# Long-term participation in collaborative fisheries research improves volunteer angler opinions on fisheries data quality and marine protected area performance

Erica T Jarvis [Corresp., 1] , Allison N Kellum [1] , Jennifer A Chiu [2] , Grant T Waltz [3] , Samantha Murray [1] , Dean E Wendt [3] , Richard M Starr [2] , Brice X Semmens [1]

[1] Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California (CA), United States

[2] Fisheries and Conservation Biology, Moss Landing Marine Laboratories, Moss Landing, California, United States

[3] Department of Biological Sciences, California Polytechnic State University - San Luis Obispo, San Luis Obispo, California, United States

Corresponding Author: Erica T Jarvis
Email address: etmason@ucsd.edu

Recent marine spatial planning efforts, including the management and monitoring of marine protected areas (MPAs), increasingly focus on the importance of stakeholder engagement. For nearly 15 years, the California Collaborative Fisheries Research Program (CCFRP) has partnered volunteer anglers with researchers, the fishing industry, and resource managers to monitor groundfishes in California's network of MPAs. While the program has succeeded in generating sustained biological observations, we know little about volunteer angler demography or the impact of participation on their perceptions and opinions on fisheries data or MPAs. In this study we surveyed CCFRP volunteers to learn about (a) volunteer angler demographics and attitudes toward groundfish management and stock health, (b) volunteer angler motivations for joining and staying in the program, and (c) whether participation in the program influenced volunteer angler opinions on MPAs and the quality of data used in resource management in California. CCFRP volunteers were older and had higher fishing avidity than average within the California's recreational angling community. Many self-identified as more conservation-minded than their peers and had positive views of California groundfish management and stock health. Participation in science and giving back to fisheries resources were major motivating factors in their decision to become and remain CCFRP volunteers. Angler opinions toward MPAs and the data used for fishery management were more positive after volunteering with CCFRP. Those who had volunteered for seven or more years with CCFRP were more likely than not to gain a positive opinion of MPAs. Our survey results provide evidence that long-term engagement of stakeholders in collaborative research positively influences stakeholder opinions regarding marine resource management data and methods, and highlights CCFRP's success in engaging citizen science stakeholders in collaborative

fisheries research.

2  **Long-term Participation in Collaborative Fisheries Research Improves Volunteer**

3  **Angler Opinions on Fisheries Data Quality and Marine Protected Area**

4  **Performance**

7  Erica T. Jarvis[1], Allison N. Kellum[1], Jennifer A. Chiu[2], Grant T. Waltz[3], Samantha Murray[1],

8  Dean E. Wendt[3], Richard M. Starr[2], Brice X. Semmens[1]

10  [1]Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, USA

11  [2]Fisheries and Conservation Biology, Moss Landing Marine Laboratories, Moss Landing, CA,

12  USA

13  [3]Department of Biological Sciences, California Polytechnic State University, San Luis Obispo,

14  CA, USA

16  Corresponding Author:

17  Erica Jarvis[1]

18  9500 Gilman Dr., La Jolla, CA 92093-0208, USA

19  Email address: etmason@ucsd.edu

## Abstract

21      Recent marine spatial planning efforts, including the management and monitoring of

22   marine protected areas (MPAs), increasingly focus on the importance of stakeholder

23   engagement. For nearly 15 years, the California Collaborative Fisheries Research Program

24   (CCFRP) has partnered volunteer anglers with researchers, the fishing industry, and resource

25   managers to monitor groundfishes in California's network of MPAs. While the program has

26   succeeded in generating sustained biological observations, we know little about volunteer angler

27   demography or the impact of participation on their perceptions and opinions on fisheries data or

28   MPAs. In this study we surveyed CCFRP volunteers to learn about (a) volunteer angler

29   demographics and attitudes toward groundfish management and stock health, (b) volunteer

30   angler motivations for joining and staying in the program, and (c) whether participation in the

31   program influenced volunteer angler opinions on MPAs and the quality of data used in resource

32   management in California. CCFRP volunteers were older and had higher fishing avidity than

33   average within the California recreational angling community. Many self-identified as more

34   conservation-minded than their peers and had positive views of California groundfish

35   management and stock health. Participation in science and giving back to fisheries resources

36   were major motivating factors in their decision to become and remain CCFRP volunteers. Angler

37   opinions toward MPAs and the data used for fishery management were more positive after

38   volunteering with CCFRP. Those who had volunteered for seven or more years with CCFRP

39   were more likely than not to gain a positive opinion of MPAs. Our survey results provide

40   evidence that long-term engagement of stakeholders in collaborative research positively

41   influences stakeholder opinions regarding marine resource management data and methods, and

42   highlights CCFRP's success in engaging citizen science stakeholders in collaborative fisheries

43   research.

44

## Introduction

46      Stakeholder engagement is an important part of marine resource protection and

47   management (Pomeroy & Douvere, 2008). Benefits of such engagement include the

48   incorporation of local knowledge into policy, and the potential to build stakeholder trust in

49   management decisions (Yochum, Starr & Wendt, 2011). California's Marine Life Protection Act

50   (MLPA) of 1999 (California) directed the state to redesign California's marine protection areas

51    (MPAs) to function as a network and increase protection of the state's marine habitats, wildlife,

52    and cultural sites. Establishment of the statewide MPA network took 13 years and involved

53    considerable effort to engage stakeholders (Gleason et al., 2010). Multiple assessments of the

54    MLPA stakeholder process found that it effectively achieved broad participation of resource

55    users and interest groups across the state (Fox et al., 2013; Gleason et al., 2013; Kirlin et al.,

56    2013). Since implementing the MPA network, the state (i.e. California Department of Fish and

57    Wildlife (CDFW), California Ocean Protection Council (OPC), and California Fish and Game

58    Commission (FGC)), in partnership with California Ocean Science Trust (OST), has supported

59    public engagement through continued scientific monitoring of fish populations inside and outside

60    MPA boundaries (OST, CDFW & OPC, 2012, 2017).

61         The California Collaborative Fisheries Research Program (CCFRP) was created in 2006

62    by a coalition of scientists, resource managers, commercial passenger fishing vessel (CPFV)

63    operators, and recreational anglers (Wendt & Starr, 2009). The program uses a hook-and-line

64    sampling design to monitor the abundance and size of groundfish species (e.g., rockfish, flatfish,

65    roundfish, and skates and rays); data are used to make long-term comparisons of species

66    diversity, catch rates, and length-frequency distributions within and among paired MPA and

67    reference sites (sites similar in character and location to the MPA, but without the protections

68    afforded the MPA). Between 2007 and 2016, CCFRP annually surveyed four sets of MPAs along

69    the central coast including Año Nuevo State Marine Reserve (SMR), Point Lobos SMR, Piedras

70    Blancas SMR, and Point Buchon SMR (Fig. 1). These MPAs were implemented in 2007 and are

71    located within the Central Coast MLPA planning region that extends from Pigeon Point to Point

72    Conception, CA.

73         CCFRP's volunteer saltwater recreational anglers are central to the program's

74    standardized hook-and-line survey. Once a fish is caught by a volunteer angler, it is processed by

75    scientists who identify, measure, tag (externally), and release the catch (Wendt & Starr, 2009).

76    Volunteering requires a commitment to early mornings and near constant fishing effort without

77    the benefit of keeping the day's catch. Nevertheless, volunteering gives participants the unique

78    opportunity to fish in MPAs designated as no-take zones where fishing is otherwise prohibited. It

79    also offers volunteer anglers the opportunity to interact with the science crew and make their

80    own observations on the similarities and differences between the catches in MPAs and reference

81    areas. This participation, and the direct observation of the scientific process, is thought to instill a

82  sense of ownership and trust among participants in the data being collected (Yochum, Starr &

83  Wendt, 2011).

84      The CCFRP program capitalizes on the expertise and knowledge of the fishing industry,

85  angling public, participating scientists, and managers; together, these constituents work toward a

86  common goal (e.g., measuring MPA effectiveness) that ultimately gives the group a shared

87  purpose (Wendt & Starr, 2009; Yochum, Starr & Wendt, 2011). CCFRP relies on relationship

88  building and transparency to create buy-in of MPA monitoring, evaluation, and management by

89  involving stakeholders in all aspects of the program, from study design to data collection and

90  sharing. An example of these efforts is the annual Volunteer Appreciation and Data Workshop

91  hosted by the coordinating staff from California Polytechnic University, San Luis Obispo (Cal

92  Poly) and Moss Landing Marine Labs (MLML), where survey results and trip highlights are

93  shared with volunteer participants and other partners. To date, the impact of these events on

94  angler opinions of MPAs has not been evaluated.

95      Human dimensions such as effective engagement, honesty, trust, and transparency can

96  impact the success of MPAs (Gall & Rodwell, 2016; Ordoñez-Gauger et al., 2018). However,

97  research on public knowledge, attitudes, and perceptions of California's MPA is sparse, and

98  studies that do exist vary widely across geographic region and composition of study populations

99  (Baldassare et al., 2007, 2017; Loper, 2008; Ordoñez-Gauger et al., 2018). While the success of

100 CCFRP in generating valuable monitoring data is clear (Wendt & Starr, 2009; Starr et al., 2015),

101 the degree to which CCFRP participation has influenced volunteer perceptions of California's

102 MPAs is less clear. In addition, the essential context for understanding this influence – (a) the

103 demographics and characteristics of the CCFRP volunteer anglers and (b) their perceptions on

104 the health of groundfish stocks, the data quality used to manage those stocks, and the

105 effectiveness of MPAs relative to groundfish management measures (e.g. depth restrictions, bag

106 limits, size limits) -- has also not been assessed. Although California's network of MPAs were

107 not specifically designed as a fishery management tool, any beneficial fisheries impacts of MPAs

108 are important in the evaluation of overall MPA effectiveness.  Thus, state resource managers

109 would be well served by learning about the volunteer anglers who help monitor California's

110 MPAs as well as their respective opinions on MPAs.

111     Given the longevity of CCFRP, and extensive volunteer participation, the program provides a

112 valuable opportunity to measure outcomes of long-term stakeholder engagement. We used an

113    online survey of current and former CCFRP volunteer anglers to learn about (a) volunteer angler

114    demographics and attitudes toward groundfish management and stock health, (b) volunteer

115    angler motivations for joining and staying in the program, and (c) whether participation in the

116    program influenced volunteer angler opinions on MPAs and the quality of data used in resource

117    management in California. By characterizing the population of CCFRP angler volunteers and

118    their perceptions in relation to their volunteer efforts, our intent is to characterize the realized

119    benefits of CCFRP as a collaborative research program, beyond the fisheries data it yields.

