

1 The divergent effect of capture depth and associated barotrauma on post-recompression
2 survival of canary (*Sebastes pinniger*) and yelloweye rockfish (*S. ruberrimus*)

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15

Highlights

Postrecompression survival of two physoclists from deep capture depth was studied.

At capture, the external signs of severe barotrauma were similar for both species.

Survival (48 h) of the two rockfishes diverged sharply as capture depth increased.

Yelloweye rockfish survival remained high while canary rockfish dropped to 25%.

16 **Abstract**

17 We evaluated the external signs of barotrauma and 48-h post-recompression survival for
18 54 canary and 81 yelloweye rockfish captured at depths of 46-174 m, much deeper than a
19 similar prior experiment, but within the depth range of recreational fishery catch and
20 discard. Survival was measured using specialized sea cages for holding individual fish.
21 The external physical signs associated with extreme expansion and retention of
22 swimbladder gas (pronounced barotrauma), including esophageal eversion, exophthalmia
23 and ocular emphysema, were common for both species at these capture depths and were
24 more frequent than in prior studies conducted at shallower depths. Despite similar
25 frequencies of most external barotrauma signs, 48-h post-recompression survival of the
26 two species diverged markedly as capture depth increased. Survival of yelloweye
27 rockfish was above 80% across all capture depths, while survival of canary rockfish was
28 lower, declining sharply to just 25% at capture depths greater than 135 m. Fish of both
29 species that were alive after 48 h of caging displayed very few of the external signs of
30 pronounced barotrauma and had a high submergence success rate when released at the
31 surface. Logistic regression analysis, using a combined data set from this and an earlier
32 experiment conducted at shallower capture depths, was used to more broadly evaluate
33 factors influencing post-recompression survival. For canary rockfish, depth of capture
34 was negatively related to survival ($P < 0.0001$), but the surface-bottom temperature
35 differential was not ($P > 0.05$). Exophthalmia and ocular emphysema were each
36 negatively associated with survival for canary rockfish ($P < 0.05$). For yelloweye rockfish,
37 no significant associations were found between post-recompression survival and capture
38 depth, the surface-bottom temperature differential or any of the signs of pronounced
39 barotrauma ($P > 0.05$).

40 **1. Introduction**

41 In multi-species hook-and-line fisheries, rules requiring non-retention of particular
42 species are a common approach to limiting fishing mortality on weaker stocks. The
43 effectiveness of non-retention depends on a variety of factors, but particularly upon the
44 survival rate of released fish. Post-release survival can be difficult to estimate due to the
45 many factors that can reduce it, including capture-related injuries, handling time,
46 environmental conditions and predation after release (Davis 2002). Estimation of post-
47 release survival is especially complex for species with closed swim bladders
48 (physoclists), such as Pacific rockfish (*Sebastes* spp.), that experience a suite of injuries
49 from barotrauma that are typically exacerbated by greater depth of capture (Hannah et al.
50 2008a, Jarvis and Lowe 2008, Pribyl et al. 2009). At surface pressure, some of these
51 species have extreme buoyancy from retained swim-bladder gas that can also prevent
52 them from submerging and returning to the seafloor under their own power (Hannah et al.
53 2008b, Hochhalter 2012), further complicating the estimation of post-release survival in a
54 fishery.

55

56 The depressed status of several Pacific rockfishes in U.S. coastal waters has led to non-
57 retention rules for these species in hook-and-line fisheries (PFMC and NMFS 2012),
58 particularly fisheries encountering yelloweye (*Sebastes ruberrimus*) and canary rockfish
59 (*S. pinniger*) and cowcod (*S. levis*). Yelloweye rockfish and cowcod typically inhabit
60 high-relief rocky areas with boulders and crevices, while canary rockfish are found in
61 these habitats as well as flat bedrock and mixed mud-boulder habitats (Love et al. 2002).
62 Concerns about the effects of capture-induced barotrauma on these species have
63 prompted a variety of studies investigating both the typical injuries from barotrauma, as

64 well as the potential for post-release submergence and survival (Hannah and Matteson
65 2007, Hannah et al. 2008b, Hochhalter and Reed 2011, Pribyl et al. 2011, Hochhalter
66 2012). For yelloweye rockfish, both short-term (48 h) and longer-term (17 d) studies of
67 post-release survival have shown high survival when these fish are returned to depth,
68 referred to as “post-recompression survival” (Hochhalter and Reed 2011, Hannah et al.
69 2012). The single short-term post-recompression survival study on canary rockfish has
70 also shown very high survival (Hannah et al. 2012). However, survival studies for these
71 two overfished species were conducted almost exclusively at capture depths less than 64
72 m. Fishery capture and release of these fishes frequently occurs at much deeper capture
73 depths, up to at least 175 m. We report here on a field study evaluating the short-term
74 post-recompression survival of canary and yelloweye rockfish at much greater depths of
75 capture, ranging from 46 m to 175 m.

