

Assessment of the Responses of Rockfish Populations to Rockfish Conservation Areas in Central California

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Introduction

- Between 1987 and 1998, California Department of Fish and Game (CDFG) (Now Department of Fish and Wildlife) conducted sampling onboard 2,267 sport fishing trips: recording catch-rates, size, and species compositions for nearly 300,000 fishes
- Rockfish Conservation Areas (RCAs) were established in 2002 after seven rockfish species (Bocaccio, Canary Rockfish, Cowcod, Darkblotched Rockfish, Pacific Ocean Perch, Widow Rockfish, and Yelloweye Rockfish) were declared overfished
- This collaborative project was formed between P.I.'s Dr. Sue Sogard and Dr. John Field of the the National Marine Fisheries Service (NMFS) and Dr. Rick Starr of Moss Landing Marine Laboratories (MLML) with the goal of assessing how 12 years of RCAs have affected rockfish populations, especially in relatively shallower regions of the RCA, which were previously frequented by fisheries.

Results and Discussion

- Mean catch per unit effort (CPUE) increased at all sites relative to 1995-98 catch-rate data (Fig 2A)
- Yellowtail rockfish (*Sebastes flavidus*) collected during 2012-14 were significantly larger at Cordell Bank and Half Moon Bay, but significantly smaller at the Farallon Islands when compared with fish from 1995-98. The latter was likely due to a recruitment pulse. (Fig 2B)
- A greater proportion of fishes, including Yellowtail and Canary Rockfish, were mature in deeper sites (Fig 2C)
- In addition to Yellowtail, Blue Rockfish (*Sebastes mystinus* sp.), Canary Rockfish (*Sebastes pinniger*), Rosy Rockfish (*Sebastes rosaceus*), and Widow Rockfish (*Sebastes entomelas*), were the next top four species caught during 1995-98. During 2012-14, this order of abundance shifted to Canary Rockfish, Blue Rockfish, Widow Rockfish, Rosy Rockfish (Fig 2D)