120

## Materials & Methods

### Survey

123       We distributed an online survey to 722 volunteer anglers who participated in CCFRP

124    with Cal Poly and MLML between 2007 and 2018. This group represented a subgroup of the

125    entire volunteer population during that time period (N=901), as 179 volunteer anglers had

126    previously opted out of receiving communications from CCFRP and two other groups,

127    individuals without e-mail addresses and anglers under the age of 18 years, were not contacted.

128    We used Qualtrics, an online survey platform, to deliver the survey questionnaire. Respondents

129    provided written consent by agreeing to participate in the survey. The questionnaire consisted of

130    29 questions arranged into four sections: (a) CCFRP volunteering; (b) fisheries management and

131    health of California groundfish stocks; (c) MPAs; and (d) demographics and miscellaneous

132    questions (*Article S1*). We included multiple question types (yes/no, multiple-response, ordinal

133    scale, and free-response) and designed the survey so that respondents could complete their

134    responses in approximately 15 minutes. The University of California, San Diego Institutional

135    Review Board (IRB) certified this study of volunteer anglers as exempt from IRB review.

136       We distributed the survey via a series of e-mails sent to subjects over a two-week period

137    in Spring 2018. The first e-mail invited subjects to participate in the survey, and two subsequent

138    e-mails sent seven and 12 days into the study period reminded subjects to complete the survey.

139    Each e-mail contained a description of the study, a letter of consent, and a link to the online

140    questionnaire.

141 Angler demographics and characteristics

142    Age and gender comprised the survey's demographic categories; other characteristics

143 included years of fishing experience, frequency of fishing, degree of conservation-mindedness,

144 whether anglers had any prior work experience in marine resource management or the

145 recreational or commercial fishing industries, whether anglers had fished in MPA sites prior to

146 those areas being designated MPAs, and whether anglers had ever participated in the MLPA

147 planning process.

148    We categorized angling avidity (i.e. a relative measure of the enthusiasm an angler has

149 for the sport) into three avidity levels – low, medium, or high – based on the number of saltwater

150 angling trips they took per year, outside of CCFRP surveys, with low being <4 days, medium 4-

151 23 days, and high >23 days per year. Angler avidity ranges were based on the National

152 Oceanographic and Atmospheric Administration (NOAA) West Coast Fishing Avidity categories

153 (Rubio, Brinson & Wallmo, 2014).

154

155 Volunteer perceptions of groundfish management and stock health

156    In addition to characterizing the general opinion of anglers on the health of groundfish

157 stocks and the effectiveness of specific regulations, we also compared the percentage of

158 respondent opinions across related work experience categories to gauge the relative degree of

159 consensus in opinions among these groups.

160

161 Measures of volunteer participation and opinion change

162    Our primary focus for assessing change in CCFRP volunteer angler opinions was on

163 MPAs in California, and secondarily, on the quality of data used for fishery management. Given

164 that MPAs are known to elicit stronger opinions with the angling public than fishery

165 management data, questions regarding fishery management data were limited to whether

166 volunteers had an opinion of these data before CCFRP participation, and of those that did,

167 whether their opinion changed either positively or negatively after having volunteered with

168 CCFRP.

169    With respect to MPAs, we were interested in (a) capturing the distribution of opinions on

170 MPAs both before and after CCFRP participation, (b) characterizing the extent of opinion

171 change across the group, and (c) examining whether opinion change is mediated by the extent of

172  program participation. Respondents answered questions on an ordinal scale. They could report an

173  opinion of "Positive," "Somewhat positive," "Somewhat negative," "Negative," or "No

174  opinion." We coded the answers 1, 2, 3, 4, and 5 respectively. To capture the overall proportion

175  of respondents having a change in opinion on MPAs after volunteering with CCFRP, we

176  subtracted the answer code corresponding to their opinion after CCFRP participation from the

177  answer code corresponding to their opinion before volunteering with CCFRP. Results that were

178  positive indicated a positive change in opinion of MPAs, results that were negative indicated a

179  negative change in opinion of MPAs, and results that were "0" represented no change in opinion.

180  We coded these differences numerically into a single variable representing change in opinion,

181  with positive change coded as "1", no change coded as "2," and negative change coded as "3."

182      To evaluate volunteer opinion change relative to levels of volunteer participation, we

183  focused on three measures of CCFRP volunteer angler participation: (a) number of years since

184  becoming a volunteer angler; (b) approximate number of CCFRP sampling trips attended; and

185  (c) the number of CCFRP Volunteer Angler Appreciation and Data Workshops an angler had

186  attended. We calculated the number of years since an angler became a volunteer by subtracting

187  the year the respondent started volunteering from the year 2018 (the year we conducted the

188  survey). Given the survey was anonymous, we calculated the approximate number of sampling

189  trips a respondent went on throughout their time with CCFRP by multiplying the number of

190  years a volunteer participated in CCFRP by the average number of trips they went on per year.

191      We used the nnet, broom, and car packages (Venables & Ripley, 2002; Fox & Weisberg,

192  2019; Robinson & Hayes, 2020) in R version 6.3.1 (R-Core-Team, 2019) to run a multinomial

193  logistic regression model and test the effect of each measure of volunteer participation on

194  respondents having a positive, negative, or no opinion change on the creation of MPAs (*Data*

195  *S1*). We used the MNLpred package (Neumann, 2020) to construct predicted probabilities and

196  95% confidence intervals for each opinion change category over levels of participation (*Data*

197  *S1*). Demographics and characteristics of respondents were also compared across opinion change

198  categories.

199

200  **Results**

201      Of the 722 current and former volunteer anglers contacted about the survey, one-hundred

202  and twelve (112) completed and submitted a survey (*Data S1*), for a response rate of 15%. One

203    respondent had not yet volunteered on sampling trips, leaving 111 surveys included in the

204    analysis. Excluding one outlier (24.7 hr), the average time respondents took to complete and

205    submit the survey was 12.4 min (± 6.4 *SD*).

206

207    Volunteer demographics and characteristics

208       The distribution of respondent age was skewed left, with nearly one third of respondents

209    being between 65 and 74 years of age, and the next largest age bracket being 55-64 years old

210    (17%). Most respondents were male (86%); twelve percent (12%) were female. Two percent

211    (2%) of respondents chose the option "I prefer not to say." Respondents had medium to high

212    avidity for saltwater angling, with 40% taking between four and 23 trips a year and 35% taking

213    more than 23 trips a year. Eighteen percent (18%) of respondents said they participated in the

214    MLPA planning process. Of those participating in the MLPA planning process, 90% were

215    characterized as having high or medium angling avidity (45% each).

216       Seventy percent (70%) of volunteer anglers who responded to the survey considered

217    themselves to be more conservation minded than their peers in the recreational fishing

218    community, and an additional 25% thought they were similarly conservation minded with their

219    peers. Sixty-five percent (65%) of respondents did not have any experience in marine resource

220    management, or the recreational or commercial fishing industries. Twenty-four percent (24%)

221    had experience working in the fishing industry sector, and 14% had some experience with

222    marine resource management (there was some overlap between these groups). Forty-five percent

223    (45%) of the respondents had previously fished in areas that are now MPAs. Seventy-four

224    percent (74%) of respondents participated in surveys of both MPA and reference areas during

225    their time as volunteers with CCFRP.

226

227    Volunteer perceptions of groundfish management and stock health

228       Many respondents (52%) believed California groundfish stocks were healthy, while 25%

229    thought they were somewhat unhealthy or very unhealthy; the distribution of responses was

230    similar across related work experience category (Fig. 2A). Nearly four out of five respondents

231    (79%) thought that California groundfish stocks were very well managed, well managed, or

232    adequately managed; 14% believed they were poorly managed, and 2% thought they were very

233 poorly managed. The distribution of responses regarding the management of stocks varied by

234 related work experience. Respondents having no related work experience and respondents with

235 marine resource management experience had a more positive response toward the management

236 of groundfish stocks than respondents having worked in the fishing industry (Fig. 2B).

237      Eighty-five percent (85%) of respondents thought seasonal closures and bag limits were

238 effective fisheries management tools for groundfish stocks, while spatial closures and depth

239 restrictions were considered relatively less effective (Fig. 3A). Negative responses toward the

240 effectiveness of spatial closures and depth restrictions were comprised mostly of respondents

241 with experience working in the fishing industry (Fig. 3B). Respondents with no experience and

242 those with fishing industry experience were least certain about depth restrictions; this type of

243 regulation comprised the highest percentage of "Not sure" responses in these groups (Fig. 3C).

244

245 Motivations for volunteering with CCFRP

246      Nearly all respondents said they plan to continue volunteering with CCFRP (93%). Of those

247 who plan to continue volunteering (N=102), the reasons why they joined the program were the

248 same as the reasons why they continue volunteering with the program (Fig. 4). The most

249 frequently selected reason for continuing to volunteer with CCFRP was the opportunity to

250 participate in science (75%).  Sixty-eight percent (68%) selected "giving back to fisheries

251 resources," and 58% selected "enjoying a day of fishing provided by CCFRP" as key reasons

252 why they both joined the program and why they stay involved (Fig. 4). Several respondents who

253 responded "Other" described desires to help fisheries or help marine resource managers gather

254 data to use in management. Three respondents replied that the opportunity to learn was important

255 to why they joined the program, and an additional three respondents cited learning new

256 information as a reason for continuing to volunteer.

257      Eight respondents (7%) said that they do not plan to continue volunteering with CCFRP.

258 Reasons included lack of available volunteer spots (n = 2), personal health (n = 2), seasickness (n

259 = 1), old age (n = 1), turned into a job (n = 1), and a lack of extra time to volunteer (n =1).

