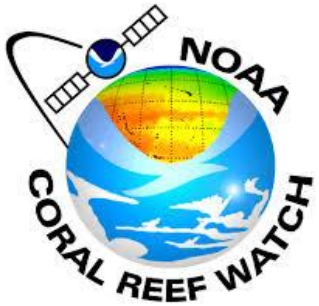
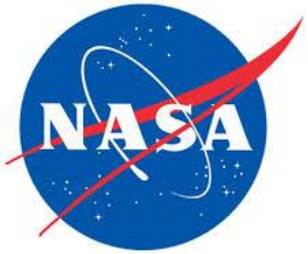
Fore-C: a coral disease forecasting tool for the Pacific

Multi-factor coral disease forecasts

NOAA Coral Reef Watch & University of Hawai‘i at Mānoa





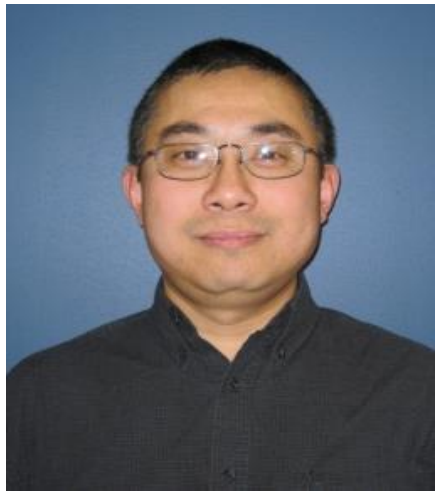
Jamie Caldwell

Scott Heron

Austin Greene

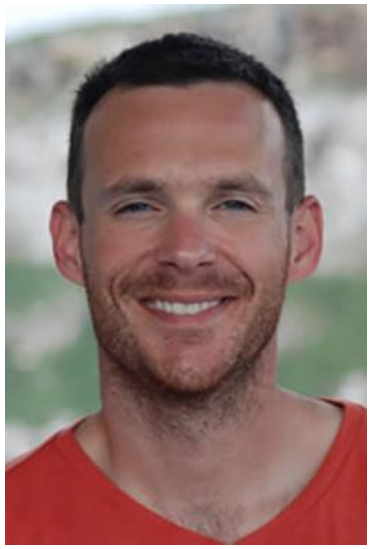
Megan Donahue

Mark Eakin



Gang Liu

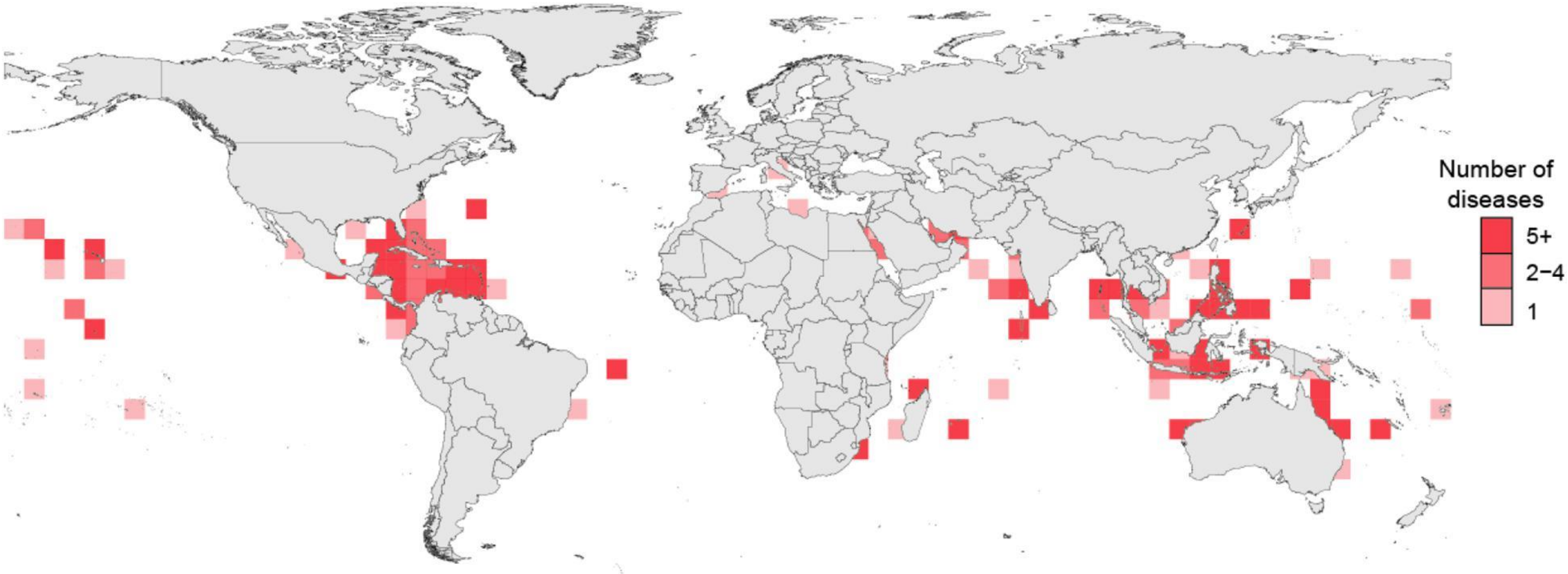
Erick Geiger



Derek Manzello

Coral reefs are threatened ecosystems

Coral disease impacts are widespread



Vega Thurber et al. 2020

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D

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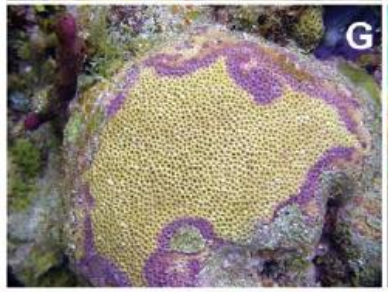
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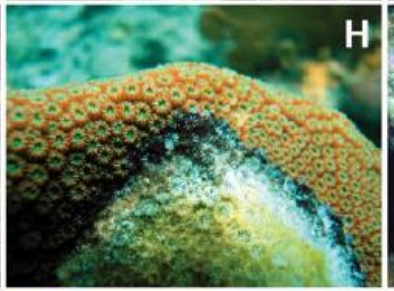
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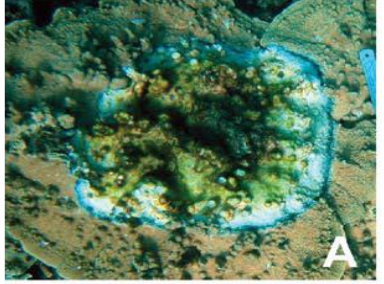
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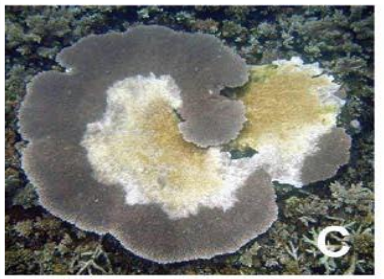
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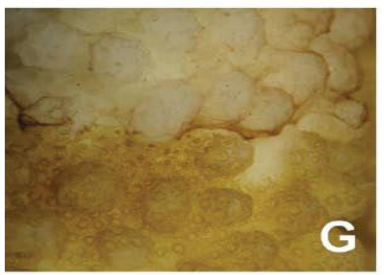
