma between species. Using hook-and-line methods on a reef off the coast of Nanaimo, BC, we captured inshore rockfishes from a small aluminum vessel. Location, time, and depth of capture were recorded, and each rockfish was assessed for six external signs of barotrauma before being released using a SeaQualizer descending device. In addition to contributing to short-term mortality, barotrauma injuries might also be affecting the long-term reproduction, foraging, predator evasion, vocalizations, or susceptibility to disease of released rockfishes. To address this, each fish was externally tagged with the goal of collecting encounter histories months or even years later using mark–recapture techniques. To assess predation on the released rockfishes, we monitored the descents using a downward facing camera positioned above the fish. A collaborative effort between the University of Victoria, DFO, Ball State University, and The Angler's Atlas, we hope that this work positively impacts local rockfish conservation efforts and helps to preserve these critical species along the Pacific coast for generations to come.

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