260

### Change in opinions on data quality, MPAs

262     Prior to volunteering with CCFRP, sixty-one percent (61%) of anglers reported having no
263     opinion of the quality of data used for resource management. Of the 39% that did have an
264     opinion (n = 43), 51% reported their participation in CCFRP had positively changed their
265     opinion, while 47% reported their participation had no change on their opinion (Fig. 5). Of those
266     that reported a change in opinion (n = 23), 16 anglers reported the change was more positive, six
267     reported the change went from negative to positive, and one reported the change was more
268     negative.
269     Sixty percent (60%) of volunteer anglers surveyed said that they had positive or
270     somewhat positive opinions of the creation of MPAs before they began volunteering, and 28%
271     said they had somewhat negative or negative opinions of MPA creation in California before
272     volunteering (Fig. 6). Fifteen percent (15%) of respondents said they did not have any opinion of
273     MPAs before joining the program. When volunteers were asked what their opinions were after
274     volunteering with CCFRP, 89% said they had a positive or somewhat positive opinion of MPAs.
275     This large increase in positive opinion was matched by a decrease in somewhat negative and
276     negative opinions, as well as an even greater decrease in those who held no opinion of MPAs
277     from before volunteering with CCFRP to after (Fig. 6A). The proportion of respondents having
278     no change of opinion on the creation of MPAs after volunteering with CCFRP was 48%; these
279     respondents comprised 95% of those having a positive or somewhat positive opinion before
280     participating with CCFRP. Of those respondents having a change of opinion, 46% had a positive
281     change and 5% of respondents had a negative change in opinion of MPAs after volunteering with
282     CCFRP (Fig. 6B).
283     One hundred and seven (107) of the respondents answered all questions related to MPA
284     opinion change and the three calculated measures of participation (length of time since joining
285     the program, number of Volunteer Appreciation and Data Workshops attended, and total number
286     of trips attended). The number of years volunteers participated with CCFRP was nearly
287     uniformly distributed; volunteers who had been with the program since 2007 made up the highest
288     percentage (15%) and newly recruited volunteers (in 2017) followed behind at 12%. Fifty-four
289     percent (54%) of volunteers surveyed never attended an annual Volunteer Appreciation and Data
290     Workshop. Of the 46% who had, most attended one to four workshops. Six percent (6%) of

291   respondents attended five or more workshops. The estimated number of CCFRP trips attended

292   ranged from one trip to 154 trips (median = 8 trips, mean = 17 trips). Seventeen percent (17%) of

293   respondents attended one sampling trip.

294          Length of time since joining CCFRP was the only significant predictor of having a

295   change in opinion regarding MPAs (Table 2). In general, as the time since joining CCFRP

296   increased, a volunteer angler was more likely to have a positive change in opinion on MPAs than

297   having no change in opinion ($RRR$ = 0.82, 95% CI = 0.72, 0.92, $z$ = -0.293, $p$ = 0.003; Fig. 7).

298

299   Demographics and characteristics across opinion change categories

300          Many characteristics of volunteers were similar across opinion change categories,

301   including gender, angler avidity, and conservation mindedness; however, respondents who

302   expressed no opinion change of MPAs tended to be younger than those who had a positive

303   change in opinion of MPAs (Table 3). Those respondents who had previously worked in marine

304   resource management were split between having no change in (positive) opinion and having a

305   positive change in opinion of MPAs (Table 3).

306          The sample size for those who expressed a negative change of opinion toward MPAs

307   consisted of five respondents. Of these, none participated in the MLPA planning process or

308   worked previously in marine resource management. Three had fished in both MPAs and

309   reference sites with CCFRP, but none had visited the same MPA sites with CCFRP that they had

310   fished in before the implementation of MPAs in 2007 (Table 3).

311

312   **Discussion**

313          Our results provide evidence that long-term engagement of stakeholders in collaborative

314   research can positively change angler opinions on MPAs. At the outset, the creators of CCFRP

315   postulated that collaborative research was a "potent mechanism" that could (among other listed

316   benefits) build trust in fisheries management and develop a more accurate consensus about

317   resource status (Wendt & Starr, 2009). These anticipated outcomes are directly linked to the

318   collaborative nature of the program, where participants are working together toward a shared

319   goal (Wendt & Starr, 2009; Yochum, Starr & Wendt, 2011). CCFRP straddles two modes of

320   public engagement in science: collaborative fisheries research and citizen science. In so doing, it

321   draws from a long history of scientists partnering with members of the fishing industry to study

322   fish populations or develop management tools (Hartley & Robertson, 2009; Mireles, Nakamura

323   & Wendt, 2012; Gleason, Iudicello & Caselle, 2017). Citizen science – also called community-

324   based or participatory science – involves members of the public who are not scientists by trade

325   (Mckinley et al., 2017), and it differs from collaborative fisheries research in that the volunteers

326   are not necessarily part of the fishing industry. While the partnership between CCFRP and

327   CPFVs follows a more traditional collaborative fisheries research model, the inclusion of the

328   angling public distinguishes CCFRP as having successfully integrated citizen science into

329   collaborative fisheries research.

330

## 331   CCFRP volunteers are mostly older, avid anglers

332        CCFRP volunteers who responded to our survey were representative of fresh and

333   saltwater anglers in California (mostly men); however, they were relatively older. Forty-nine

334   percent (49%) of the larger angling community are between 18 and 44 years old and less than

335   4% are 65 or older (US Fish and Wildlife Service, 2011). In contrast, 18 to 44-year-olds made up

336   less than a third of our angler respondents, and 40% were over the age of 65. CCFRP surveys

337   occur only on weekdays, of which older, retired adults are more likely to be free for volunteering

338   compared to younger anglers. This older demographic may have influenced the proportional

339   distributions of certain volunteer characteristics such as angler avidity (i.e. more time for fishing

340   opportunities) and perceptions that could be influenced by having a more historical perspective

341   (e.g., stock health). Our survey did not include questions regarding household income or

342   ethnicity.

343        Relative to saltwater recreational anglers on the West Coast of the United States (Rubio,

344   Brinson & Wallmo, 2014), CCFRP volunteer anglers surveyed in our study had higher fishing

345   avidity, having on average participated in a higher number of fishing trips (non CCFRP-related)

346   in the last year. Anglers with high fishing avidity have a greater stake in fisheries management

347   decisions. For instance, in a 2014 survey of saltwater recreational anglers, angler avidity was

348   positively correlated with perceived importance of ensuring "that the opinions of all recreational

349   fisheries stakeholders are considered in policy-making" (Rubio, Brinson & Wallmo, 2014).

350   While our volunteers were not asked to report their opinions on the importance of stakeholder

351    input in policy making, we found that avid CCFRP volunteer angler respondents were more

352    likely to have participated in the MLPA planning process.

353         Levels of public participation in the California MLPA planning process were very high,

354    with over 4,000 members of the public attending planning-related events and over 70,000 public

355    comments submitted during the process and environmental review (Gleason et al., 2013). Still,

356    with over 39 million residents in California ("United States Census Bureau QuickFacts:

357    California," 2017), this is a relatively small proportion of participants. In our study, one in five

358    CCFRP survey respondents participated in the MLPA in some form, making them more engaged

359    than the average resident. Perhaps not surprisingly, about one third of our respondents who

360    participated in the MLPA were marine resource managers, however not all of those who had

361    worked in marine resource management participated in the MLPA.

362         We found that CCFRP has successfully engaged members of the general public, as two

363    thirds of respondents had no work experience related to either marine management or the fishing

364    industry. Although the general audience targeted for volunteer angler recruitment was

365    recreational anglers (Wendt & Starr, 2009), the experience of fishing side-by-side with people

366    from different professional backgrounds may aid in the relationship-building that is an important

367    cornerstone of the program.

368

## CCFRP volunteer anglers are motivated by science and conservation

369

370         Part of CCFRP's success in relationship building is evidenced by the willingness of

371    anglers to want to continue to participate in the program year after year. Most respondents said

372    they plan to continue volunteering. There were 140-150 volunteer anglers that participated in the

373    2017 sampling season between the two programs ("Volunteer Appreciation Event & Data

374    Workshop," 2018), so it is likely that the 111 respondents in our study represent an accurate

375    sample of those who plan to continue with the program. The reasons respondents chose to stay

376    with the program were the same three reasons they cited for joining CCFRP in the first place: (a)

377    to participate in science; (b) to give back to fisheries resources; and (c) to enjoy a day of fishing

378    provided by CCFRP. These responses demonstrate that CCFRP anglers are not solely driven by

379    the novelty of fishing inside MPAs, but by their interest in being involved in fisheries research.

380    A handful of respondents were high school teachers who responded that learning was a motivator

381    for why they joined. Three other respondents listed learning as a motivator for why they stayed.

382   Across marine and coastal citizen science projects, increasing knowledge is often a frequent

383   motivation for volunteering (Thiel et al., 2014).

384

385   ## Volunteer angler consensus on groundfish health and management

386        A lack of transparency between fishery managers and the fishing community has often

387   led to angler distrust of fishery assessments and management measures (Yochum, Starr &

388   Wendt, 2011); thus, one goal of collaborative fisheries research is garnering accurate consensus

389   among the fishing community regarding resource health. In this study, most CCFRP respondents,

390   regardless of their related work experience (including no related experience), believed

391   groundfish stocks were somewhat healthy. This is a relatively accurate assessment considering

392   most species of fish comprising the groundfish fishery in California are rockfish. While many

393   West Coast rockfish stocks were collapsed and designated overfished at the turn of the 21st

394   century (Pacific Fishery Management Council, 2008), many have since rebuilt, and several are

395   rebuilding (NOAA Fisheries, 2019). The agreement that groundfish stocks are somewhat

396   healthy, regardless of related work experience, suggests that there is accurate consensus of

397   resource status among these groups. Although not explicitly addressed in our survey, it seems

398   likely that CCFRP volunteer participation influenced these angler perceptions over time. It is

399   also possible CCFRP volunteer perceptions regarding groundfish stock health are influenced by

400   historical perspectives, as older respondents are more likely to have participated in groundfish

401   fishing prior to the collapse and subsequent recovery of many rockfish stocks. In another survey

402   of the iconic saltwater bass fishery in southern California, fishermen with more years of

403   experience (and typically older in age) were more likely to have an accurate perception of stock

404   health (Bellquist et al., 2017). In our survey, the proportion of younger respondents who had a

405   "neutral" opinion regarding groundfish stocks was higher than that of the older respondents.

406        Most (79%) respondents thought groundfish stocks were well-managed. Many (65%)

407   believed spatial closures (including MPAs) were effective in ensuring healthy groundfish stocks

408   in California, though catch limits and season closures had higher support (85% each); 21% were

409   "unsure" and 14% believed spatial management to be "not effective." Most of the uncertainty

410   and negative opinion of spatial management was by respondents having worked in the fishing

411   industry. However, depth restrictions were least popular among all related work experience

412   categories and garnered the greatest amount of uncertainty. Depth restrictions for groundfish in

413  central California prohibit fishing in waters greater than 50 fathoms (91.4 m) and were intended

414  to assist in rebuilding overfished rockfish stocks such as Canary Rockfish (*Sebastes pinniger*)

415  and Yelloweye Rockfish (*Sebastes ruberrimus*). However, fishing these depths for other popular

416  recreational groundfishes in central California (e.g., Lingcod (*Ophiodon elongatus*), Cabezon

417  (*Scorpaenichthys marmoratus*), and Greenlings (Family Hexagrammidae) is also precluded by

418  this regulation, and could be driving some of the uncertainty among respondents. In addition,

419  although Canary Rockfish was rebuilt in 2015 (Thorson & Wetzel, 2015), Yelloweye Rockfish

420  remains in rebuilding status (Gertseva & Cope, 2017). Interestingly, except for depth restrictions,

421  the relative proportion of respondents stating groundfish management measures are effective was

422  similar across regulations and related work experience categories.

