

Evaluating fish community responses across the California MPA network using collaborative fisheries research



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Outline

1. CCFRP background and introduction to MPAs
2. Monitoring methods
3. Results: long-term (15 yr time series from central CA)
4. Results: statewide (5 yr time series from N. to S. CA)
5. Results: tag-recapture and fish movements
6. Results: volunteer angler survey
7. Discussion



California Collaborative Fisheries Research Program (CCFRP)



- Community science, fishery-independent (catch- and-release) research program that combines the expertise and ideas of:
 - Fishing community
 - Academic scientists
 - Resources managers
- Conduct scientifically rigorous data collection and analyses for MPA monitoring and fisheries management, with outreach and education to the angling community





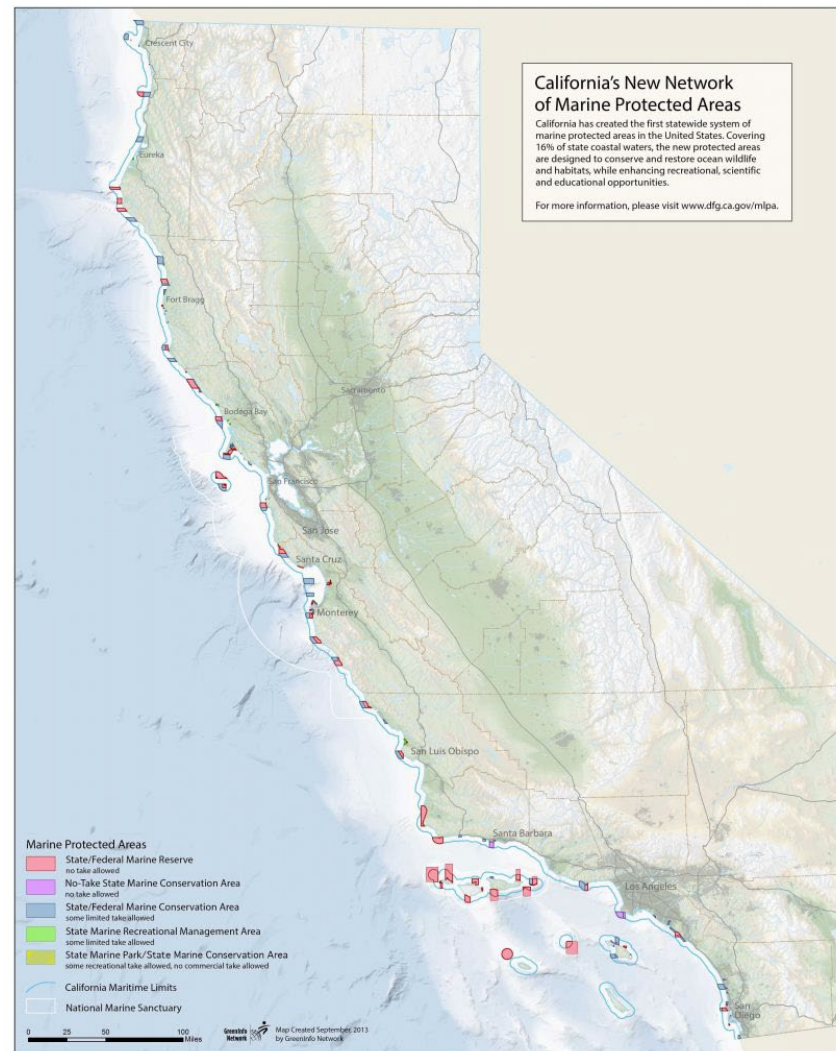
Why Collaborative Research?

- Engage fishers in science and co-management
- Generate fine-scale spatial data on fish stocks
- Create shared understanding of the status of state marine resources
- Build trust and facilitate communication among key stakeholders, scientists, and resource managers
- Increase ocean stewardship



Marine Life Protection Act (MLPA)

- State law passed in 1999
- Mandated the creation of a network of marine protected areas (MPAs) to protect diversity and ecosystem function and enhance fisheries sustainability
- Implementation occurred from 2007 (central CA) thru 2012 (northern CA) through a process involving stakeholder input and the best available scientific advice on sizing, spacing, and area protected
- Currently there are 124 MPAs in California covering 16% of state waters (852 square miles)



Decadal Review MPA Evaluation Questions

1. Are there differences in the abundance, size structure, and biomass of fishes inside and outside MPAs and have they changed over time?
2. How do factors such as fishing pressure, MPA area, MPA age, or geographic location affect the strength of MPA responses?
3. Is there evidence for spillover of fishes from MPAs or are MPAs large enough to contain the home ranges of fishes?
4. How have perceptions of MPAs changed for volunteer anglers that participate with CCFRP?



California MPA Network





California MPA Network



**Northern
California**
45 MPAs
Est. 2010-2012



**Central
California**
29 MPAs
Est. 2007



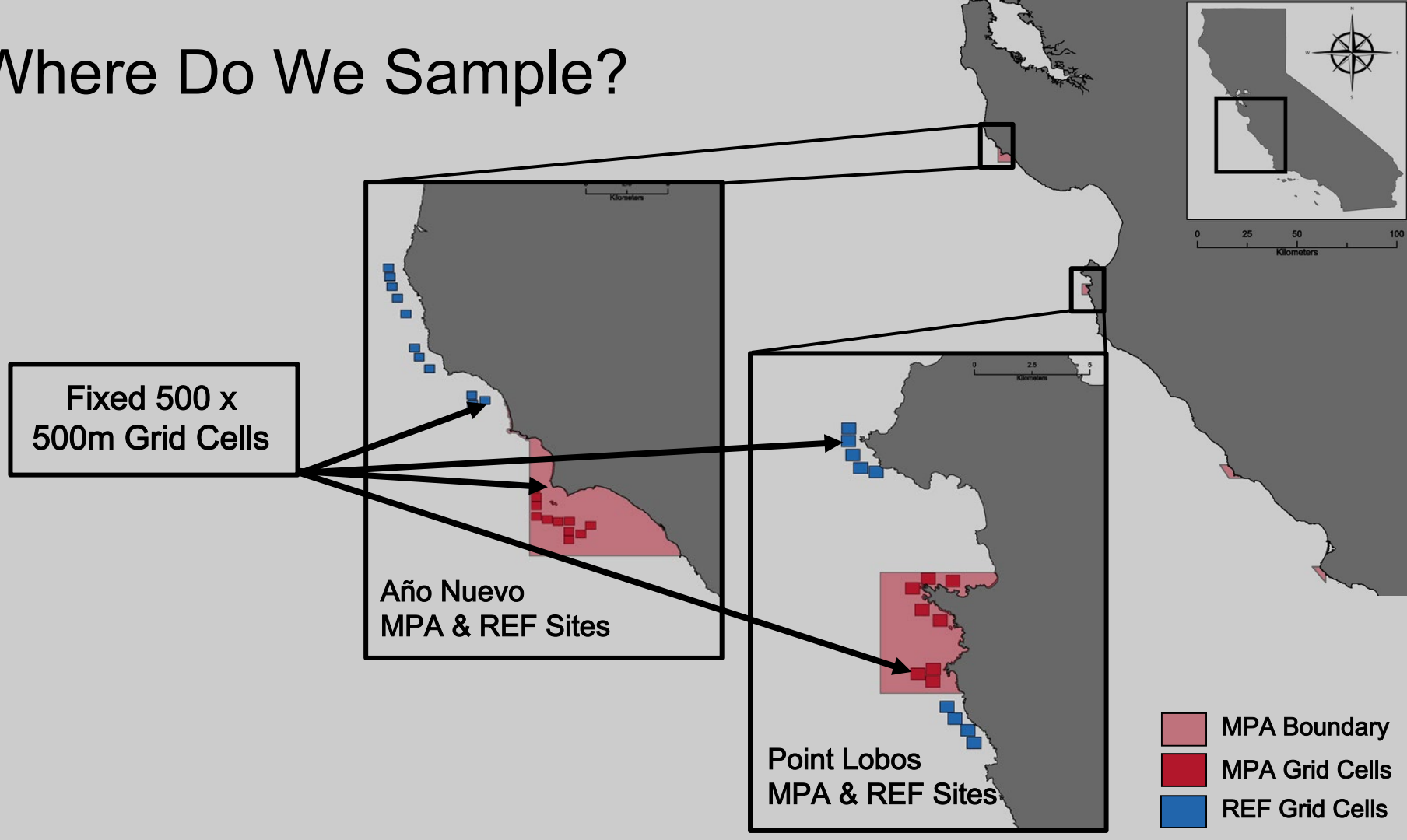
**Southern
California**
50 MPAs
Est. 2003-2012



Sampling Design – involving stakeholders

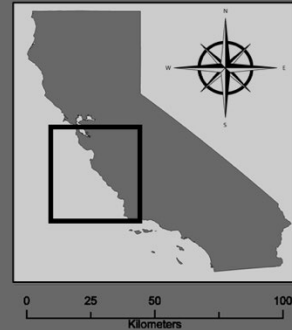
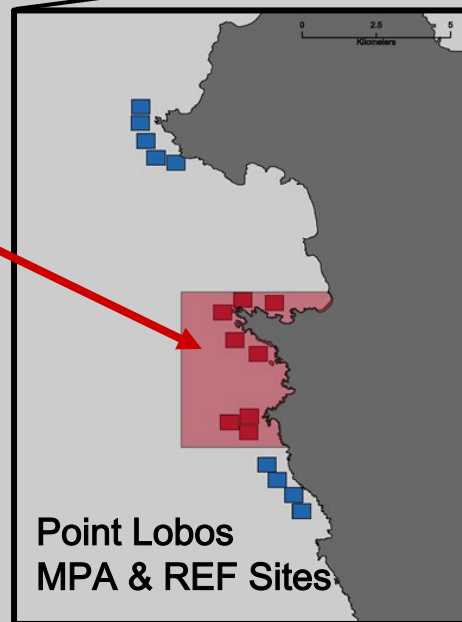
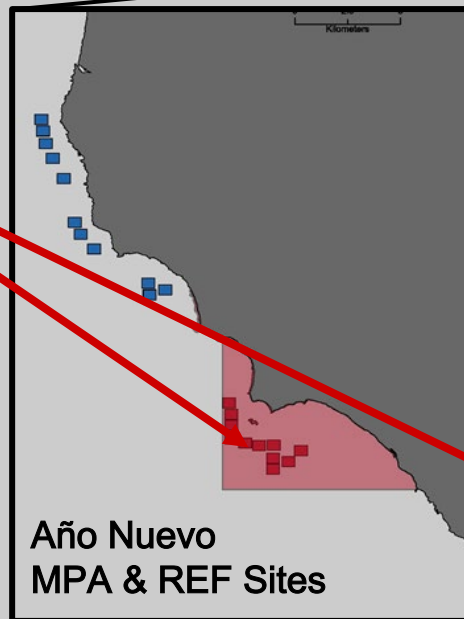


Where Do We Sample?