76

77 **2. Methods**

78 *2.1 Post-recompression survival*

79 We evaluated post-recompression survival using a variation of the sea-caging method
80 described in detail in Hannah et al. (2012). Sampling was conducted on a chartered
81 commercial passenger fishing vessel equipped with a hydraulic block between September
82 2012 and October 2013, at 2 areas in the vicinity of Stonewall Bank, Oregon (Figure 1).
83 Fish were captured using rod and reel and terminal tackle commonly used in the
84 recreational rockfish fishery. Anglers fished just above the bottom, however, the capture
85 of fish that were suspended above the bottom may have occurred, as is the case for the
86 recreational fishery. Both species were captured in each sampling trip, however, the
87 majority of the yelloweye rockfish were sampled in September-October 2012, while most

88 of the canary rockfish were sampled in September-October 2013. Sampling effort was
89 distributed across a depth range of 46-175 m. For depths of capture between 46 and 84 m
90 (Figure 1, sampling area 1), a sampling goal of 15 canary and 15 yelloweye rockfish from
91 each of four 9-10 m depth zones was chosen. To sample greater depths, we utilized a
92 single depth zone of 135-175 m and a sampling goal of just 10 fish of each species
93 (Figure 1, sampling area 2). The reduced sampling goals in the deeper sampling area
94 were chosen to offset the longer travel time to this area and the increased handling time
95 needed to retrieve both hooked fish and cages from this depth range. Our choice of depth
96 ranges was also constrained by the availability of rocky reef habitat within the study area
97 at various depths.

98
99 After capture, each fish was scored for a standardized set of external signs of barotrauma
100 (Table 1) using a subset of the indicators from Hannah et al. (2008b) and Pribyl et al.
101 (2009). The subset of barotrauma signs we chose are indicative of extreme expansion
102 *and retention* of swimbladder gas, and will be referred to simply as signs of “pronounced
103 barotrauma”. It should be noted however that because rockfish sometimes lose
104 expanding gas through ruptures in the pharyngo-cleithral membrane, the range of the
105 external signs is not always a reliable indicator of the severity of internal trauma
106 (Hannah et al 2008a, Pribyl et al. 2009). After scoring for barotrauma, each fish was then
107 placed in a wet tray for measurement of fork length (cm). The fish was then
108 photographed and placed in a sea cage that was partially filled with seawater and the cage
109 lid was sealed and secured with a large cable-tie. The cage was then deployed as soon as
110 the vessel could navigate to a nearby point of similar depth, over suitable bottom for
111 successful cage retrieval. As in Hannah et al. (2012), the surface interval of fish was

112 minimized and calculated from the time the fish was brought on board to deployment of
113 the cage overboard. A data logger (Vemco, Minilog-08-TDR, 0.1°C resolution, $\pm 0.2^\circ\text{C}$
114 accuracy, 0.4 m depth resolution) was attached to one cage per depth interval to record
115 depth and bottom temperature. Surface water temperature and salinity were also
116 recorded at cage deployment and retrieval for each depth category in which sampling was
117 conducted.

118

119 The sea cages we used for holding rockfish have been described in detail in Hannah et al.
120 (2012) and were designed specifically to minimize adverse cage-effects on fish. The
121 cages incorporated non-abrasive surfaces for all parts that might contact the fish and
122 sufficiently heavy steel bases to be self-righting and to resist current-induced movement.
123 They were also isolated from the forces generated by the mooring line to the surface by a
124 double anchoring system and incorporated screening designed to exclude carnivorous
125 amphipods while maintaining adequate water exchange. We made only two alterations to
126 the cage design described by Hannah et al. (2012) to adapt it to the much deeper depths
127 sampled in this study. We changed the gasket material used to seal the cage lid to a non-
128 compressible material to prevent seal failure at these greater depths and we increased the
129 length of the mooring lines used.

130

131 Our study utilized a nominal caging duration of 48 h, but allowed durations ranging from
132 44-96 h in consideration of inclement weather or sea conditions and vessel availability.
133 Following retrieval of each cage, fish were evaluated for survival while still in seawater
134 in the cage. They were then removed from the cage, the physical signs of barotrauma
135 were again noted, another photo was taken and the fish was released at the surface. The

136 ability of each fish to submerge following release was recorded, and any surviving fish
137 that could not submerge were assisted back to depth with a sub-surface release device
138 (Theberge and Parker 2005).

139

140 2.2 Data analysis

141 We estimated post-recompression survival by species and depth zone using LaPlace point
142 estimates to compensate for small sample sizes, as suggested by Lewis and Sauro (2006)
143 and Jarvis and Lowe (2008). We calculated 95% binomial confidence intervals for
144 survival using the adjusted Wald method (Sauro and Lewis 2005).

145

146 To provide a more complete picture of the effect of capture depth on barotrauma and
147 post-recompression survival for these two species, we combined the data from this study
148 with data from shallower depths of capture collected with very similar methods as
149 reported by Hannah et al. (2012). We used logistic regression (JMP software ver. 6.02)
150 to evaluate the effect of depth of capture and the surface-bottom temperature differential
151 on post-recompression survival for both data sets. The surface-bottom temperature
152 differential has been related to mortality in hook-and-line captured red snapper (*Lutjanus*
153 *campechanus*, Diamond and Campbell 2009), and may be important for black rockfish
154 (*Sebastes melanops*, Hannah et al. 2012). We also included it in this study because at the
155 deeper depths we sampled, the temperature differential was likely to be greater than in
156 previous studies conducted at shallower depths (Hannah et al. 2012). For both data sets,
157 we graphically evaluated the relationship between specific signs of pronounced
158 barotrauma and depth of capture. We also evaluated the association between these

159 barotrauma signs and post-recompression survival for the combined data sets using
160 Fisher's exact test (Sokal and Rolf 1981).