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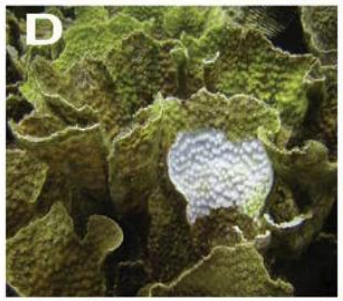
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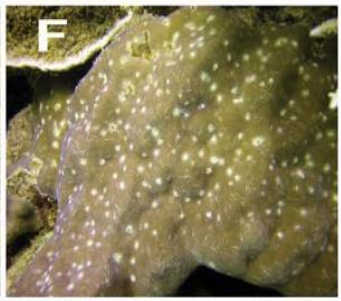
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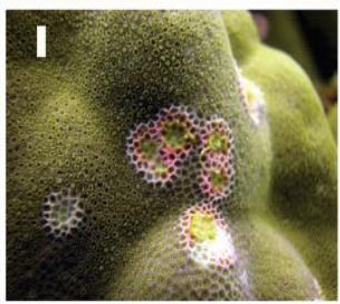
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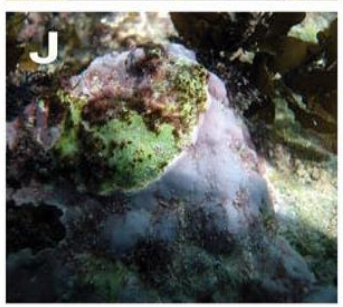
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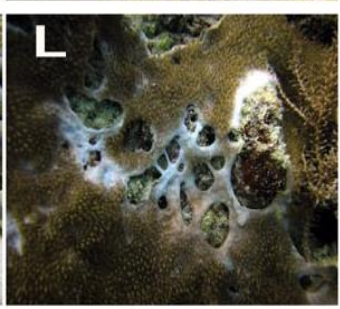
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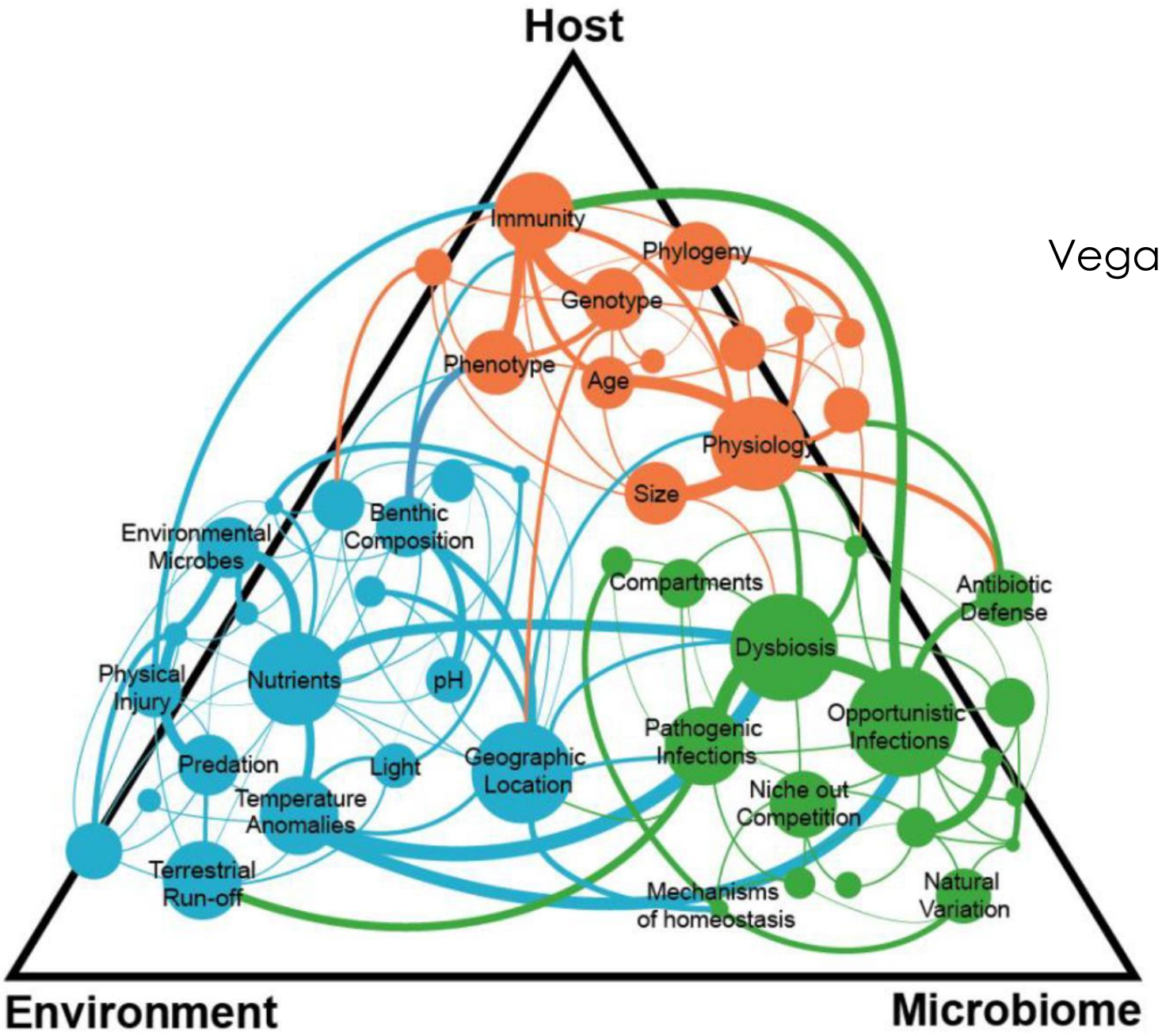


Vega Thurber et al. 2020

Coral Disease Outbreak Risk – CRW's first disease monitoring tool

Heron et al. (2010) PLoS one

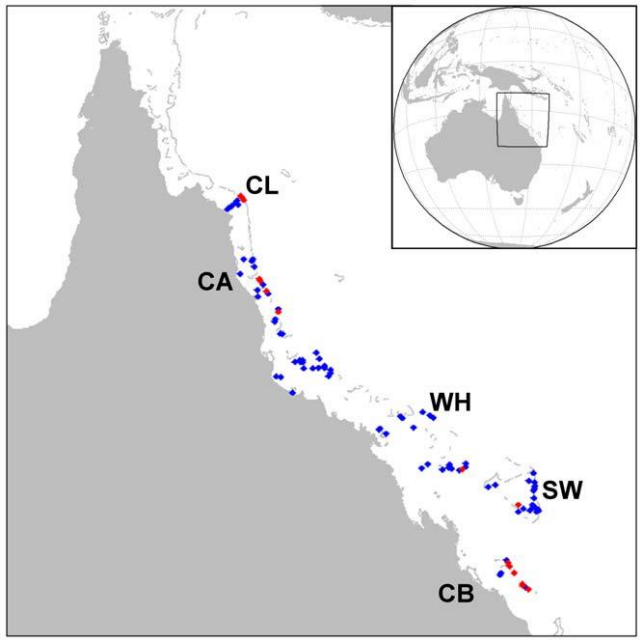
OPEN ACCESS Freely available online

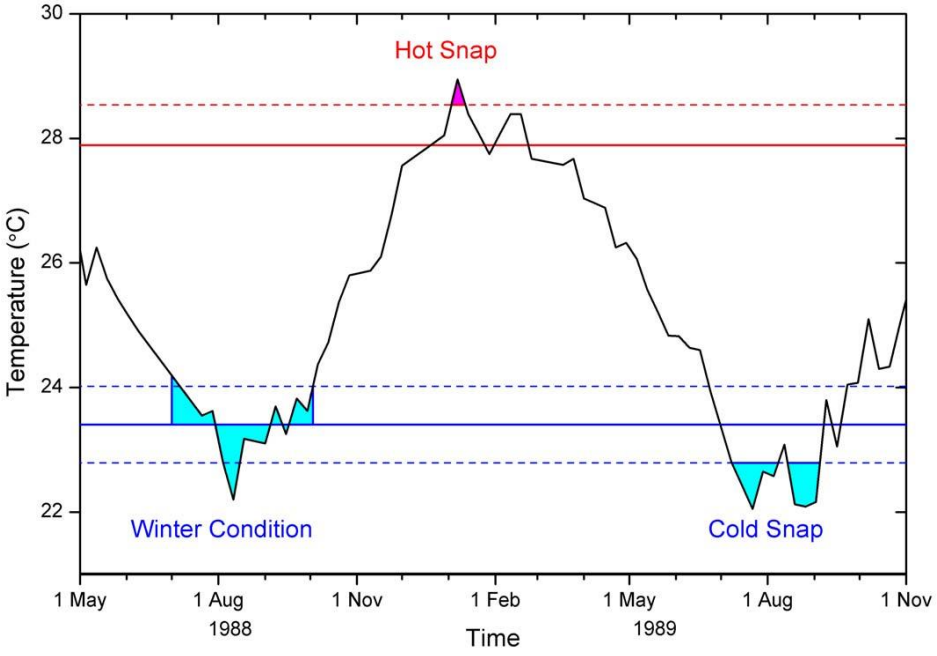
PLoS one

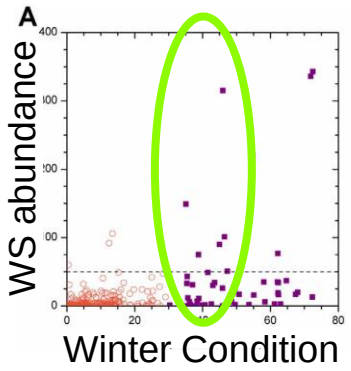
Summer Hot Snaps and Winter Conditions: Modelling White Syndrome Outbreaks on Great Barrier Reef Corals

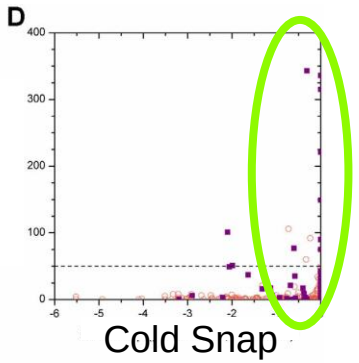
Scott F. Heron[1,2*], Bette L. Willis[3], William J. Skirving[2], C. Mark Eakin[4], Cathie A. Page[3], Ian R. Miller[5]

