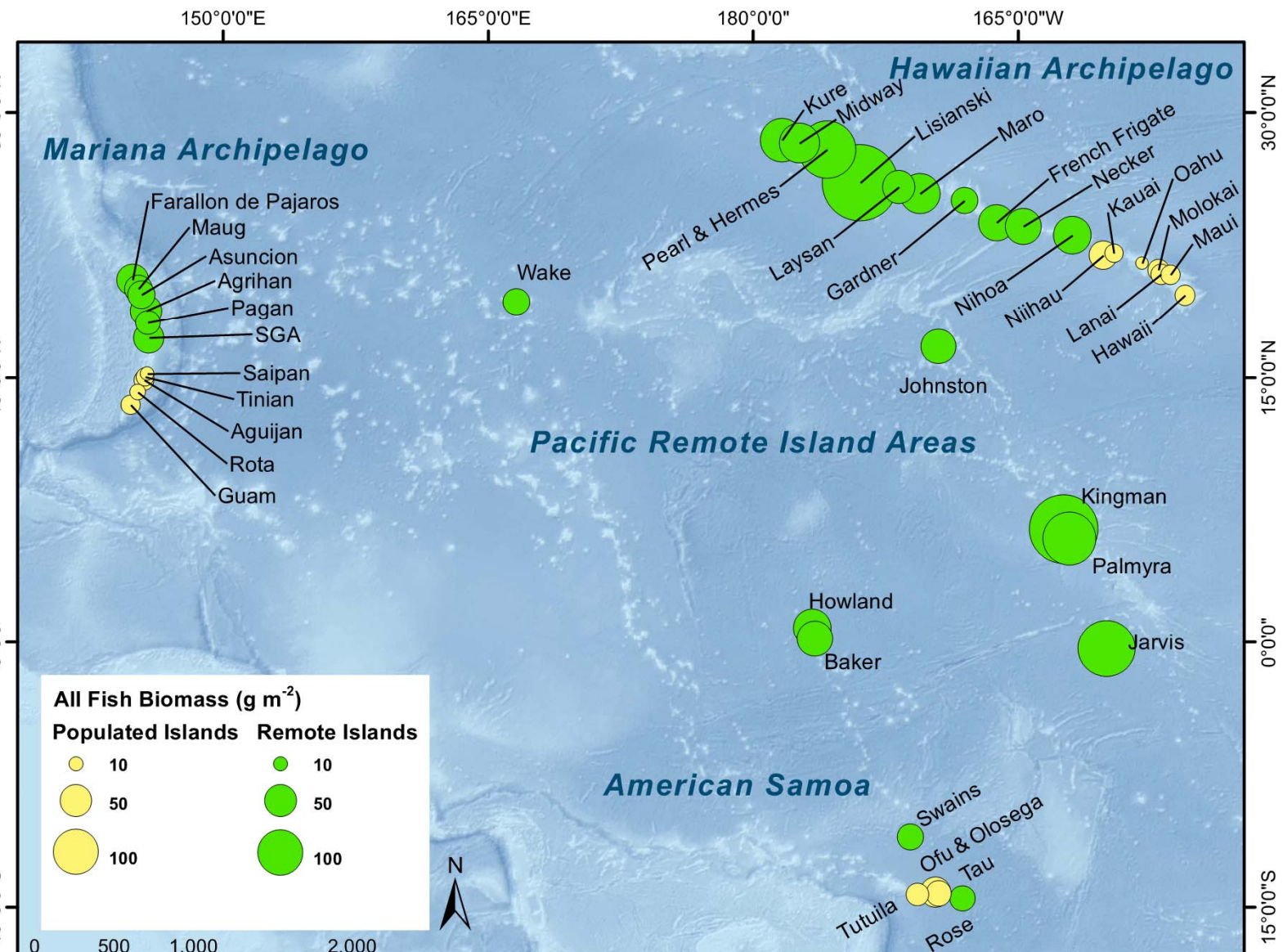
Putting Human Impacts on Fish Populations in Perspective: Spatial Variation on a Local Scale

