Barotrauma effects in rockfish

(Brill et al. 2008; Hannah and Matteson 2007; Hannah et al. 2008a; Hannah et al. 2008b; Jarvis and Lowe 2008; Pribyl et al. 2011; Pribyl et al. 2009; Rogers et al. 2008)

Brill, R., C. Magel, M. Davis, R. Hannah, and P. Rankin. 2008. Effects of rapid decompression and exposure to bright light on visual function in black rockfish (Sebastes melanops) and Pacific halibut (Hippoglossus stenolepis). Fishery Bulletin 106(4):427-437.

Demersal Fishes hauled up from depth experience rapid decompression. In physoclists, this can cause overexpansion of the swim bladder and resultant injuries to multiple organs (barotrauma), including severe exophthalmia ("pop-eye"). Before release, fishes can also be subjected to asphyxia and exposure to direct sunlight. Little is known, however, about possible sensory deficits resulting from the events accompanying capture. To address this issue, electroretinography was used to measure the changes in retinal light sensitivity, flicker fusion frequency, and spectral sensitivity in black rockfish (Sebastes melanops) subjected to rapid decompression (from 4 atmospheres absolute [ATA] to 1 ATA) and Pacific halibut (Hippoglossus stenolepis) exposed to 15 minutes of simulated sunlight. Rapid decompression had no measurable influence on retinal function in black rockfish. In contrast, exposure to bright light significantly reduced retinal light sensitivity of Pacific halibut, predominately by affecting the photopigment which absorbs the green wavelengths of light (approximate to 520-580 nm) most strongly. This detriment is likely to have severe consequences for postrelease foraging success in green-wavelength-dominated coastal waters. The visual system of Pacific halibut has characteristics typical of species adapted to low light environments, and these characteristics may underlie their vulnerability to injury from exposure to bright light.

Hannah, R. W., and K. M. Matteson. 2007. Behavior of nine species of Pacific rockfish after hook-and-line capture, recompression, and release. Transactions of the American Fisheries Society 136(1):24-33.

We evaluated the effect of barotrauma on the behavior of nine species of Pacific rockfish Sebastes spp. after hook-and-line capture and release using a video-equipped underwater release cage. Sampling was conducted across a range of bottom depths (12-194 m), mostly where barotrauma resulting from an expanded swim bladder and gaseous release of dissolved blood gases would be expected. Behavioral impairment from barotrauma was depth related but highly species specific. Increased depth of capture was associated with lower behavioral scores for black rockfish S. melanops, blue rockfish S. mystinus, and yelloweye rockfish S. ruberrimus, but not for canary rockfish S. pinniger. Behaviorally impaired fish showed a decreased ability to maintain vertical orientation and were slower in exiting the release cage. Species differed in the degree of behavioral impairment resulting from barotrauma and in how rapidly behavioral impairment increased with depth of capture. When captured at depths between 40 and 99 m, blue rockfish showed the most serious behavioral impairment, 8 of 18 (44%) failing to swim away at the time of release and simply drifting off in a sideways or upside-down posture. In the same depth range all of the other species sampled showed only moderate behavioral impairment, which is indicative

of some potential for survival after discard by the fishery. Surface observations of the external signs of barotrauma were variable among species and were poor indicators of which species would show behavioral impairment upon release at depth. Within individual species, however, the external signs of barotrauma were associated with an increased probability of behavioral impairment at time of release.

Hannah, R. W., S. J. Parker, and K. M. Matteson. 2008a. Escaping the surface: The effect of capture depth on submergence success of surface-released Pacific rockfish. North American Journal of Fisheries Management 28(3):694-700.

We evaluated the effect of capture depth and fish size on the ability of several Pacific rockfishes Sebastes spp. to resubmerge after hook-and-line capture and surface release. We observed fish as they were released into a bottomless floating enclosure, and we recorded submergence success within a 5-min time limit. Submergence success was greater than 80% for all rockfish captured in depths less than 30 in. Yellowtail rockfish S. flavidus (N = 51) were 100% successful at submerging in less than 49 s at all depths sampled (10-51 m). At capture depths of 40-51 m, submergence success was 89% for quillback rockfish S. maliger (N = 9), 65% for black rockfish S. melanops (N = 46), and 30% for canary rockfish S. pinniger (N = 40). At depths of 30-51 m, submergence success was 32% for blue rockfish S. mystinus (N = 31). The external signs of barotrauma (e.g., exopthalmia, eversion of the esophagus) increased with depth of capture and were least prevalent in yellowtail rockfish and quillback rockfish. The presence of severe esophageal eversion (beyond the buccal cavity) was strongly negatively associated with submergence success for several species ($P < 0.01$). At 40-51-m capture depths, the frequency of severe esophageal eversion by species was correlated with the frequency of submergence failure ($P < 0.05$). Logistic regression showed a negative relationship between depth of capture and submergence success for black rockfish ($P < 0.001$), blue rockfish ($P < 0.001$), and canary rockfish ($P < 0.05$). Larger body length negatively influenced submergence success only in blue rockfish ($P < 0.05$).