423      The focus of CCFRP is not to educate anglers on groundfish management and

424  regulations. However, because groundfish regulations include mandatory release of overfished

425  rockfish species, CCFRP does actively work to increase angler awareness of the susceptibility of

426  rockfishes to pressure-related (i.e. depth-related) injuries associated with angling and the utility

427  of recompression (i.e., releasing fish back to depth). Generally, fishing deeper results in an

428  increased susceptibility to barotrauma and decreased survival rates of rockfishes; thus, CCFRP

429  protocol has always restricted captains to fish areas in depths less than 36.7 m (120 ft).

430  Additionally, CCFRP science crew release fish showing signs of barotrauma back to depth with

431  descending devices since recompression alleviates signs of barotrauma and significantly

432  increases release survival of many rockfishes (Jarvis & Lowe, 2008; Hannah, Rankin & Blume,

433  2012). These measures ultimately promote ethical rockfish angling practices.

434

435  CCFRP positively influences opinions on data quality, MPAs

436      In addition to outreach, a typical day on the water provides CCFRP volunteers

437  opportunities to observe how data are collected. Important survey protocol details are relayed to

438  CCFRP volunteer anglers on each day's pre-survey briefing. At the end of the day, the science

439  crew debriefs the anglers on overall fish count, fish counts by angler, and biggest and smallest

440  fish caught, etc. Thus, although the anglers do not assist with recording data, the anglers are

441  immediately able to informally verify the data collected that day, based on their own

442  observations and recollections. Prior to volunteering with CCFRP, most respondents did not have

443  an opinion of the data used in resource management; however, after participation with CCFRP,

444    the majority of those with an opinion changed their opinion to more positive. Building trust in

445    the quality of data used for management is an important step toward increasing angler

446    perceptions of groundfish management measures, including MPAs. It is also worth noting that

447    anglers with high avidity serve CCFRP by providing highly experienced angling services, and

448    likely relatively high consistency in angler skill levels, all positively influencing data quality.

449        The majority of CCFRP volunteers responding to our survey identified themselves as

450    being more conservation-minded than their peers, and this may explain why CCFRP volunteers

451    generally had positive opinions toward the creation of California MPAs before participation with

452    CCFRP. However, many of those who had negative opinions of MPAs, or no opinion at all,

453    gained a positive opinion of them after volunteering with CCFRP. This increase in positive

454    perceptions of MPAs mirrors the perceptions of California's general public. In 2017, more than

455    three in four Californians said that it was very important that California have MPAs; a 20 point

456    increase since 2006 (Baldassare et al., 2007, 2017). Thus, there appears to be an increase in

457    support for MPAs across the state in the last ten years, including among CCFRP volunteers.

458

459    Time with CCFRP influences positive change in opinion of MPAs

460        A positive change of opinion toward MPAs was directly related to the number of years

461    since respondents joined CCFRP. Other measures of participation, including the number of

462    Volunteer Appreciation and Data Workshops or the number of CCFRP trips attended, were not

463    significantly related to MPA opinion change, indicating that change in angler perceptions takes

464    time. In this study, the length of time necessary to achieve a greater than fifty percent (50%)

465    probability of having a positive change in opinion on MPAs was about seven years since joining

466    CCFRP. Long-term stakeholder engagement with CCFRP corresponds with a longer period

467    directly and indirectly gaining knowledge and awareness of MPAs through participation in

468    survey trips and through CCFRP communications, including e-mails, e-newsletters, and posts on

469    social media. Although Volunteer Appreciation and Data Workshops are arguably an important

470    part of CCFRP's relationship building and outreach tools, it is often lived experiences that are

471    more salient and have more impact on people's knowledge, attitudes, and perceptions.

472        In 2017, CCFRP was expanded statewide, and now includes a partnership of six

473    academic institutions that lead and organize surveys to actively monitor 14 MPAs in California

474    (Moss Landing Marine Laboraties, 2020). Between 2017 and 2019, eight-hundred and ninety-

475    eight (898) CCFRP volunteer anglers assisted science crew and CPFV captains/crew in

476    surveying 77,202 fish representing 94 species statewide (R Brooks, 2020, pers. comm.). This

477    large expansion of the program offers additional opportunity to learn about (a) demographics and

478    characteristics of the fishing industry sector of CCFRP (CFPV captains and crew), (b) how

479    demographics and characteristics compare by region within and among stakeholder groups, and

480    (c) whether CCFRP has had differential influence on MPA perceptions across stakeholder

481    groups. Bringing increased awareness of the social dimensions of stakeholders involved in

482    collaborative fisheries research can only serve to continue to build relationships, create buy-in on

483    management measures, and offer insights into areas of outreach that may need improvement.

484

485    ## Conclusions

486        Our survey highlights CCFRP as a model for incorporating citizen science into

487    collaborative fisheries research by capturing the realized benefits of collaborating with the

488    angling public. We have a clearer view of who CCFRP volunteers are as a group, and how

489    participation in the program has shaped their perspectives. CCFRP volunteers are older and have

490    a higher fishing avidity than the broader recreational angling community in California. Although

491    they represent a heterogeneous group in terms of experience with related industry sectors, their

492    perceptions of groundfish stock health and management are generally in agreement. Overall,

493    these volunteers have a positive view of the data collected for resource management and the

494    MPAs they help to monitor, that can be attributed, in part, to long-term participation in the

495    program. Most notably, a positive change in opinion on MPAs was more likely to occur only

496    after considerable time engaged with CCFRP (i.e. 7+ years). Future endeavors to develop new

497    citizen science partnerships with collaborative fisheries research programs, in which to achieve

498    similar benefits as CCFRP (e.g., building stewardship and advocacy), should focus not only on

499    recruiting as many volunteers as possible, but in retaining those volunteers for as long as

500    possible.

501

502    ## Acknowledgements

503        This manuscript is based on A. Kellum's Master of Advanced Studies (MAS) Capstone

504    Project at Scripps Institution of Oceanography, UC San Diego. E. Brazier assisted with survey

505    design and analysis. T. Courtney, L. Waterhouse, N. Rosen, A. Siddall, L. Bellquist, and L.

506    Oremland provided technical expertise and advice. The staff, captains, and crews of Central

507    Coast Sportfishing, Morro Bay Landing, Patriot Sportfishing, and Virg's Landing provided

508    research survey support to Cal Poly while those of Tigerfish Sportfishing, Huli Cat Sportfishing,

509    Kahuna Sportfishing, and J & M Sportfishing provided survey support to MLML. We are

510    indebted to all the Central Coast CCFRP volunteer anglers, past and present, for their dedication

511    to CCFRP and to those respondents who took the time to participate in our survey.

512

513    **References**

514

515    Baldassare M, Bonner D, Kordus D, Lopes L. 2017. *PPIC Statewide Survey: Californians and*

516        *the environment*. San Francisco.

517    Baldassare M, Bonner D, Paluch J, Petek S. 2007. *PPIC Statewide Survey: Californians and the*

518        *environment*.

519    Bellquist L, Semmens B, Stohs S, Siddall A. 2017. Impacts of recently implemented recreational

520        fisheries regulations on the Commercial Passenger Fishing Vessel fishery for Paralabrax sp.

521        in California. *Marine Policy* 86:134–143. DOI: 10.1016/j.marpol.2017.09.017.

522    California. *Fish and Game Code*. Sacramento.

523    Fox E, Poncelet E, Connor D, Vasques J, Ugoretz J, McCreary S, Monié D, Harty M, Gleason

524        M. 2013. Adapting stakeholder processes to region-specific challenges in marine protected

525        area network planning. *Ocean & Coastal Management* 74:24–33. DOI:

526        http://dx.doi.org/10.1016/j.ocecoaman.2012.07.008.

527    Fox J, Weisberg S. 2019. *An {R} Companion to Applied Regression.* Thousand Oaks, California:

528        Sage.

529    Gall SC, Rodwell LD. 2016. Evaluating the social acceptability of Marine Protected Areas.

530        *Marine Policy* 65:30–38. DOI: 10.1016/j.marpol.2015.12.004.

531    Gertseva V, Cope JM. 2017. *Stock assessment of the yelloweye rockfish (Sebastes ruberrimus) in*

532        *state and Federal waters off California , Oregon and Washington*.

533    Gleason M, Fox E, Ashcraft S, Vasques J, Whiteman E, Serpa P, Saarman E, Caldwell M,

534        Frimodig A, Miller-Henson M, Kirlin J, Ota B, Pope E, Weber M, Wiseman K. 2013.

535        Designing a network of marine protected areas in California: Achievements, costs, lessons

536        learned, and challenges ahead. *Ocean and Coastal Management* 74:90–101. DOI:

537        10.1016/j.ocecoaman.2012.08.013.

538    Gleason M, Iudicello S, Caselle J. 2017. *Collaborative Fisheries Research in California: a*

539        *Situational Analysis*.

540    Gleason M, McCreary S, Miller-Henson M, Ugoretz J, Fox E, Merrifield M, McClintock W,

541        Serpa P, Hoffman K. 2010. Science-based and stakeholder-driven marine protected area

542        network planning: A successful case study from north central California. *Ocean and*

543        *Coastal Management* 53:52–68. DOI: 10.1016/j.ocecoaman.2009.12.001.

544    Hannah RW, Rankin PS, Blume MTO. 2012. Use of a novel cage system to measure

545        postrecompression survival of Northeast Pacific rockfish. *Marine and Coastal Fisheries*

546        4:46–56. DOI: 10.1080/19425120.2012.655849.

547    Hartley TW, Robertson RA. 2009. Stakeholder Collaboration in Fisheries Research: Integrating

548        Knowledge Among Fishing Leaders and Science Partners in Northern New England.

549        *Society and Natural Resources* 22:42–55. DOI: 10.1080/08941920802001010.

550    Jarvis ET, Lowe CG. 2008. The effects of barotrauma on the catch-and-release survival of

551        southern California nearshore and shelf rockfish (Scorpaenidae, Sebastes spp.). *Canadian*

552        *Journal of Fisheries and Aquatic Sciences* 65:1286–1296. DOI: 10.1139/F08-071.

553    Kirlin J, Caldwell M, Gleason M, Weber M, Ugoretz J, Fox E, Miller-Henson M. 2013.

554        California's Marine Life Protection Act Initiative: Supporting implementation of legislation

555        establishing a statewide network of marine protected areas. *Ocean and Coastal*

556        *Management* 74:3–13. DOI: 10.1016/j.ocecoaman.2012.08.015.