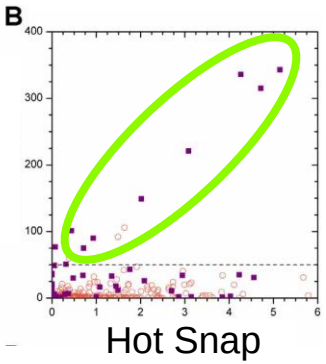
1 Coral Reef Watch, National Oceanic and Atmospheric Administration, Townsville, Queensland, Australia, 2 Physics Department and Marine Geophysical Laboratory, School of Engineering and Physical Sciences, James Cook University, Townsville, Queensland, Australia, 3 School of Marine and Tropical Biology and ARC Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, Queensland, Australia, 4 Coral Reef Watch, National Oceanic and Atmospheric Administration, Silver Spring, Maryland, United States of America, 5 Long Term Monitoring Program, Australian Institute of Marine Science, Townsville, Queensland, Australia

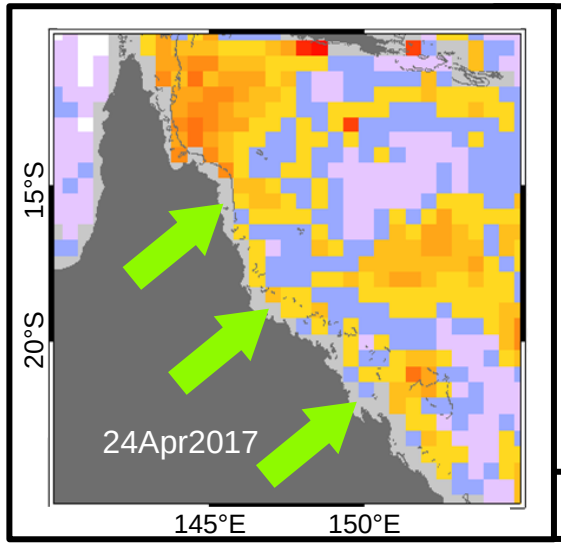


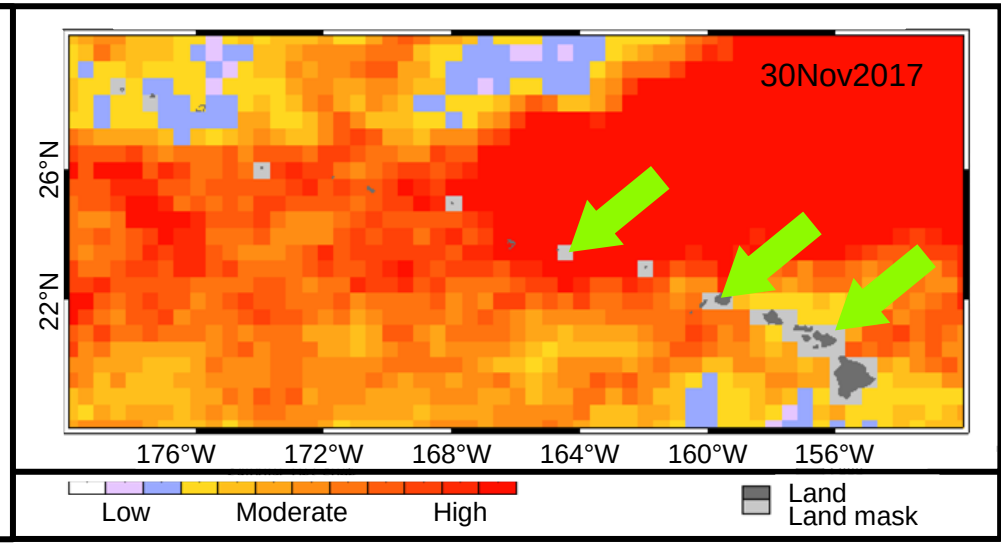