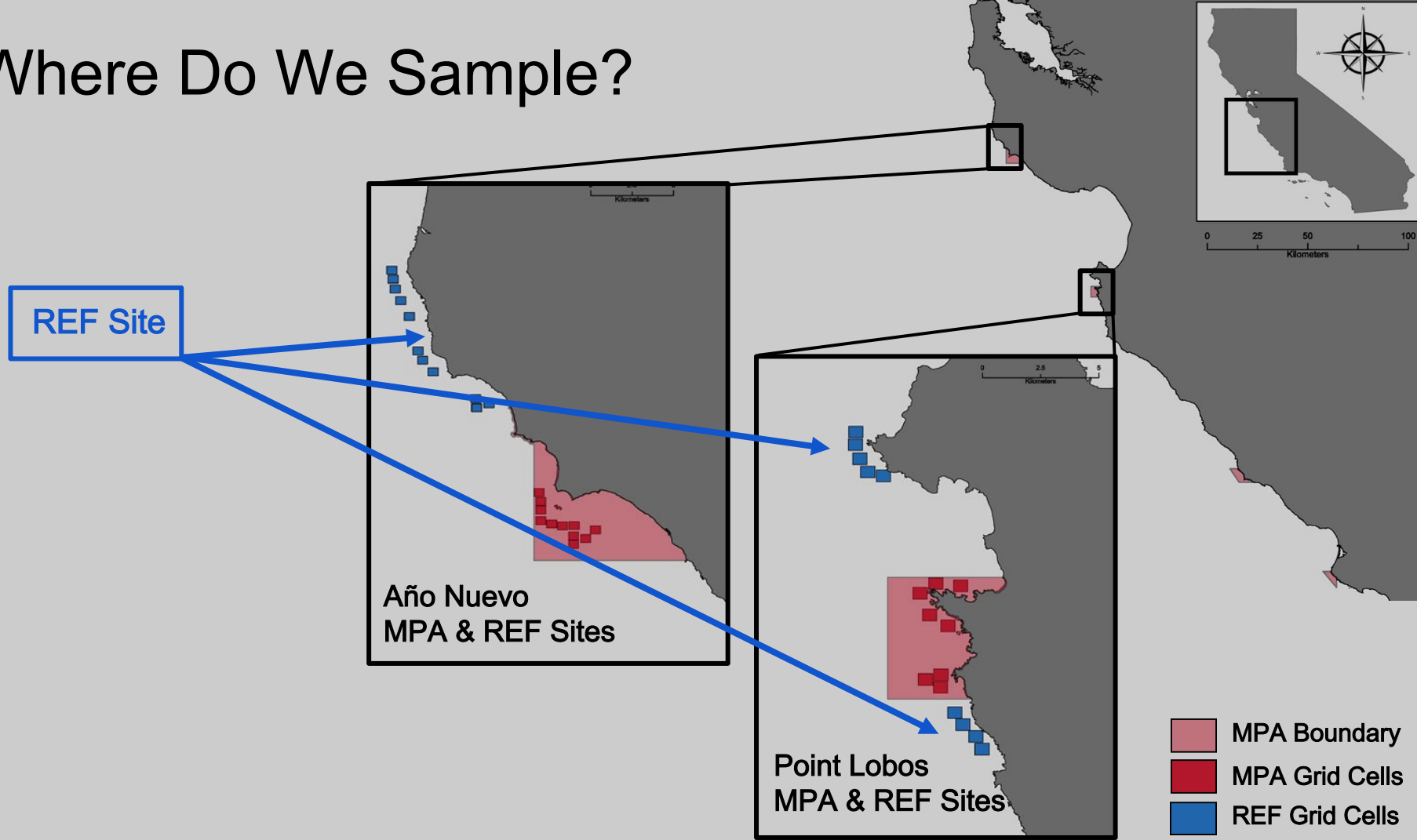


Where Do We Sample?

MPA Site

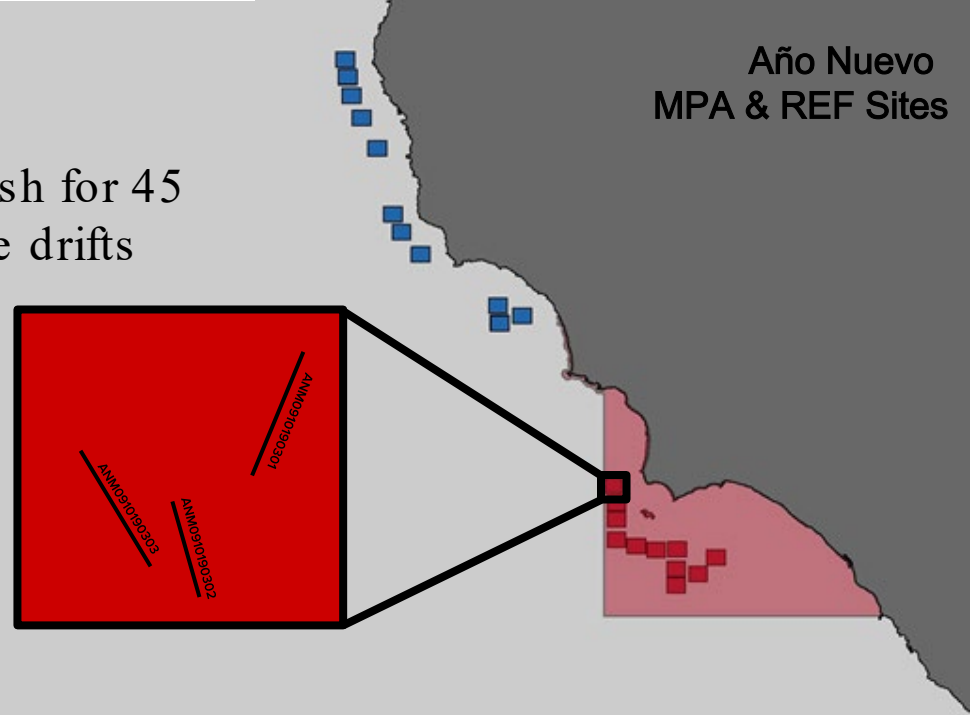


Where Do We Sample?



How Do We Sample?

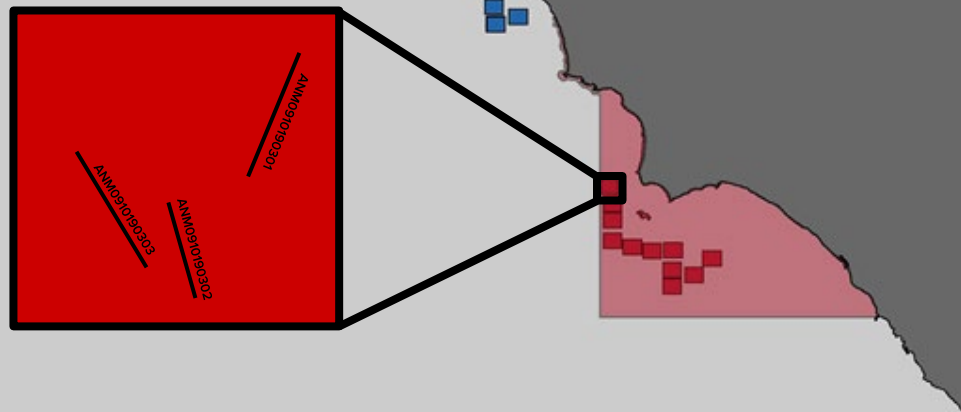
- Each time we visit a cell we aim to fish for 45 minutes, broken into three 15 minute drifts



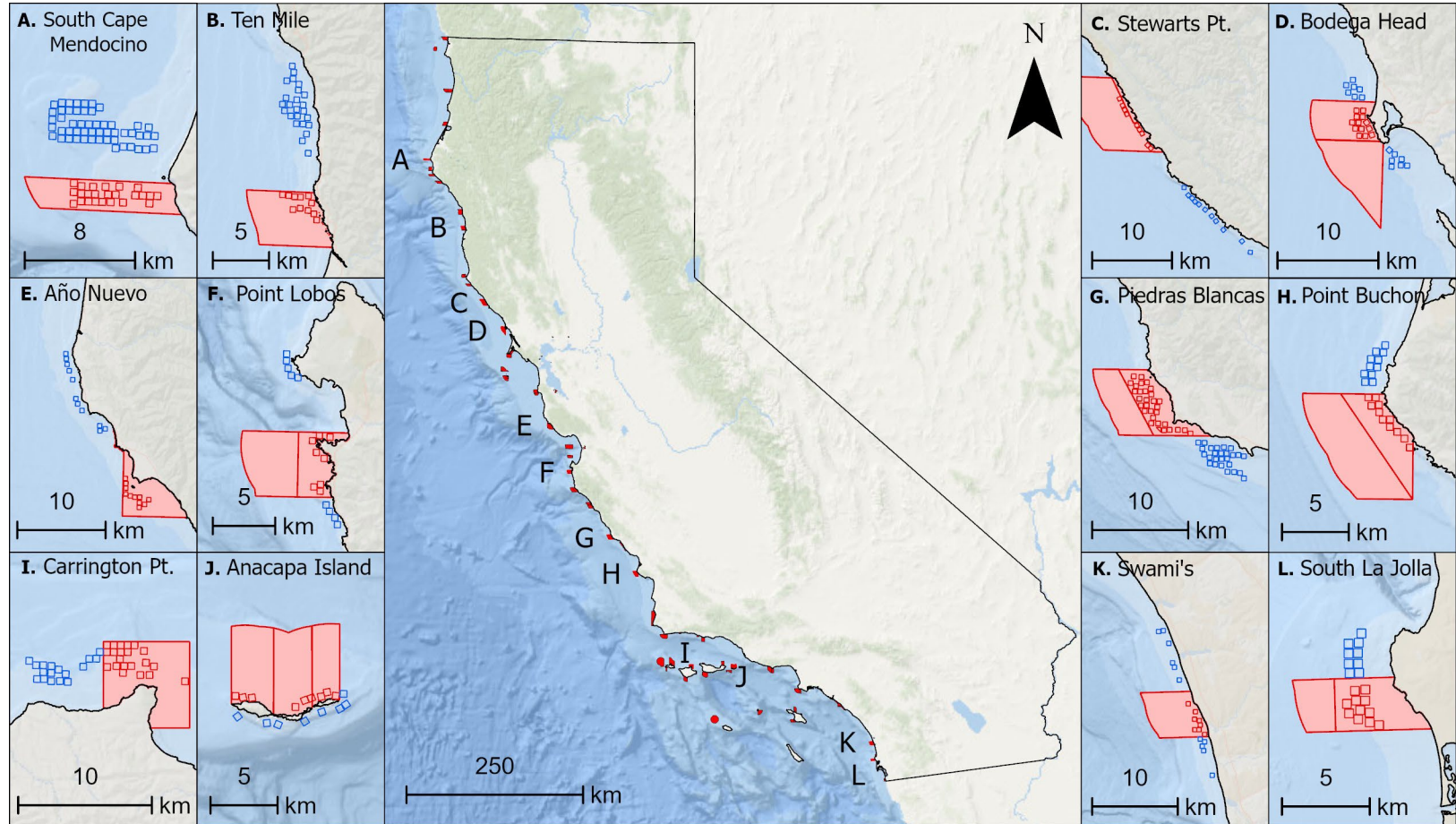
How Do We Sample?

Año Nuevo
MPA & REF Sites

- Each time we visit a cell we aim to fish for 45 minutes, broken into three 15 minute drifts
- Data collected during drift:
 - Start/stop times
 - GPS coordinates
 - Angler number
 - Species caught
 - Total length (cm)
 - Fish condition
 - Tag number



Statewide CCFRP MPA/REF sites



CCFRP Summary (2007 -2022)

- ❑ 700+ sampling days at sea
- ❑ 31 sportfishing boats, 53 captains
- ❑ 2,000+ individual volunteer anglers
- ❑ 200,000+ fishes (95 spp.) caught
- ❑ 75,000 fishes tagged and released





CCFRP Long -Term Monitoring Highlights



How we measure relative abundance: Catch-Per-Unit-Effort (CPUE)

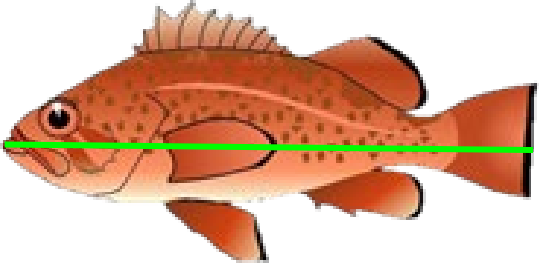
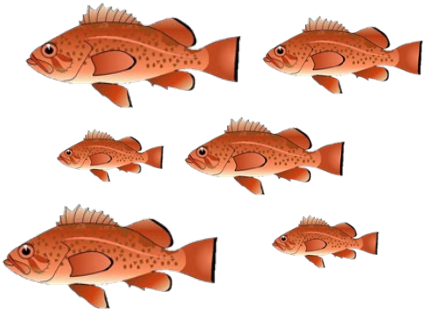
Here, CPUE is catch per angler-hour