557    Loper CE. 2008. Valuing Networks of Marine Reserves: An Assessment of Recreational Users'

558        Preferences for Marine Conservation in California's Channel Islands. University of

559        Delaware.

560    Mckinley DC, Miller-rushing AJ, Ballard HL, Bonney R, Brown H, Cook-Patton SC, Evans DM,

561        French RA, Parrish JK, Phillips TB, Ryan SF, Shanley LA, Shirk JL, Stepenuck KF,

562        Weltzin JF, Wiggins A, Boyle OD, Briggs RD, Chapin SF, Hewitt DA, Preuss PW, Soukup

563        MA. 2017. Citizen science can improve conservation science, natural resource management,

564        and environmental protection. *Biological Conservation* 208:15–28. DOI:

565        10.1016/j.biocon.2016.05.015.

566    Mireles C, Nakamura R, Wendt DE. 2012. A collaborative approach to investigate site fidelity,

567        home range, and homing behavior of cabezon (Scorpaenichthys marmoratus). *Fisheries*

568      *Research* 113:133–142. DOI: 10.1016/j.fishres.2011.10.008.

569     Neumann M. 2020. MNLpred - Simulated Predicted Probabilities for Multinomial Logit Models

570      (Version 0.0.2).

571     NOAA Fisheries. 2019. *Status of Stocks 2018, Annual Report to Congress on the Status of U.S.*

572      *Fisheries*.

573     Ordoñez-Gauger L, Richmond L, Hackett S, Chen C. 2018. It's a trust thing: Assessing

574      fishermen's perceptions of the California North Coast marine protected area network.

575      *Ocean and Coastal Management* 158:144–153. DOI: 10.1016/j.ocecoaman.2018.03.034.

576     OST, CDFW, OPC. 2012. *State of the California Central Coast: Results from Baseline*

577      *Monitoring of Marine Protected Areas 2007–2012*.

578     OST, CDFW, OPC. 2017. *State of the California South Coast: Summary of Findings from*

579      *Baseline Monitoring of Marine Protected Areas, 2011–2015*.

580     Pacific Fishery Management Council. 2008. Pacific Coast Groundfish Fishery Stock Assessment

581      and Fishery Evaluation, Volume 1. :1–235.

582     Pomeroy R, Douvere F. 2008. The engagement of stakeholders in the marine spatial planning

583      process. *Marine Policy* 32:816–822. DOI: 10.1016/j.marpol.2008.03.017.

584     R-Core-Team. 2019. R: A language and environment for statistical computing.

585     Robinson D, Hayes A. 2020. broom: Convert Statistical Analysis Objects into Tidy Tibbles.

586     Rubio G, Brinson AA, Wallmo K. 2014. *Attitudes and Preferences of Saltwater Recreational*

587      *Anglers: Report from the 2013 National Saltwater Angler Survey, Volume II Regional*

588      *Analysis*.

589     Starr RM, Wendt DE, Barnes CL, Marks CI, Malone D, Waltz G, Schmidt KT, Chiu J, Launer

590      AL, Hall NC, Yochum N. 2015. Variation in Responses of Fishes across Multiple Reserves

591      within a Network of Marine Protected Areas in Temperate Waters. *PLoS ONE* 10:1–24.

592      DOI: 10.1371/journal.pone.0118502.

593     Thiel M, Penna-Diaz MA, Luna-Jorquera G, Salas S, Sellanes J, Stotz W. 2014. Citizen

594      Scientists and Marine Research: Volunteer Participants, Their Contributions, and Projection

595      for the Future. *Oceanography and Marine Biology: An Annual Review*:257–314. DOI:

596      10.1201/b17143-6.

597     Thorson JT, Wetzel C. 2015. *The status of canary rockfish (Sebastes pinniger) in the California*

598      *Current in 2015*.

599    United States Census Bureau QuickFacts: California. 2017. *Available at*

600       *https://www.census.gov/quickfacts/CA* (accessed January 29, 2020).

601    US Fish and Wildlife Service. 2011. *2011 National Survey of Fishing, Hunting, and Wildlife-*

602       *Associated Recreation: California*.

603    Venables WN, Ripley BD. 2002. Package "nnet." *Modern Applied Statistics with S.*

604    Volunteer Appreciation Event & Data Workshop. 2018. *Available at*

605       *https://www.mlml.calstate.edu/ccfrp/wp-content/uploads/sites/57/2017/09/2018-MLML-*

606       *CCFRP-Workshop.pdf* (accessed January 29, 2020).

607    Wendt DE, Starr RM. 2009. Collaborative Research: An Effective Way to Collect Data for Stock

608       Assessments and Evaluate Marine Protected Areas in California. *Marine and Coastal*

609       *Fisheries: Dynamis, Management, and Ecosystem Science* 1:315–324. DOI: 10.1577/C08-

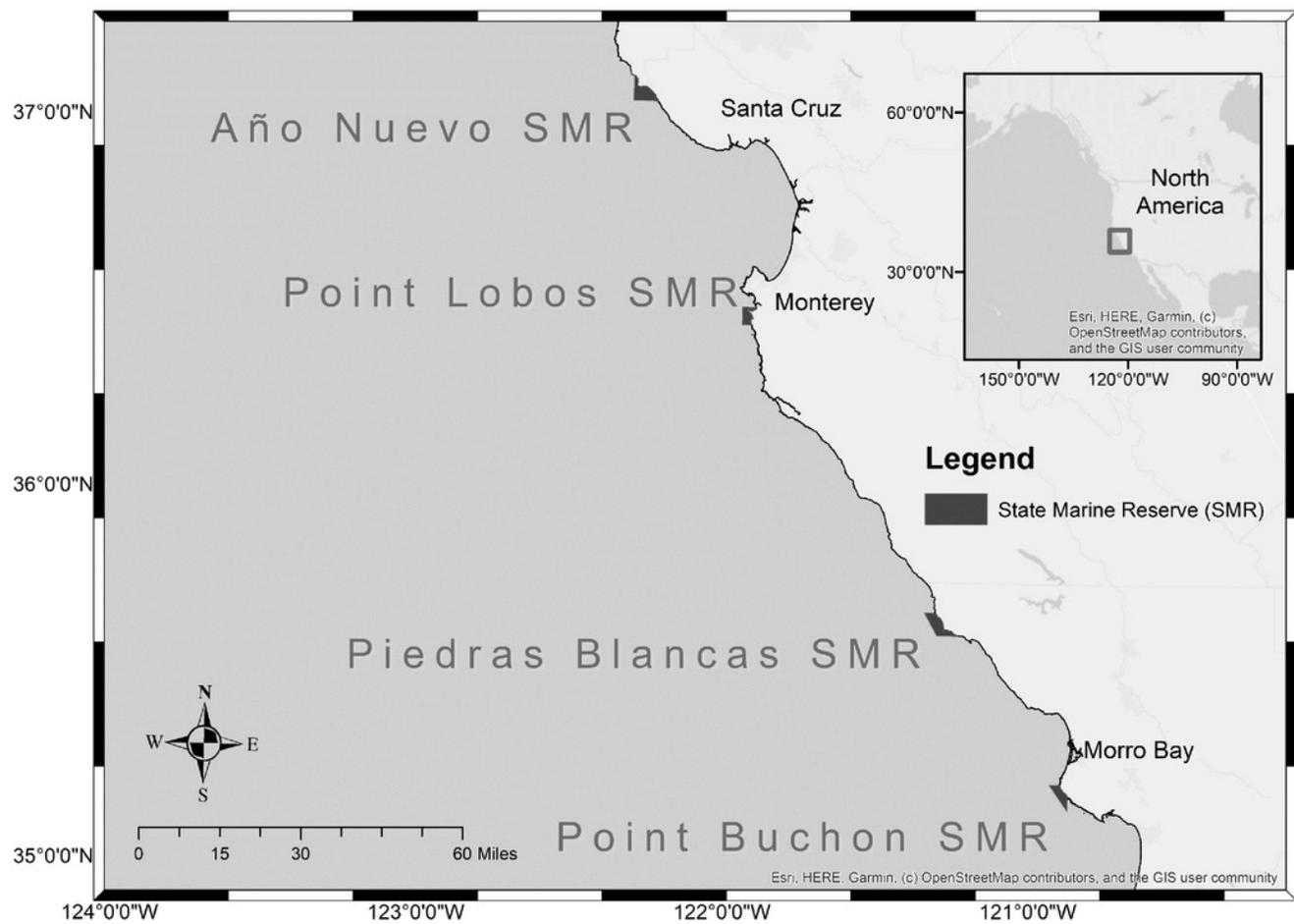
610       054.1.