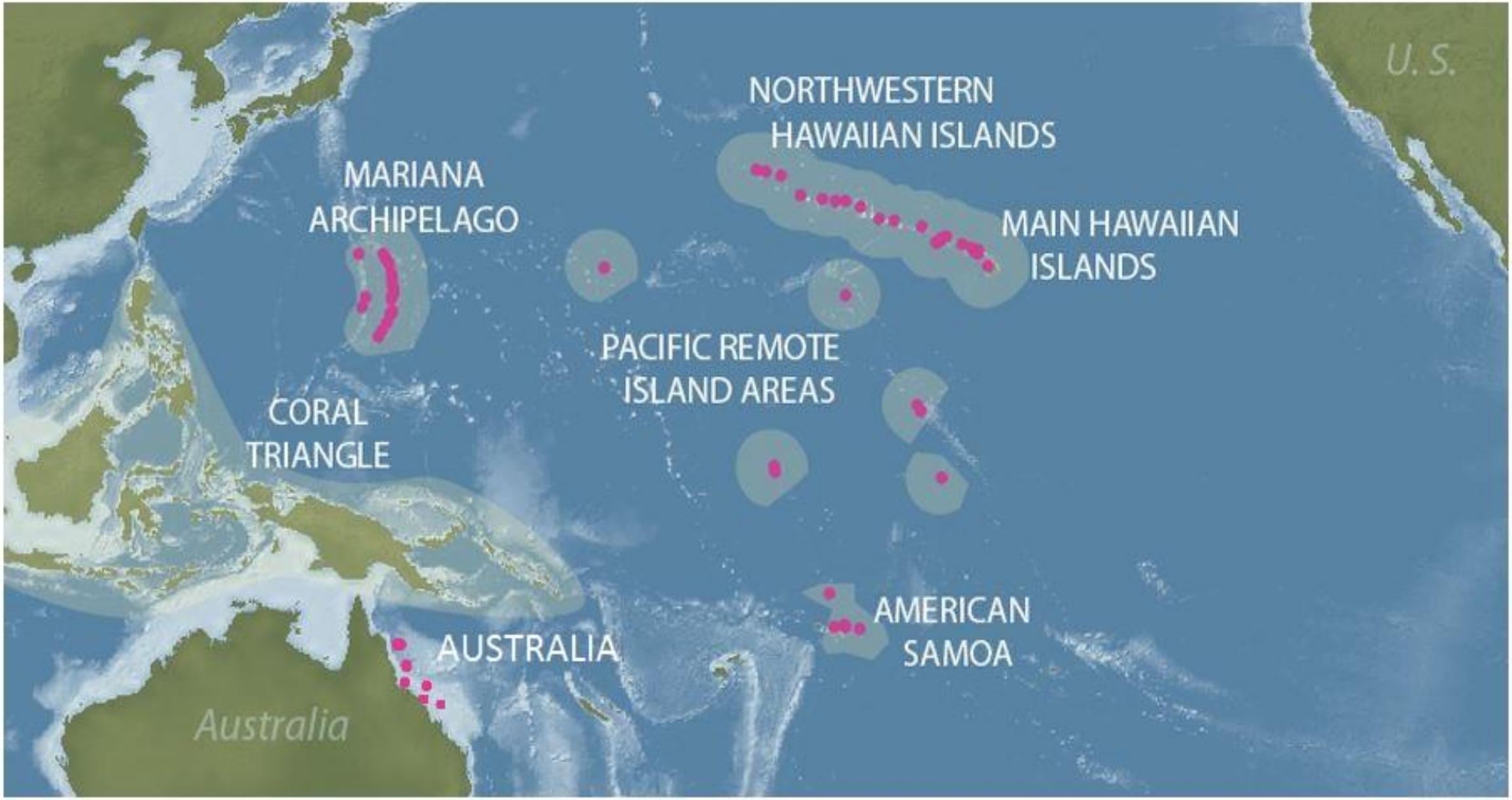








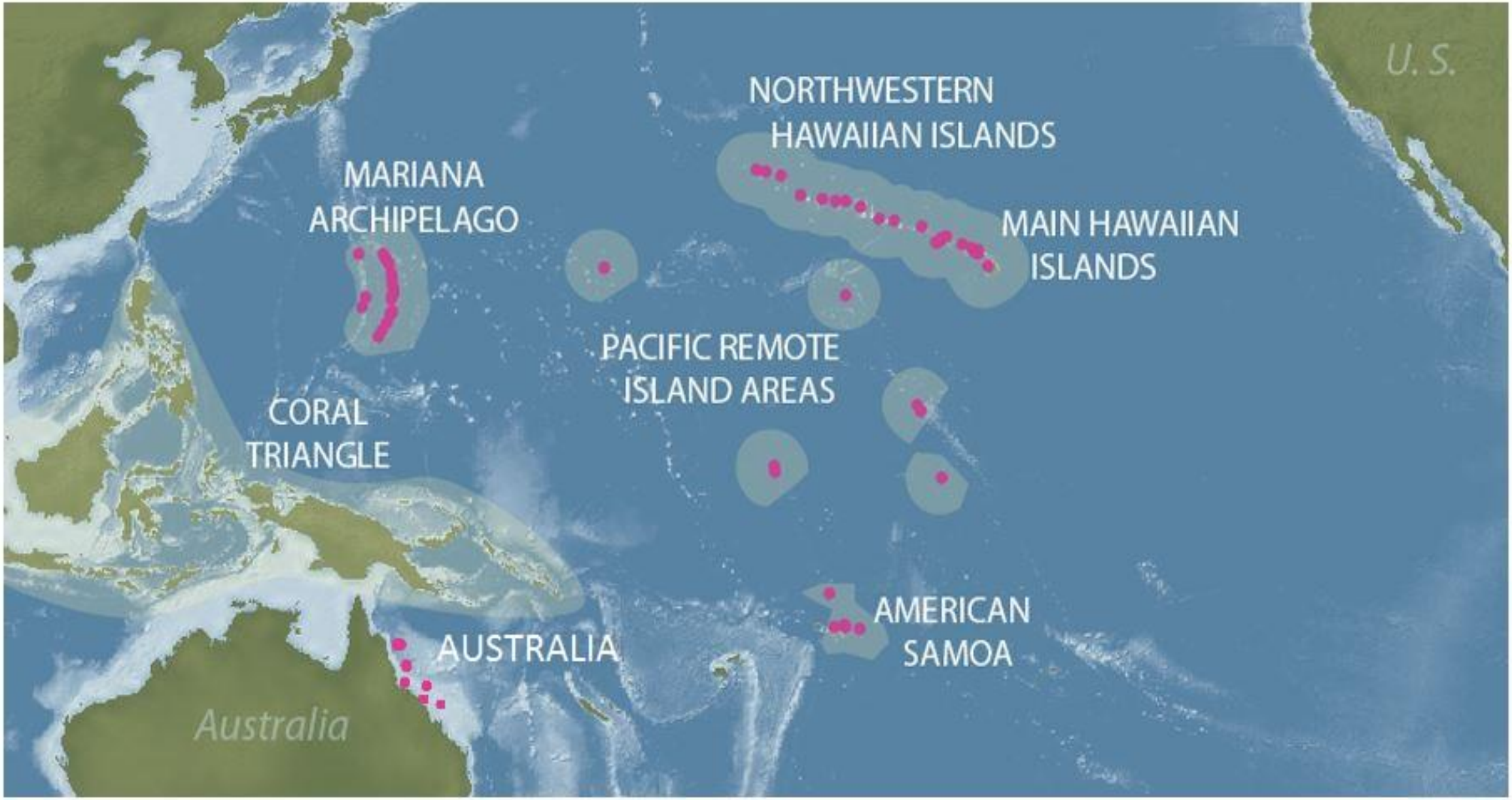
End-user engagement


U.S.
NORTHWESTERN HAWAIIAN ISLANDS
MARIANA ARCHIPELAGO
MAIN HAWAIIAN ISLANDS
PACIFIC REMOTE ISLAND AREAS
CORAL TRIANGLE
AMERICAN SAMOA
AUSTRALIA
Australia

Hawaii Coral Disease (HICORDIS)

Prevalence, host density, survey date and location

Caldwell *et al.* 2016a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Australia

Tissue loss

Growth anomalies

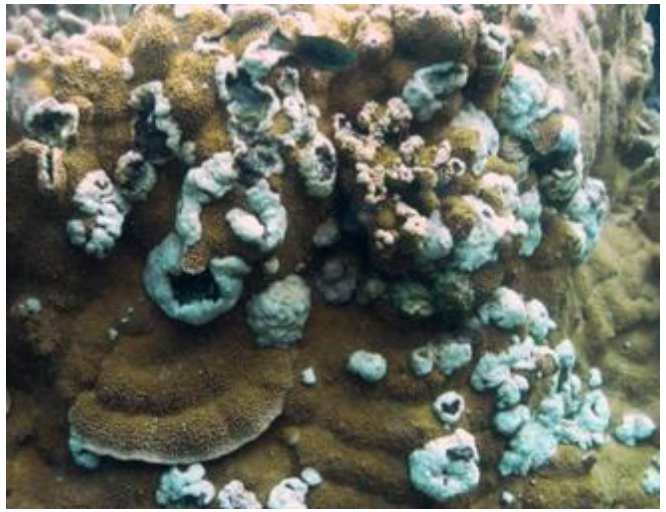
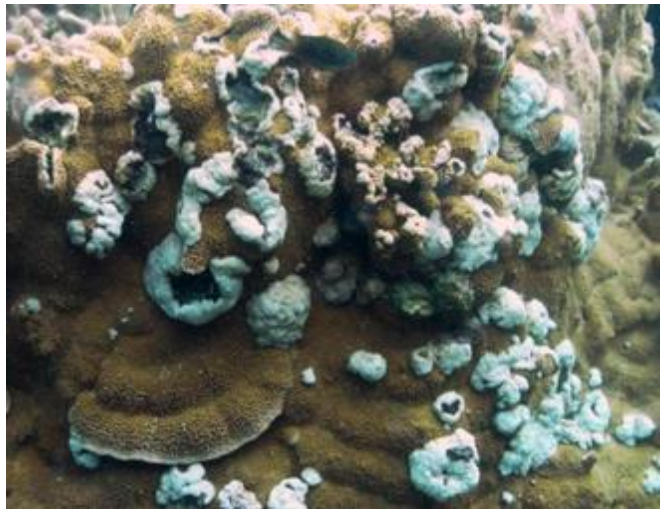


Photo sources: Eyes of the Reef

Tissue loss

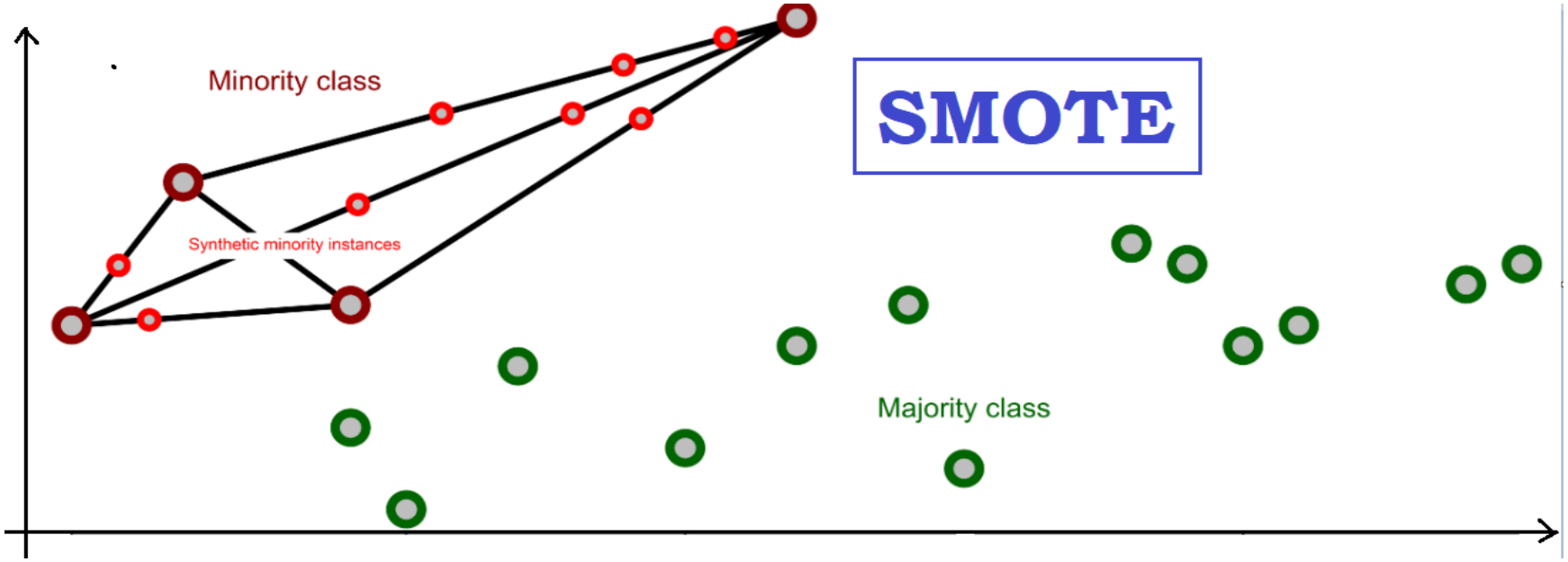
Growth anomalies



Disease	Region	- Dis	+ Dis	% zeros
GA	US Pacific	1415	324	77%
	GBR	34919	1160	97%
WS	US Pacific	1558	169	89%
	GBR	35352	1203	97%