161

162 **3. Results**

163 We completed 11 deployments of 7-16 sea cages each between September, 2012 and
164 October, 2013. In all, 135 canary and yelloweye rockfish from 5 depth intervals up to
165 174 m were evaluated for signs of pronounced barotrauma (Table 1) and caged to
166 evaluate post-recompression survival (Table 2). This total included 81 yelloweye and 54
167 canary rockfish. The length range of canary and yelloweye rockfish sampled was 26-52
168 cm and 30-59 cm, respectively (Table 2). Time-at-the-surface averaged (± 1 standard
169 error) 2.8 (± 0.2) min for all 135 fish, with only 2 specimens having a surface interval
170 longer than 5 min, both of which survived. Post-recompression survival of yelloweye
171 rockfish was very high across all depths of capture, with 77 of 81 fish surviving (95.1%,
172 Table 2). Survival of canary rockfish was much lower, with 42 of the 54 canary rockfish
173 sampled surviving (77.8%, Table 2).

174

175 The LaPlace point estimates of survival show a marked divergence between canary and
176 yelloweye rockfish in 48-h survival as a function of depth of capture (Figure 2). At
177 capture depths greater than 135 m, the survival of canary rockfish declined to only about
178 25%, while the survival of yelloweye rockfish remained well above 80% (Figure 2).

179 Inspection of the fish captured at depths greater than 135 m showed that for canary
180 rockfish, a large amount of blood pooling under the pharyngo-cleithral membrane was
181 frequently observed. For both species, dissections of the specimens that died frequently
182 showed evidence of pronounced bleeding within the abdominal cavity and/or within the

183 pericardial cavity. Two non-surviving yelloweye rockfish also showed visible evidence
184 of embolisms or ruptures in the heart muscle.

185

186 At all capture depths sampled, esophageal eversion was very frequently observed in both
187 canary and yelloweye rockfish at initial capture, being noted in 70% or more of the
188 specimens (Figure 3, panel A and B). Across all capture depths, exophthalmia was noted
189 in 50% or more of the canary rockfish and 40% or more of the yelloweye rockfish
190 (Figure 3, panel A and B). Ocular emphysema was less frequently encountered in both
191 species (Figure 3, panel A and B). However it increased in frequency as capture depth
192 increased, reaching levels of 70% in canary rockfish and 40% in yelloweye rockfish at
193 capture depths greater than 135 m (Figure 3, panel A and B). A comparison of
194 barotrauma signs from this study with those noted by Hannah et al. (2012, Figure 3, panel
195 C and D) shows that for both species, exophthalmia and ocular emphysema were
196 generally more frequent at the greater depths sampled in this study (Figure 3, panel A and
197 B). Also notable in this comparison is the variability that can be observed in barotrauma
198 signs as a function of depth of capture (Figure 3). For example, at capture depths of 46-
199 54 m, exophthalmia in both species was much more frequent in this study than observed
200 in 2009-10 sampling (Hannah et al. 2012).

201

202 Most fish that were alive after 48 h of caging were judged to be in good condition. Signs
203 of pronounced barotrauma were mostly absent, especially in yelloweye rockfish and
204 almost all of the fish were able to submerge without assistance when released at the sea
205 surface. Of 42 canary and 77 yelloweye rockfish released, 41 and 76, respectively, were
206 capable of submerging.

207

208 Logistic regression of 48-h post-recompression survival on depth of capture and the
209 surface-bottom temperature differential, for the data collected in this study, showed no
210 relationship between survival in yelloweye rockfish and either variable ($P>0.05$). For
211 canary rockfish sampled in this study, post-recompression survival was significantly
212 negatively related to capture depth ($P<0.05$), but not to the surface-bottom temperature
213 differential ($P>0.05$).

214

215 Logistic regression analysis of the combined data from this study and data from Hannah
216 et al. (2012) showed that post-recompression survival was not significantly related to the
217 surface-bottom temperature differential in either canary or yelloweye rockfish ($P>0.05$),
218 even though the differential was much higher, as expected, at the deeper depths of
219 capture (Figure 4). In the combined data set, 48-h post-recompression survival was
220 negatively related to capture depth for canary rockfish, ($P<0.0001$), but not for
221 yelloweye rockfish ($P>0.05$, Table 3). A comparison of the two fitted curves for the
222 combined data sets (Figure 5) and the frequency of barotrauma signs (Figure 3) shows
223 that increasing capture depth created pronounced barotrauma in both species, however,
224 the negative effect on survival was much stronger for canary rockfish. This was
225 supported by the results of the Fisher's exact tests. The presence of exophthalmia and
226 ocular emphysema was each negatively associated with survival in canary rockfish
227 ($P<0.05$), while none of the physical signs of barotrauma were negatively associated with
228 survival in yelloweye rockfish ($P>0.05$).

229

230 **4. Discussion**

231 The divergence of 48-h post-recompression survival of canary and yelloweye rockfish as
232 depth of capture increased beyond 135 m shows how difficult it can be to evaluate the
233 survival potential of rockfish with barotrauma based on their appearance at the surface.
234 Most specimens of both species captured at these depths showed some signs of
235 pronounced barotrauma, yet nearly all of the yelloweye rockfish survived following
236 recompression while many of the canary rockfish perished as capture depth increased
237 beyond about 75 m. Studies of post-recompression release behavior also support the
238 notion that surface observations are not indicative of survival, at least for rockfish that
239 tend to retain most of their expanded swimbladder gas (Hannah and Matteson 2007,
240 Hannah et al. 2008a). The retained gas can make it very difficult or impossible for
241 rockfish to submerge (Hannah et al. 2008b, Hochhalter 2012) and also interferes with the
242 evaluation of reflex behaviors, which have been shown to be useful predictors of survival
243 in other captured and discarded fishes (Davis 2007, Davis and Ottmar 2006).