611    Yochum N, Starr RM, Wendt DE. 2011. Utilizing Fishermen Knowledge and Expertise: Keys to

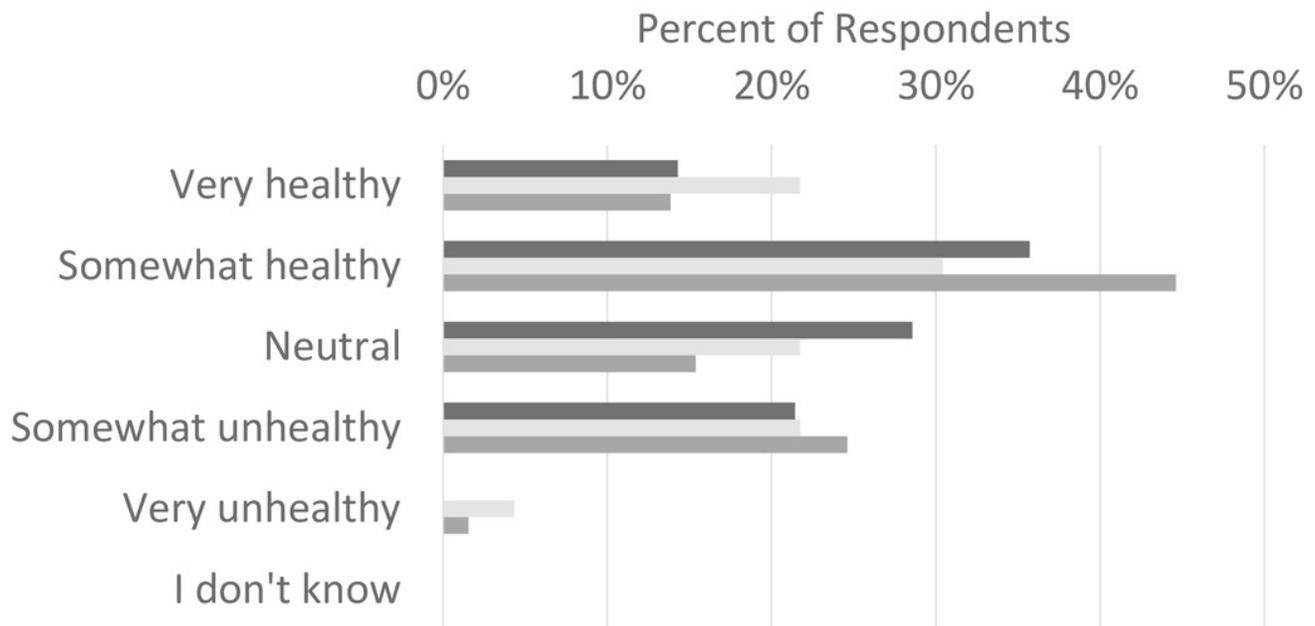
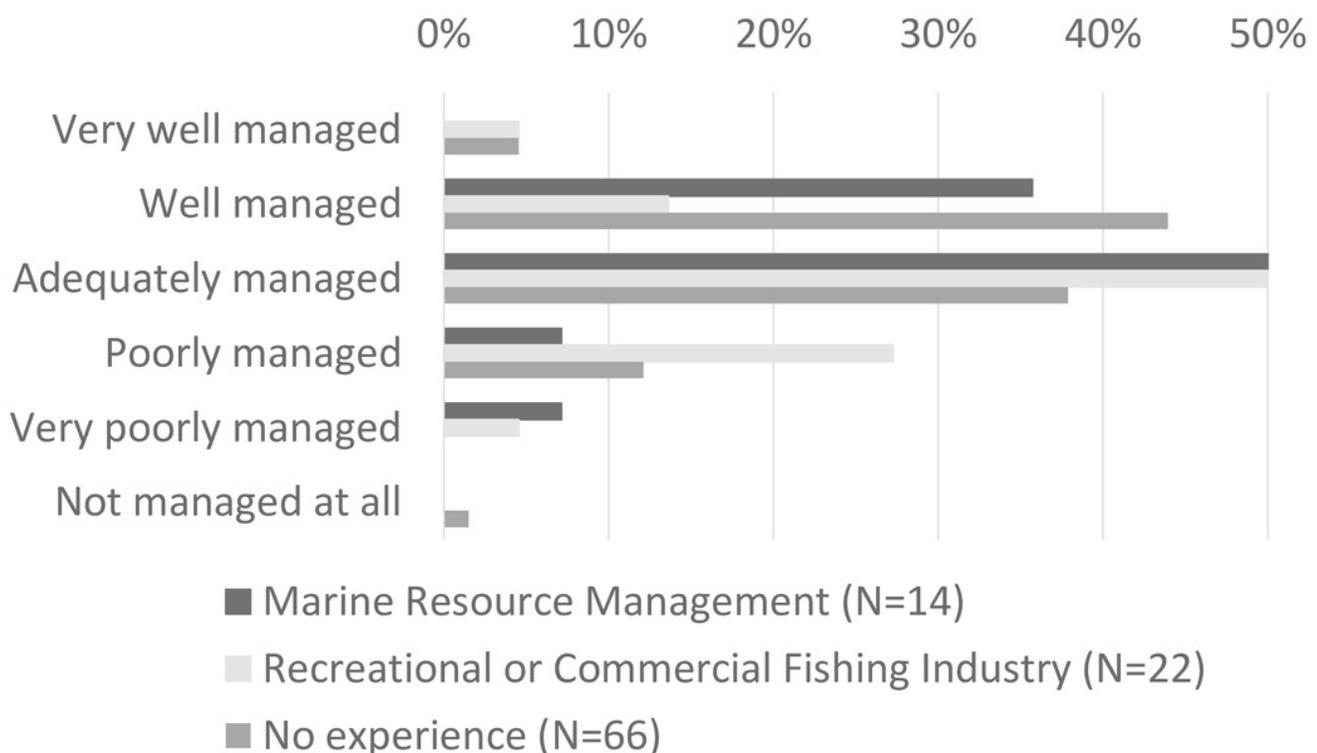
612       Success for Collaborative Fisheries Research. *Fisheries* 36:593–605. DOI:

613       10.1080/03632415.2011.633467.

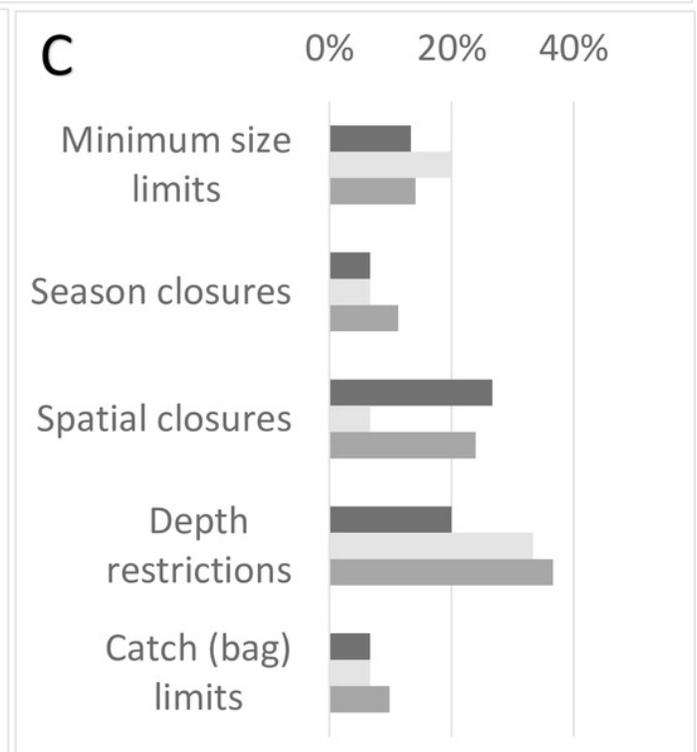
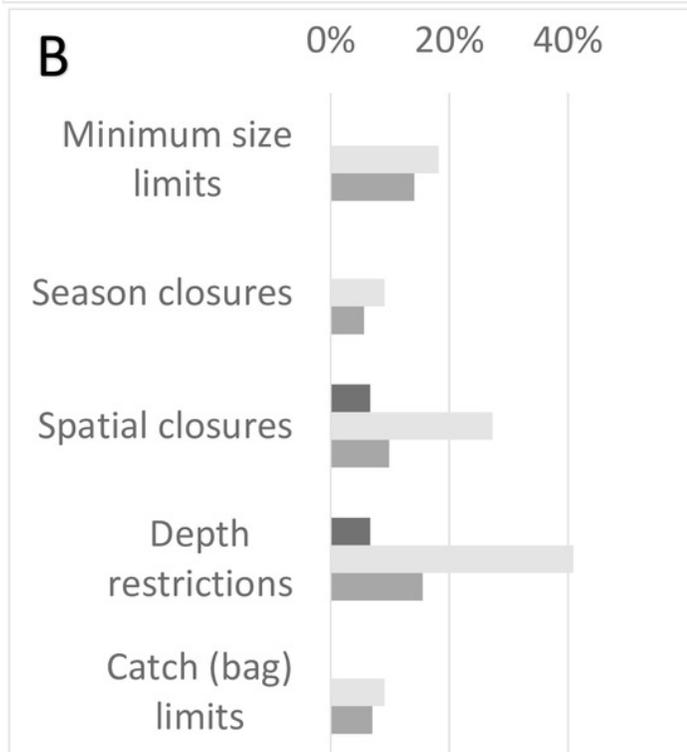
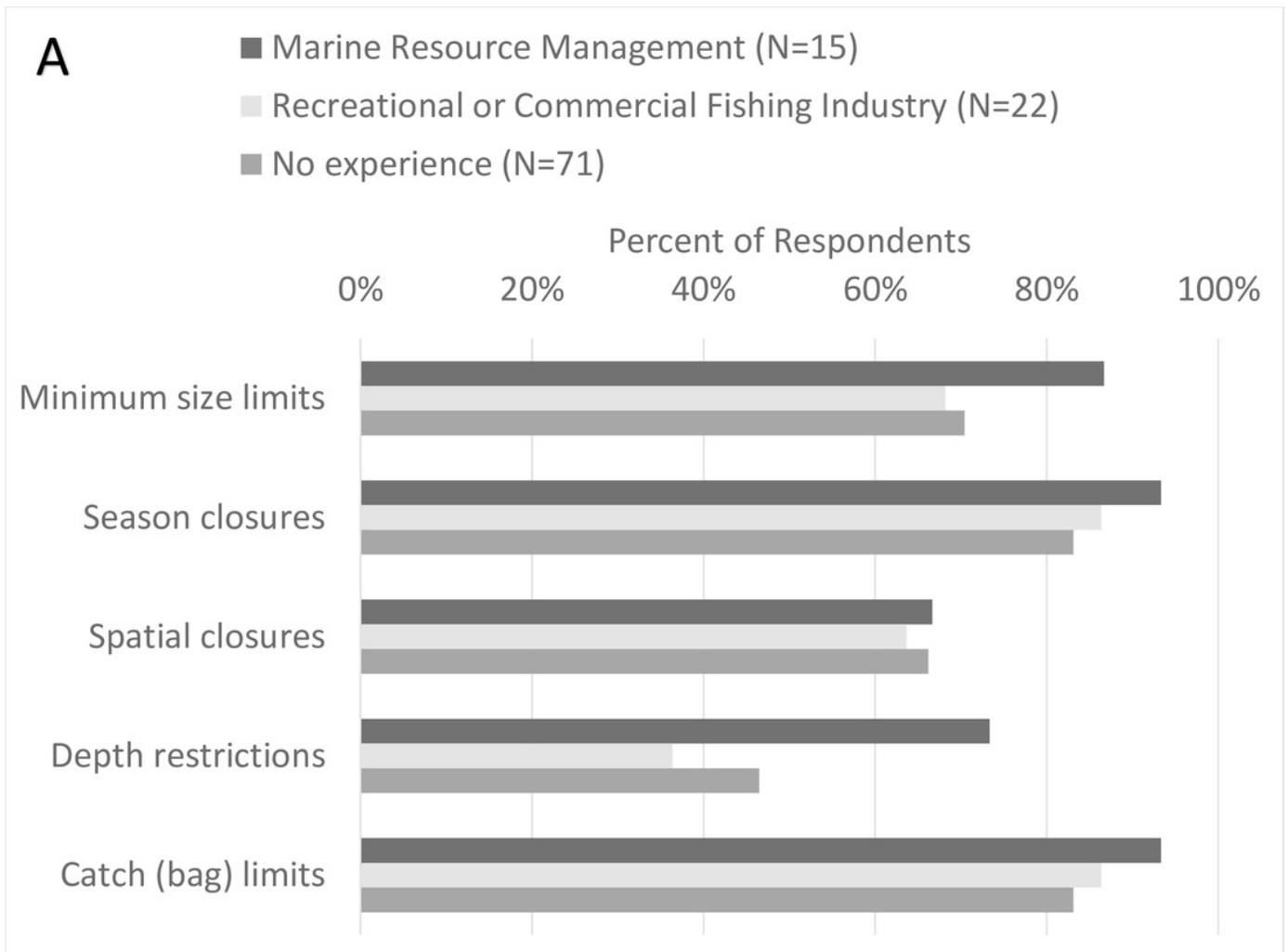
# Figure 1

Marine Protected Areas in central California monitored by CCFRP between 2007 and 2016.