REEF SMART, Hawai‘i State Division of Aquatic Resources
June 26, 2014

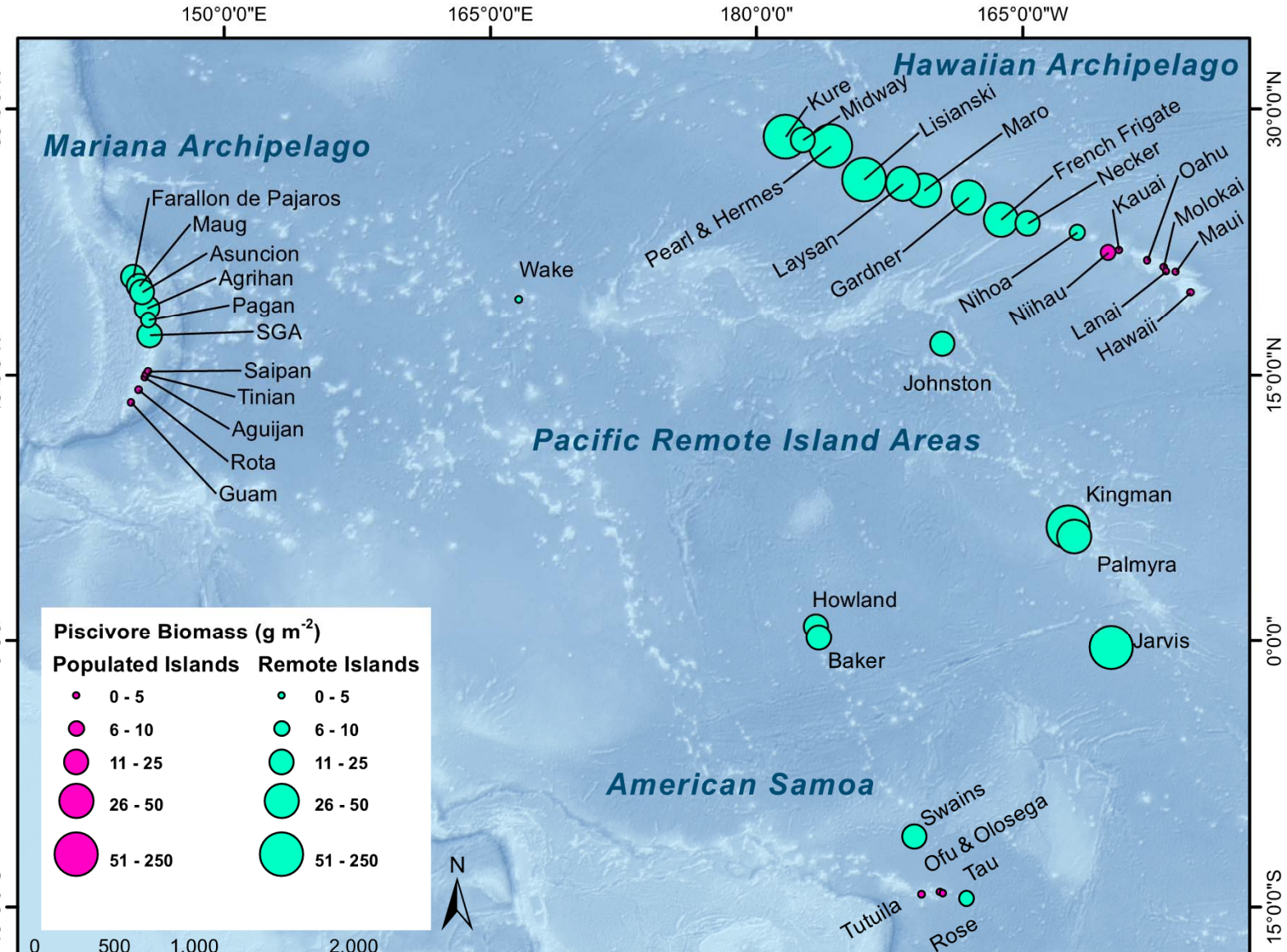
Kelvin D Gorospe[1]
Megan J Donahue[2]
Ivor D Williams[1]