Photo sources: Eyes of the Reef

Synthetic Minority Over-sampling Technique (SMOTE)



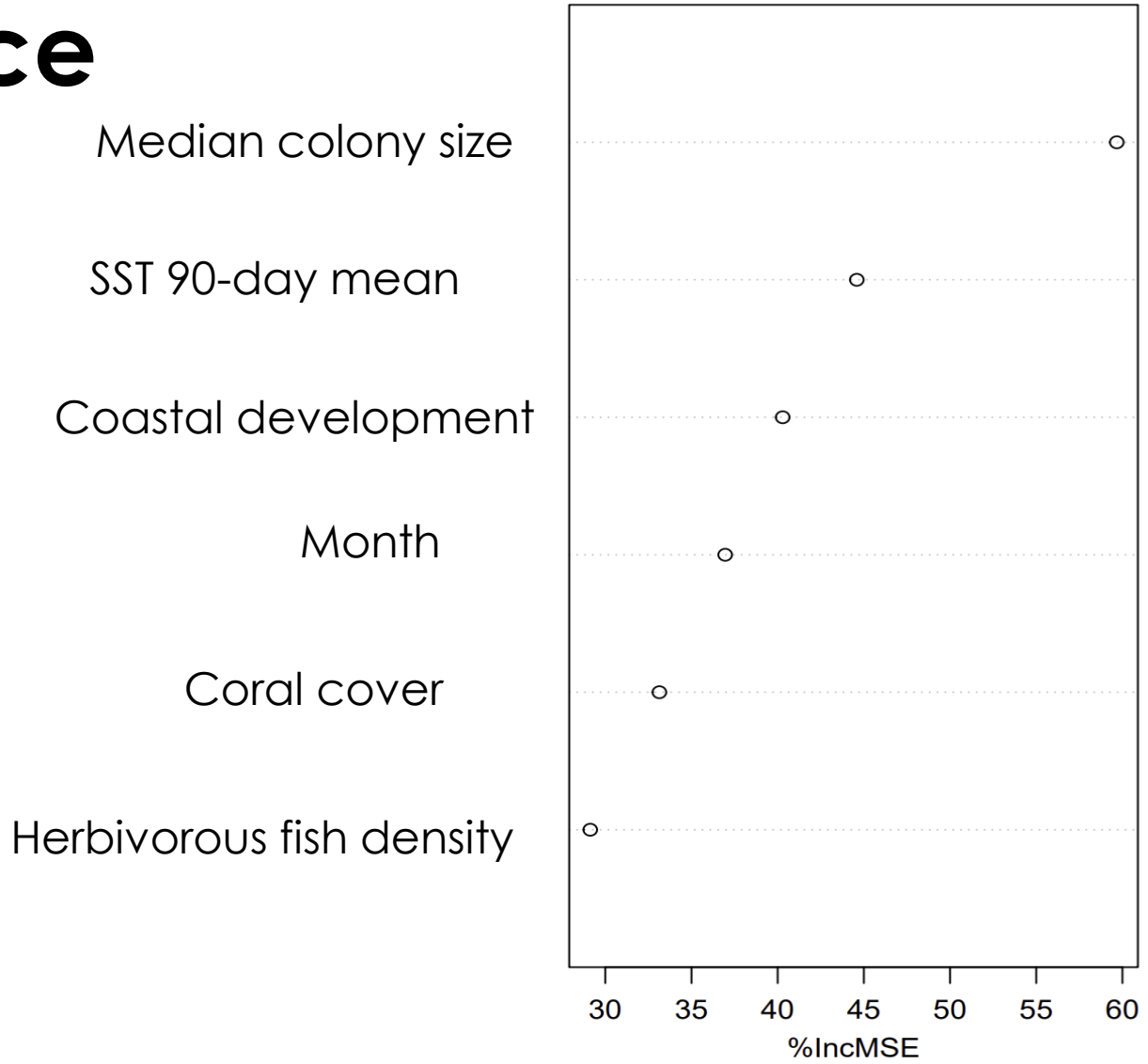
Predictor variables tested in initial models

Disease Region	Growth anomalies GBR	Growth anomalies U.S. Pacific	White syndromes GBR	White syndromes U.S. Pacific
Var 1	Month	Month	Month	Month
Var 2	Coral cover	Coral cover	Coral cover	Coral cover
Var 3	Fish abundance	Herbivorous fish density	Winter condition	Winter condition
Var 4	90-day SST mean	90-day SST mean	Hot snaps	Hot snaps
Var 5	Coastal development	Coastal development	Long term Kd(490) median	Long term Kd(490) median
Var 6	Long term Kd(490) median	Long term Kd(490) median	Long term Kd(490) variability	Long term Kd(490) variability
Var 7	Long term Kd(490) variability	Long term Kd(490) variability	3-week Kd(490) median	3-week Kd(490) median
Var 8	3-week Kd(490) median	3-week Kd(490) median	3-week Kd(490) variability	3-week Kd(490) variability
Var 9	3-week Kd(490) variability	3-week Kd(490) variability	Fish abundance	Herbivorous fish density
Var 10		Median colony size		Parrotfish density
Var 11		Colony size variability		Butterflyfish density
Var 12				Median colony size

Quantile Regression Forests

- Modeled disease-region combinations separately
- Model development on 75% of SMOTE dataset