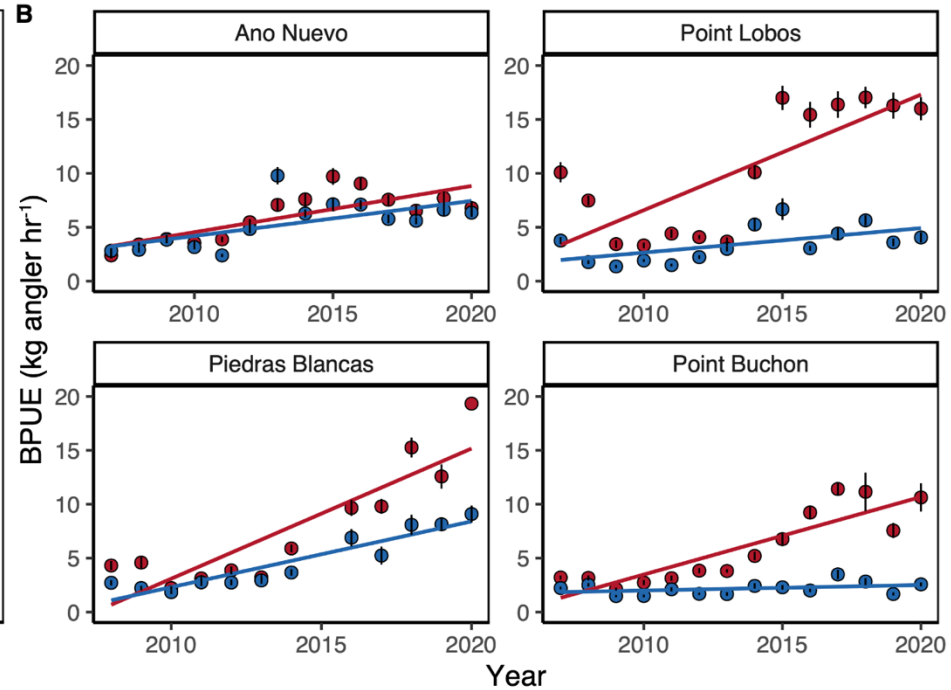
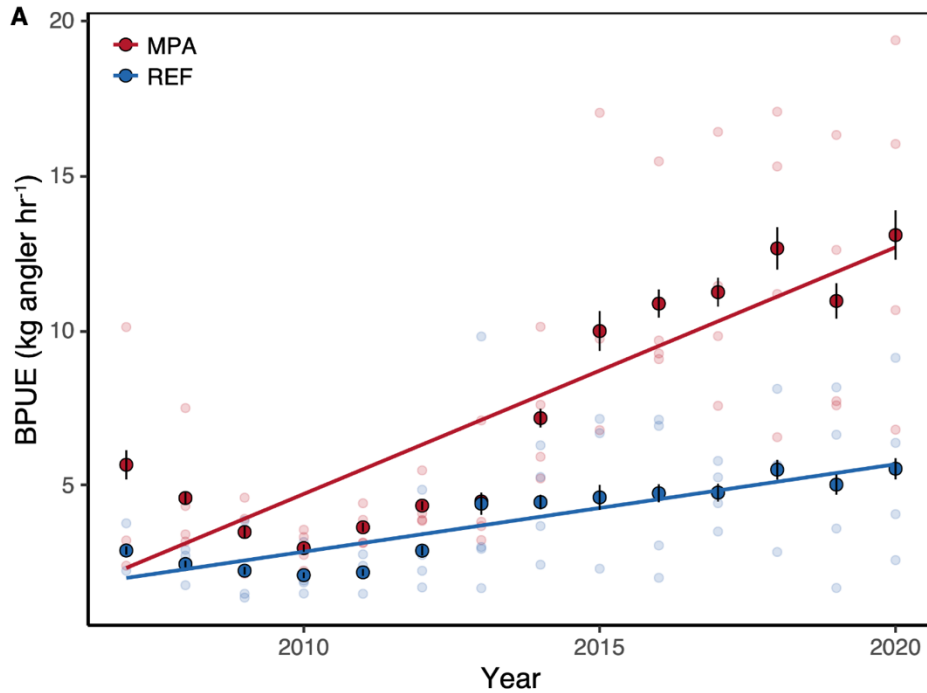
$$\text{CPUE} = \frac{\text{Number of fishes caught}}{[\text{total drift time}] \times [\text{\# anglers fishing}] - [\text{angler off time}]}$$

Calculating Biomass -Per-Unit-Effort with CPUE and Length Data

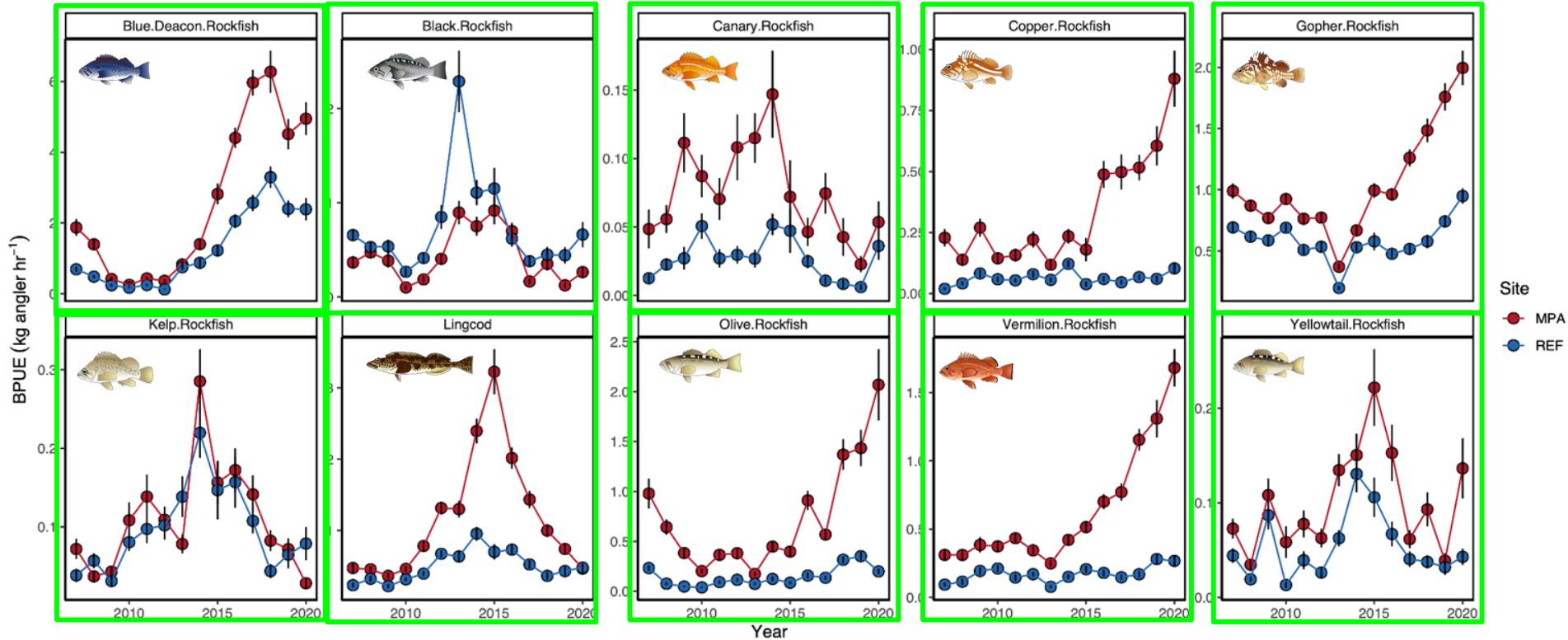
$$\begin{array}{ccccc} \text{Length (cm)} & & \text{CPUE} & & \\ \text{Published} & & & & \text{BPUE} \\ \text{Length - Weight} & & & & \text{(kg angler hr}^{-1}\text{)} \\ \text{Relationships} & & & & \\ \text{(cm to kg)} & & & & \end{array}$$

 \times  $=$

More fish biomass in MPAs over time!

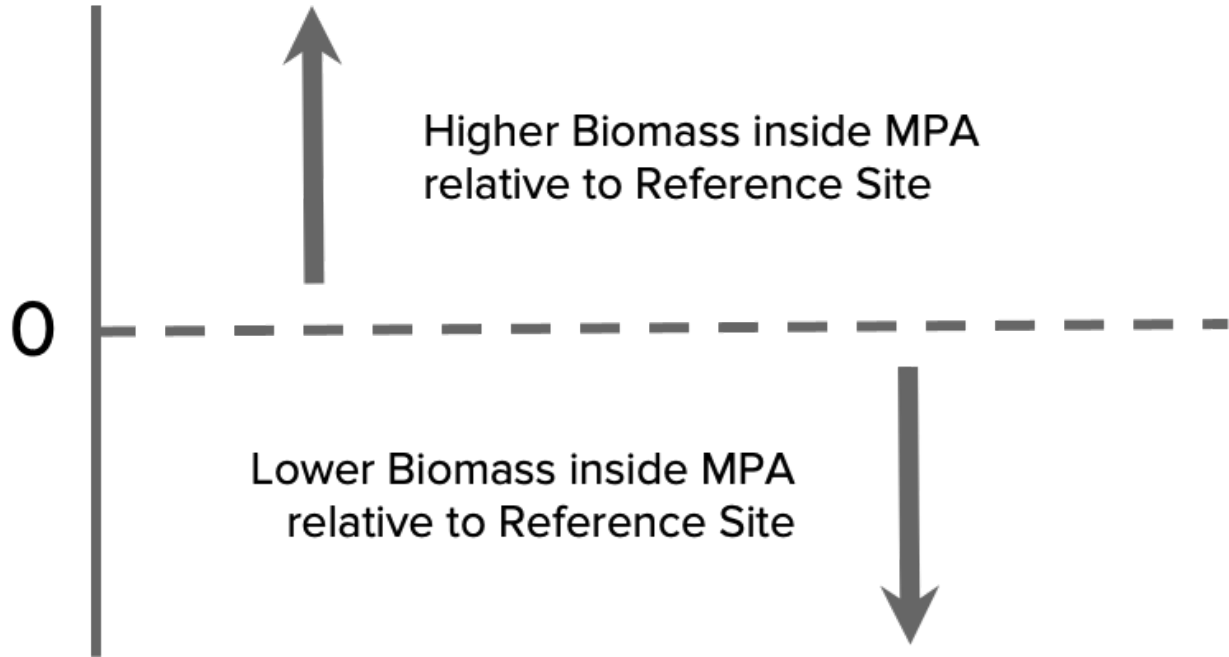
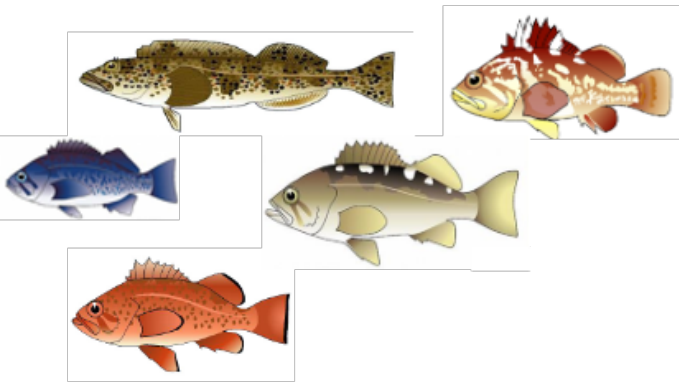