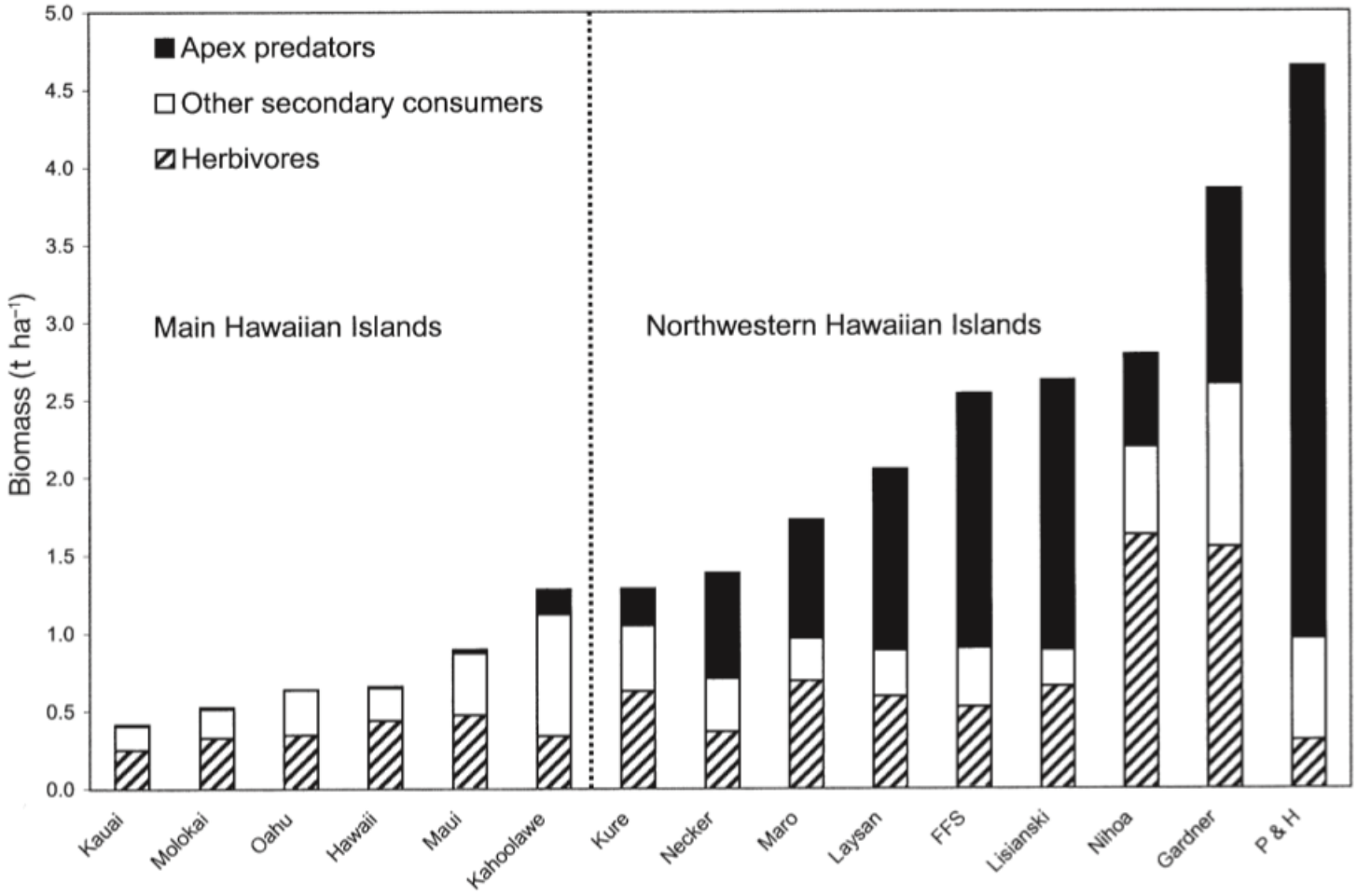
[1]Coral Reef Ecosystem Division, Pacific Islands Fisheries Science Center, NOAA
[2]Hawai‘i Institute of Marine Biology, University of Hawai‘i at Mānoa