244

245 Our data for canary rockfish suggest that there may be a critical capture depth for some
246 rockfish species at which post-recompression survival decreases rapidly. Between the
247 capture depth intervals of 75-84 m and 135-174 m, post-recompression survival of canary
248 rockfish plummeted from about 80% to just 25% (Figure 2). Our observations of pooled
249 blood under the pharyngo-clethral membrane of captured canary rockfish and in the
250 abdomen of canary rockfish that failed to survive suggests that critical internal physical
251 injuries can be caused by barotrauma at these capture depths. Across these same 2 depth
252 intervals, the typical external signs of pronounced barotrauma in canary rockfish
253 increased just moderately in frequency (Figure 3, panel A and B). The high 48-h post-
254 recompression survival of yelloweye rockfish captured at depths greater than 135 m, also

255 experiencing the effects of pronounced barotrauma, was unexpected and is surprising.
256 It's possible that a similar critical capture depth exists for yelloweye rockfish, but simply
257 at a greater depth of capture than sampled in this study.

258

259 It should be noted that our study results represent just an initial estimate of how capture
260 depth and related barotrauma influence post-recompression survival of these two species.
261 With the modest sample sizes in our study, it was not possible to evaluate the many
262 factors that often affect survival, such as fish size or age, time spent above the bottom for
263 schooling species, season or variable environmental conditions, handling, surface
264 interval, predation and longterm health effects from barotrauma (Davis 2002). Some of
265 these factors simply require additional studies, but others are very difficult to study in the
266 field. For example, the ontogenetic migration of Pacific rockfish (Love et al. 2002)
267 makes it difficult to separate the effects of fish size and capture-depth on barotrauma and
268 post-recompression survival, as they are inherently somewhat confounded from a
269 sampling standpoint.

270

271 The absence of most of the physical signs of pronounced barotrauma noted in the
272 rockfish that survived 48 h of sea caging is consistent with prior sea-caging studies with a
273 wide variety of rockfish species (Jarvis and Lowe 2008, Hannah et al. 2012). It is also
274 consistent with the physical model of how barotrauma signs are thought to develop in
275 rockfish (Hannah et al 2008a). Esophageal eversion, exophthalmia and ocular
276 emphysema result from the expansion and “patterned” anterior travel of gas that escapes
277 from the compromised swimbladder of a rockfish during ascent and decompression. The
278 gas that has escaped into a variety of tissues then contracts during recompression and can

279 be removed quickly via absorption into the blood and normal respiration. Since the
280 swimbladders of rockfish typically cannot heal and re-inflate appreciably within 48 h
281 (Parker et al. 2006), the second decompression event does not produce the typical
282 physical signs associated with swimbladder gas expansion and travel.

283

284 The estimates developed in this study can be very useful for informing the management
285 of hook-and-line fisheries that encounter these two overfished species, especially in
286 combination with data on submergence success as a function of capture depth, like that
287 provided by Hochhalter (2012) for yelloweye rockfish. For example, a primary
288 recommendation from prior studies of post-recompression survival and submergence
289 success for these two species was that hook-and-line fishers should use a variety of
290 “descending” devices to help released fish overcome surface buoyancy (Theberge and
291 Parker 2005, Hochhalter and Reed 2011, Hannah et al. 2012, Hochhalter 2012). The data
292 from this study suggest that descending devices may have a positive effect on survival of
293 yelloweye rockfish across a wide depth range (Figure 6, lower panel). However, for
294 canary rockfish captured at depths greater than 135 m, survival may be so low that it
295 might be better to either allow retention of these fish or to simply not allow a fishery to
296 operate at these deeper depths (Figure 6, upper panel).

297

298 Although short-term post-recompression survival is now better understood for a variety
299 of Pacific rockfish species (Jarvis and Lowe 2008, Hochhalter and Reed 2011, Hannah et
300 al. 2012), longer term studies of the health of rockfish that have experienced pronounced
301 barotrauma are still badly needed, as well as studies evaluating the cumulative effects of
302 multiple capture events on these long-lived fishes. Critical as well, is understanding the

303 behavioral and sensory compromise that may be evident in fish immediately post-
304 recompression, in the absence of a protective cage. Fish suffering from extensive gas
305 embolisms at the surface may be physically and physiologically compromised for some
306 unknown period of time. It's reasonable to expect that after recompression some time
307 would be needed for recovery, leaving fish vulnerable to predation or unable to quickly
308 seek refuge in a school or within specific habitat. Until such studies can be completed,
309 the effectiveness of population rebuilding strategies for Pacific rockfish that rely heavily
310 on non-retention in hook-and-line fisheries remains uncertain.

311

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316

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- 378

379 **Figure captions**

380 Figure 1. Location of the study areas at Stonewall Bank, Oregon.

381

382 Figure 2. LaPlace point estimates of the proportion of canary and yelloweye rockfish
383 surviving after 48 h of sea caging, by depth of capture (m), with 95% confidence
384 intervals.

