

Variation in ecological performance
across a large network of MPAs in
California complicates adaptive
management.

Jenn Caselle *Univ. of California, Santa Barbara*

Mark Carr *Univ. of California, Santa Cruz*

Barbara Spiecker *Univ. of California, Santa Barbara*

Dan Malone *Univ. of California, Santa Cruz*

Avrey Parsons-Field *Univ. of California, Santa Barbara*

Kyle Cavanaugh *Univ. of California, Los Angeles*

Daniel Pondella *Occidental College*

Brian Tissot *Cal Poly Humboldt University*

UC SANTA BARBARA

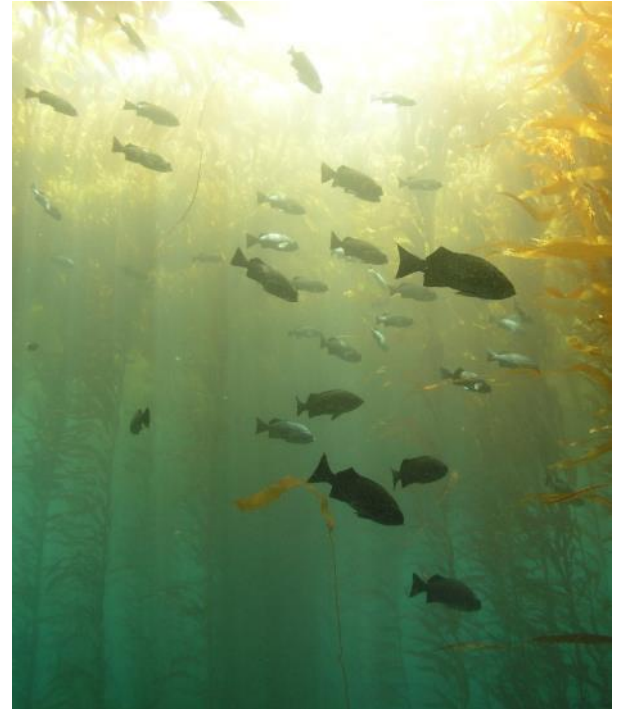
Marine Science Institute

MPA BACKGROUND

CA Marine Life Protection Act

Three ecological goals:

- Protect the **natural diversity and abundance of marine life**, and the structure, function and integrity of **marine ecosystems**.
- Help sustain, conserve and **protect marine life populations**, including those of economic value, and **rebuild** those that are depleted.
- Protect marine natural heritage, including protection of **representative and unique marine life habitats** in CA waters for their intrinsic values.
- **Ensure that MPAs are designed and managed as a network**

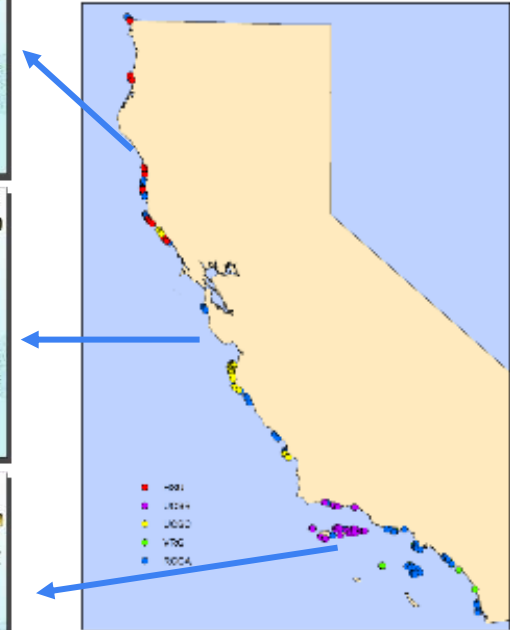
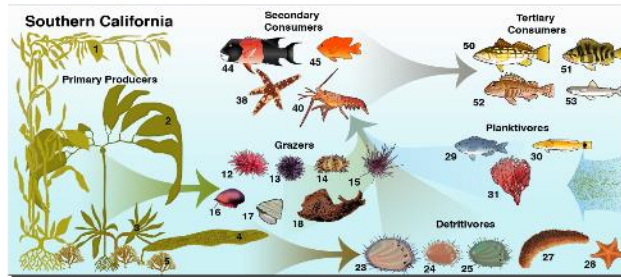
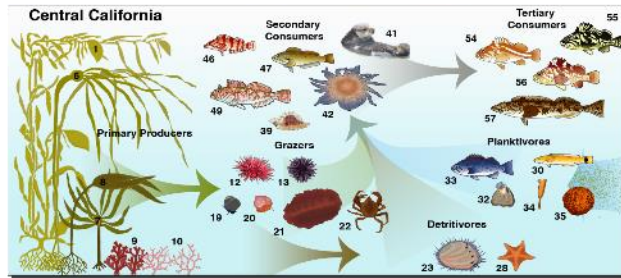
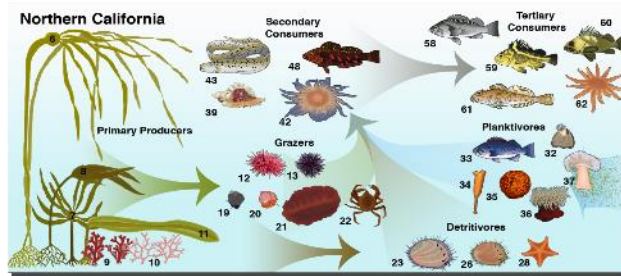
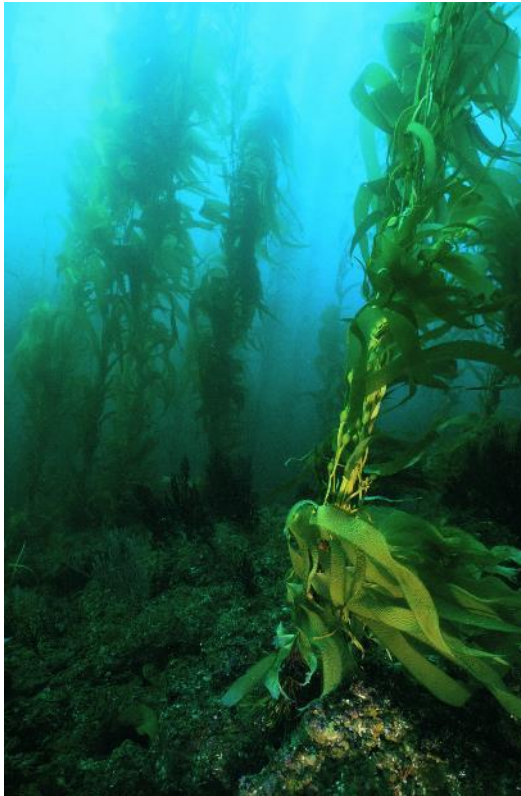