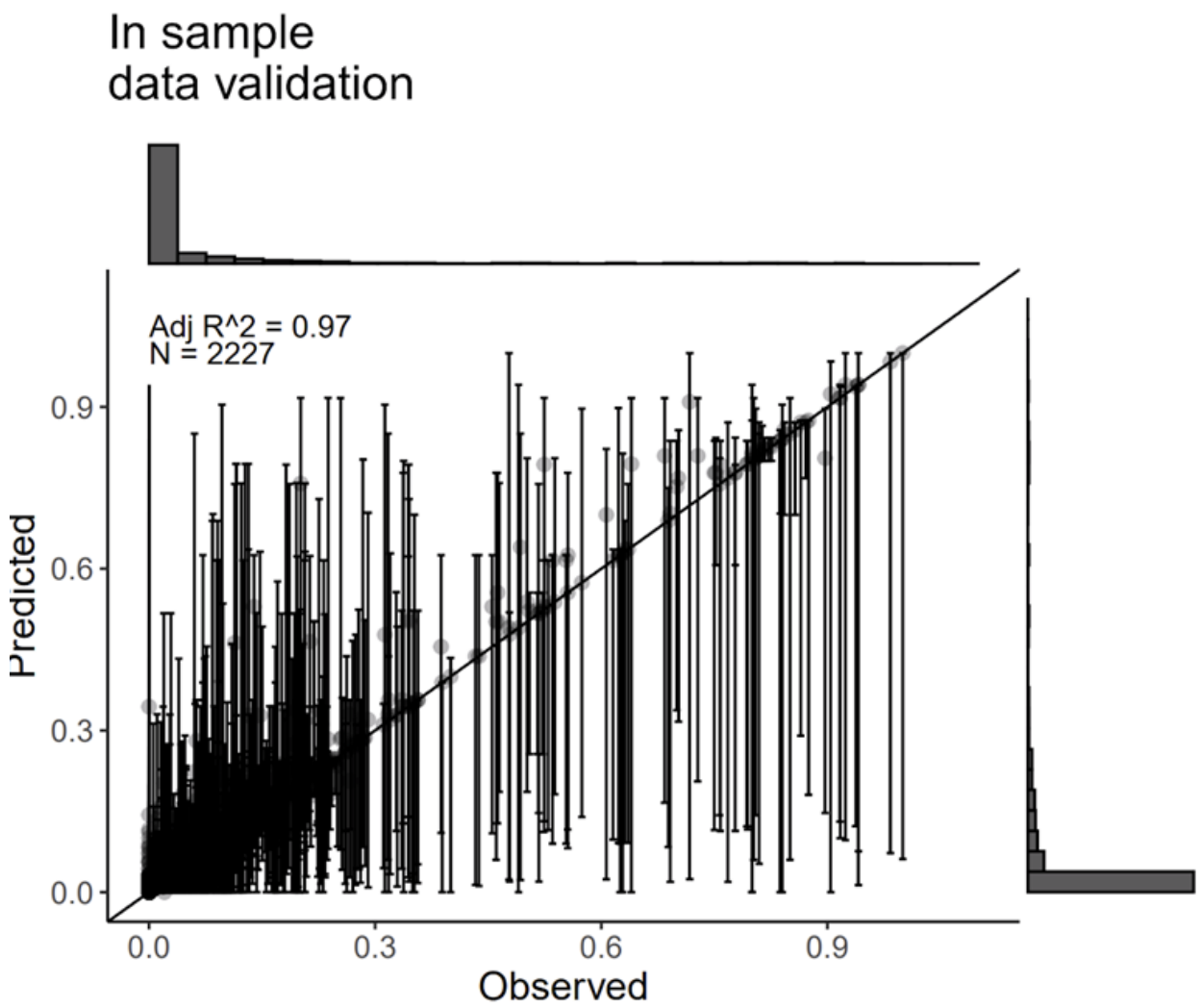
Variable importance

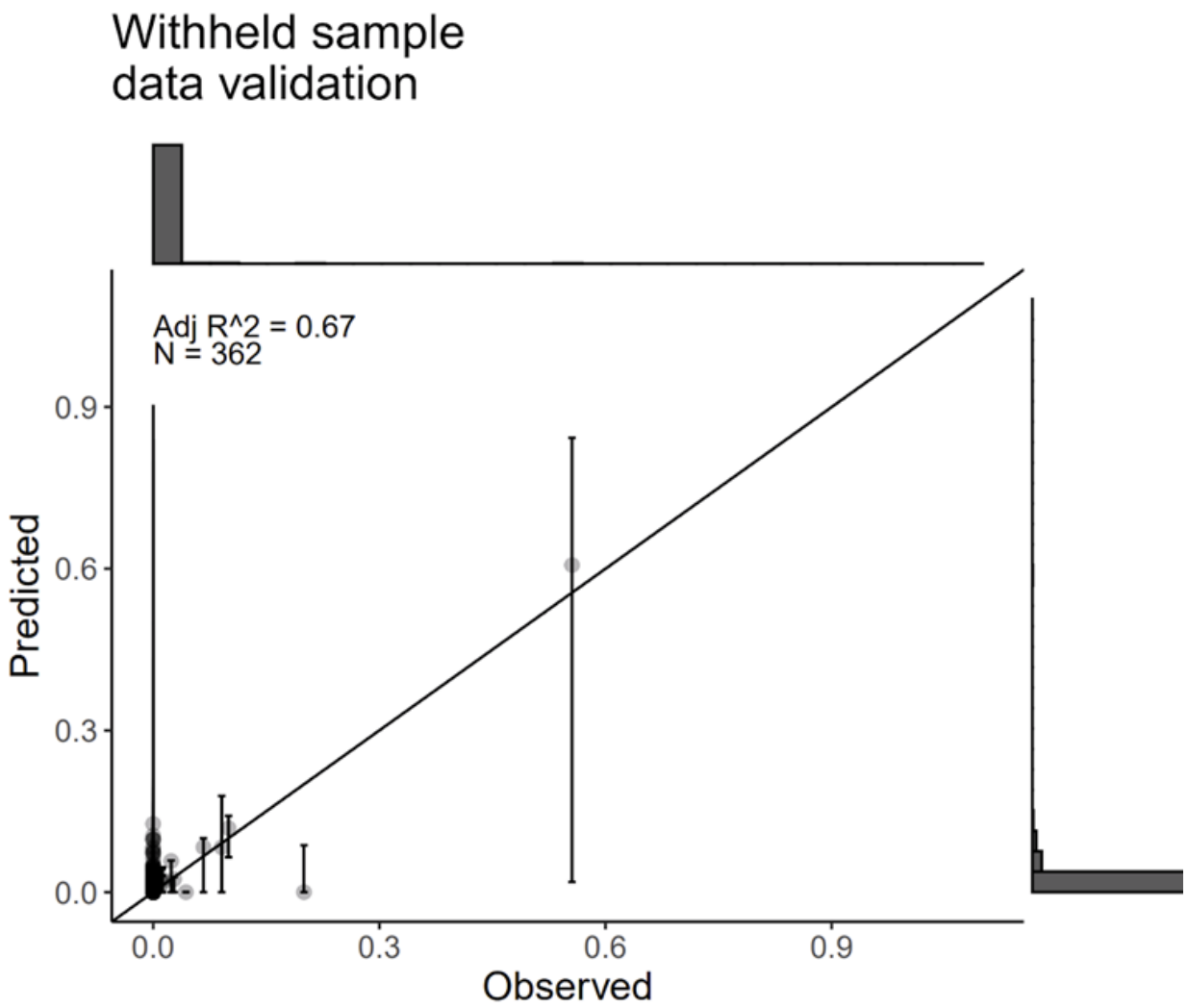


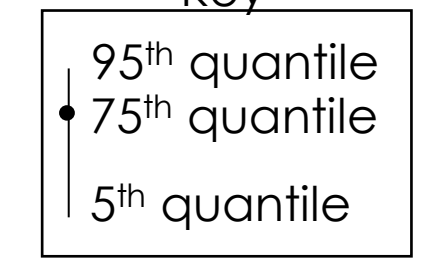
%incMSE = Percent increase in Mean Squared Error

Growth anomalies, U.S. Pacific

Model accuracy







Multi-factor coral disease forecast

Product scope

Regions	• American Samoa • Guam & CNMI • Great Barrier Reef, Australia • Hawaii • Pacific Remote Island Area
Diseases	• Growth anomalies • White syndromes
Spatial scales	• 5 km • Management zones

Time scale	• 6 months of weekly predictions:
	  • Predictions for 3 months prior to current date
	  • Forecasts for 3 months following current date