73% of species had greater biomass inside MPAs

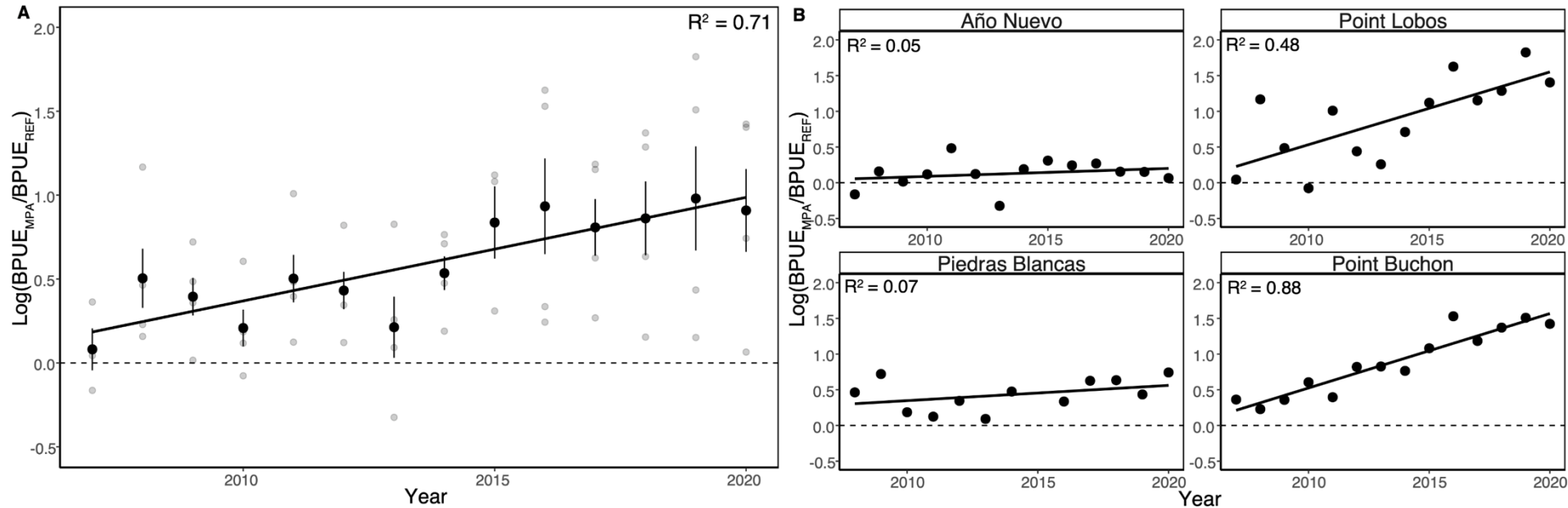


Calculating response ratios to examine the effectiveness of MPAs

$$\text{Log}\left(\frac{\text{Biomass MPA}}{\text{Biomass REF}}\right)$$

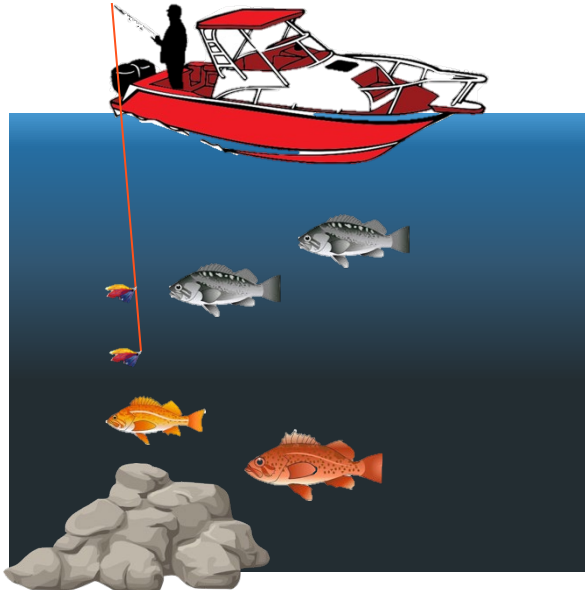


On average, response ratios increase through time on the central coast



We can use response ratios to examine what factors influence MPA efficacy

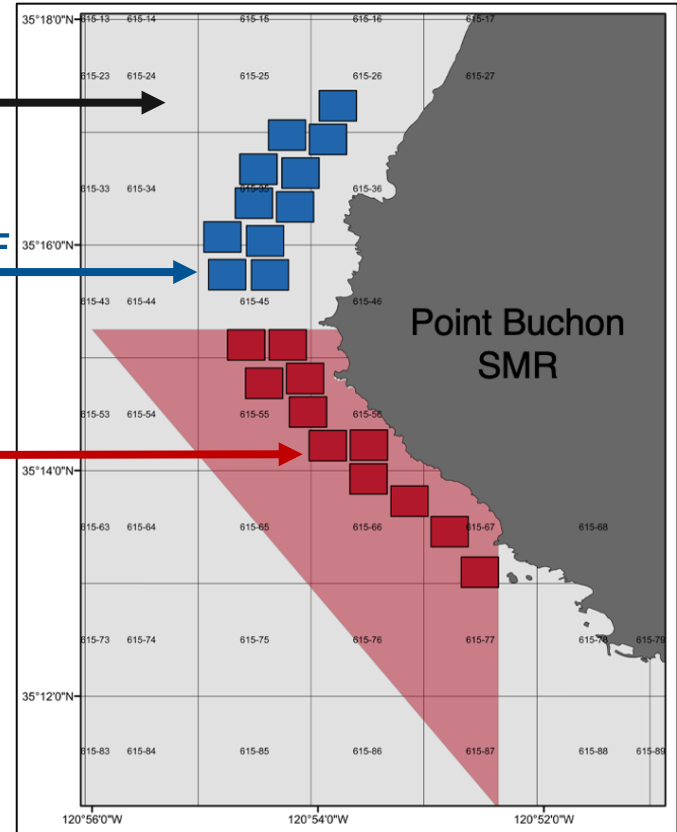
For example:
Fishing effort outside
the MPA