MPA BACKGROUND

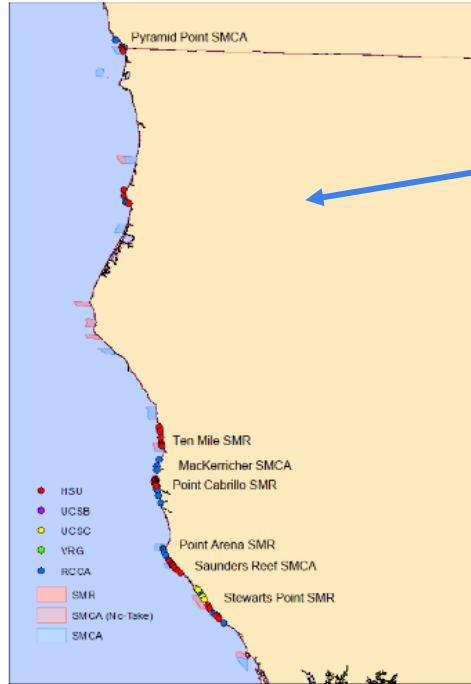
- MPAs established between 2007 and 2012 in four coastal regions
- 124 MPAs total covering 2197 km², 16% of state waters



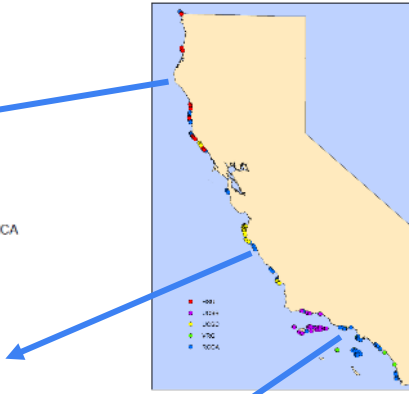
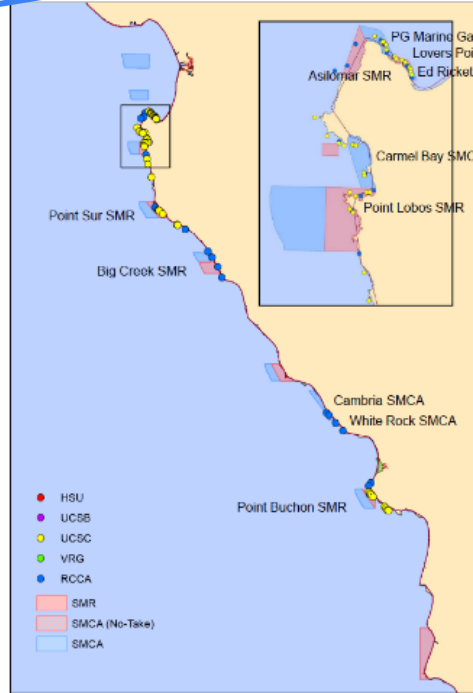
CALIFORNIA BACKGROUND



NETWORK-WIDE KELP FOREST MONITORING



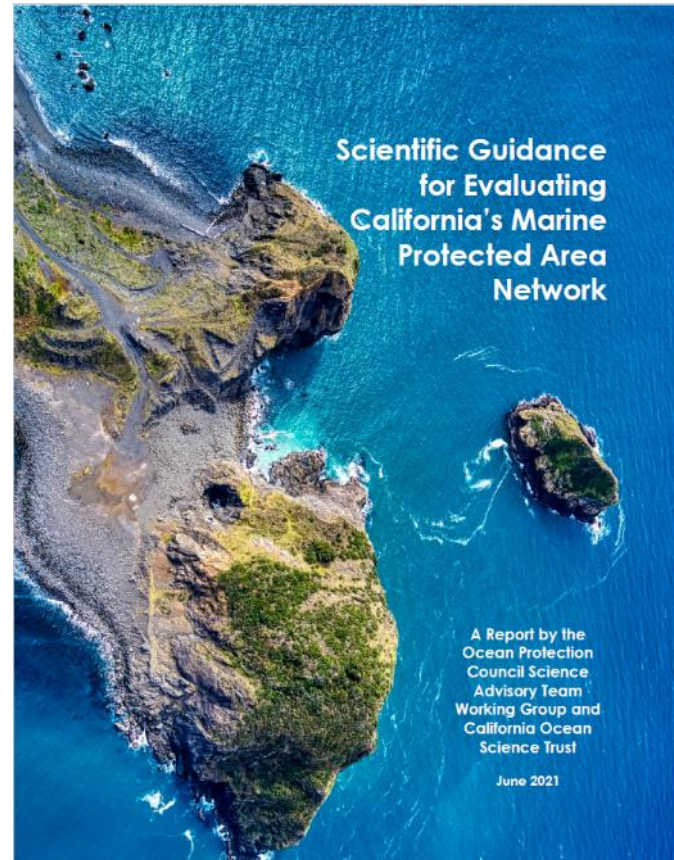
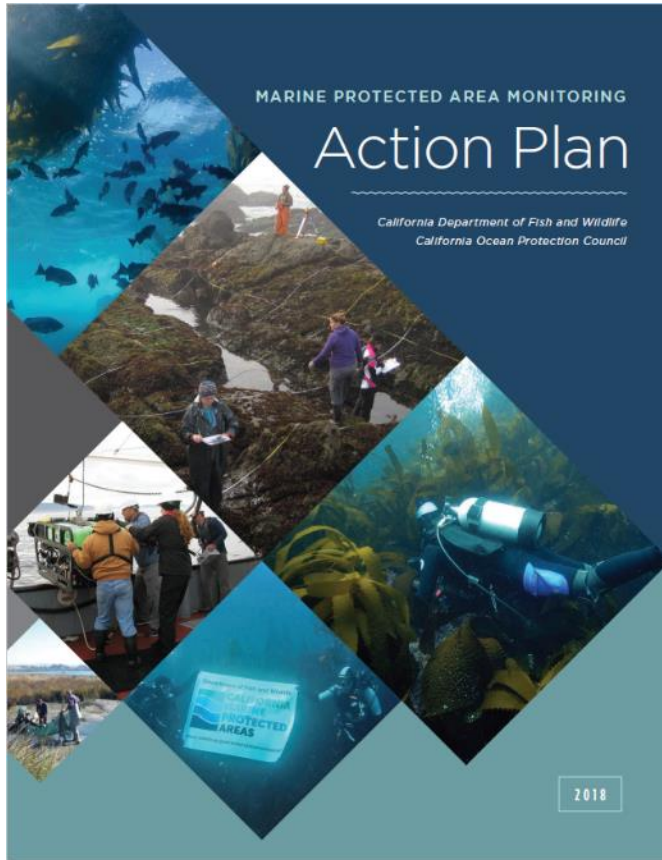
277 sites in 65 MPAs
23 years
55,000 transects
>390 divers