cific Reef Assessment and Monitoring Program

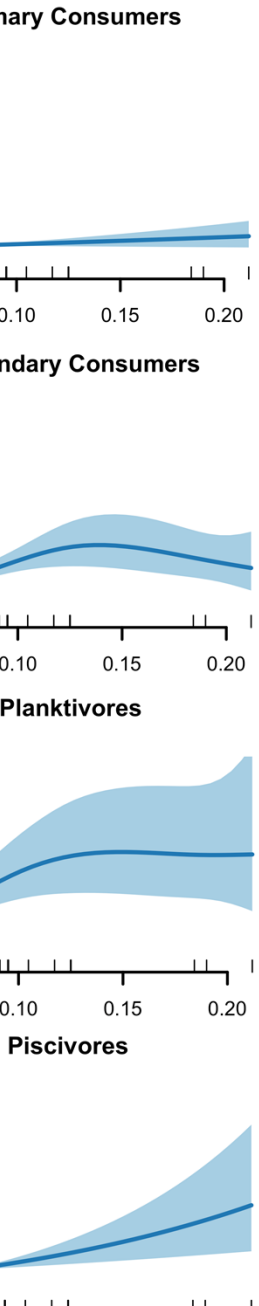


cific Reef Assessment and Monitoring Program

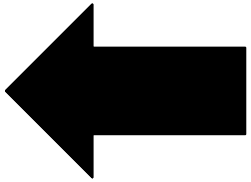


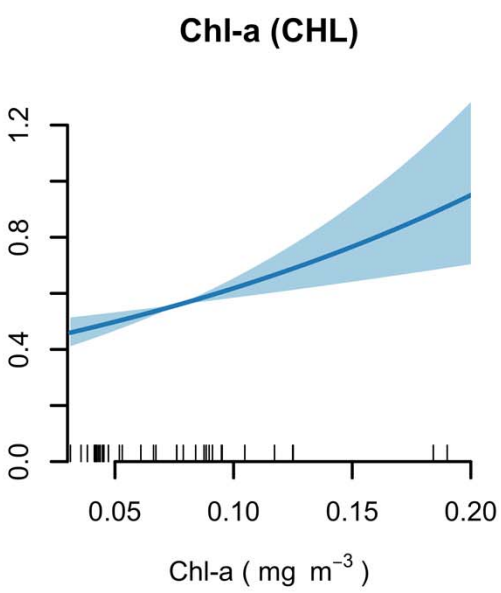


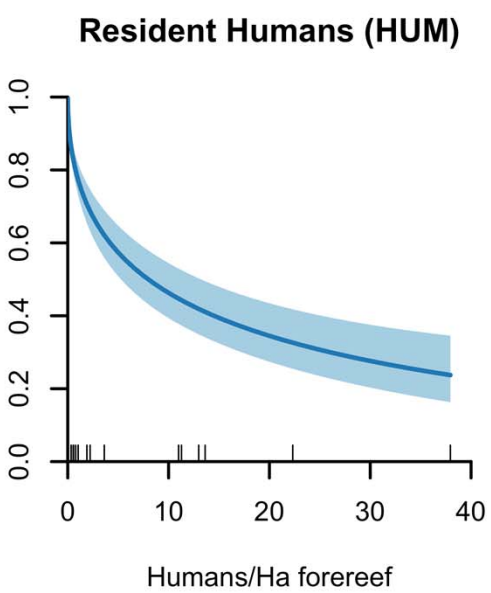
Friedlander and DeMartini

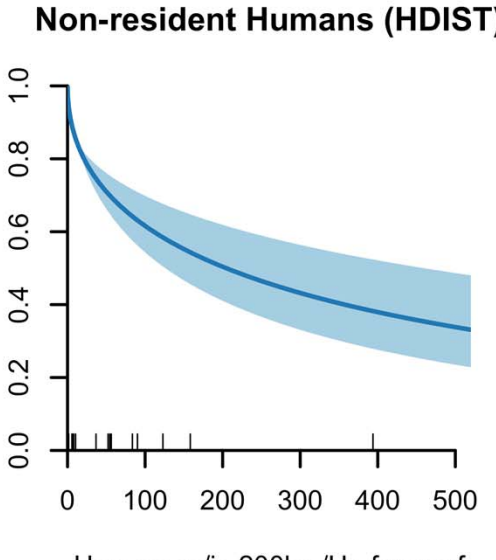

nary Consumers
0.10
0.15
0.20
ndary Consumers
0.10
0.15
0.20
Planktivores
0.10
0.15
0.20
Piscivores