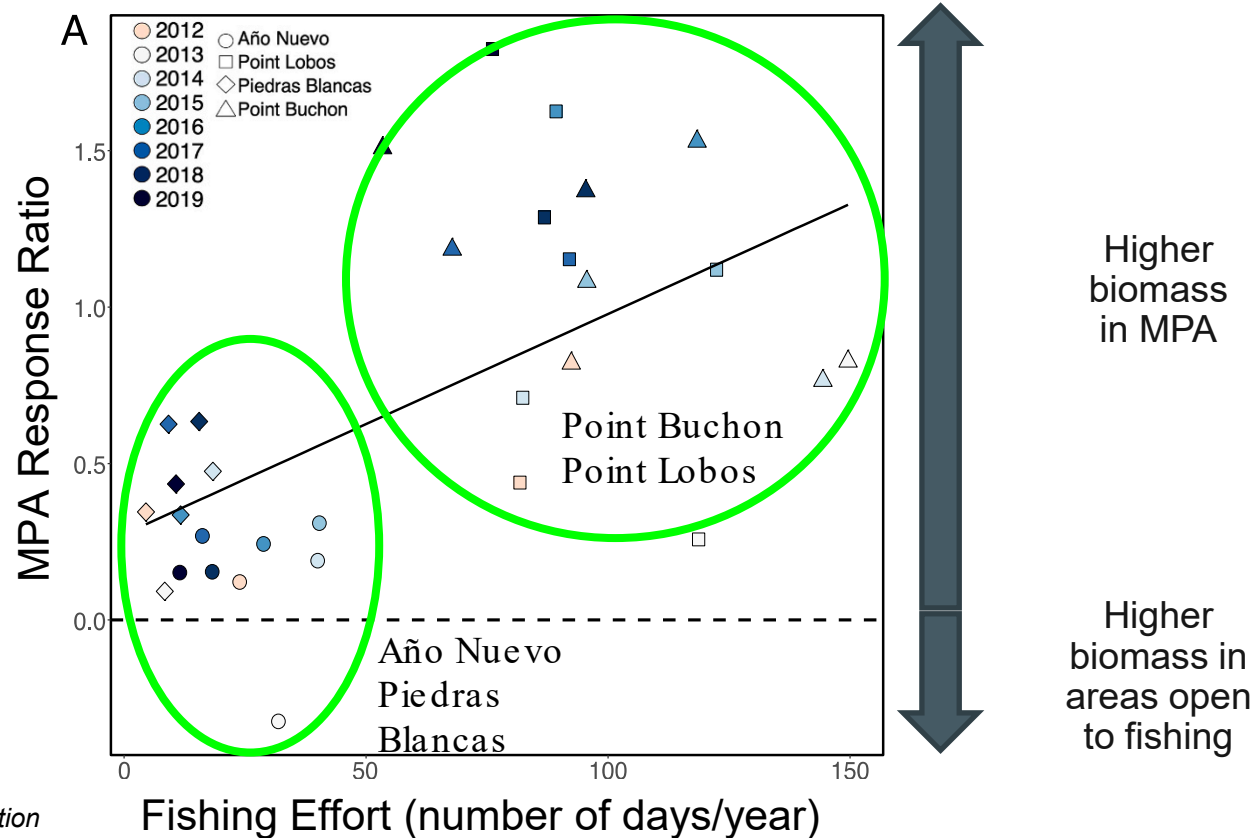
CDFW fishery
microblocks

CCFRP REF
cell

CCFRP MPA
cell



Fishing effort outside MPAs influences the positive effects of closure

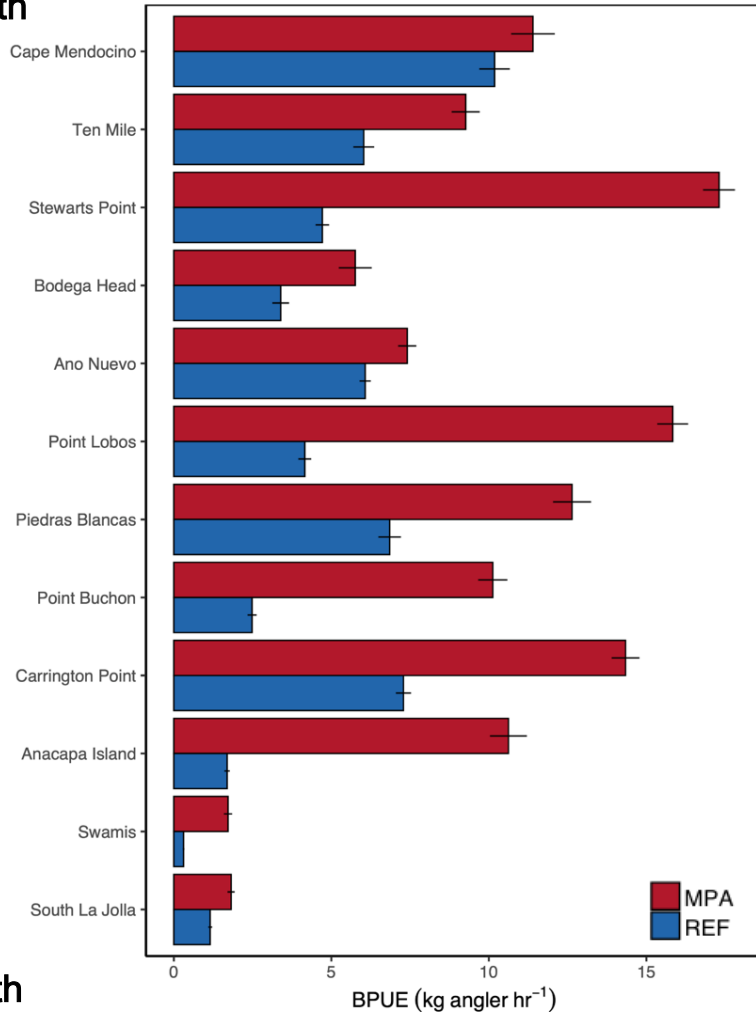




CCFRP Statewide MPA Highlights



North

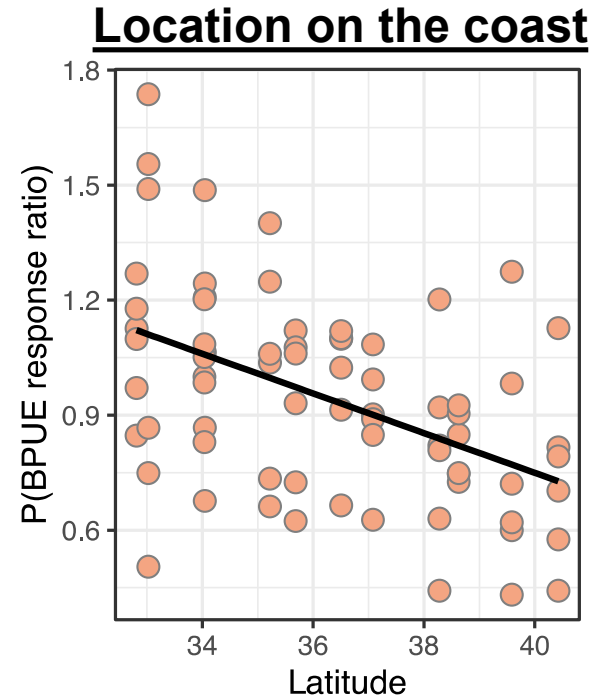
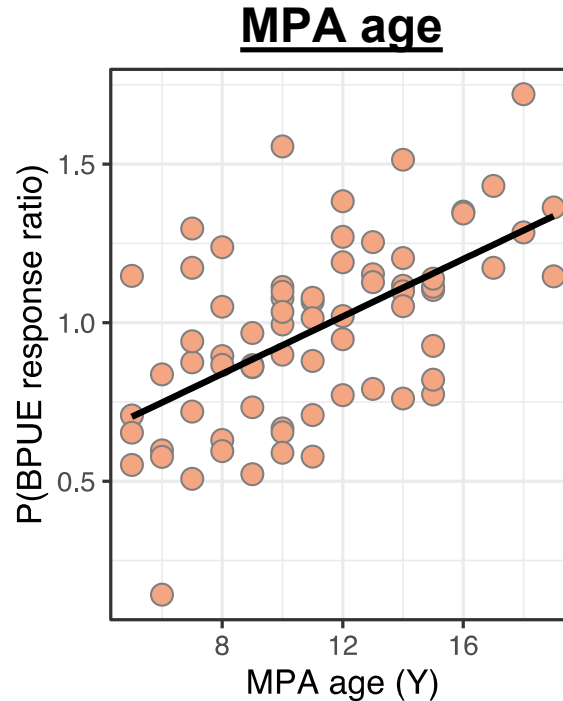
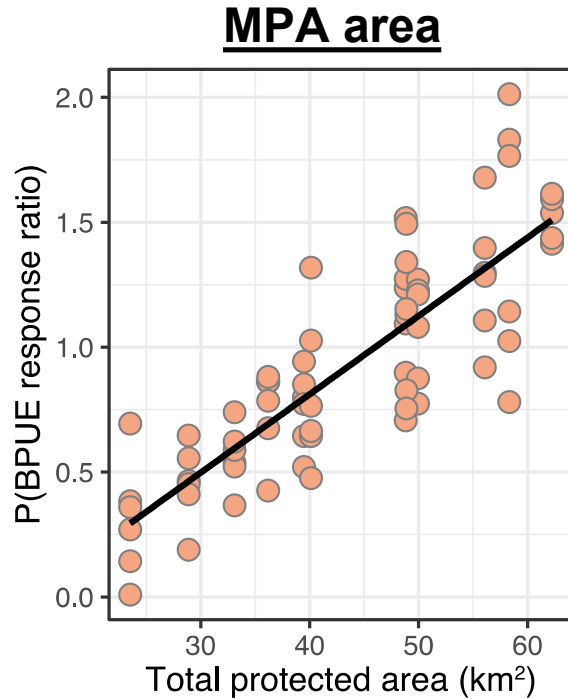


South

Fish biomass is higher inside MPAs but differs spatially across the state

- The strength of the MPA response is much stronger in some locations than others
- What factors are responsible for those spatial differences in MPA effectiveness?

MPA area, location, and age predict the strength of fish biomass responses

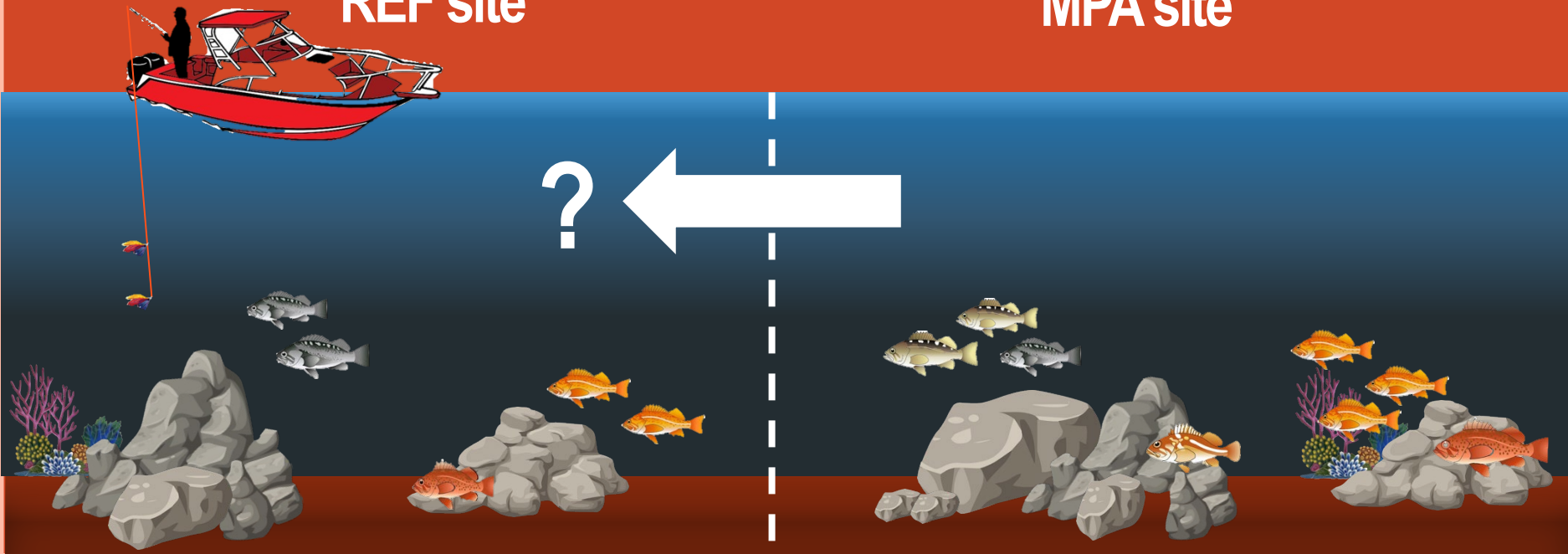




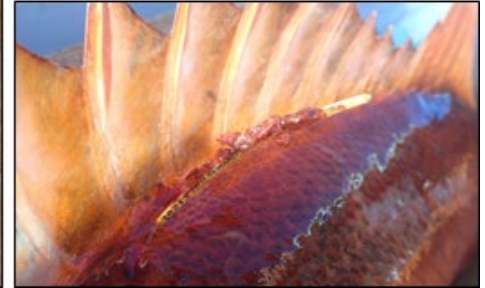
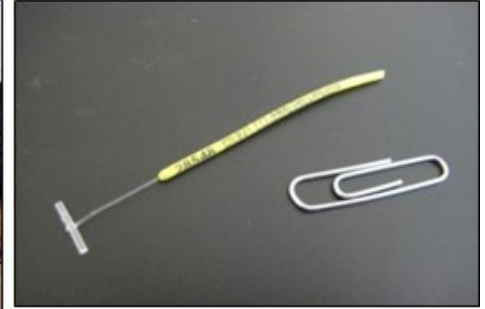
What is the rate of spillover from MPAs to areas open to fishing?

REF site

MPA site



Tag Returns!





REWARD FOR TAG RETURN INFORMATION



Moss Landing Marine Labs, along with several other institutions along the California coast, have been working with commercial fishermen, charter boat captains, and recreational anglers to tag and release nearshore fishes. The objective of this study is to obtain growth, movement, and mortality rates of fishes found along the coast in order to gain a better understanding of these economically important species. Tags may have algae growing on them, so please keep an eye out.



If you catch a tagged fish (whether you keep it or throw it back), please record and report:

- Tag number
- Health of tagging site (algae growth?)
- Date caught
- Species
- Overall health of the fish
- Total length (end of snout to end of tail)
- GPS coordinates
- Depth caught

Moss Landing Marine Laboratories
8272 Moss Landing Road
Moss Landing, CA 95039

Email: mml-ccfrp@sjsu.edu
Phone: (831) 771-4479

To learn more about the California Collaborative Fisheries Research Program, visit:
<https://mml.sjsu.edu/ccfrp/>



CA Collaborative Fisheries Research Program

Thank you for reporting your tagged fish!



Information about your fish:

Tag #80517	Tagged	Caught
Date	8/9/2021	2/13/2022
Latitude	36°28.434'N	36°28.472'N
Longitude	121°56.838'W	121°56.794'W
Depth (m/ft)	48.77 m / 160 ft	38.4 m / 126 ft
Length (cm/in)	30 cm / 11.8 in	Approx. 11 in

To learn more about this program, please visit our website: <https://www.mml.sjsu.edu/ccfrp/>
Like us on **Facebook**
Follow us on **Instagram**, **YouTube**, and **Twitter**
(@CCFRP)

Information about Gopher Rockfish (*Sebastes carnatus*)

Maximum Size: 42.5 cm (17 in)¹

Range: From Cape Blanco, Region to southern Baja California, Mexico but they are most common from Sonoma County to Santa Monica Bay, California¹

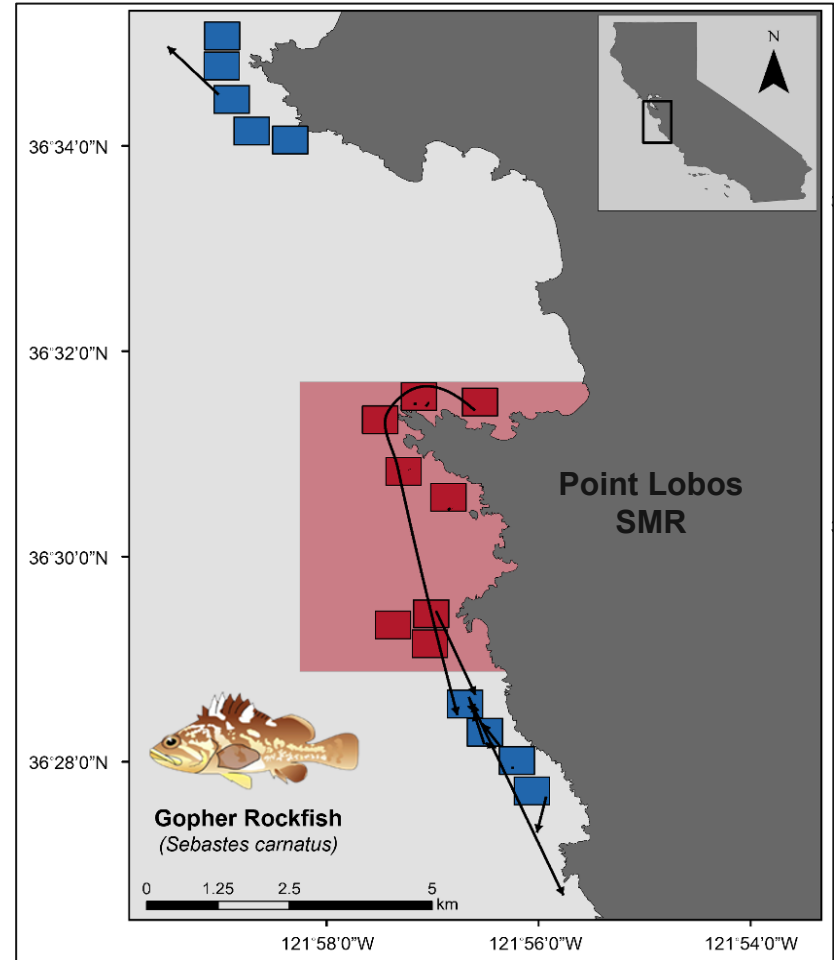
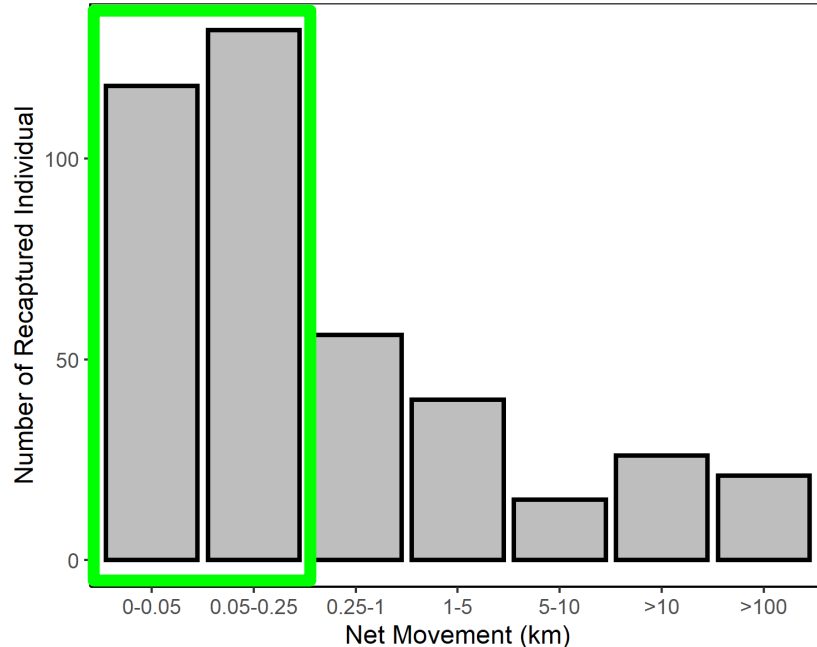
Life History Information: Gopher Rockfish settle near kelp fronds as young of the year around June and July. With growth, individuals move down the kelp stipes to the bottom, where they take up residence in the characteristic rocky habitat of older juveniles and adults. This species of Rockfish have been found from intertidal water to 80 m (264 ft). Gopher Rockfish are largely territorial and have home ranges up to 10-12 m², although longer distance movements sometimes occur. They feed primarily at night on benthic crabs and shrimps, cephalopods, and fishes such as sculpins and juvenile rockfishes. Generally, females begin maturing around 16-17.5 cm (6-7 in.) at 3-4 years old. Males begin maturing about one year earlier and at smaller sizes.