- Humboldt State
- Reef Check
- UCSC
- UCSB
- Occidental



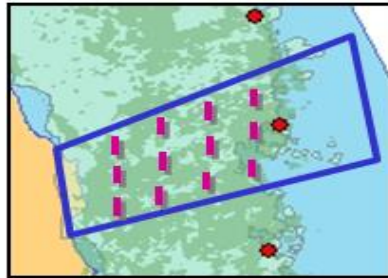
GUIDING DOCUMENTS



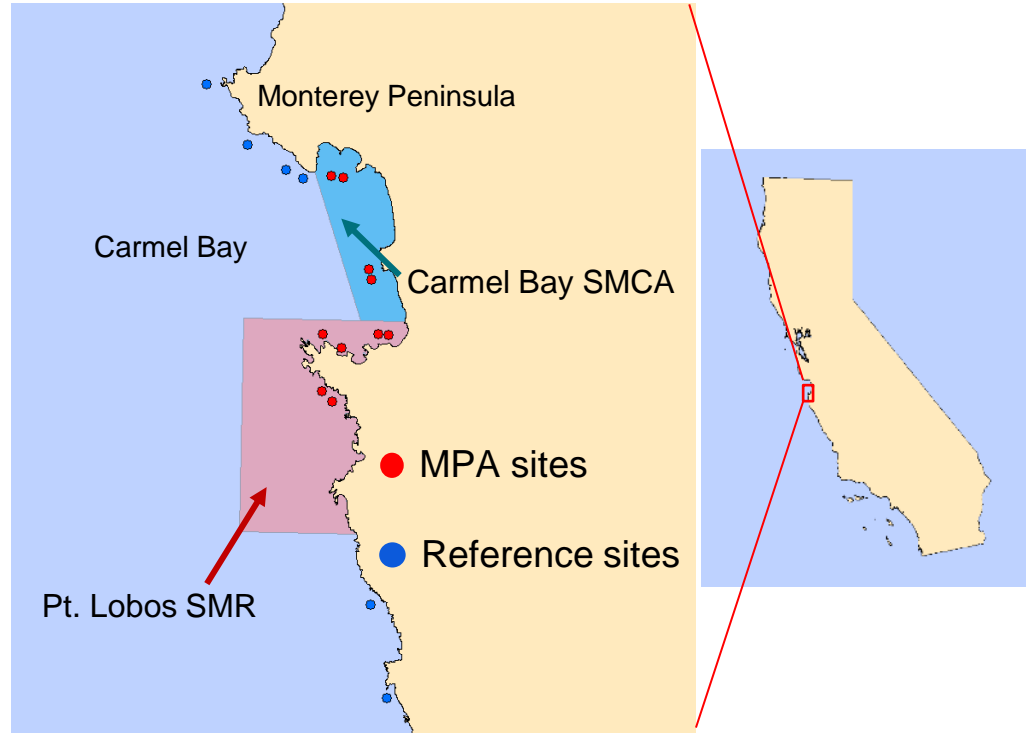
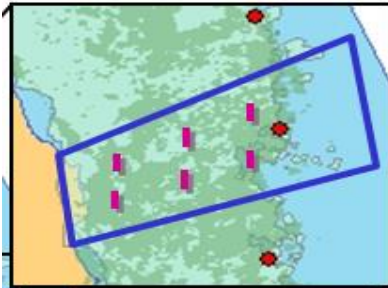
Spatial Design of Monitoring Program



Fish transects:
5m, 10m, 15m, 20m



Algae, invertebrate transects:
5m, 12.5m, 20m



ANALYTICAL DESIGN

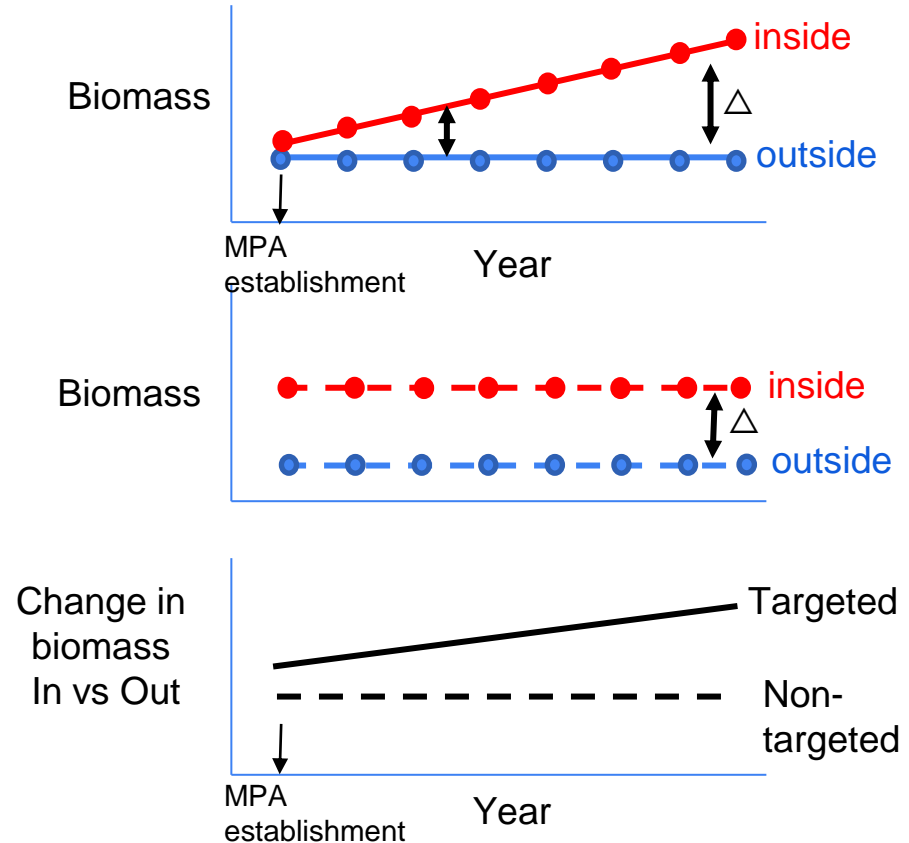
Hypothesis

Species targeted by fisheries show **greater** biomass increases over time inside MPAs than outside MPAs

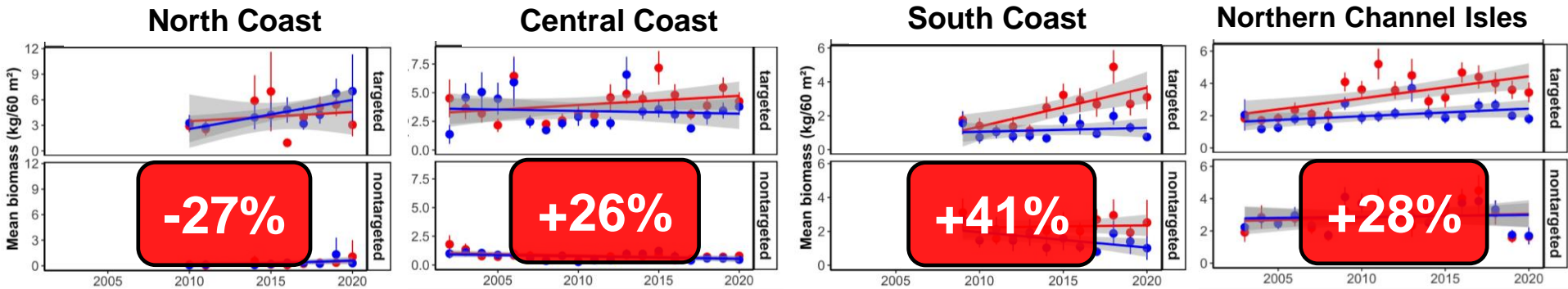
Species NOT targeted by fisheries exhibit **similar** changes in biomass over time inside MPAs vs. outside MPAs

Change in biomass of Targeted species over time will be **greater** than non-targeted species **inside** MPAs

Predicted pattern



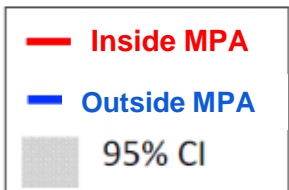
Do CA MPAs show a positive reserve effects for biomass of fishes?