Hannah, R. W., P. S. Rankin, A. N. Penny, and S. J. Parker. 2008b. Physical model of the development of external signs of barotrauma in Pacific rockfish. Aquatic Biology 3(3):291-296.

Four species of Sebastes (Pacific rockfish) showed evidence of a wide array of internal injuries from capture-induced barotrauma, including liver and swimbladder damage, organ displacement related to esophageal eversion, and hemorrhage in the pericardium and abdominal cavity. However, clear evidence of swimbladder rupture was not observed in all fish with external signs of barotrauma. Injection of air through the body wall into the swimbladders of rockfish carcasses generated all of the common external signs of barotrauma documented in wild-captured fish, suggesting that the physical effects of swimbladder gas expansion can create these gross external signs without embolism from dissolved blood gases. Dissections of injected black rockfish S. melanops carcasses showed that, typically, injected air escaped the swimbladder without obvious rupture, moving in an anterio-dorsal direction, generating bulges and air bubbles that were externally visible through the branchiostegal membrane. Injected air also collected dorsally to the esophagus, posterior to the pharyngeal teeth, causing the esophagus to roll outwards into the buccal cavity (esophageal eversion). Injected air also frequently traveled further forward, collecting medially to the eyeball, leading to exophthalmia, and then moved distally along the fascia, invading the corneal stroma from the edges, resulting in corneal emphysemas. Air injected into the swimbladders of quillback rockfish S. maliger carcasses generated similar eye effects, but also escaped through ruptures in the branchiostegal membrane and did not generate esophageal eversion, which is also infrequent in wild-caught specimens. These results demonstrate that the major external signs of barotrauma in Pacific rockfish can develop as result of escaping swimbladder gases following an internal 'path of least resistance'.

Jarvis, E. T., and C. G. Lowe. 2008. The effects of barotrauma on the catch-and-release survival of southern California nearshore and shelf rockfish (Scorpaenidae, Sebastes spp.). Canadian Journal of Fisheries and Aquatic Sciences 65(07):1286-1296.

Two experiments were used to assess the effects of barotrauma on initial capture survival and short-term postrecompression survival of line-caught (range 18-225 m) southern California rockfish (Sebastes spp.). Occurrence of external and internal signs of barotrauma was characterized across all species. Despite species-specific differences in the extent of barotrauma observed, initial capture survival of rockfish held in a live well for a 10-min period following capture was 68% overall (19 species, n = 168). Overall 2-day survival of rockfish following recompression in cages was also 68% (17 species, n = 257). Short-term survival varied across species (range 36% to 82%), as did the occurrence of external signs of barotrauma. The degree of external signs of barotrauma was not a significant predictor of initial capture survival or short-term survival. The most significant predictor of short-term survival was surface holding time, with short-term survival increasing with decreasing surface holding time. These results suggest that rapid recompression of rockfish can significantly decrease discard mortality and could potentially enhance rockfish conservation.Original Abstract: Deux experiences nous ont servi evaluer les effets du barotraumatisme sur la survie initiale a la capture et la survie a court terme apres la recompression de sebastes (Sebastes spp.) du sud de la Californie captures a la ligne (etendue des profondeurs de 18-225 m). Nous avons observe des signes externes et internes de barotraumatisme chez toutes les especes. Malgre des differences specifiques de l'importance du barotraumatisme, la survie initiale a la capture des sebastes gardes dans un vivier pendant 10 min suivant la capture est globalement de 68 % (19 especes, n = 168). La survie globale des sebastes gardes dans des cages pendant 2 jours apres la recompression est aussi de 68 % (17 especes, n = 257). La survie a court terme varie d'une espece a l'autre (etendue de 36 a 82 %), de meme que la presence de signes externes de barotraumatisme. L'importance des signes externes de barotraumatisme ne permet pas de predire avec assurance la survie initiale a la capture, ni la survie a court terme. La variable la plus significative pour predire la survie a court terme est la duree de la retenue du poisson en surface, la survie augmentant en fonction inverse de la duree de la retenue en surface. Ces resultats indiquent qu'une recompression rapide des sebastes peut reduire de facon significative la mortalite lors de leur rejet a la mer et pourrait potentiellement favoriser la conservation des sebastes.