Your fish was tagged and released near the Point Lobos reference site, was at liberty for 188 days, and moved approximately 0.062 miles (net distance traveled).

¹Love, M.S., 2002. *The Rockfishes of the Northeast Pacific*. Really Big Press, Santa Barbara, CA. pp. 234-236.

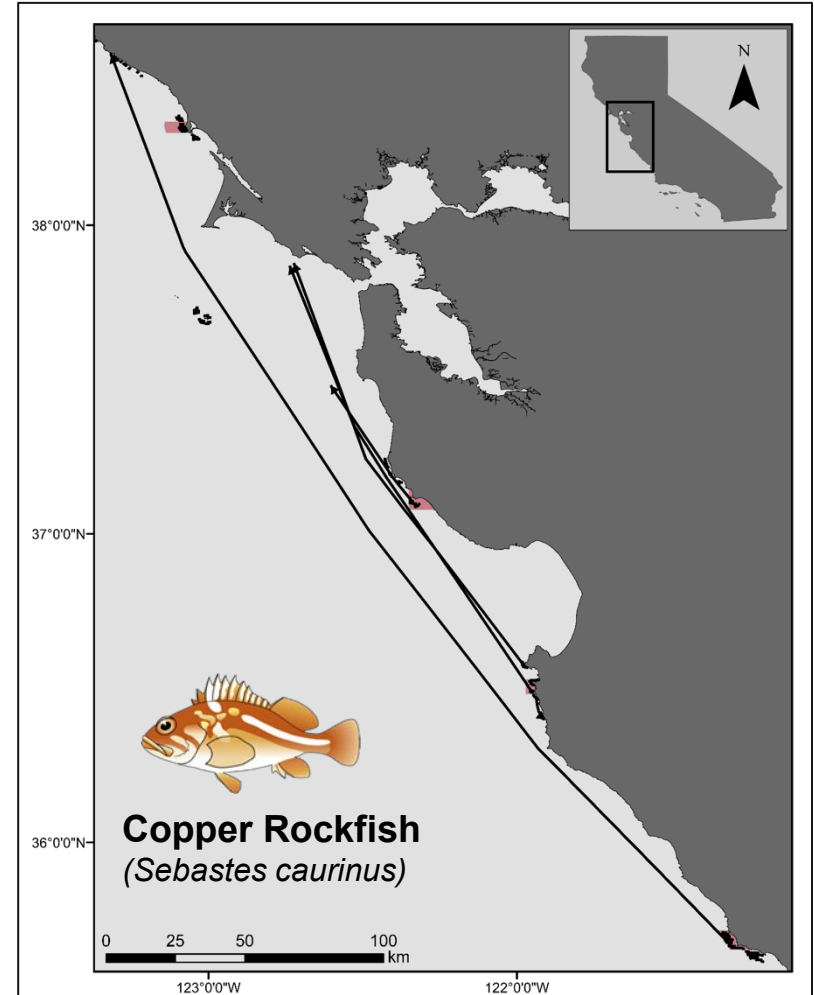
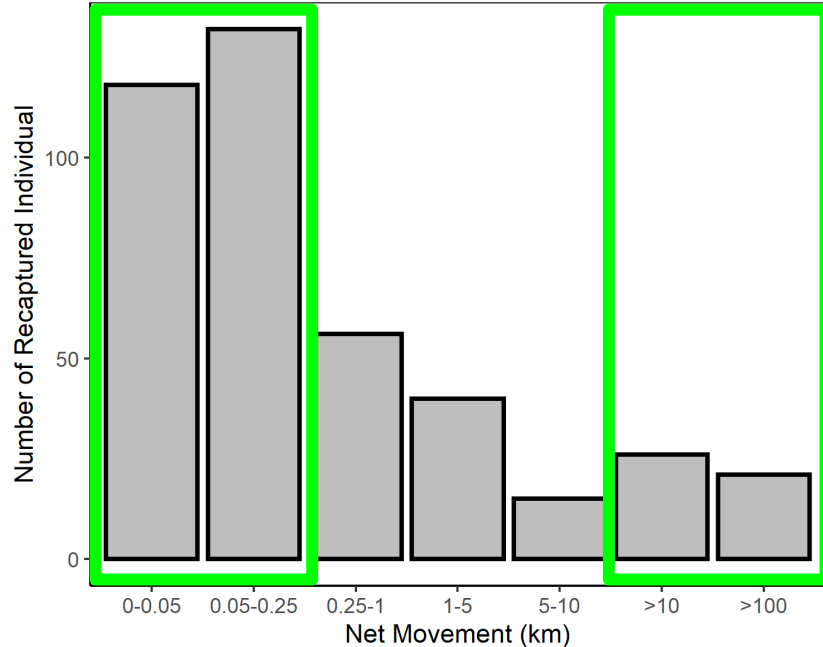
Uses of CCFRP Tag - Return Data

Tag-recaptures provide information on species movements and spillover from MPAs



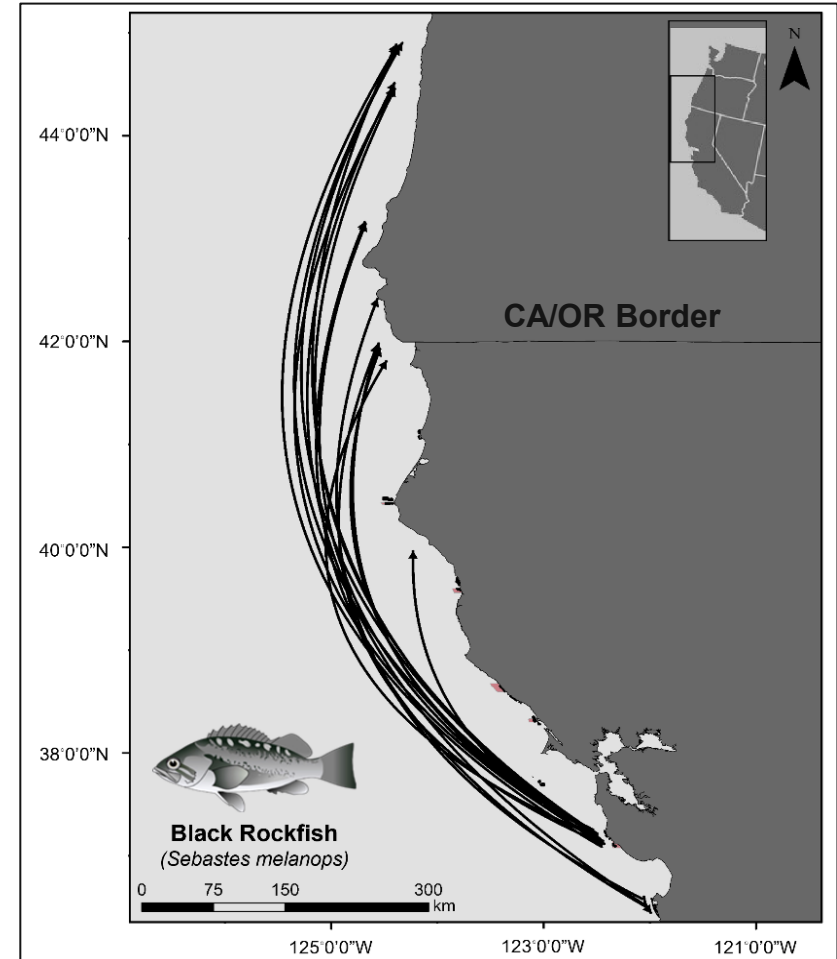
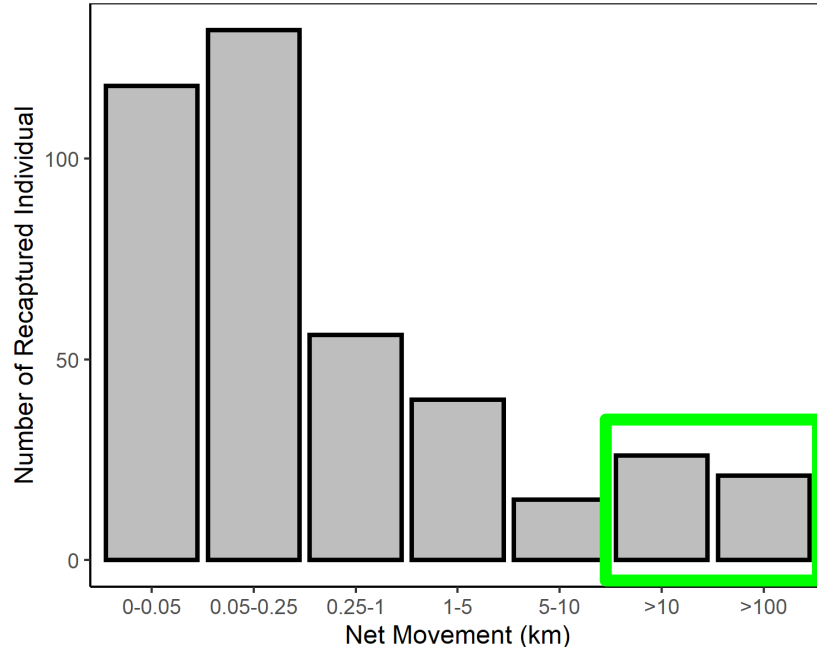
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Uses of CCFRP Tag - Return Data