Northern and Central California showed no significant patterns between Targeted and Non-targeted species or Inside and Outside MPAs

South Coast and Northern Channel Islands showed a significant **increase in biomass** of Targeted species within these MPAs relative to outside MPAs

But... **Northern Channel Islands** is the only region where Targeted species within the MPAs **diverge significantly** from Non-targeted species



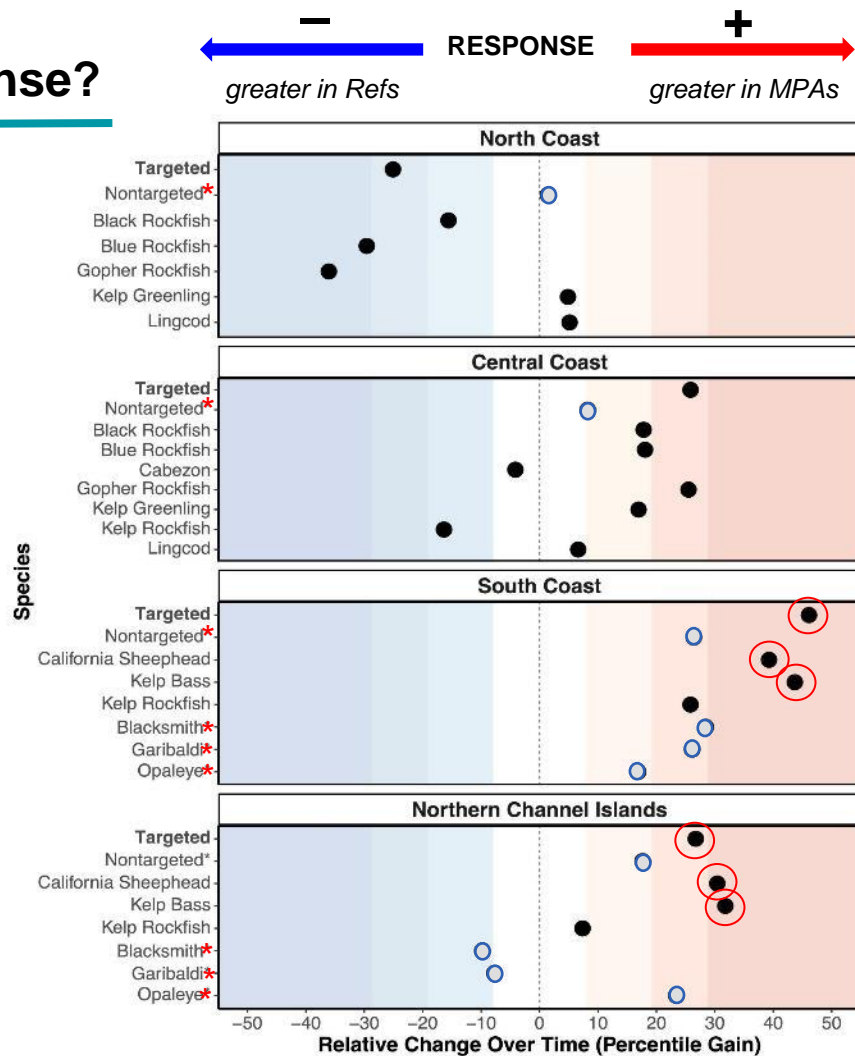
Do Targeted Fishes Differ in Their Response?

Change in Fish Biomass Over Time

- All Targeted
- All Non-targeted *
- Focal Species

Stronger MPA responses in the **So. Coast**
and **No. Channel Islands**:

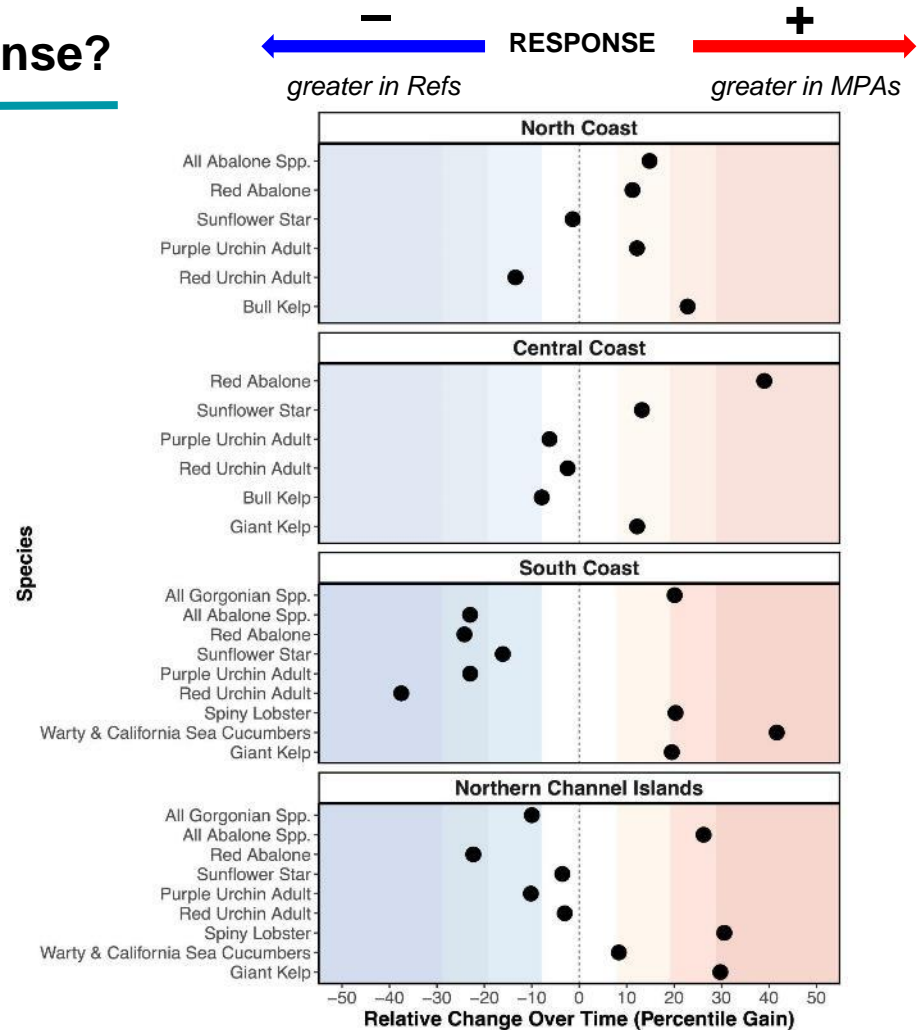
- Fished species
- California Sheephead
- Kelp Bass



Do Inverts and Algae differ in their response?