Forecasting

“Static” Variables

- Coral Size and Cover
- Fish Density

Seasonal Variables

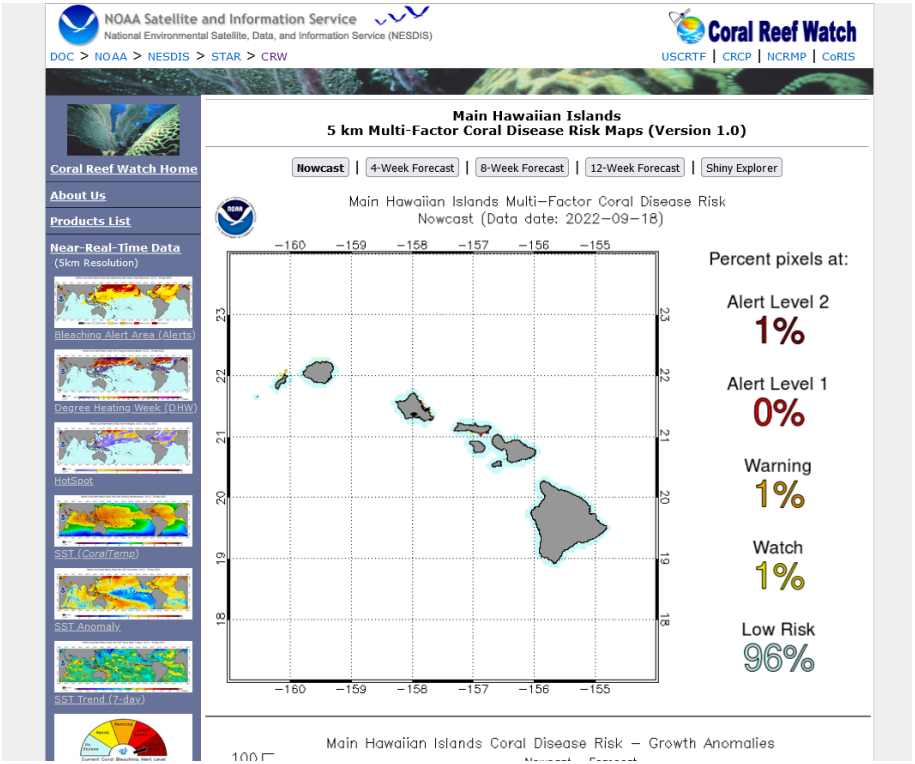
- Ocean Color Climatologies

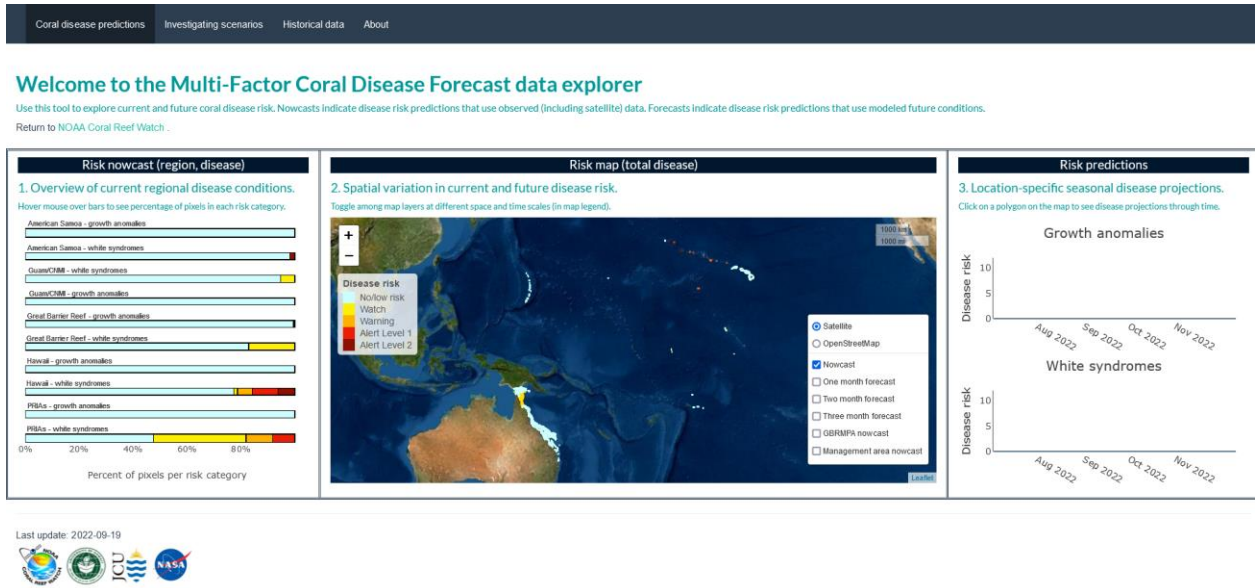
Forecast Variables

Weekly updates

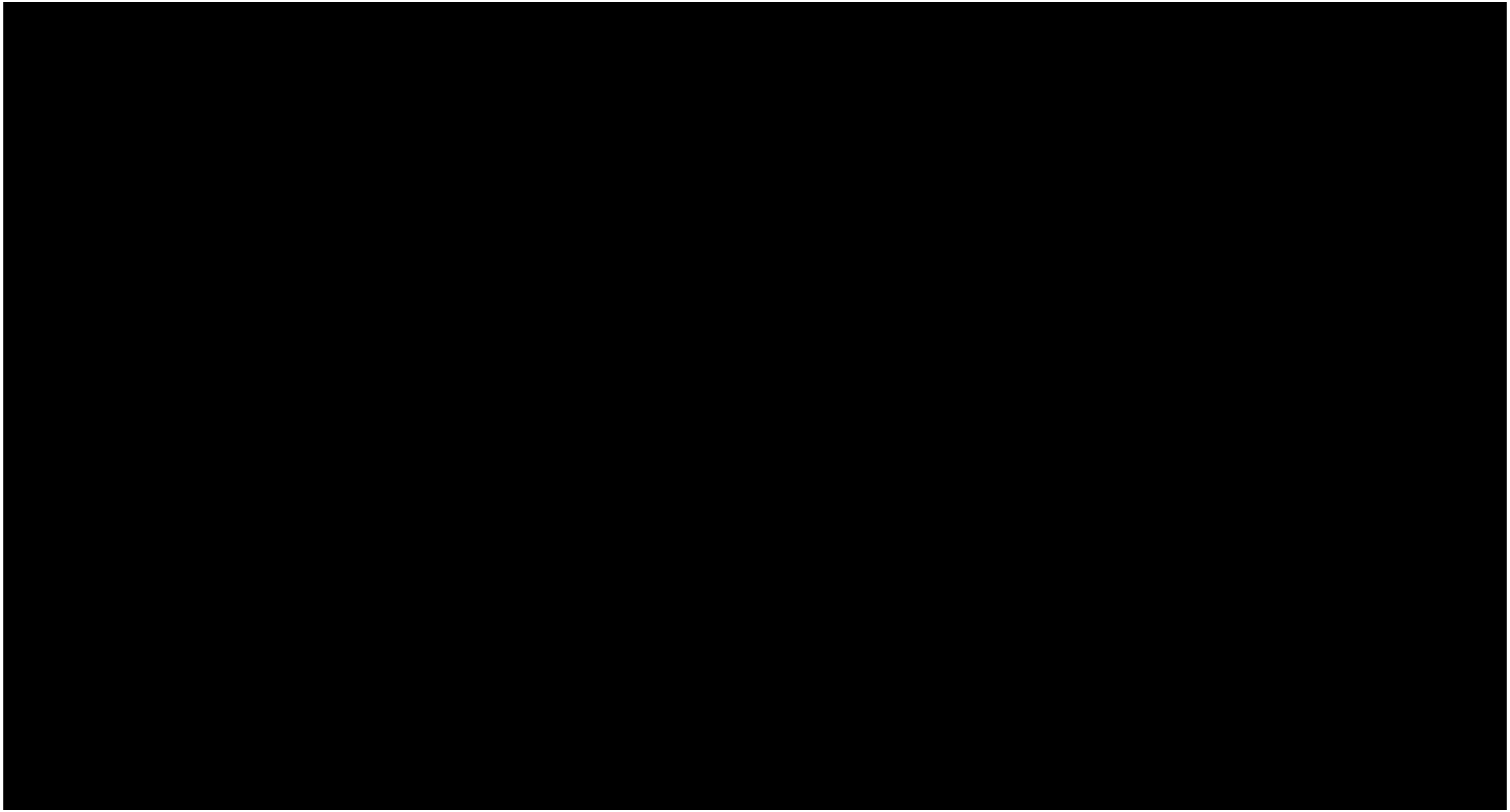
1, 2, 3 mos forecast

- Temperature Anomalies calculated from CFS forecast of SST





Overview of new product



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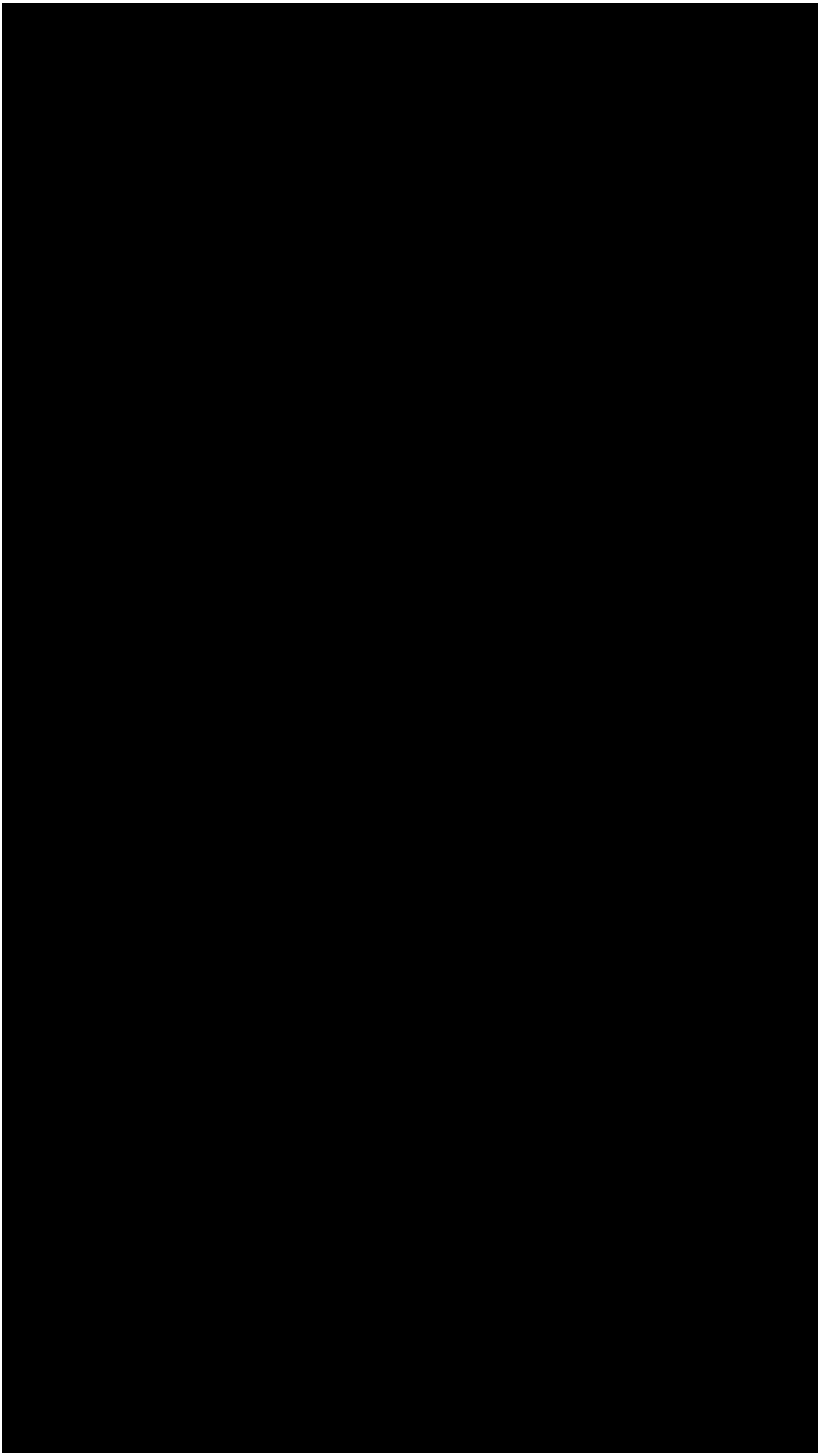
Forecasts