Pribyl, A. L., M. L. Kent, S. J. Parker, and C. B. Schreck. 2011. The response to forced decompression in six species of Pacific rockfish. Transactions of the American Fisheries Society 140(2):374-383.

Abstract Pacific rockfish experience high discard mortality when captured owing to a condition called barotrauma, which is caused by the change in pressure during capture. This condition appears to be species specific at the macroscopic level; however, little is known about the microscopic tissue-level effects of barotrauma. Determining whether tissue-level injuries are also species specific or influenced by factors such as life history and phylogenetic relatedness can improve our management of discard mortality. We evaluated the responses of six species of Pacific rockfish (black rockfish Sebastes melanops, blue rockfish S. mystinus, yellowtail rockfish S. flavidus, quillback rockfish S. maliger, canary rockfish S. pinniger, and yelloweye rockfish S. ruberrimus) captured from varying depths to forced decompression at the histological level (heart ventricle, rete mirabile, head kidney, liver, gill, and eye) as well as the macroscopic level. At the macroscopic level we focused on injuries caused by barotrauma, namely, everted esophaguses, exophthalmia, ocular emphysema, and ruptured swim bladders. Yellowtail and quillback rockfish experienced the fewest macroscopic injuries. Depth of capture influenced the presence of exophthalmia in quillback rockfish and ocular emphysema in quillback and

yelloweye rockfish. Tissue injuries as a result of forced decompression included emphysema in the heart ventricle, emboli in the vessels of the rete mirabile, and emboli in the vessels of the head kidney. No injuries were observed at the histological level in the liver, gill, or eye owing to barotrauma. We could not detect a difference in the tissue-level response to barotrauma among the six species, suggesting that all species are susceptible to high internal gas pressure during forced decompression. Received June 9, 2010; accepted December 18, 2010

Pribyl, A. L., C. B. Schreck, M. L. Kent, and S. J. Parker. 2009. The differential response to decompression in three species of nearshore Pacific rockfish. North American Journal of Fisheries Management 29(5):1479-1486.

In this study, the macroscopic, morphological, and physiological responses to decompression of black rockfish S. melanops, blue rockfish S. mystinus, and yellowtail rockfish S. flavidus, all nearshore species, were investigated. The rockfish were adjusted to 4.5 atmospheres absolute (ATA; 35 m) over a period of 7-10 d in hyperbaric pressure chambers and when neutrally buoyant were rapidly brought to surface pressure in a simulated ascent. They were then examined for barotrauma injury, and the heart ventricle, head kidney, liver, gill, and pseudobranch were collected for histological analysis. We observed more macroscopic barotrauma indicators in black rockfish and blue rockfish than in yellowtail rockfish. Yellowtail rockfish had a low percentage of ruptured swimbladders (25%) compared to black rockfish (80%) and blue rockfish (100%). Histological analysis showed emphysema was present in the heart ventricle of more than one-half of the black rockfish, 11% of the blue rockfish, and none of the yellowtail rockfish. No other tissue had observable injury at the histological level that was attributable to barotrauma. The lack of injury at the tissue level for black, blue, and yellowtail rockfishes decompressed from 4.5 ATA is remarkable.

Rogers, B. L., C. G. Lowe, E. Fernandez-Juricic, and L. R. Frank. 2008. Utilizing magnetic resonance imaging (MRI) to assess the effects of angling-induced barotrauma on rockfish (Sebastes). Canadian Journal of Fisheries and Aquatic Sciences 65(7):1245-1249.