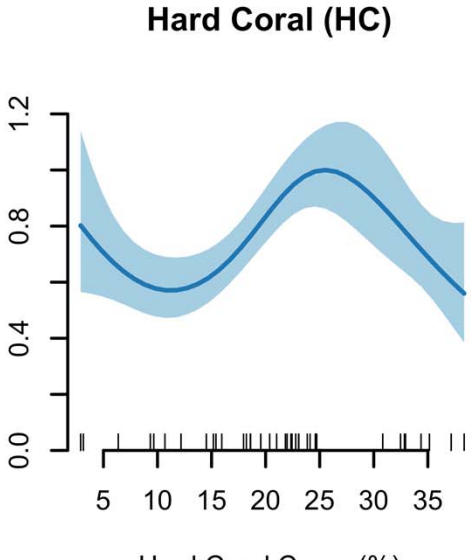
ALL FISH




Chl-a (CHL)
0.0
0.4
0.8
1.2
0.05
0.10
0.15
0.20
Chl-a (mg m^{-3})


Resident Humans (HUM)
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
Humans/Ha forereef


Non-resident Humans (HDIST)
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500


Hard Coral (HC)
0.0
0.4
0.8
1.2
5
10
15
20
25
30
35

Long-term Goals:

To continue to explore the effects of both habitat variation and human impacts on fish biomass

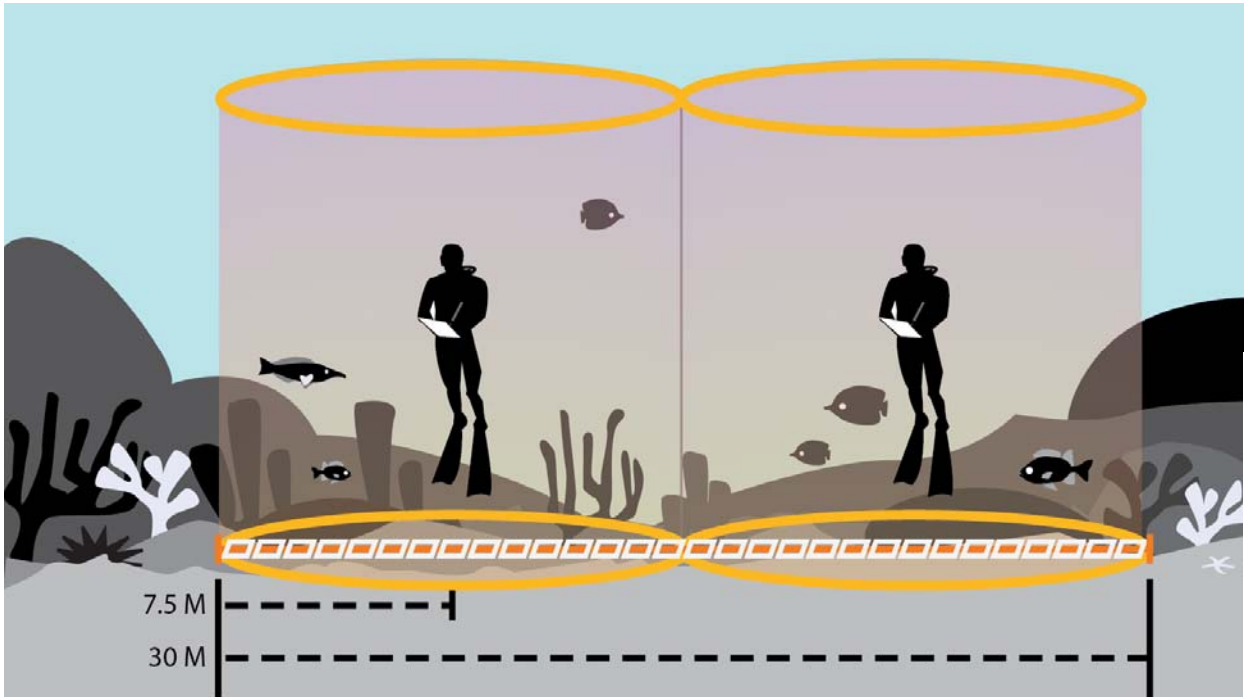
To gain an understanding of anthropogenic impact on fish populations on a site-specific scale