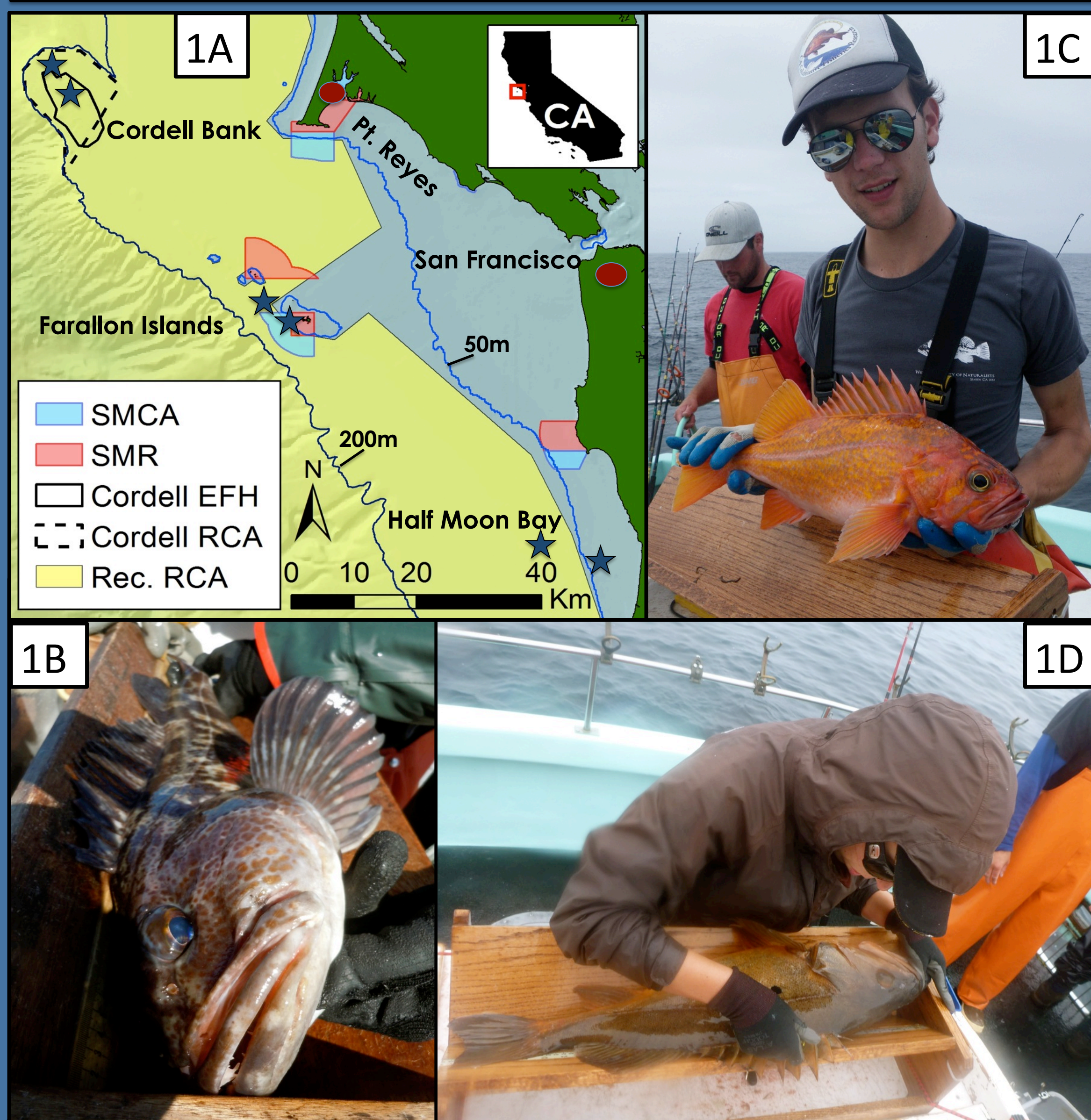
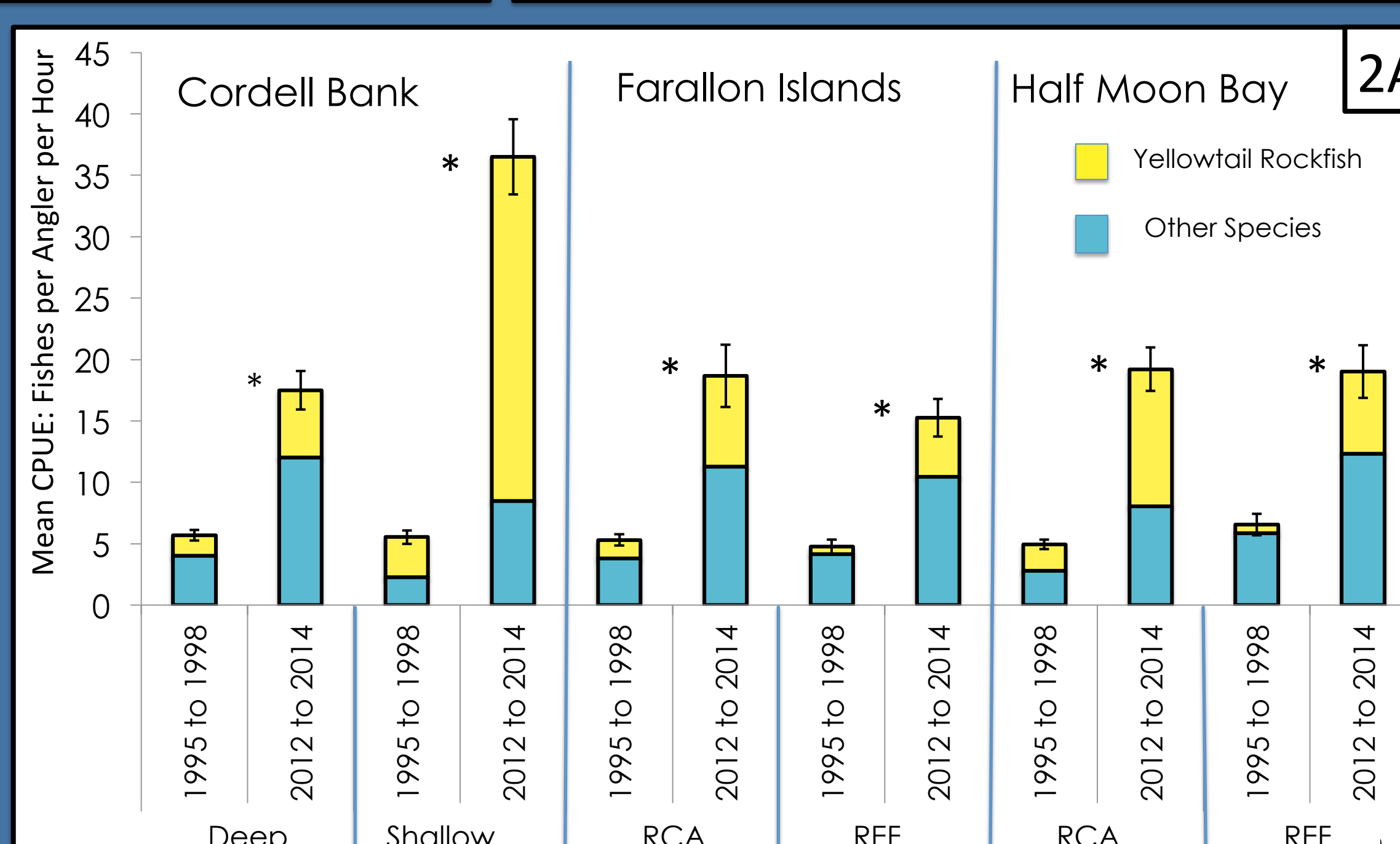