The physical consequences of barotrauma on the economically important rockfish (Sebastes) were evaluated with a novel method using T-2-weighted magnetic resonance imaging (MRI) in combination with image segmentation and analysis. For this pilot study, two fishes were captured on hook-and-line from 100 m, euthanized, and scanned in a 3 Tesla human MRI scanner. Analyses were made on each fish, one exhibiting swim bladder overinflation and exophthalmia and the other showing low to moderate swim bladder overinflation. Air space volumes in the body were quantified using image segmentation techniques that allow definition of individual anatomical regions in the three-dimensional MRIs. The individual exhibiting the most severe signs of barotrauma revealed the first observation of a gas-filled orbital space behind the eyes, which was not observable by gross dissection. Severe exophthalmia resulted in extreme stretching of the optic nerves, which was clearly validated with dissections and not seen in the other individual. Expanding gas from swim bladder overinflation must leak from the swim bladder, rupture the peritoneum, and enter the cranium. This MRI method of evaluating rockfish following rapid decompression is useful for quantifying the magnitude of internal barotrauma associated with decompression and complementing studies on the effects of capture and discard mortality of rockfishes.

Recompression in rockfish

(Hannah and Matteson 2007; Hannah et al. 2008; Hannah et al. 2012; Hochhalter and Reed 2011; Jarvis and Lowe 2008; Parker et al. 2006; Pribyl et al. 2012a; Pribyl et al. 2012b; Rogers et al. 2011)

Blain, Brittany, personal communication. Master's student, University of Alaska-Fairbanks. E-mail: brittanyblain@gmail.com

This work was conducted at the same reef that was used in Hochhalter's yelloweye survival study (also used the same yelloweye tagged in his study). In 2008, 45 yelloweye were tagged in a pilot study, and in 2009, 182 yelloweye were tagged during the mark-recapture study (Hochhalter and Reed 2011). This resulted in a grand total of 227 individual yelloweye tagged on the reef at the end of 2009. Natural mortality, mortality associated with the catch-and-release process, and emigration all likely influenced the number of tagged individuals available in 2010 by some unknown amount. The sex ratio of the tagged individuals was unknown so they were not sure of the exact number of tagged females. Sampling efforts during the egg/lavae carrying season (May 1st - July 15th) in 2010 captured a total of 108 yelloweye, 55 of which were recaptures. Sixteen of the recaptured individuals were sexually mature (>40 cm TL) females; 8 were spent and 8 were gravid. These fish had been at liberty for 330 - 729 days from the time of initial capture and exposure to barotrauma. Larvae from the eight gravid females were analyzed for oil globule volume, lipid content, and protein content. These values were compared to those from 14 newly captured females (no know previous exposure to barotrauma). Brittany found no evidence that barotrauma impacts the reproductive viability of female yelloweye in subsequent years: all 16 recaptured females had successfully gone through gonad development, mating, larval gestation, and, for 8 of them, parturition. She also found no evidence that maternal contribution to larval energetics was compromised by previous exposure to barotrauma; larvae oil globule volumes were similar between those from newly captured females and those from recaptured females.

Hannah, R. W., and K. M. Matteson. 2007. Behavior of nine species of Pacific rockfish after hook-and-line capture, recompression, and release. Transactions of the American Fisheries Society 136(1):24-33.

We evaluated the effect of barotrauma on the behavior of nine species of Pacific rockfish Sebastes spp. after hook-and-line capture and release using a video-equipped underwater release cage. Sampling was conducted across a range of bottom depths (12-194 m), mostly where barotrauma resulting from an expanded swim bladder and gaseous release of dissolved blood gases would be expected. Behavioral impairment from barotrauma was depth related but highly species specific. Increased depth of capture was associated with lower behavioral scores for black rockfish S. melanops, blue rockfish S. mystinus, and yelloweye rockfish S. ruberrimus, but not for canary rockfish S. pinniger. Behaviorally impaired fish showed a decreased ability to maintain vertical orientation and were slower in exiting the release cage. Species differed in the degree of behavioral impairment resulting from barotrauma and in how rapidly behavioral impairment increased with depth of capture. When captured at depths between 40 and 99 m, blue rockfish showed the most serious behavioral impairment, 8 of 18 (44%) failing to swim away at the time of release and simply drifting off in a sideways or upside-down posture. In the same depth range all of the other species sampled showed only moderate behavioral impairment, which is indicative of some potential for survival after discard by the fishery. Surface observations of the external signs of barotrauma were variable among species and were poor indicators of which species would show behavioral impairment upon release at depth. Within individual species, however, the external signs of barotrauma were associated with an increased probability of behavioral impairment at time of release.