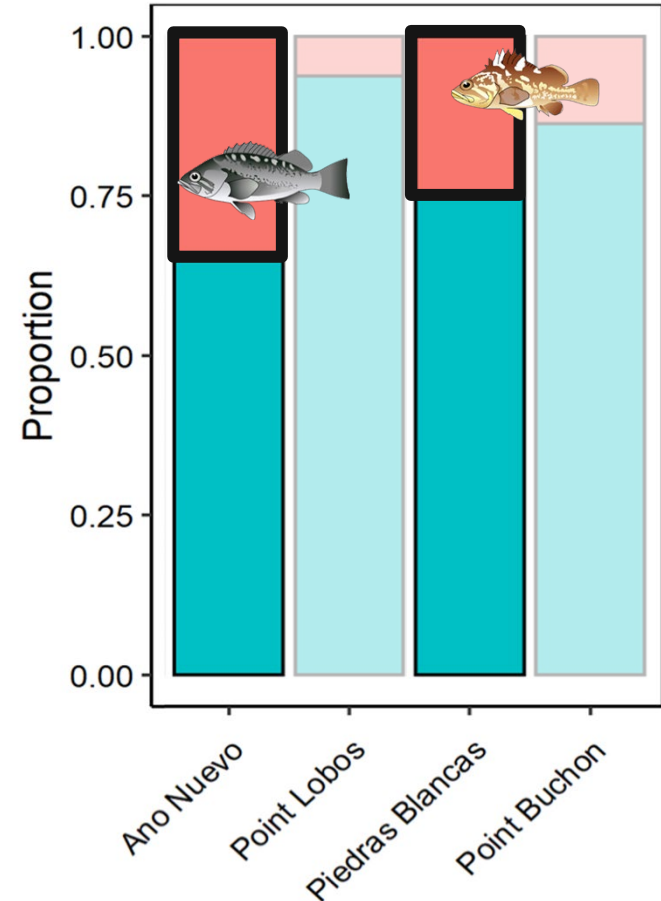
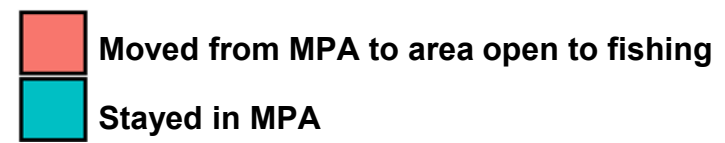
Tag-recaptures provide information on species movements and spillover from MPAs



Uses of CCFRP Tag - Return Data

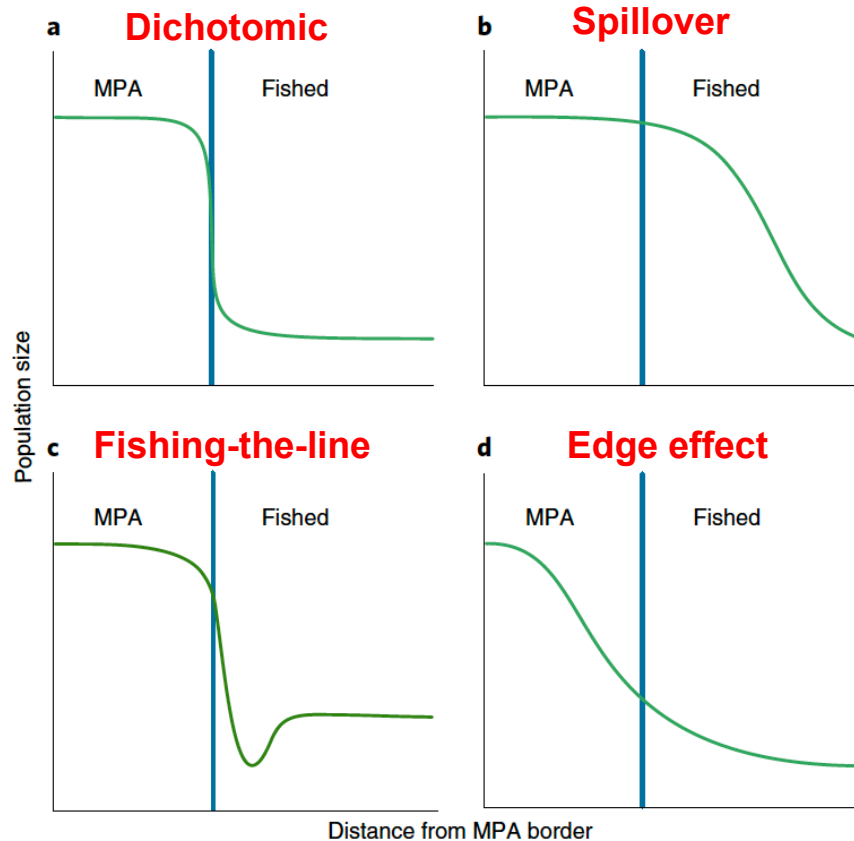
Assessing Spillover with Central California Tag-Recapture Data:

- 25,500 fishes tagged in MPAs
- 136 tag-recaptures originally tagged in MPAs (0.5% recapture rate)
- 17% recaptured fishes originally tagged in MPAs spilled over to areas open to fishing



Hypotheses for spatial patterns across M P A boundaries

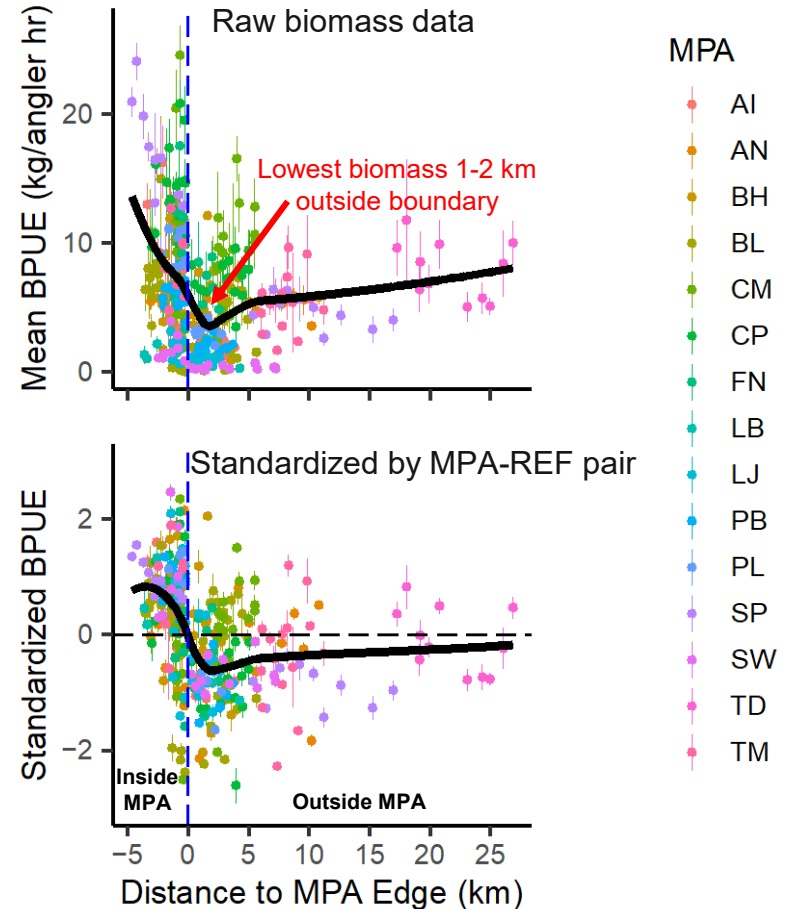
- Various hypothesized patterns for how fish populations may change with increasing distance from the MPA boundary
- We used this framework to examine how fish biomass changes in grid cells at increasing distance from the nearest boundary in California



Evidence for fishing

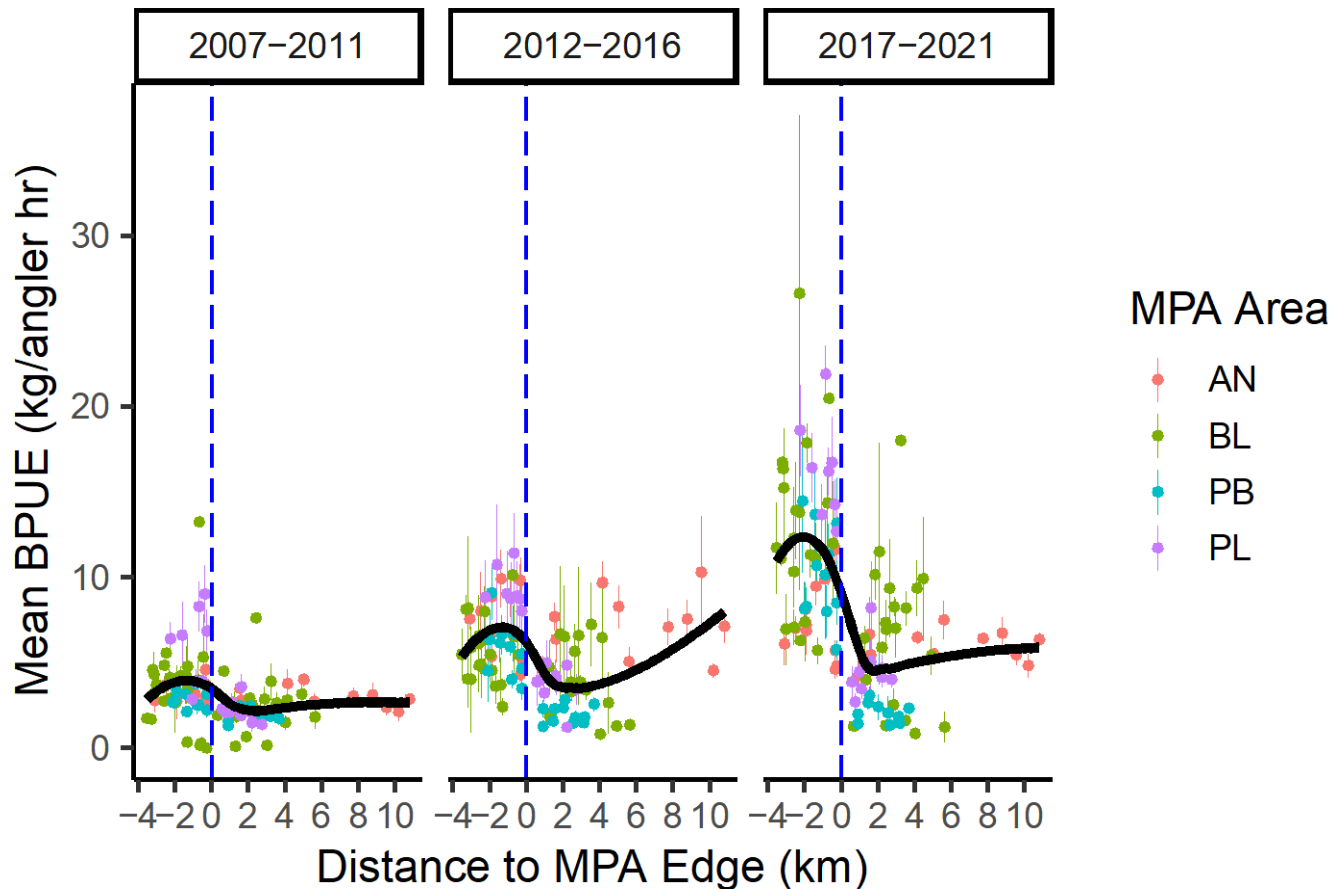
- Highest biomass in the center of MPAs
- Biomass decreases from the center of MPAs across the boundary
- Prominent dip in biomass occurs 1-2 km outside the MPA boundary, indicative of fishing-the-line effects

-the-line behavior



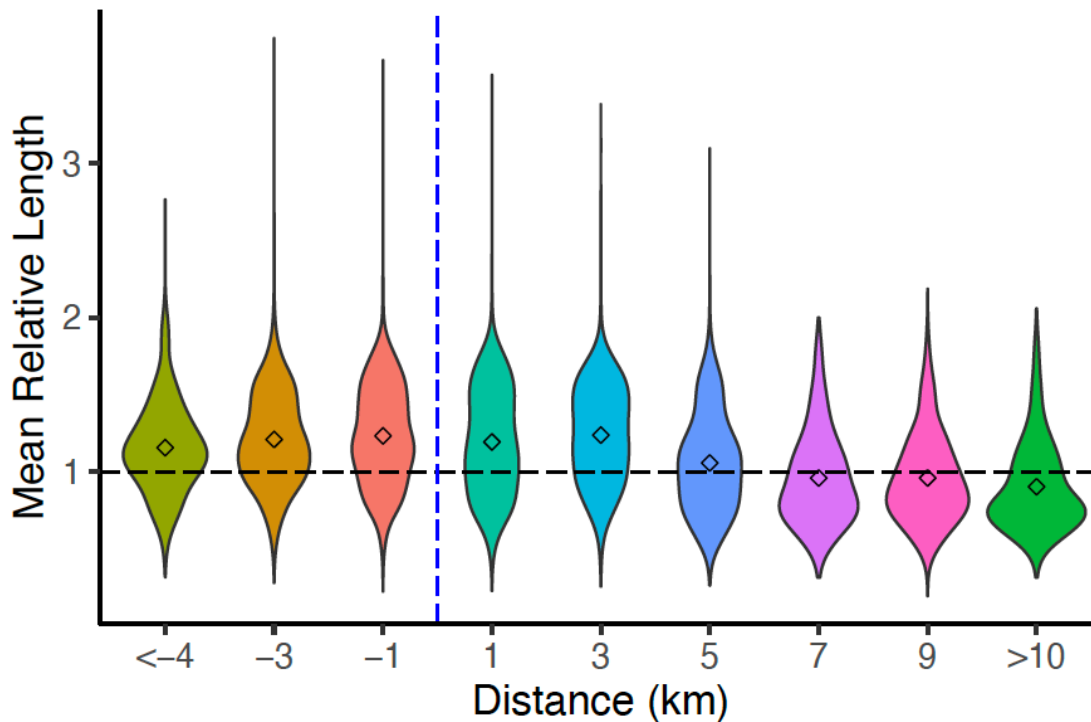
Evidence for fishing -the-line behavior

- In central CA the fishing-the-line response increases over time from the year of MPA implementation in 2007