Figure 1
A: Map of study area with three study locations labeled: Cordell Bank (Cordell), Farallon Islands (Farallons), and Half Moon Bay (HMB). Sample sites are marked with blue stars. State Marine Conservation Areas (SMCA) are shown in light blue. State Marine Reserves (SMR) are shown in light red. 50 m and 200 m isobaths are displayed in light and dark blue respectively.

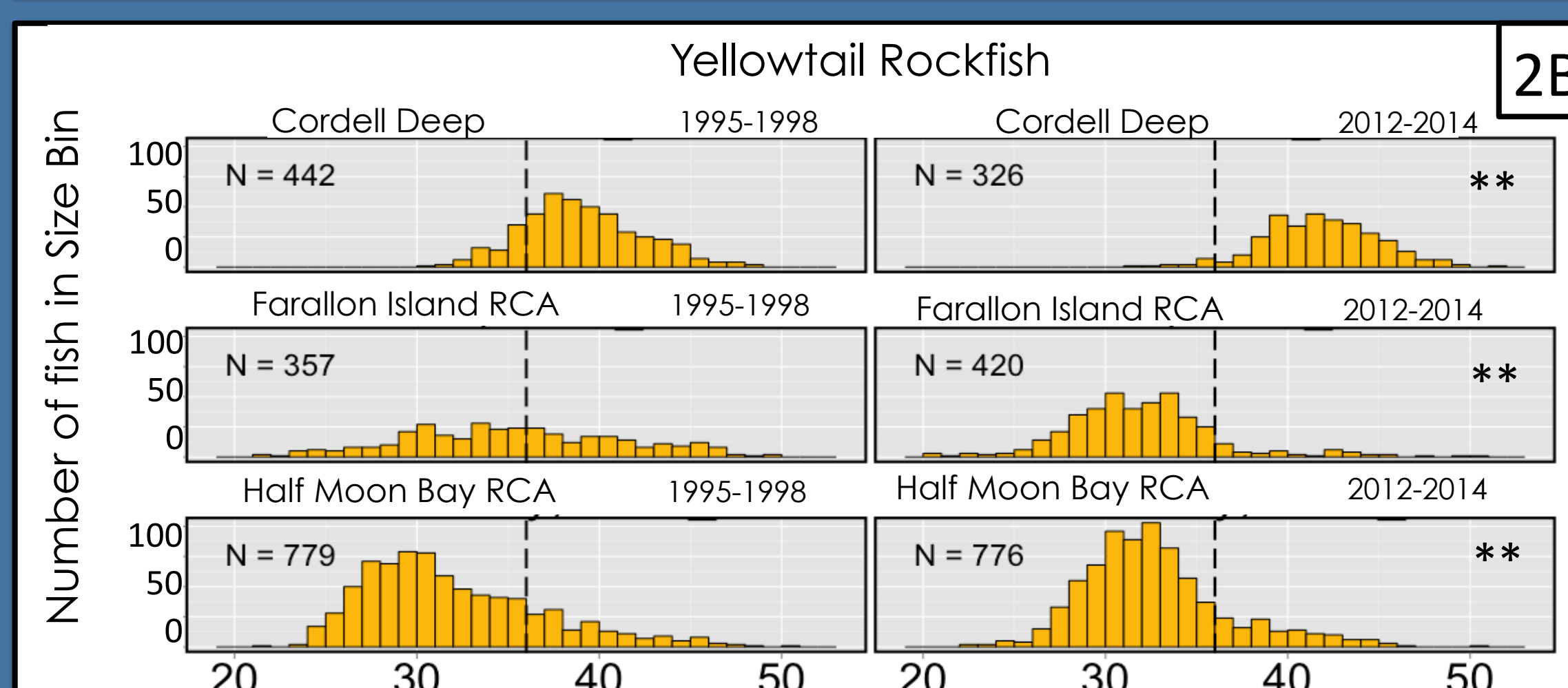
B: Science crew measuring a Lingcod (*Ophiodon elongatus*)