385

386 Figure 3. Percentage of canary and yelloweye rockfish displaying 3 different signs of
387 pronounced barotrauma at initial capture, as a function of depth of capture (m),
388 September 2012 through October 2013 (panel A and B) and from the 2009-10 study by
389 Hannah et al. (2012, panel C and D). Sample size in parentheses.

390

391 Figure 4. Mean difference in temperature ($^{\circ}\text{C}$, ± 1 standard error) between the sea surface
392 and seafloor, by capture-depth interval (m) from all canary and yelloweye rockfish cage
393 deployments from this study (2012-13) and from Hannah et al. (2012, 2009-2010).

394

395 Figure 5. Fitted logistic curve of the proportion of yelloweye and canary rockfish
396 surviving 48 h after hook-and-line capture and recompression, as a function of capture
397 depth (m).

398

399 Figure 6. Fitted logistic curves comparing the proportion of canary and yelloweye
400 rockfish submerging following surface release and surviving 48 h after hook-and-line
401 capture and recompression, as a function of capture depth (m). Modeled submergence

402 data for canary and yelloweye rockfish are from Hannah et al. (2008b) and Hochhalter
403 (2012), respectively.

404

405 Table 1. Indicators used to identify the physical signs of pronounced barotrauma in
406 canary and yelloweye rockfish.

| Symptom | Indicators |
|--------------------------------------|---|
| Esophageal eversion | Eversion of esophageal tissue at least 1 cm into the buccal cavity. |
| Exophthalmia (popeye) | Eye protruding outward from orbit |
| Ocular emphysema (gas in the eye) | Gas present within the eye or connective tissue surrounding the eye |

407

408 Table 2. Summary of canary and yelloweye rockfish captured by hook-and-line in waters off Newport, Oregon and held in individual
 409 cages to estimate 48 h post-recompression survival, by species and capture depth interval (m). Mean fork length (standard error) by
 410 species and depth interval is also shown. The number of mortalities is shown in parentheses.

| Common name | Scientific name | Statistic | Depth of capture | | | | | Total |
|--------------------|----------------------------|-------------|------------------|----------|----------|-----------|-----------|---------|
| | | | 46-54 m | 55-64 m | 65-74 m | 75-84 m | 135-174 m | |
| Canary rockfish | <i>Sebastes pinniger</i> | Number | 5(0) | 13(0) | 11(1) | 15(3) | 10(8) | 54(12) |
| | | Mean length | 35.0±1.8 | 32.4±0.9 | 35.6±0.7 | 36.2 ±0.9 | 48.3 ±1.0 | |
| Yelloweye rockfish | <i>Sebastes ruberrimus</i> | Number | 11(0) | 20(1) | 20(1) | 20(1) | 10(1) | 81(4) |
| | | Mean length | 38.5±1.2 | 39.9±2.1 | 43.8±1.4 | 44.8±1.7 | 55.4±1.7 | |
| Total | | | 16(0) | 33(1) | 31(2) | 35(4) | 20(9) | 135(16) |

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413 Table 3. Results of logistic regression analysis of the proportion of rockfish surviving after 48 h versus depth (m) of capture for canary
 414 and yelloweye rockfish. Curves were fitted using the canary and yelloweye rockfish data from this study in combination with the data
 415 from shallower depths of capture reported in Hannah et al. (2012).

| Species | Independent variable | Coefficients | Standard error | P - value | Whole model Chi-square | R squared |
|--------------------|----------------------|--------------|----------------|-----------|------------------------|-----------|
| Canary rockfish | constant | 6.3499 | 1.1442 | <0.0001 | 34.9821 | 0.4854 |
| | depth of capture | -0.0531 | 0.0116 | <0.0001 | | |
| Yelloweye rockfish | constant | 4.4034 | 1.1583 | 0.0001 | 1.3616 | 0.0400 |
| | depth of capture | 0.0150 | 0.0118 | 0.2043 | | |