To establish a framework for analyzing our data on a species-level, beginning with DAR's ten priority species

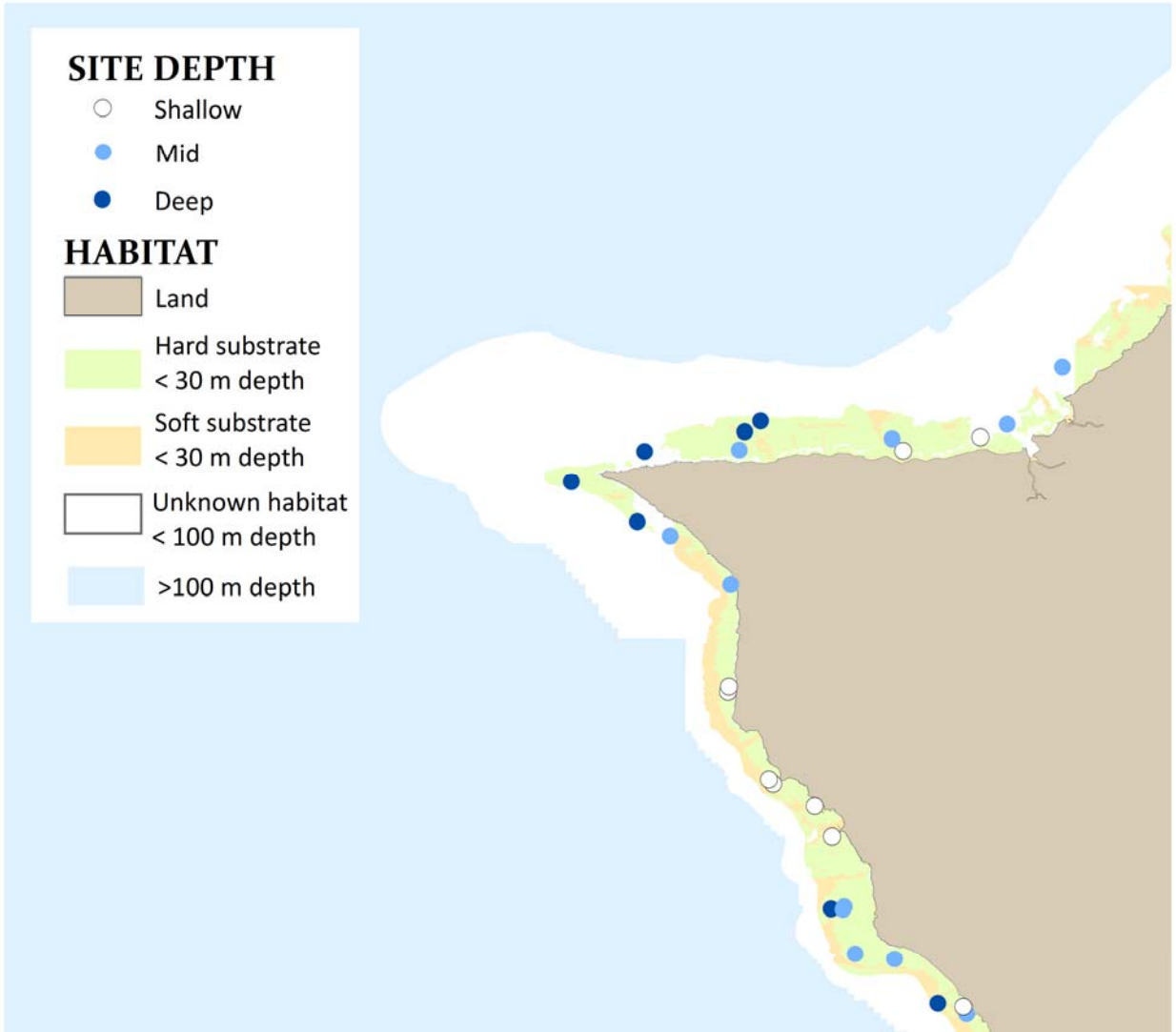
op Ten Priority Species
es Local Action Strategy Hawaii)
s rubroviolaceus
nx melampygus
peneus porphyreus
unicornis
oidichthys vanicolensis
urus spilurus
thurus triostegus sandvicensis
thurus achilles
actylus sexfilis

Collection:

ationary-Point-Count
andomized hard-bottom location at depths of 0-30m
ired 15-m diameter cylinders
ounts and lengths of fish: TOTAL BIOMASS or SPECIES-LEVEL BIOMASS
notographs of benthos taken along transects: HABITAT VARIATION



pling Design:
tratified random based on depth



How is our data used?