Hannah, R. W., S. J. Parker, and K. M. Matteson. 2008. Escaping the surface: The effect of capture depth on submergence success of surface-released Pacific rockfish. North American Journal of Fisheries Management 28(3):694-700.

We evaluated the effect of capture depth and fish size on the ability of several Pacific rockfishes Sebastes spp. to resubmerge after hook-and-line capture and surface release. We observed fish as they were released into a bottomless floating enclosure, and we recorded submergence success within a 5-min time limit. Submergence success was greater than 80% for all rockfish captured in depths less than 30 in. Yellowtail rockfish S. flavidus (N = 51) were 100% successful at submerging in less than 49 s at all depths sampled (10-51 m). At capture depths of 40-51 m, submergence success was 89% for quillback rockfish S. maliger (N = 9), 65% for black rockfish S. melanops (N = 46), and 30% for canary rockfish S. pinniger (N = 40). At depths of 30-51 m, submergence success was 32% for blue rockfish S. mystinus (N = 31). The external signs of barotrauma (e.g., exopthalmia, eversion of the esophagus) increased with depth of capture and were least prevalent in yellowtail rockfish and quillback rockfish. The presence of severe esophageal eversion (beyond the buccal cavity) was strongly negatively associated with submergence success for several species ($P < 0.01$). At 40-51-m capture depths, the frequency of severe esophageal eversion by species was correlated with the frequency of submergence failure ($P < 0.05$). Logistic regression showed a negative relationship between depth of capture and submergence success for black rockfish ($P < 0.001$), blue rockfish ($P < 0.001$), and canary rockfish ($P < 0.05$). Larger body length negatively influenced submergence success only in blue rockfish ($P < 0.05$).

Hannah, R. W., P. S. Rankin, and M. T. O. Blume. 2012. Use of a Novel Cage System to Measure Postrecompression Survival of Northeast Pacific Rockfish. Marine and Coastal Fisheries 4(1):46-56.

We used a caging system designed to minimize the adverse effects of caging fish in marine waters to evaluate the discard mortality of seven species of rockfish Sebastes with barotrauma. Altogether, 288 rockfish were captured, scored for barotrauma, evaluated behaviorally at the surface, and caged individually on the seafloor for 48 h to determine survival. With the exception of three blue rockfish S. mystinus, the condition of surviving fish after cage confinement from 41 to 71 h was excellent. At capture depths up to 54 m, survival was 100% for yelloweye rockfish S. ruberrimus (n = 25) and copper rockfish S. caurinus (n = 10) and 78% for blue rockfish (n = 36). At capture depths up to 64 m, survival was 100% for canary rockfish S. pinniger (n = 41) and quillback rockfish S. maliger (n = 28) and 90% for black rockfish S. melanops (n = 144). Black rockfish survival was negatively associated with capture depth (m) and the surface?bottom temperature differential (°C). Blue rockfish survival was negatively associated with capture depth. Barotrauma signs and surface behavior scores were not good indicators of survival potential across species but were useful within species. In black and blue rockfish, severe barotrauma was negatively associated with survival, while higher scores on reflex behaviors at the surface were positively associated with survival. The high survival rates and excellent condition of some species in this study suggest that requiring hook-and-line fishers to use recompression devices to help discarded rockfish return to depth may increase survival for some species. Received April 14, 2011; accepted July 30, 2011

Hochhalter, S. J., and D. J. Reed. 2011. The effectiveness of deepwater release at improving the survival of discarded yelloweye rockfish. North American Journal of Fisheries Management 31(5):852-860.

The effectiveness of deepwater release at improving the 17-d survival of discarded yelloweye rockfish Sebastes ruberrimus was determined by comparing an estimate of survival for individuals released at depth with an estimate of submergence probability for individuals released at the water's surface. A mark-recapture study was used to generate a maximum likelihood estimate of the 17-d survival

probability of yelloweye rockfish (n = 182) caught by hook and line (depth = 18-72 m) and subsequently released at depth. The average Cormack-Jolly-Seber survival probability for yelloweye rockfish released at depth was remarkably high (0.988; 95% confidence interval = 0.478-0.999) and positively correlated with individual total length. Survival probability was not significantly influenced by the range of capture depths explored in this study or by exposure to barotrauma and other capture stressors. The submergence success of yelloweye rockfish released at the water's surface was 0.221 (95% confidence interval = 0.149-0.315), suggesting that the maximum survival potential of individuals released at the surface is low. The results of this study indicate that the average survival of discarded yelloweye rockfish can be substantially improved by deepwater release. Received March 25, 2011; accepted June 22, 2011

Jarvis, E. T., and C. G. Lowe. 2008. The effects of barotrauma on the catch-and-release survival of southern California nearshore and shelf rockfish (Scorpaenidae, Sebastes spp.). Canadian Journal of Fisheries and Aquatic Sciences 65(07):1286-1296.