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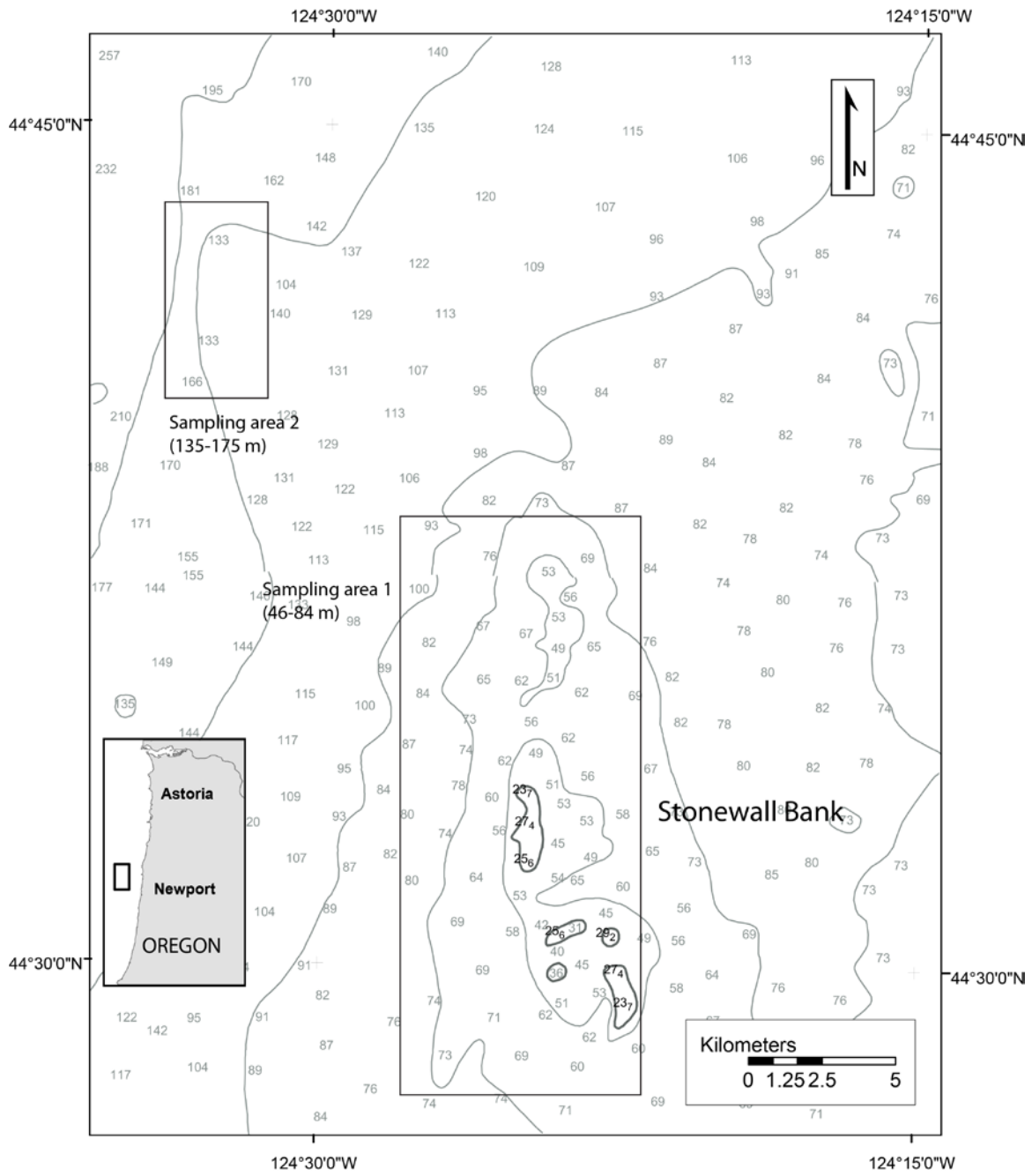