Change in Density Over Time

→ *Focal Species*



Do Inverts and Algae differ in their response?

Change in Density Over Time

→ *Focal Species*

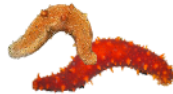
Stronger MPA responses:

- **Central Coast:** Red abalone
- **South Coast/NCI:**

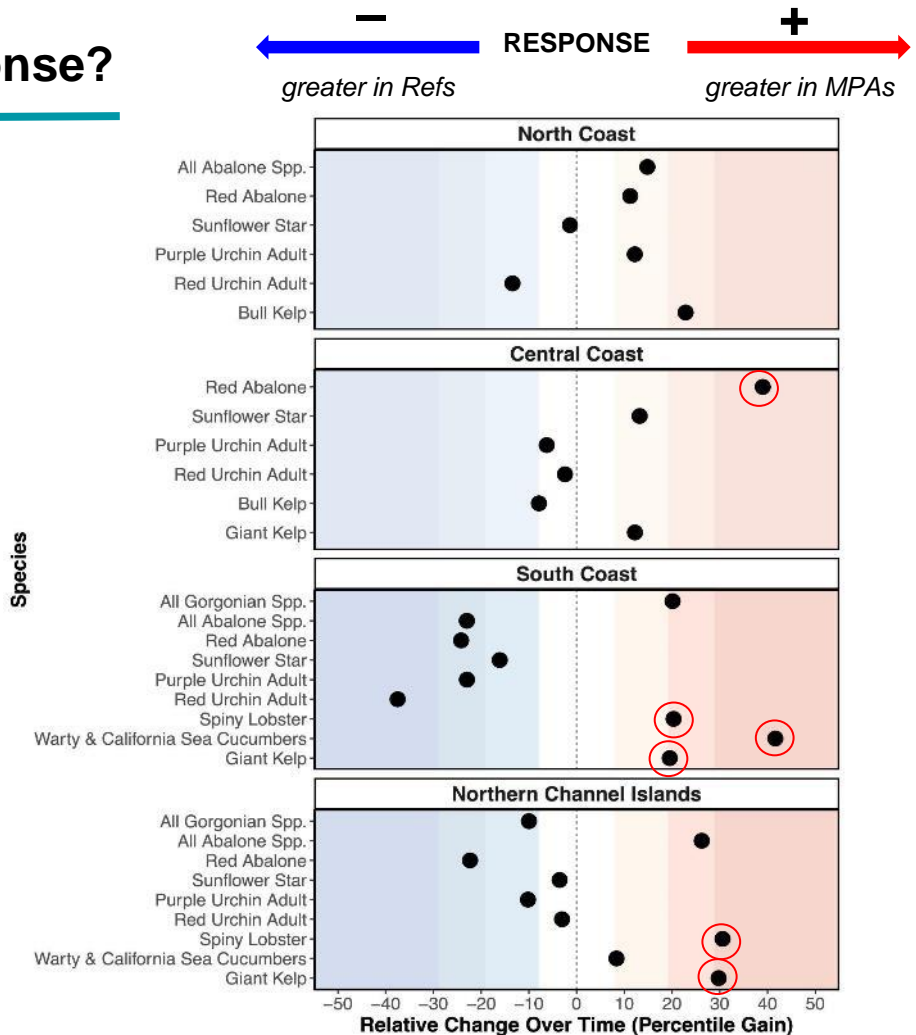
Spiny lobster



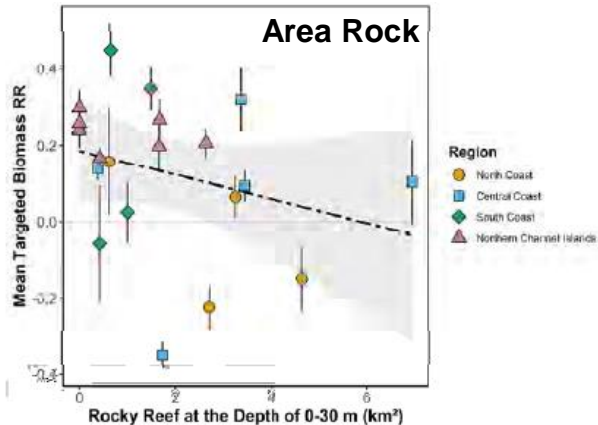
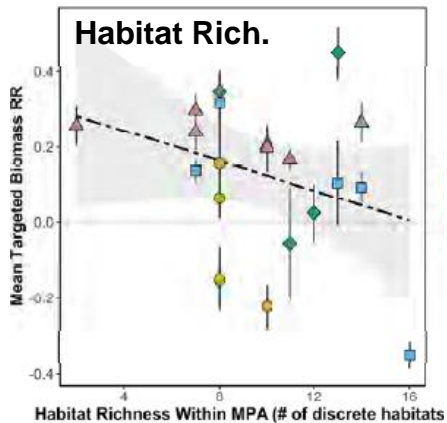
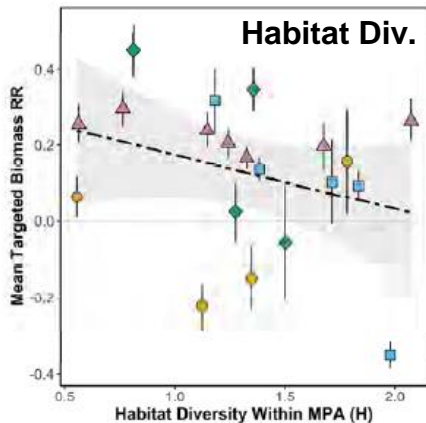
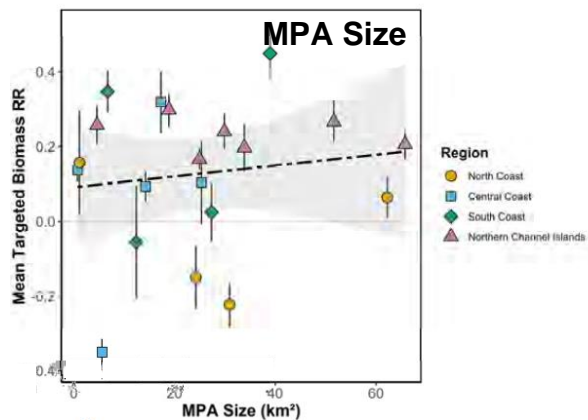
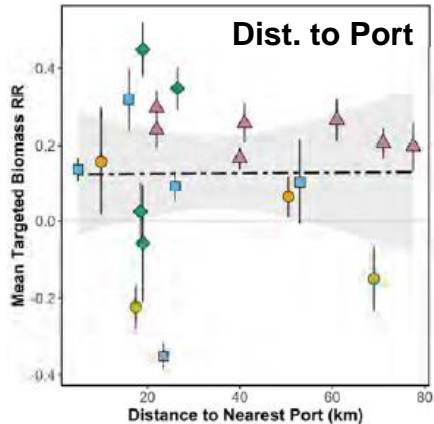
sea cucumbers



giant kelp



Do MPA characteristics explain responses for targeted fish?