Two experiments were used to assess the effects of barotrauma on initial capture survival and short-term postrecompression survival of line-caught (range 18-225 m) southern California rockfish (Sebastes spp.). Occurrence of external and internal signs of barotrauma was characterized across all species. Despite species-specific differences in the extent of barotrauma observed, initial capture survival of rockfish held in a live well for a 10-min period following capture was 68% overall (19 species, n = 168). Overall 2-day survival of rockfish following recompression in cages was also 68% (17 species, n = 257). Short-term survival varied across species (range 36% to 82%), as did the occurrence of external signs of barotrauma. The degree of external signs of barotrauma was not a significant predictor of initial capture survival or short-term survival. The most significant predictor of short-term survival was surface holding time, with short-term survival increasing with decreasing surface holding time. These results suggest that rapid recompression of rockfish can significantly decrease discard mortality and could potentially enhance rockfish conservation.Original Abstract: Deux experiences nous ont servi evaluer les effets du barotraumatisme sur la survie initiale a la capture et la survie a court terme apres la recompression de sebastes (Sebastes spp.) du sud de la Californie captures a la ligne (etendue des profondeurs de 18-225 m). Nous avons observe des signes externes et internes de barotraumatisme chez toutes les especes. Malgre des differences specifiques de l'importance du barotraumatisme, la survie initiale a la capture des sebastes gardes dans un vivier pendant 10 min suivant la capture est globalement de 68 % (19 especes, n = 168). La survie globale des sebastes gardes dans des cages pendant 2 jours apres la recompression est aussi de 68 % (17 especes, n = 257). La survie a court terme varie d'une espece a l'autre (etendue de 36 a 82 %), de meme que la presence de signes externes de barotraumatisme. L'importance des signes externes de barotraumatisme ne permet pas de predire avec assurance la survie initiale a la capture, ni la survie a court terme. La variable la plus significative pour predire la survie a court terme est la duree de la retenue du poisson en surface, la survie augmentant en fonction inverse de la duree de la retenue en surface. Ces resultats indiquent qu'une recompression rapide des sebastes peut reduire de facon significative la mortalite lors de leur rejet a la mer et pourrait potentiellement favoriser la conservation des sebastes.

Parker, S. J., H. I. McElderry, P. S. Rankin, and R. W. Hannah. 2006. Buoyancy regulation and barotrauma in two species of nearshore rockfish. Transactions of the American Fisheries Society 135(5):1213-1223.

Fishes with closed swim bladders regulate buoyancy during depth changes by secreting and resorbing swim bladder gases. Forced ascent during fishery capture results in barotrauma caused by rapid expansion and exsolution of gases from body fluids. Pressure changes in hyperbaric chambers were used to examine changes in swim bladder integrity and acclimation rates in two ecologically different, yet congeneric, species: black rockfish Sebastes melanops and China rockfish S. nebulosus. We also

conducted simulated-capture experiments to investigate the relationship between capture in a fishery, barotrauma from pressure change, and survival after release. Black rockfish acclimated faster than China rockfish to both increases and decreases in pressure, but both species were much slower to acclimate than other physoclists, such as Atlantic cod Gadus morhua. Black rockfish required up to 48 h to acclimate from 4 atmospheres absolute (ATA; depth equivalent of 30 in) to surface pressure and required up to 168 h to become neutrally buoyant at 4 ATA after starting from surface pressure. In contrast, China rockfish required over 250 h to become neutrally buoyant at 4 ATA after starting from surface pressure. All black rockfish exposed to a 3-ATA decrease in pressure during simulated capture had ruptured swim bladders. However, mortality from simulated capture and subsequent recompression was low; only 3.3 +/- 1.7% (mean +/- SE) mortality was observed after 21 d. In experiments with black rockfish, rapid recompression reversed visible barotrauma, suggesting that a quick return to depth could be used to minimize mortality of discarded black rockfish in nearshore fisheries.