Figure 1

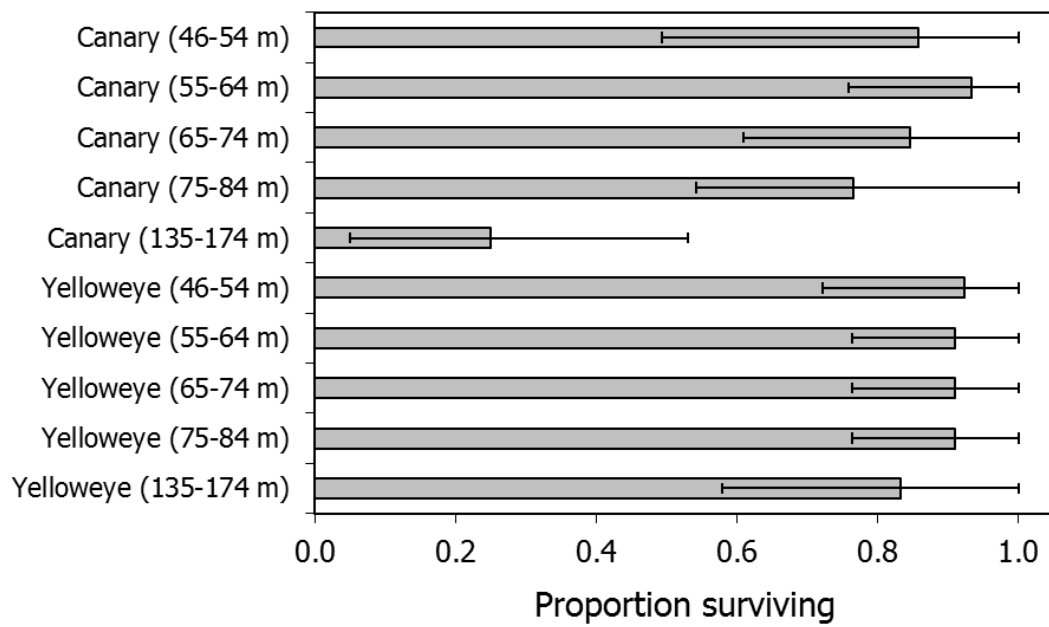


Figure 2

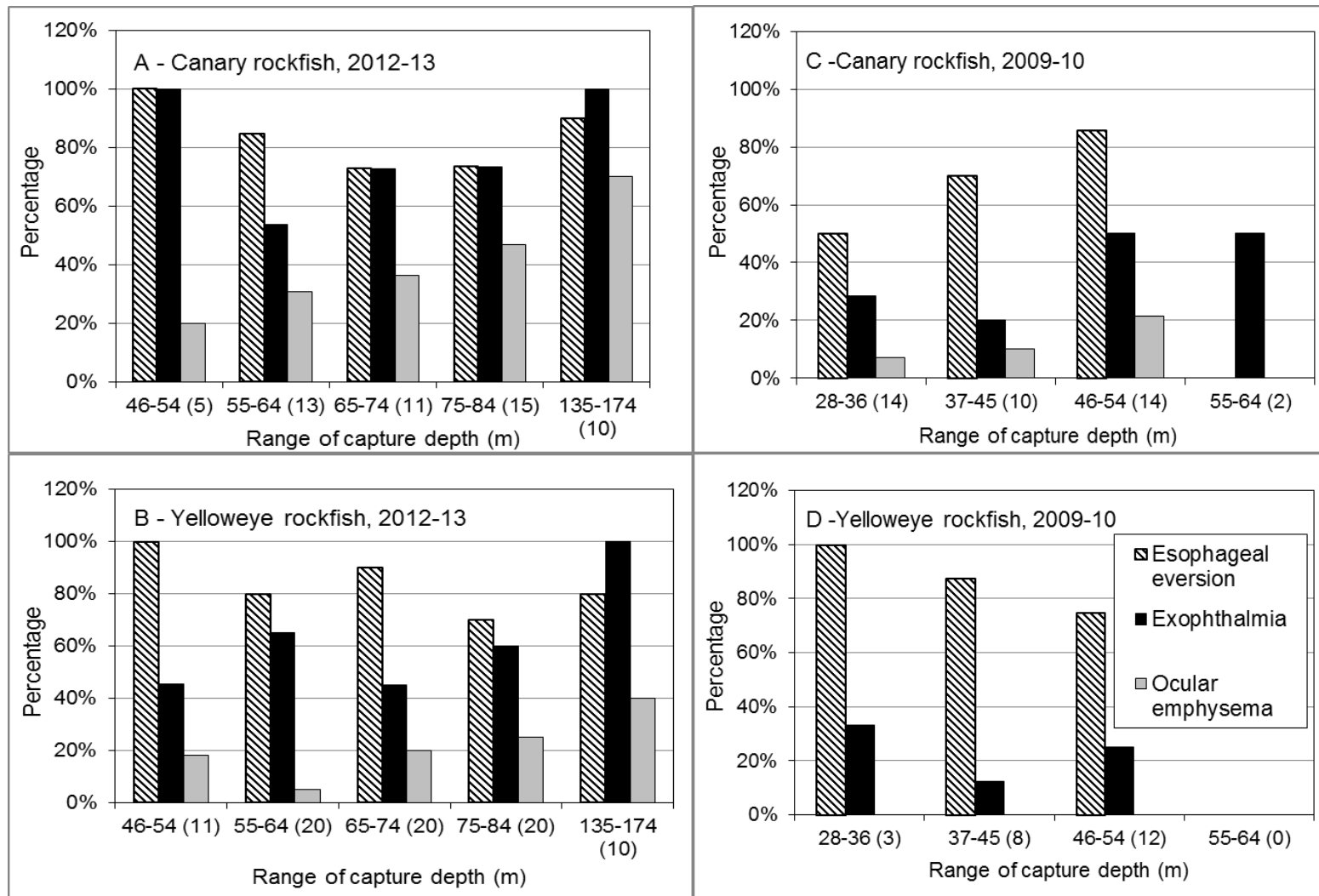


Figure 3

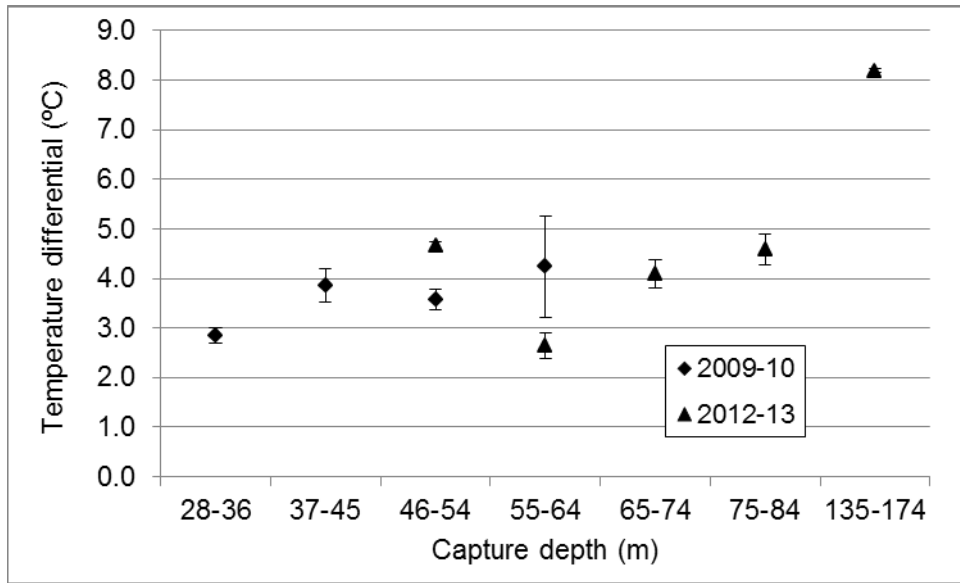


Figure 4.