C: MLML lead science crew, Ryan Fields, with a Canary Rockfish (*Sebastes pinniger*)

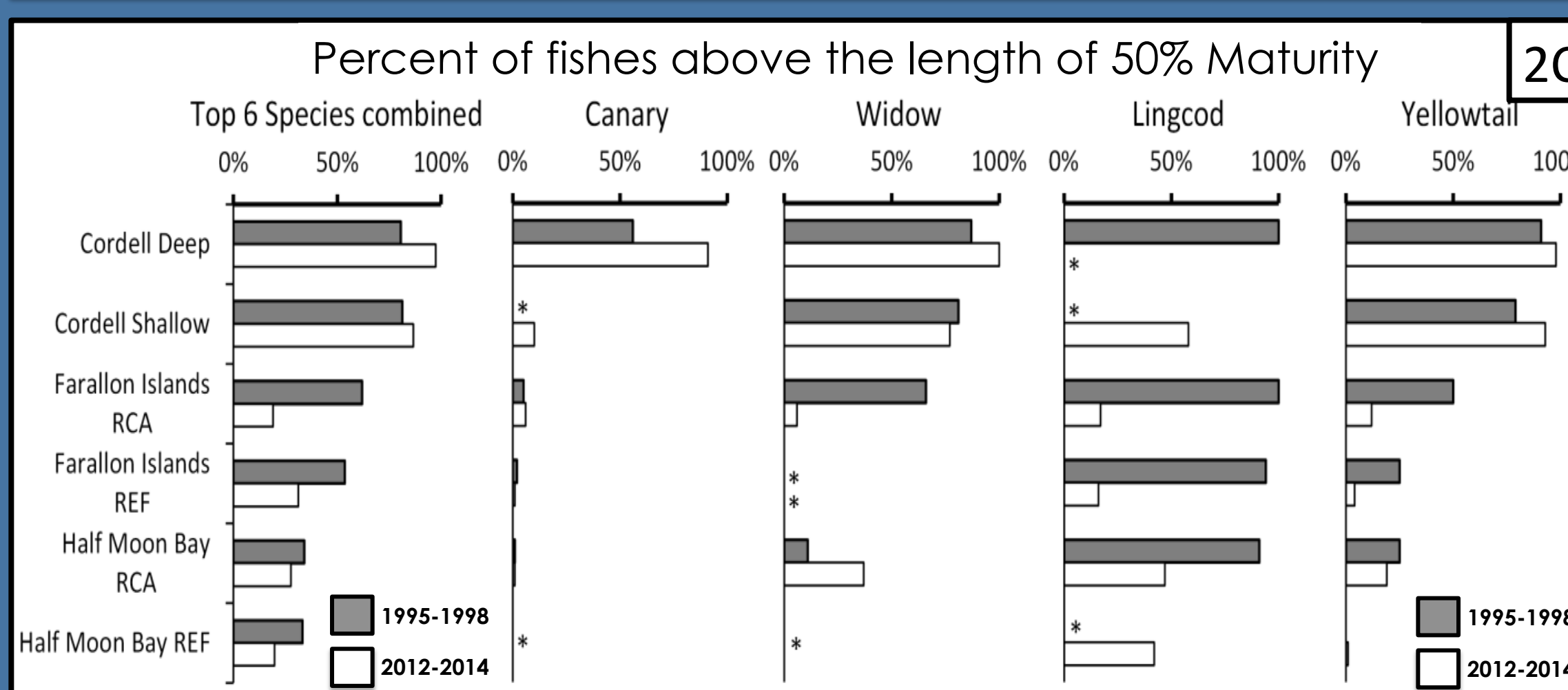
D: MLML science crew measures a large Bocaccio (*Sebastes paucispinis*)