Pribyl, A. L., C. B. Schreck, M. L. Kent, K. M. Kelley, and S. J. Parker. 2012a. Recovery potential of black rockfish, Sebastes melanops Girard, recompressed following barotrauma. Journal of Fish Diseases 35(4):275-286.

Overfished species of rockfish, Sebastes spp., from the Northeast Pacific experience high bycatch mortality because of 'barotrauma', a condition induced from the rapid change in pressure during capture. Field experiments show that it may be possible for rockfish to recover from barotrauma if quickly recompressed; however, no work has followed the physiological recovery of rockfish after recompression or determined whether it is possible for rockfish to survive barotrauma in the long term. Barotrauma was induced in adult black rockfish, Sebastes melanops Girard, from a simulated depth of 35 m, followed by recompression. Blood and selected tissues (eye, heart ventricle, head kidney, liver, rete mirabile and gonad) were sampled at days 3, 15 and 31 post-recompression to evaluate the tissue- and physiologic-level response during recovery. No mortality from barotrauma occurred during the experiments, and feeding resumed in 80% of both treatment and control fish. The primary injury in treatment fish was the presence of a ruptured swimbladder and/or a ruptured tunica externa (outer layer of swimbladder), which was slow to heal. Blood plasma was analysed for glucose, sodium, chloride, potassium, calcium, phosphorus, insulin-like growth factor-1 and cortisol. Plasma analyses indicated no strong effects because of barotrauma, suggesting overall handling stress outweighed any effect from barotrauma. Rockfish with ruptured swimbladders may face compromised competency in the wild; however, it appears the majority of black rockfish decompressed from 35 m have a high potential for recovery if recompressed immediately after capture. This research suggests recompression could be a valuable bycatch mortality reduction tool for rockfish in recreational fisheries.

Pribyl, A. L., C. B. Schreck, S. J. Parker, and V. M. Weis. 2012b. Identification of biomarkers indicative of barotrauma and recovery in black rockfish Sebastes melanops. Journal of Fish Biology doi:10.1111/j.1095-8649.2012.03322.x.

A Sebastes-specific complementary DNA (cDNA) microarray was developed to identify potential biomarkers involved in the capture stress and recovery of Sebastes species if they are assisted in returning to their original depth of capture following barotrauma. Black rockfish Sebastes melanops were exposed to simulated decompression from 4·5 atmospheres (ATA) (which resulted in barotrauma) and subsequent recompression. Sebastes melanops were sampled for liver tissue at days 3, 15 and 31 post-barotrauma. Potential candidate genes were identified from the microarray and then quantitative real-time polymerase chain reaction (QRT-PCR) was used to validate expression levels in biological replicates. Six potential biomarkers associated with the innate immune system were identified that were up-regulated in liver tissue at 3 days post-barotrauma: complement

C1q-like protein 2, complement component C3, complement regulatory plasma protein, serum amyloid A-5, c-type lysozyme and hepcidin precursor type I. In addition, complement C1q was correlated to the presence of a ruptured swimbladder, providing further support that this gene may be a good biomarker of injury and recovery. Immune genes were no longer up-regulated at day 31 post-barotrauma, a good indication of recovery in S. melanops.

Rogers, B. L., C. G. Lowe, and E. Fernández-Juricic. 2011. Recovery of visual performance in rosy rockfish (Sebastes rosaceus) following exophthalmia resulting from barotrauma. Fisheries Research 112(1–2):1-7.

Rapid ascent during fishing capture can cause exophthalmia ('pop eye') in physoclistic fishes, resulting in stretching of the optic nerves and extraocular muscles, but it is not known whether exophthalmia affects vision temporarily or permanently. We used the optokinetic reflex test to assess changes in visual performance of rosy rockfish (Sebastes rosaceus) that had experienced exophthalmia. Vision was functional 4 days after recompression and was improved after 1 month of recovery evidenced by individuals being able to track both smaller and faster-moving gratings. Our results suggest that, after recompression, rosy rockfish recover from exophthalmia fairly rapidly and perhaps fast enough to minimize significant adverse impacts on survival. This measured recovery from exophthalmia, in addition to evidence of high short-term, post-release survivorship, shows that recompression of unwanted rosy rockfish may be a viable management technique, and may be appropriate for other rockfish species, some of which are at low population densities due to high fishing pressure.