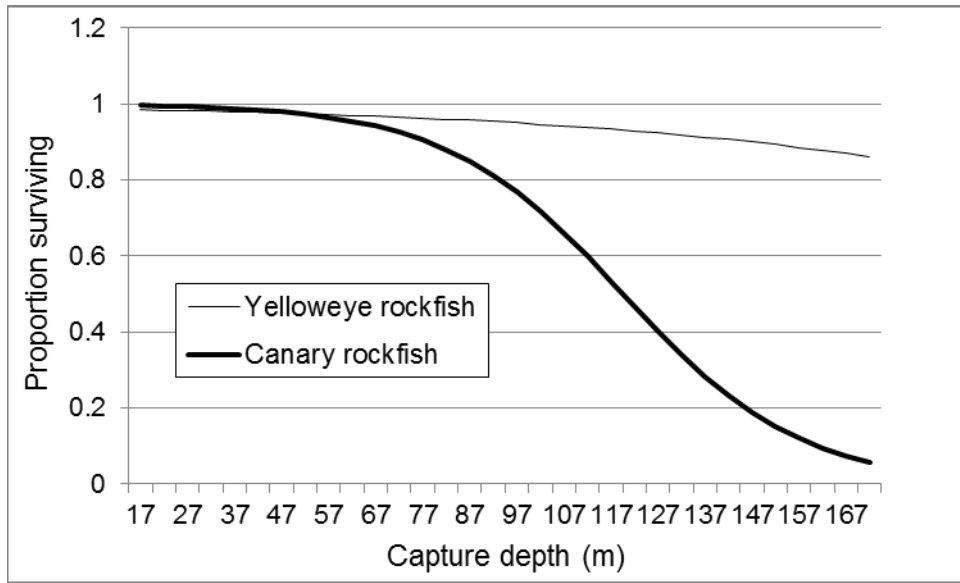


Figure 5

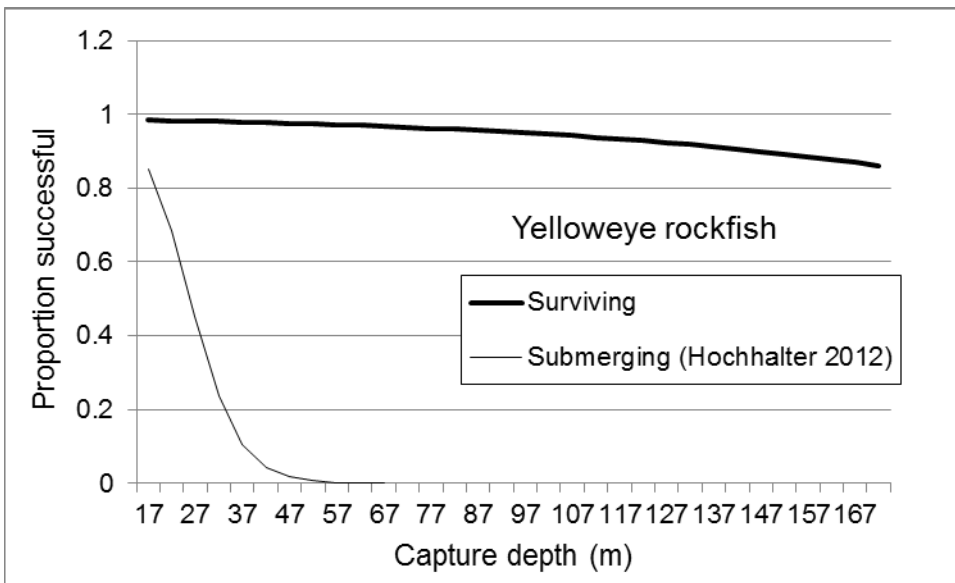
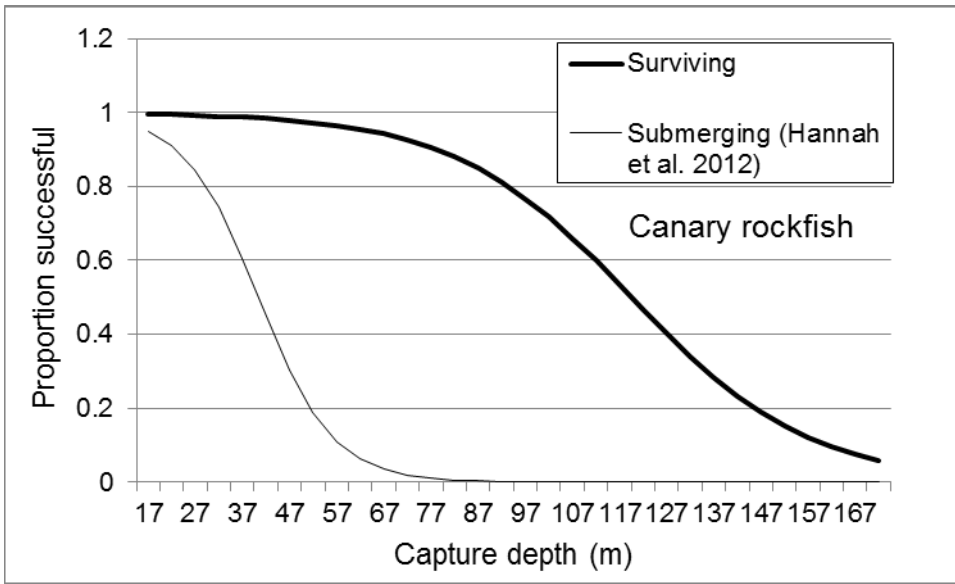


Figure 6