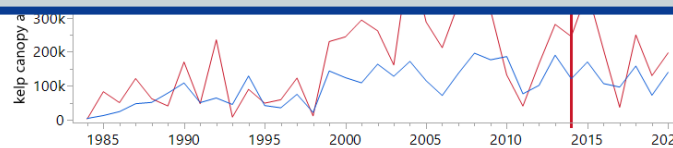
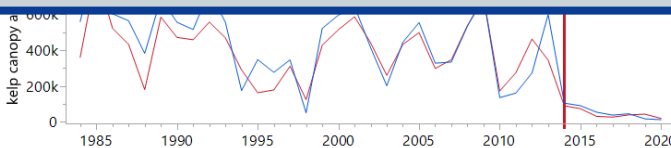
Effect of the Marine Heatwave (2014-2016) on Kelp (Bull and Giant)

North Coast
(bull kelp)

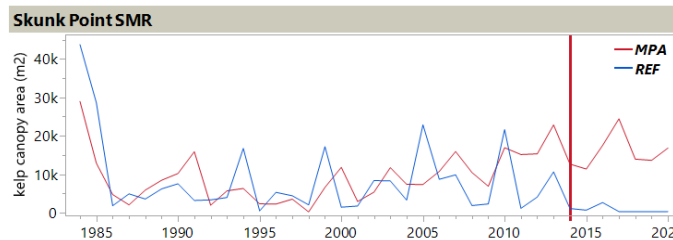
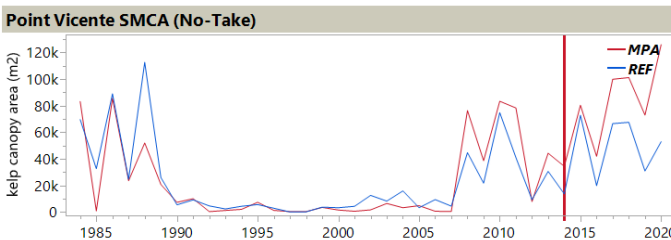


See talk by Emelly Villa at 11 am TODAY in this room

Central Coast
(bull and giant)



South Coast &
No. Channel
Islands
(giant kelp)

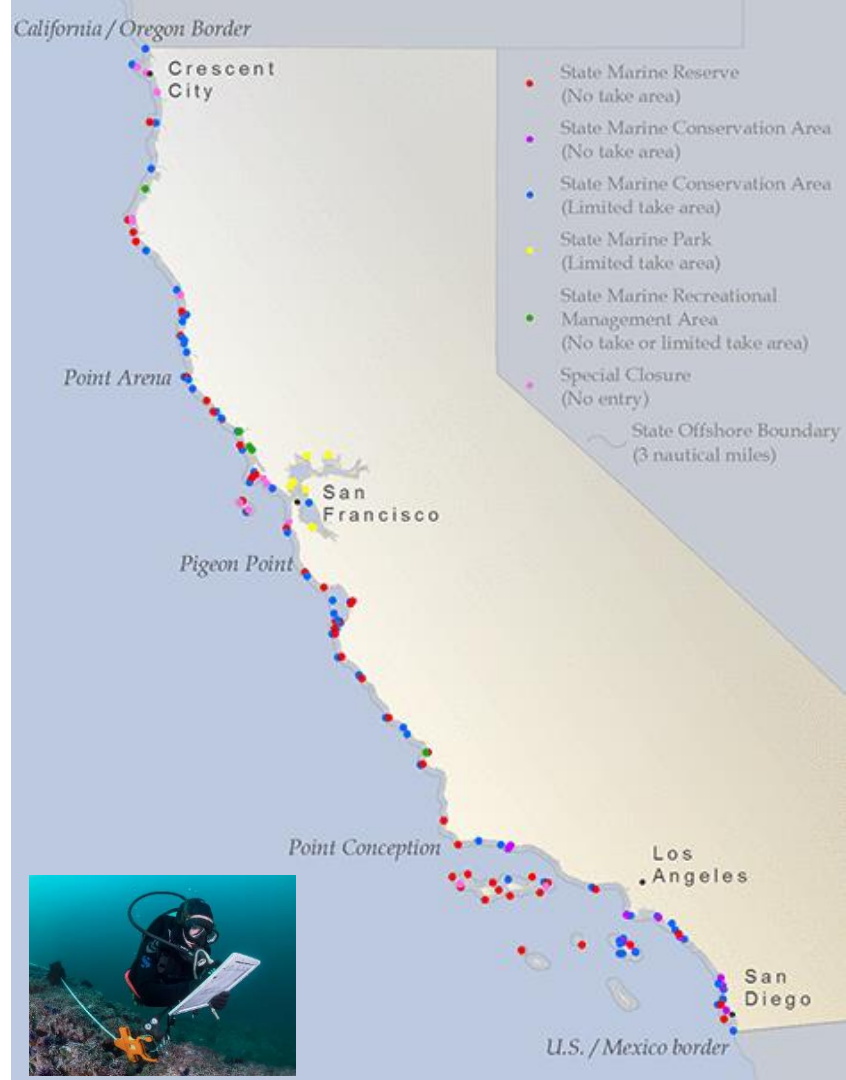


Year

Year

SUMMARY

- MPA effects **vary** across species, biogeographic regions, individual MPAs and time periods.
 - Regional scales proved more insightful than combined state-wide analyses.
- MPA design attributes (e.g. size, location, habitat) did not predict variation in performance.