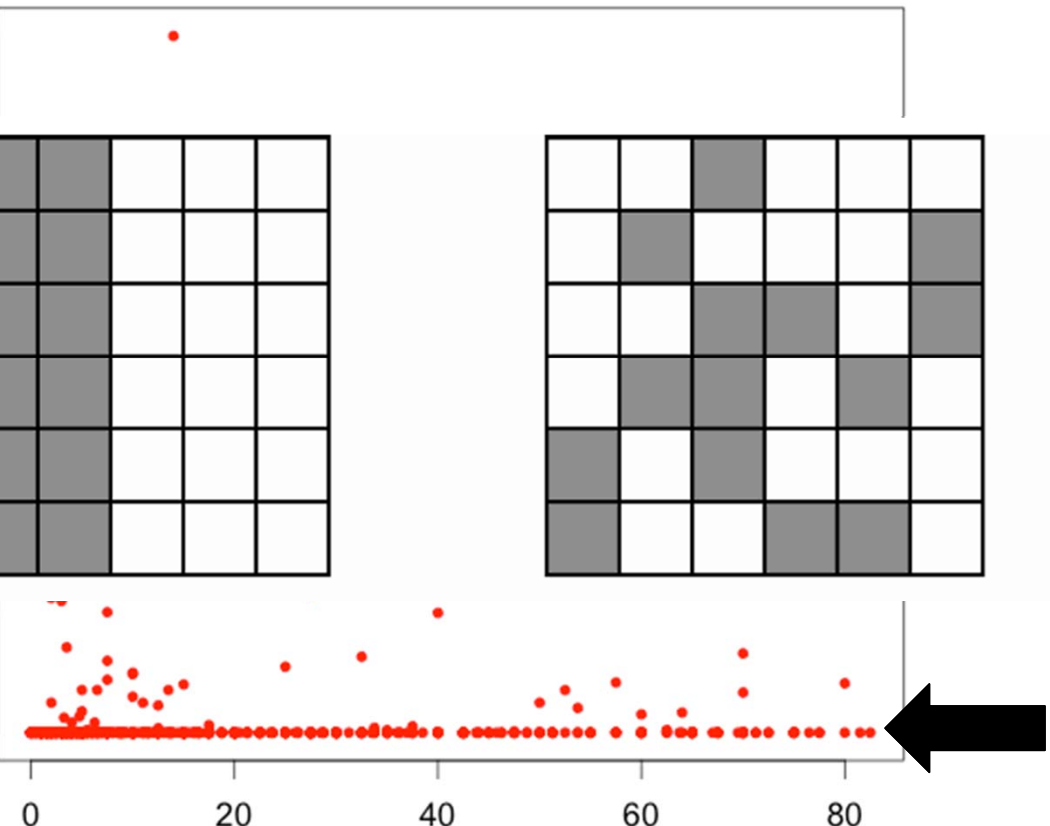
Pacific RAMP: Long-term ecological monitoring
Collaborations with academia
NOAA NMFS stock assessment: Magnuson-Stevens Act 2006
Coral Reef Conservation Program: Short-term management goals

From Coral Reef Conservation Program's Goals and Objectives 2010-2015:
"…..Federal-local partnerships must be strengthened, particularly in the areas of communication, collaboration, and implementation of joint management actions."

ata Challenges:

Zero-inflation

Hierarchical spatial dependence



Bayesian vs "classical" statistics

EXAMPLE: I do an experiment where I flip a coin 10 times, and get 4 tails.

What is the probability that the coin is fair?