# Figure 2

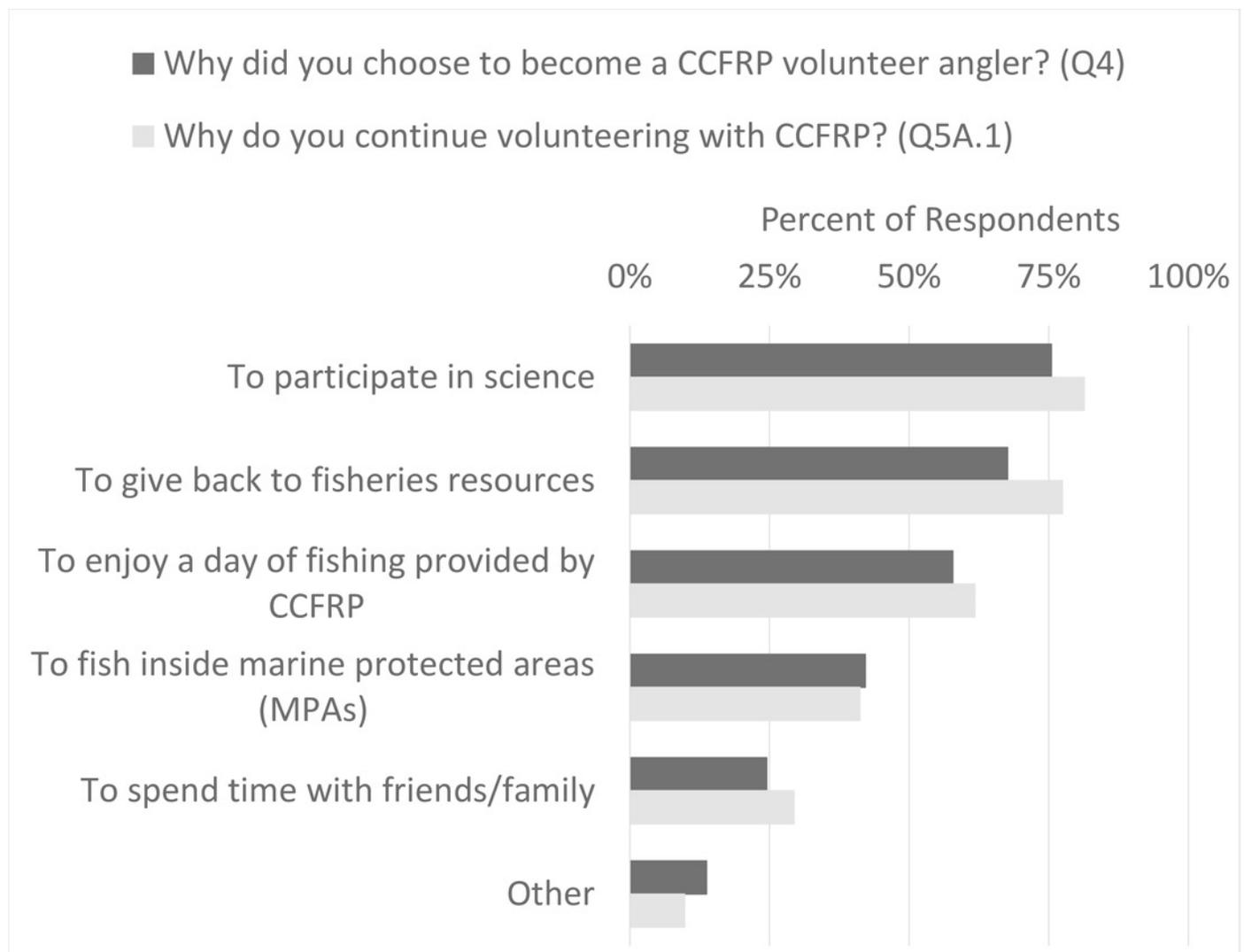
Comparison of CCFRP volunteer angler opinions on California groundfish health and management relative to their related work experience.

(A) Percentage distribution of survey respondent opinions on the health of California groundfish stocks. (B) Percentage distribution of survey respondent opinions on California groundfish management. The distribution of angler responses is reported relative to their related work experience (fisheries management, fishing industry, no experience).

# Figure 3

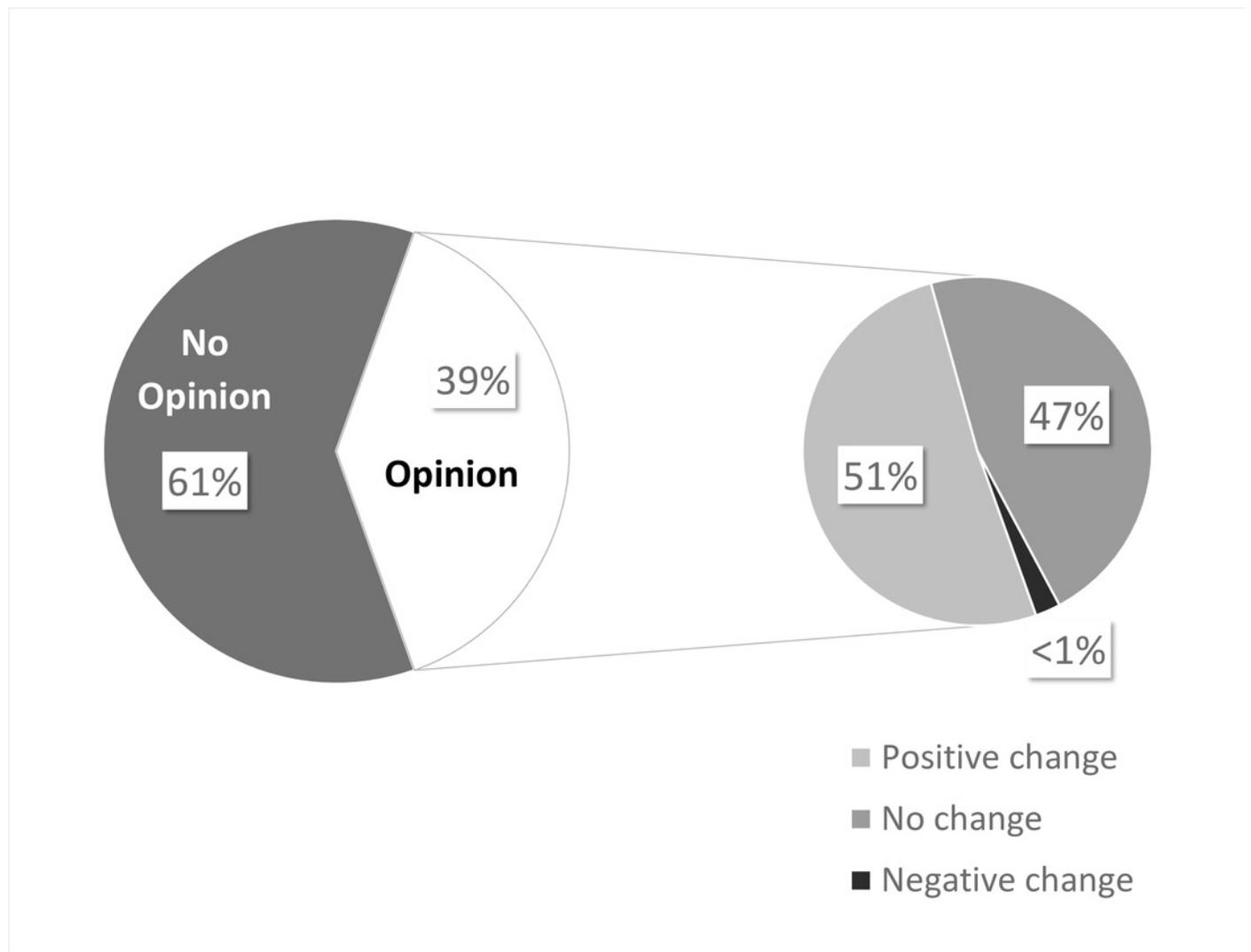
Comparison of CCFRP volunteer angler opinions on California groundfish management strategies relative to their related work experience.

(A) Percentage distribution of survey respondents who believe California groundfish management strategies to be "Effective". (B) Percentage distribution of those who believe them to be "Not effective". (C) Percentage distribution of those who responded "Not sure." The distribution of angler responses is reported relative to their related work experience (fisheries management, fishing industry, no experience).