North Coast MPAs: No clear responses

- Youngest MPAs / shortest time series
- Very difficult access – low replication and gaps
- Environmental disturbance (MHW) caused dramatic changes that could have swamped any possible MPA effects

Central Coast MPAs: Variable responses

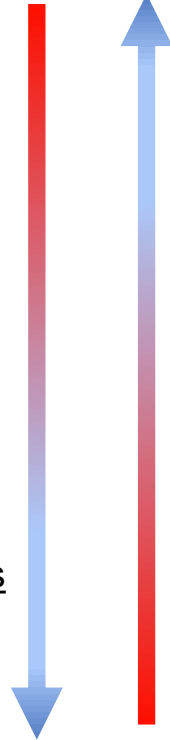
- Very well sampled region
- Variable fishing pressure within region
- Variable responses to MHW within region

No. Channel Islands/So. Coast MPAs: Strong pos. responses

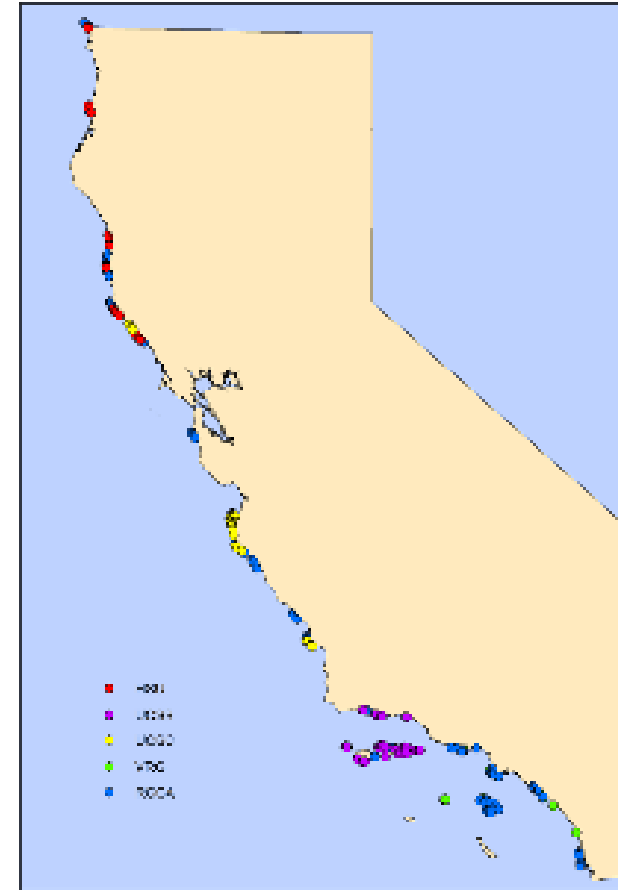
- Very well sampled region
- Moderate to very high fishing pressure
- Region less affected by MHW

MHW **Fishing**

Strong **Low**



Weak **High**



MANAGEMENT RECOMMENDATIONS

- Continue **long-term monitoring** of kelp forest ecosystems and environmental conditions
 - But **tailor monitoring regionally** in ways that make financial and ecological sense
- **Prioritize** MPAs to monitor and evaluate
 - Not every MPA requires the same level and type of monitoring
- **Prioritize** better understanding of regional drivers of MPA performance
 - Acquire **accurate fishing data** near MPAs
 - Better characterize **environmental conditions** and responses to disturbances such as MHW

By the numbers...so many to thank.....