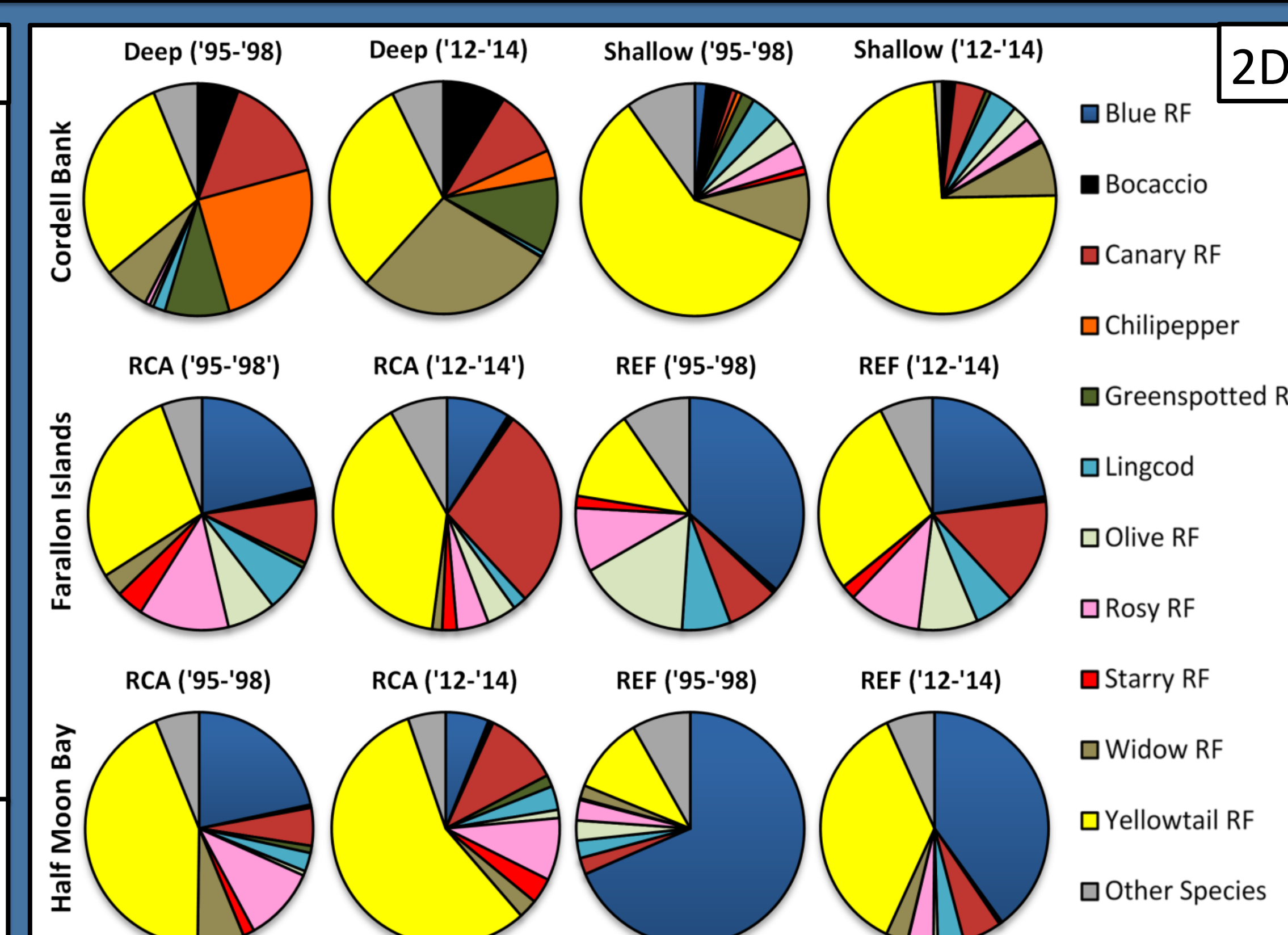
2A: Mean total CPUE (all species caught per angler per hour) shown by site and period of data collection. Yellowtail Rockfish CPUE is displayed separately as it represented the single largest proportion of any species caught. Error bars show the standard error of total CPUE. Asterisks indicate a significant mean difference in CPUE at each site between the 1995-1998 and 2012-2014 datasets ($\alpha = 0.05$).