[redacted]

Scenarios



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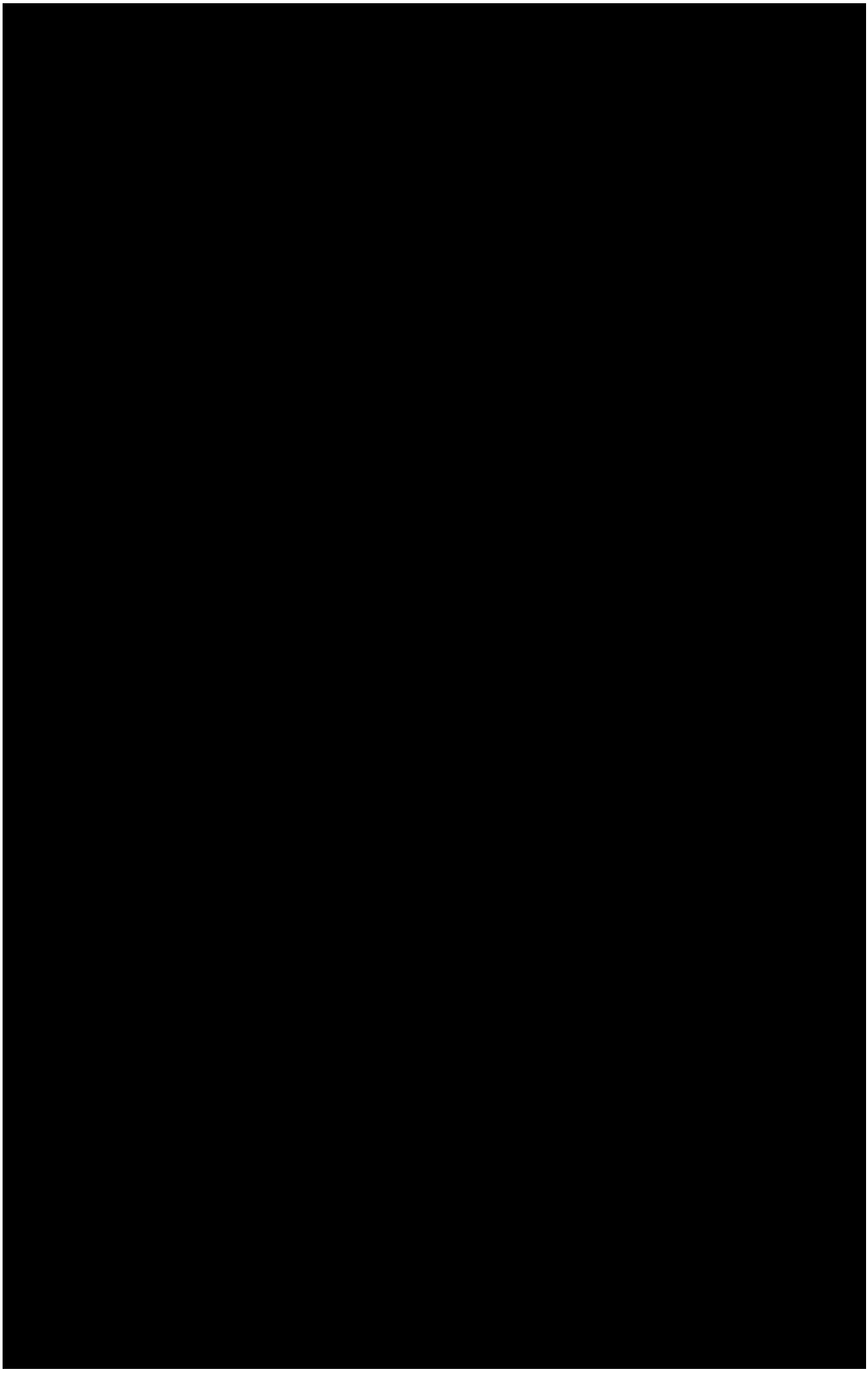
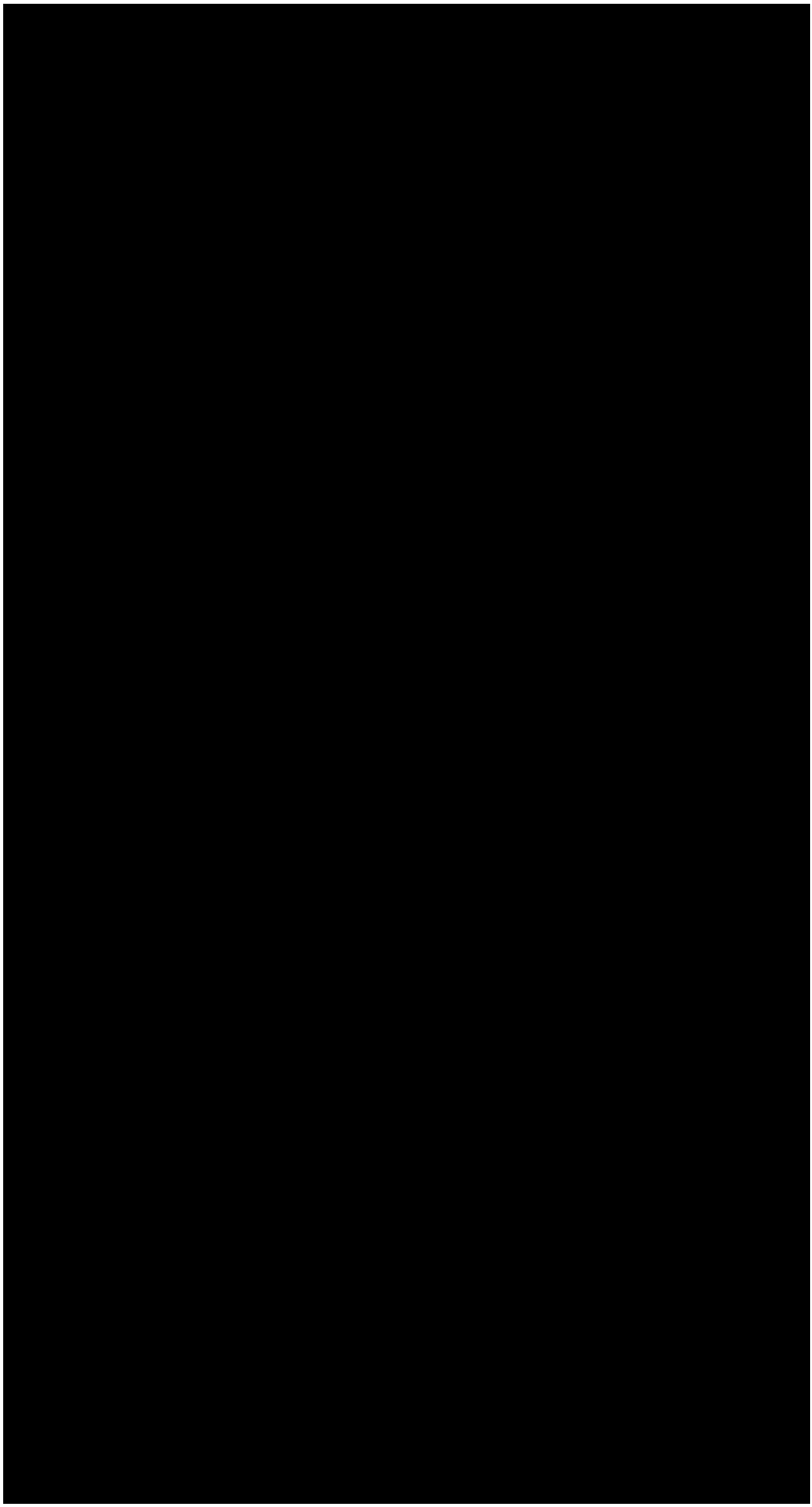


About



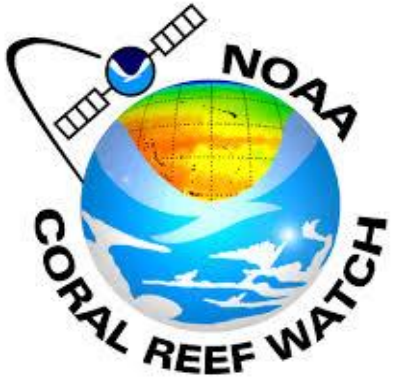
Activity

Activity sheet: https://tinyurl.com/2mmzf8zs

(Create a copy of the Google Doc if you want to fill this in.)

Link to Interactive App: http://coraldisease.com/

Funders & partners



Our Team

Megan Donahue
Jamie Caldwell
Austin Greene

Mark Eakin
Erick Geiger
Gang Liu
Jacquie De La Cour
Derek Manzello

Scott Heron
Ainsworth

Tracy

Bill Leggat
Tess Moriarty

Laurie Raymundo