23 Years
390 Divers

30,000+ Dives
70,000+ Cylinders
2,200+ Days underwater

65 MPAs
277 Sites
50,000+ Transects

AARON SUGIMOTO, ABBY BRUNNER, ADAM OBAZA, ADAM PETUSKEY, ADRIENNE MIKOVARI, AIMEE KEISER, AISLINN DUNNE, ALBERT CHANG, ALEX MCLEOD, ALEX MATSUMOTO, ALEX OLSON, ALEX RAY, ALIA AL-HUMAIIDI, ALICE SOCCODATO, ALLISON LUI, AMANDA JENSEN, AMANDA RIVARD, AMANDA TINOCO, AMBER SIMPSON, ANDREW REYNAGA, ANDY REYNAGA, ANGELA EDMUNDS, ANGELO PALMERI, ANNA JAMES, ANNA NEUMANN, ANTHONY FREDERICKS, ARMAND BARILOTTI, ARNOLD AMANN, ARON KINGSBOOK, AURORA ALIFANO, AUSTIN PYLES, AVREY PARSONS-FIELD, BECCA SELDON, BEN GRIME, BEN WEITZMAN, BILL FIELD, BILL FURLONG, BILL POWER, BINH VUONG, BONNIE ROGERS, BWEN BROCK, BRENT HAGGIN, BRETT STACY, BRIAN COHN, BRIAN MEUX, BRIAN ZAVISZA, BRIANNA BOWMAN, BRIANNA BRADY, BRITTANY THOLAN, BRYNN O'HARA, CAITLIN O'BRIEN, CALEB SCHNEIDER, CALVIN MUNSON, CARLY HAACK, CAROLYN BELAK, CASEY JULIUSSEN, CASEY SHERIDEN, CECE MARTIN, CECILIA SHIN, CELINE DE JONG, CHAD BURT, CHAD KING, CHASE MCDONALD, CHELSEA WILLIAMS, CHEYENNE JARMAN, CHRIS GOTSCHALK, CHRIS HONEYMAN, CHRIS MOBLEY, CHRIS OAKES, CHRIS TEAGUE, CHRISTIAN ORSINI, CHRISTINE DONAHUE, CHRISTOPH PIERRE, CHRISTOPHER HOLMES, CHRISTY ROE, CIAN HETTRICK, CLAIRE SAARMAN, CLARA SVEDLUND, CLAY POLLOCK, CLINT COLLINS, COLBY SMITH, COLIN GAYLORD, COLIN MCHUGH, CONNER APPLEWHITE, CONNER JAINESE, CONNOR TILMAN, CORI HUME-FLANNERY, COULSON LANTZ, COURTNEY SCARBOROUGH, CRAIG SYMS, CRAIG TINUS, CYNDI DAWSON, CYNTHIA HAYS, DAN ABBOTT, DAN GENTER, DAN MALONE, DAN PONDELLA, DANA MICHELS, DANIEL RAMIREZ, DANIEL TAPIAS-GOMEZ, DARREN JOHNSON, DAVE RIVERA, DAVID BENET, DAVID KUSHNER, DAVID OSORIO, DAVID PANEK, DAVID WITTING, DAWN BAILEY, DAWN JECH, DEVONA YATES, DIANA CHURCHILL, DIANA STELLER, DJ MACASKILL, DON CANESTRO, DONNA SCHROEDER, DOUG SIMPSON, DREW HANSON, DYLAN SIMONSON, EASTON WILLIAMS, EMILY HASCALL, EMILY SAARMAN, EMILY WILSON, EMMA HORANIC, ERIC ANDERSON, ERIC HESSELL, ERIC MOONEY, ERIC NICKISCH, ERICA SIEPKER, ERIN JACO, ETHAN NASH, FRANK HURD, FRANKIE GERRATY, FRANKLIN MOITZA, GARY LONGO, GAVIN HANSEN, GAVIN MCDONALD, GAVIN ZIRKEL, GRACE COOGAN, GRANT GRGICH, GRANT WALTZ, HAARHAUS LEE-OY, HALLE SHAUER, HANNAH HOEFS, HEATHER BURDICK, HEATHER KRAMP, HENRY VOGT, HILLARY KRUMBHOLTZ, HOWATT KING, IAN MOFFIT, IAN TANIGUCHI, IRIS KREHAHN, IVAN GIRLING, JACK FISCHETTI, JACOB EAGLETON, JACOB EURICH, JADE ZOUNES, JADEN HARDING, JAHNAVA DURYEA, JAIME GROVER, JAKE EISAGUIRRE, JAMES BENSON, JAMES WHITE, JAMIE BARLOW, JAMIE PRATT, JAN FREIHWALD, JANA COBB, JARED FIGURSKI, JARED KIBELE, JASON CARROLL, JASON GRONICH, JEAN DAVIS, JEAN DE MARIGNAC, JEFF BARR, JEFF BERNARD, JEFF HARDING, JENN CASELLE, JENN DIFFLEY, JENNIFER TARMANN, JENNY OLIVER, JEREMIAH BRANTNER, JEREMIAH ETS-HOKIN, JEREMIAH OSBORNE-GOWEY, JEREMY CLAISSE, JESSE PATTERSON, JESSE TOOTELL, JESSICA CHAPMAN, JESSICA COUTURE, JESSICA SCHEM, JESSIE HANAWAY, JOHN CENTONI, JOHN FROESCHKE, JOHN HARRIMAN, JOHN KOVACH, JOHN UGORETZ, JOHNATHAN CENTONI, JONATHAN WILLIAMS, JOHNNY ROCHE, JOLENE EVANS, JONNA ENGEL, JOSE AYALA, JOSH CARTER, JOSH PEDERSON, JOSH SMITH, JOSH SPRAGUE, JOSHUA CARTER, JULIE BURSEK, JULIE UO, JULIO GOMEZ, JUSTIN LIN, KAI KOPECKY, KAITLYN LANFIELD, KALIKO DAILEY, KARAH COX, KASEY MACRAE, KAT HEUER, KAT MAGANA, KAT RODRIGUEZ, KATE MAYER, KATE VYLET, KATELIN SEETO, KATHY GILLES, KATIE DAVIS, KATY BLAND, KATY KUNDEL, KEEGAN BELL, KEITH YAEGER, KELLY MOORE, KENAN CHAN, KEVIN BARR, KEVIN YOSHIMOTO, KINDALL MURIE, KIT CLARKE, KRISTEN KUSIC, KRISTINE BARSKY, KYLE MCDANIEL, KYLE WEISS, KYRA ANDERSON, LANNY FLAHERTY, LARS DAVENPORT, LAURA ANDERSON, LAURA KINNEY, LAUREL ZAHN, LAUREN NUTT, LAUREN PARKER, LAUREN VALENTINO, LAURIE ANDERSON, LEAH STAMPER, LEEROY HAARHAUS, LEON ROULLARD, LERIN PIERCE, LIA PROTOPAPADAKIS, LIAM ZARRI, LINDSAY CULLEN, LINDSAY MARKS, LINDSEY HESLA, LINDSEY KRAEMER, LOGAN BROWN, LUCA SILVA, LUCY MARCUS, LUIS HERNANDEZ, LYALL BELLQUIST, LYRA ORDJONIKIDZE, MAC POWER, MACKENZIE HANSLER, MAIA GRODIN, MARCOS GRABIEL, MARIE FERGUSON, MARK CARR, MARK READDIE, MARTHA BURFORD, MARY DONOVAN, MASON EMERY, MATT BISSELL, MATT CRAVENS, MATT KAY, MATT ROBART, MATTHEW CRAVENS, MAUREEN WISE, MEL MANDRUP, MELISSA DAUGHERTY, MELISSA FOLEY, MERIT MCCREA, MICHAEL CIVIELO, MICHAEL DAVIS, MICHAEL LANGHANS, MICHAEL SHEEHY, MICHAEL WEBSTER, MIKE CIVIELLO, MIKE MOSS, MIRANDA ROETHLER, MOLLY FREDLE, MONIQUE DEMALTERIS, MOOREA ANDERSON, MORGAN BOND, MORGAN WINSTON, MORIAH SEVIER, MYKLE HOBAN, NARINEH NAZARIAN, NATALIE BOLLINGER, NATE SPINDEL, NICK LORENZEN, NICOLE ALVARADO, NICOLE PETERSON, OLIVIA BARRY, PAOLO SERPA, PARKER HOUSE, PATRICK BERK, PATRICK LANE, PATRICK SALDANA, PAUL LEARY, PAUL TOMPKINS, PAULA KALTENBRUNNER, PETE HAAKER, PETE RAIMONDI, PETER CARLSON, PETER KRAUSE, PRICE CAMPBELL, RACHEL ZUERCHER, RANDOLPH SKROVAN, REBECCA HUECKEL, REED SANTEE, RICH WALSH, ROBIN FRANCIS, RODRIGO BEAS, RUDY RAIMONDI, RYAN BAKER, RYAN JENKINSON, RYAN STEPHENSON, RYAN STOKES, SABRINA GARCIA, SAM MCDONALD, SAM RICHARDSON, SAM SOULE, SARA ROSENBLATT, SARAH ASHEY, SARAH CORSBIE, SARAH FANGMAN, SARAH JEFFRIES, SARAH LUMMIS, SARAH TECK, SARAH TRAIER, SARAH WOZNIAK, SAVANNAH D'ORAZIO, SCOT LUCAS, SCOTT CLARK, SCOTT GABARA, SCOTT HAMILTON, SCOTT MILLER, SCOTT TOYAMA, SEAN ECKLEY, SEAN HOOBLER, SEAN WINDELL, SELENA MCMILLAN, SHANNON MYERS, SHAWN HARPER, SHELBY SHAPIRO, SIGRIDO ZIMMERMANN, SPENCER MCCLINTOCK, STACEY BUCKELEW, STACIE FEJTEK, STEPHANIE MUTZ, STEVE LONHART, STUART SCHWAB, SUSAN SEBRING, TAYLOR EATON, TAYLOR LEHMANN, TERRA PETRY, TERRIL EFIRD, TIM MOXON, TIMOTHY MCCLURE, THOM YOUNG, THOMAS OMOLO, TISH CONWAY-CRANOS, TODD VAN NATTA, TOM FORD, TOM MAHER, TOMMY DOLAN, TORREY GORRA, TRAVIS LEGGETT, TRAVIS MASSEY, TRISTIN MCHUGH, WADE SEDGWICK, WALTER HEADY, WILL HORSTMAYER, WILLIAM RAY, WYATT PATRY, XAVIER NELSON-ROWNTREE, YUKO YOKOZAWA, ZACH RANDELL, ZOE SCHOLZ

Partners & Funding



UC SANTA BARBARA

CAL POLY
HUMBOLDT

UCLA



Partnership for Interdisciplinary Studies of Coastal Oceans



the David &
Lucile Packard
FOUNDATION



Reef Check
WORLDWIDE

GORDON AND BETTY
MOORE
FOUNDATION



Sea Grant



OCEAN
PROTECTION
COUNCIL