2B: Yellowtail Rockfish length frequencies by region and site. Lengths (x-axis) are classified by two cm bins of fork length. Length frequencies are normalized and displayed as the proportion of fish in each length bin (y-axis). Vertical dashed lines indicate fork length at 50% maturity (35 cm) converted from total lengths in Wyllie Echeverria (1987) using methods from Echeverria and Lenarz (1984). Asterisks indicate results from Kolmogorov-Smirnov two-sample test of differences in distributions between the old dataset (1995-1998) and new dataset (2012-2014). ** $p \leq 0.001$, * $p \leq 0.05$.



2C: Summary of the percent of fishes caught at each site that were above the length of 50% maturity (Wyllie Echeverria 1987). The combined six species reported here are: Canary, Widow, Yellowtail, Blue, and Rosy Rockfish and Lingcod. Asterisks indicate species counts at sites that were less than 15 individual fish.



2D: Species compositions calculated as fraction of total CPUE (Catch per angler per hour) by site and shown for the historical dataset (1995-1998) and new dataset (2012-2014) for the 11 most abundant species.



We collected 145 ovaries with eggs or pre-parturition larvae from 15 *Sebastes* species for an ongoing reproductive study.

In some *Sebastes* species, older and larger females :

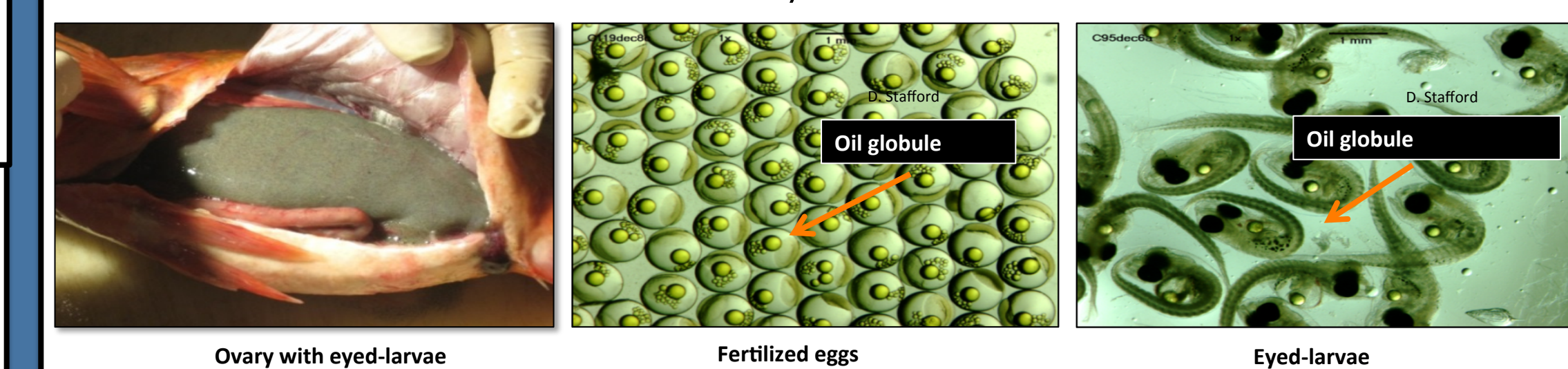
- invest comparatively more energetic resources into greater larval quality (larger sized oil globule)

- release larvae earlier in the parturition season

- produce disproportionately more young in terms of absolute fecundity (# of larvae), and relative fecundity (#larvae per g somatic weight)

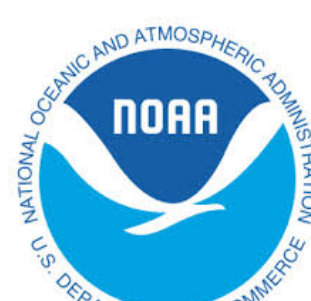
- Show an increase in the occurrence of multiple broods over a single reproductive season

Maternal effects on larval traits or the number of larvae produced may result in increased larval survival post-parturition and a reduction in recruitment variability.



Acknowledgments

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Future Steps

The 2012-2014 mean species length data will be compared with additional years of data between 1987 and 1994 in order to investigate larger time scales. The fecundity data collected is part of an ongoing project and will continue to be processed and presented at a later date.