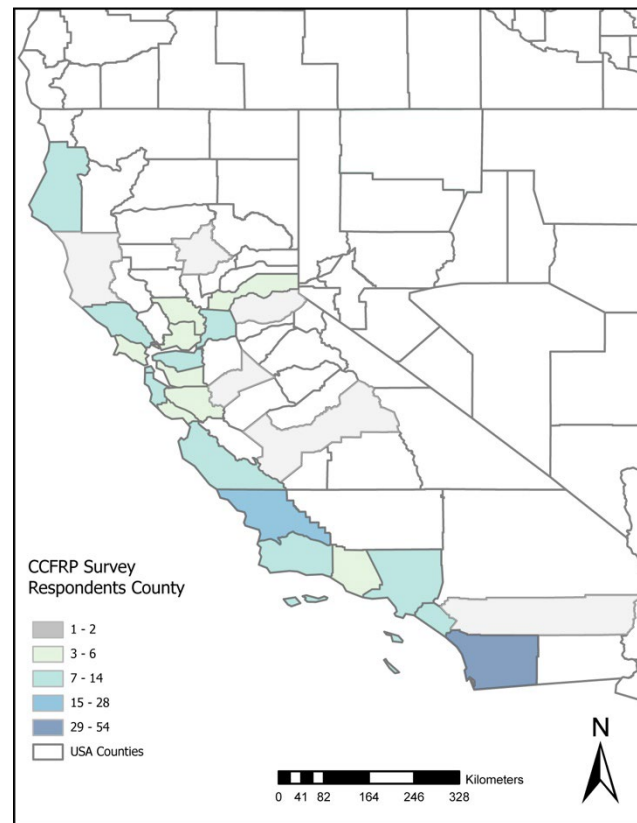
Signals of spillover extend into size structure

- Fish body size declines with distance from the MPA boundary
- Maintenance of large sizes near the boundary are likely a sign of spillover and may explain why fishermen continue to fish the boundary, despite lower catches



In 2021, we conducted a statewide survey of CCFRP angler opinions about MPAs

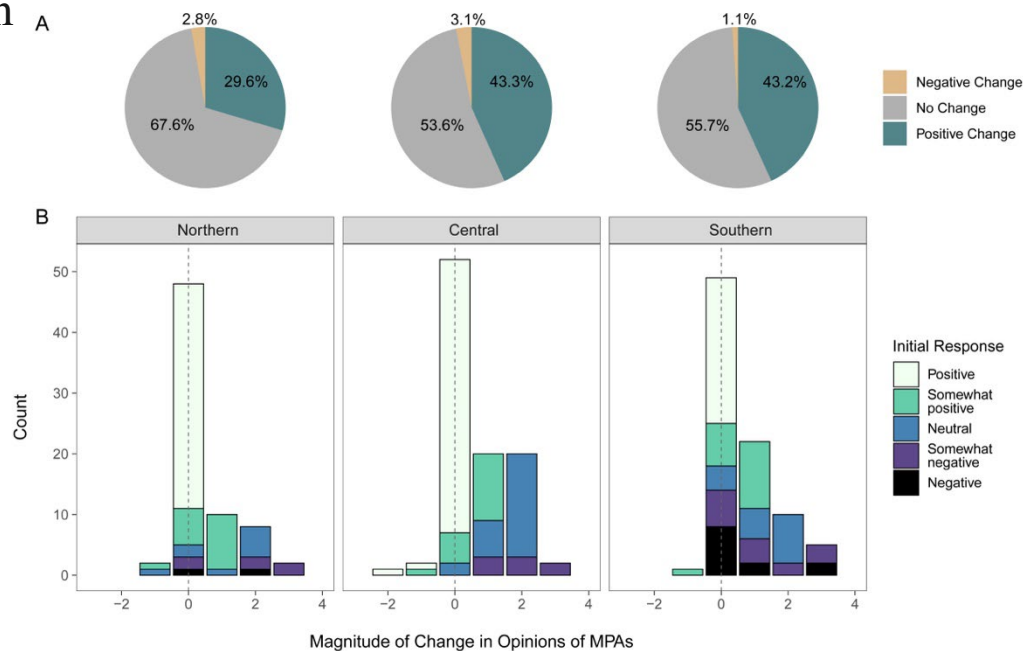
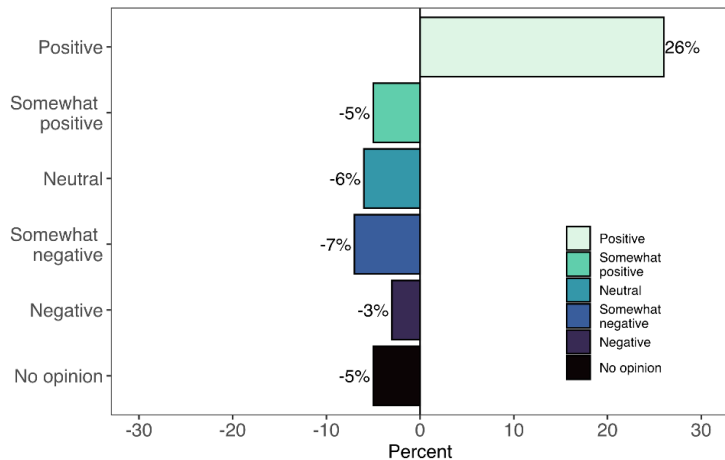
CCFRP Institution	Number of Angler Recipients	Number of Respondents	Percentage of Recipients that Responded
Humboldt State University	86	21	24.4%
Bodega Marine Laboratories at UC Davis	160	50	31.3%
Moss Landing Marine Laboratories	626	63	10.1%
Cal Poly, San Luis Obispo	234	36	15.3%
Marine Sciences Institute at UCSB	123	22	17.9%
Scripps Institution of Oceanography at UCSD	157	67	42.7%
Total	1386	262	18.9%



Opinions of MPAs before and after volunteering with CCFRP

- Perceptions of MPAs by volunteer anglers became more positive after participating with CCFRP, especially for those who volunteer longer
- Anglers in southern CA started with ^A more negative opinions of MPAs

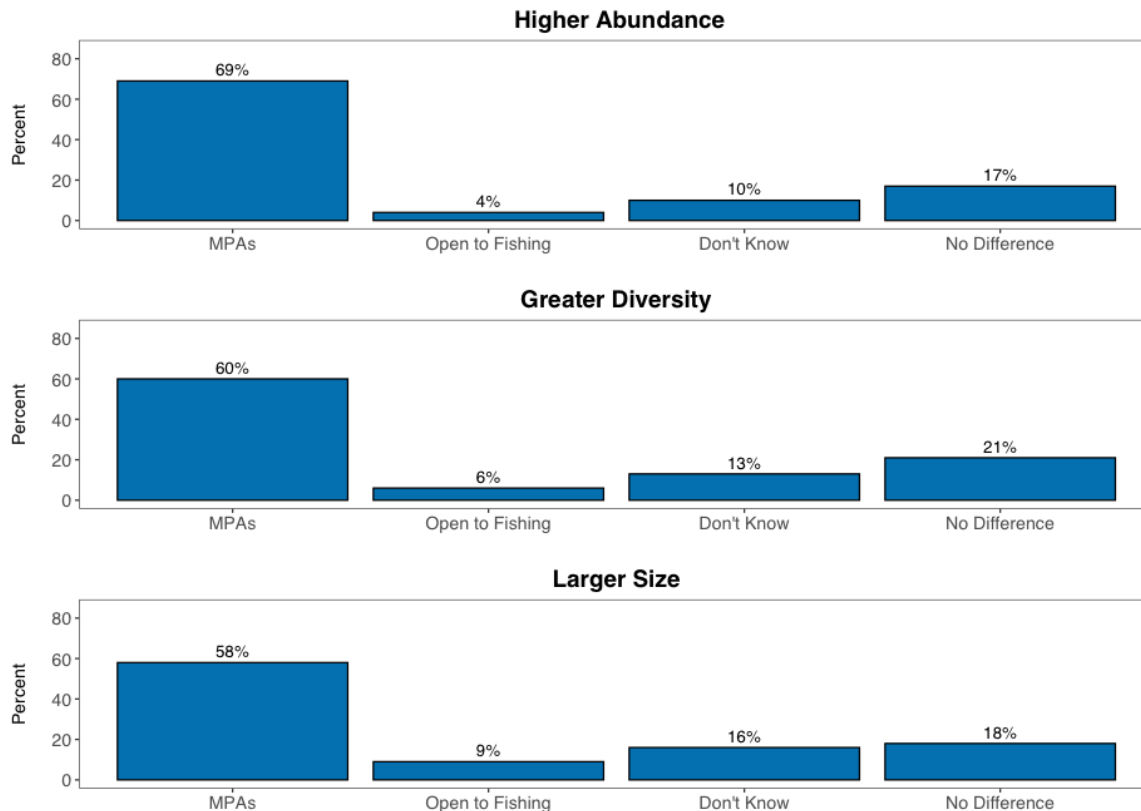
Percent Change in Opinion After Volunteering with CCFRP



Have you experienced differences in fishing inside and outside MPAs?

Anglers report that they catch...

1. more fish,
2. a greater diversity of fish species, and
3. larger sizes of fish when sampling sites inside of MPAs



Discussion

1. MPAs are working well across the statewide network. Fish are larger in body size, more abundant, and higher in biomass in nearly every MPA sampled.
2. Fishing pressure, MPA area, MPA age, and location explain differences in the strength of MPA responses across the network.
3. Despite evidence of spillover in some species, tag-recapture data indicated that the majority of fishes remained inside MPAs for extensive periods. MPAs are appropriately sized to encompass the home ranges of many nearshore species.
4. CCFRP has shown the power of collaborative research to conduct rigorous evaluations of MPAs in California. Outreach and education to the fishing community has produced tangible benefits in terms of increasingly positive opinions of MPAs.





Thank You!

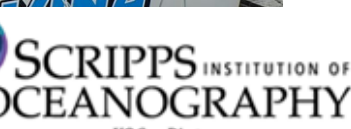
California Collaborative Fisheries Research Program

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CAL POLY
Center for Coastal Marine Sciences

UCSB



The California Collaborative Fisheries Research Program is a collaborative effort among researchers from Moss Landing Marine Laboratories, Cal Poly San Luis Obispo, Cal Poly Humboldt, Bodega Marine Laboratory, UC Santa Barbara, and Scripps Institution of Oceanography. MLML would like to thank the **volunteer anglers**, science crews, and captains and crews of F/Vs **Caroline**, **Chubasco**, **Huli Cat**, **Kahuna**, **New Captain Pete**, **New Horizon**, **Queen of Hearts**, **Sur Randy**, and **Tigerfish** for their continued support. Fish Illustrations provided by Dr. Larry Allen.

For more information, like us on Facebook and Instagram, or visit us at <https://mlml.sjsu.edu/ccfrp/>