# Figure 4

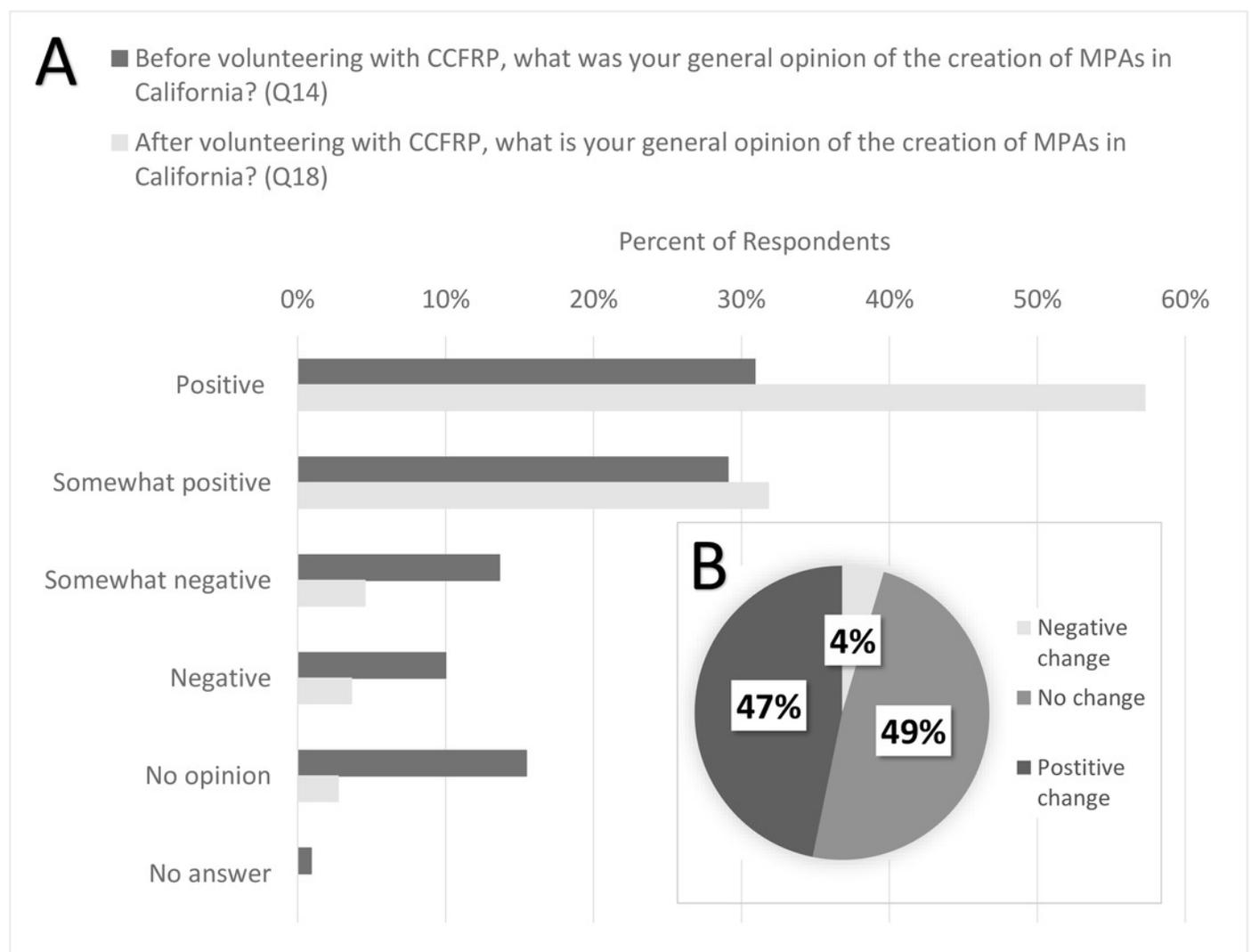
Volunteer angler motivations to join CCFRP and to continue volunteering with the program.

Percentage distribution of the reasons why survey respondents joined CCFRP and why they continue with the program (only showing responses of volunteers who plan to continue, N=102).

# Figure 5

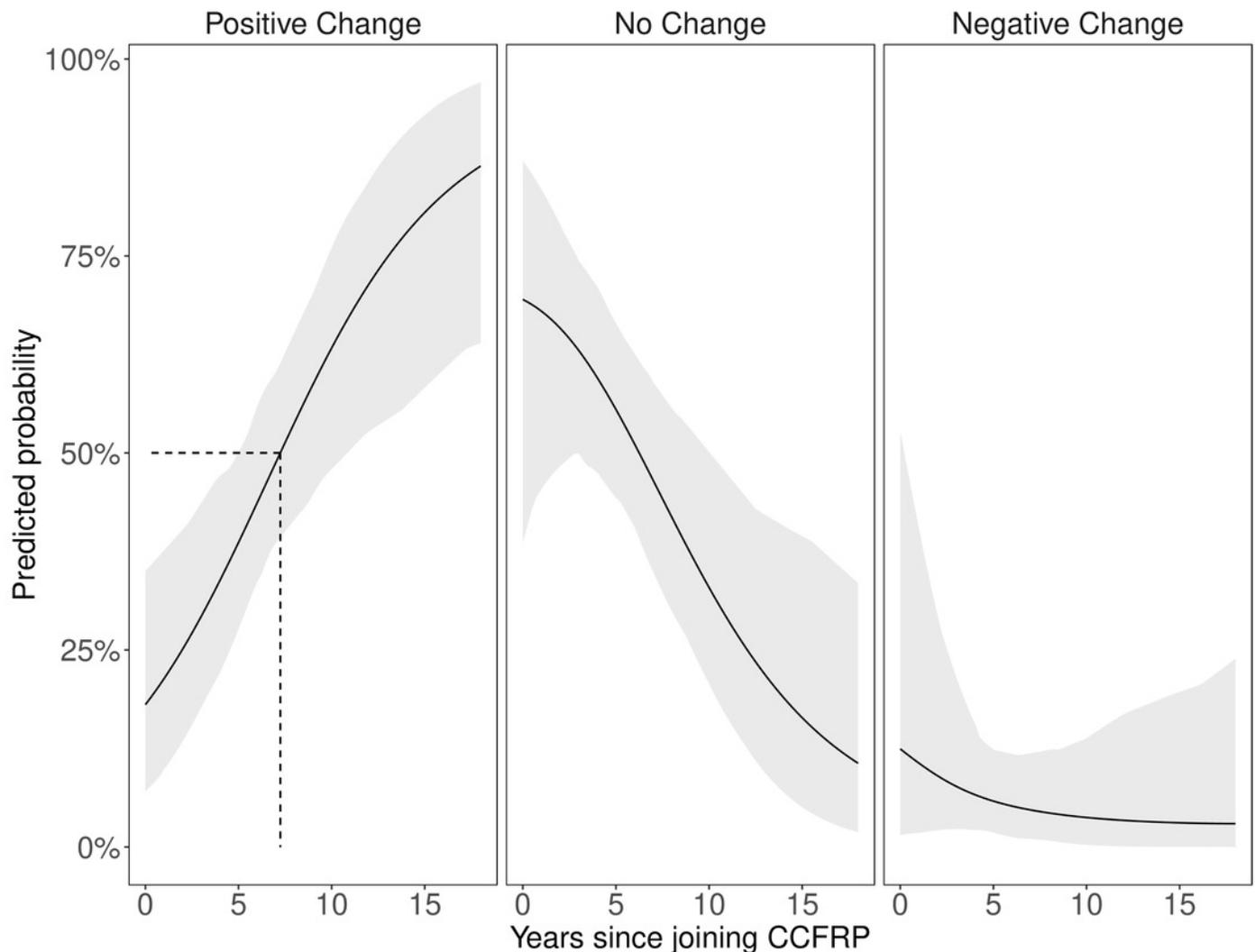
Change in opinion of CCFRP volunteer anglers on the quality of data used in fisheries resource management.

Percent of CCFRP volunteer angler survey respondents (N = 110) who had an opinion (or no opinion) on the quality of data used in fishery resource management before becoming CCFRP volunteers (left), and of those respondents who had an opinion, the percent whose opinions changed positively, negatively, or not at all, after volunteering with CCFRP (right).

# Figure 6

CCFRP volunteer angler opinions on MPAs.

(A) Percentage distribution of survey respondent opinions on MPAs before and after volunteering with CCFRP. (B) Overall percent of survey respondents having a positive, negative, or no change in opinion on MPAs after becoming CCFRP volunteers.

# Figure 7

Predicted probability of CCFRP volunteer anglers having an opinion change on MPAs.

Predicted probability (± 95% CIs) of a CCFRP volunteer angler having a positive change in opinion, no change in opinion, and negative change in opinion on MPAs relative to the length of time (years) since joining CCFRP. The dashed line relates the length of time when the probability of having a positive change in opinion on MPAs becomes greater than or equal to 50% (= 7.25 years).

Demographics and characteristics of CCFRP volunteer angler survey respondents.

| Category | Number of Respondents | Percent of Respondents |
|---|---|---|
| *Age* | | |
| 18-24 | 3 | 3% |
| 25-34 | 16 | 15% |
| 35-44 | 11 | 10% |
| 45-54 | 17 | 15% |
| 55-64 | 19 | 17% |
| 65-74 | 35 | 32% |
| 75+ | 9 | 8% |
| *Gender[a]* | | |
| Male | 95 | 86% |
| Female | 13 | 12% |
| *Angler avidity[b]* | | |
| Low | 27 | 25% |
| Medium | 44 | 40% |
| High | 38 | 35% |
| *Participated in the MLPA planning process* | | |
| Yes | 20 | 18% |
| No | 90 | 82% |
| *Conservation Mindedness[c]* | | |
| More | 77 | 70% |
| Similar | 27 | 25% |
| Less | 1 | 1% |
| *Related work experience[d]* | | |
| Recreational fishing only | 12 | 11% |
| Commercial fishing only | 3 | 3% |
| Marine resource management only | 11 | 10% |
| Management and Commercial | 0 | - |
| Management and Recreational | 2 | 2% |
| Recreational and Commercial | 7 | 6% |
| All three | 2 | 2% |
| None | 71 | 65% |
| *Fished and sampled at CCFRP sites before and after MPA creation* | | |
| Yes | 36 | 33% |
| No | 74 | 67% |
| *Total* | 110 | 100% |

[a] The 2 respondents who selected the choice "I prefer not to say" were not included.
[b] The 1 respondent who did not answer this question was not included.
[c] The 5 respondents who did not answer this question were not included.
[d] The 2 respondents who had incomplete answers for these questions were not included.

Likelihood ratio tests of the multinomial logistic regression model of change in opinion on MPAs relative to measures of volunteer angler participation with CCFRP.

Italics denote significant p-values.

| Predictors | Likelihood Ratio Tests | | |
|---|---|---|---|
| | Chi-Square | df | p |
| Length of time since joining CCFRP | 10.517 | 2 | *0.005* |
| Number of Volunteer Appreciation and Data Workshops attended | 0.218 | 2 | 0.897 |
| Number of sampling trips with CCFRP | 0.572 | 2 | 0.751 |

Distribution of CCFRP volunteer angler survey respondents by angler demographic within each MPA opinion change category.

2   .

| Category | Positive change (N=51) | No change (N=53) | Negative change (N=5) |
|---|---|---|---|
| *Age* | | | |
| 18-24 | - | 6% | - |
| 25-34 | 14% | 15% | 20% |
| 35-44 | 6% | 11% | 20% |
| 45-54 | 12% | 21% | - |
| 55-64 | 18% | 19% | - |
| 65-74 | 41% | 23% | 40% |
| 75+ | 10% | 6% | 20% |
| *Angler avidity [a]* | | | |
| Low | 24% | 26% | 20% |
| Medium | 41% | 36% | 60% |
| High | 35% | 38% | 20% |
| *Conservation Mindedness [b]* | | | |
| More | 63% | 77% | 60% |
| Similar | 29% | 21% | 20% |
| Less | 2% | - | - |
| *Related work experience [c]* | | | |
| Recreational fishing only | 6% | 15% | 20% |
| Commercial fishing only | 6% | - | - |
| Recreational and Commercial | 12% | 2% | - |
| Marine resource management only | 14% | 8% | - |
| Management and Recreational | - | 4% | - |
| All three | - | 4% | - |
| None | 63% | 66% | 60% |

[a] The 1 respondent who did not answer this question was not included.
[b] The 5 respondents who did not answer this question were not included.
[c] The 2 respondents who had incomplete answers for these questions were not included.