Null-hypothesis significance testing (NHST) statistics:

- Probability of the data given your hypothesis

If the coin is fair, then what's the probability of obtaining 4 tails?

if $p<0.05$ you reject your null hypothesis

Bayesian statistics:

- Probability of a hypothesis given your data

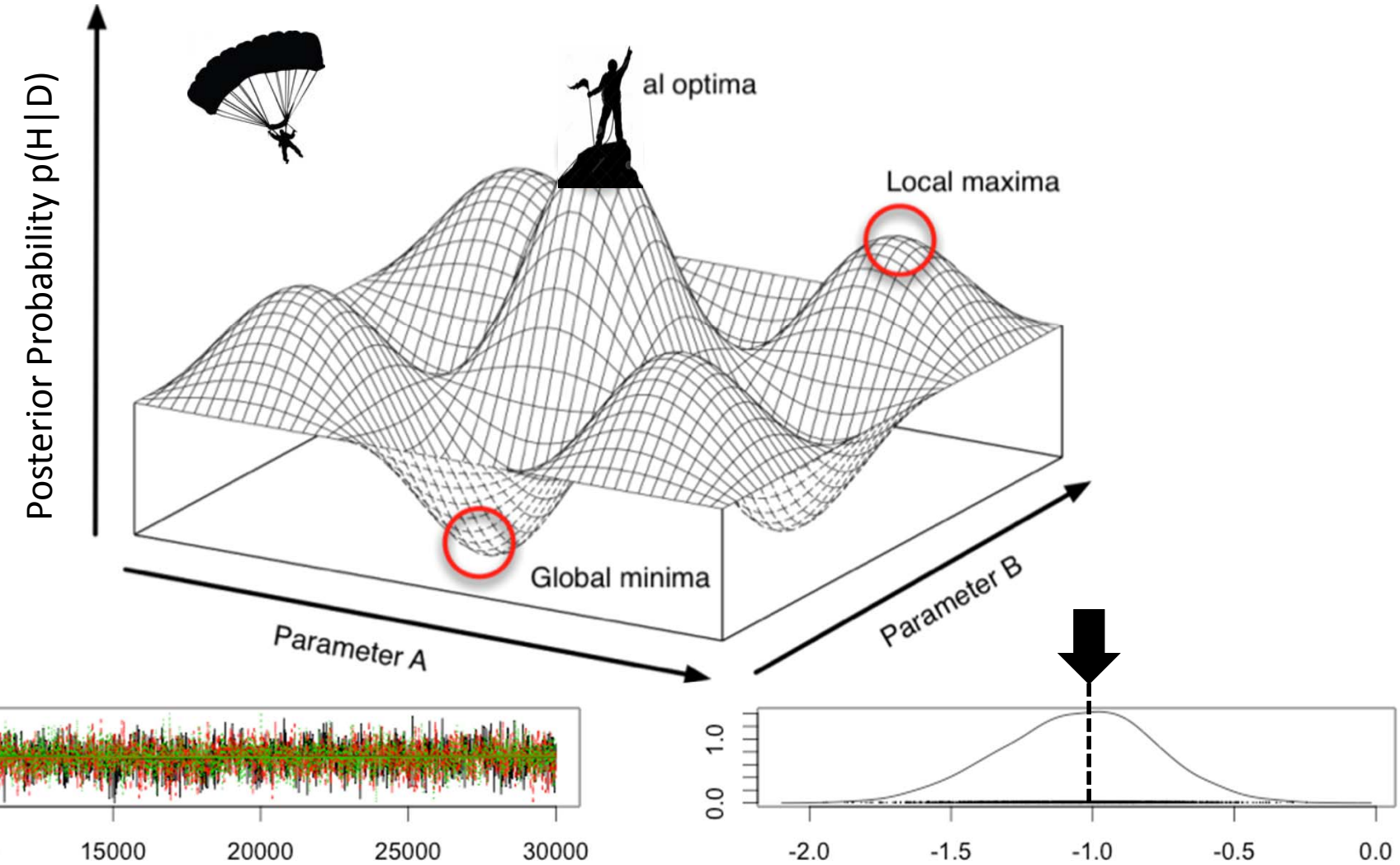
If we observe 4 tails, then **what is the probability that the coin is fair?** → **p(H|D)**

posterior probability likelihood prior

Bayes' rule: **p(H|D)** = $\frac{p(D|H)p(H)}{p(D)}$

MCMC Markov Chain Monte Carlo

elievable hypothesis



Take home message

ata Challenges:

Zero-inflation

Hierarchical spatial dependence

yesian analysis:

Seamlessly handles zero-inflation

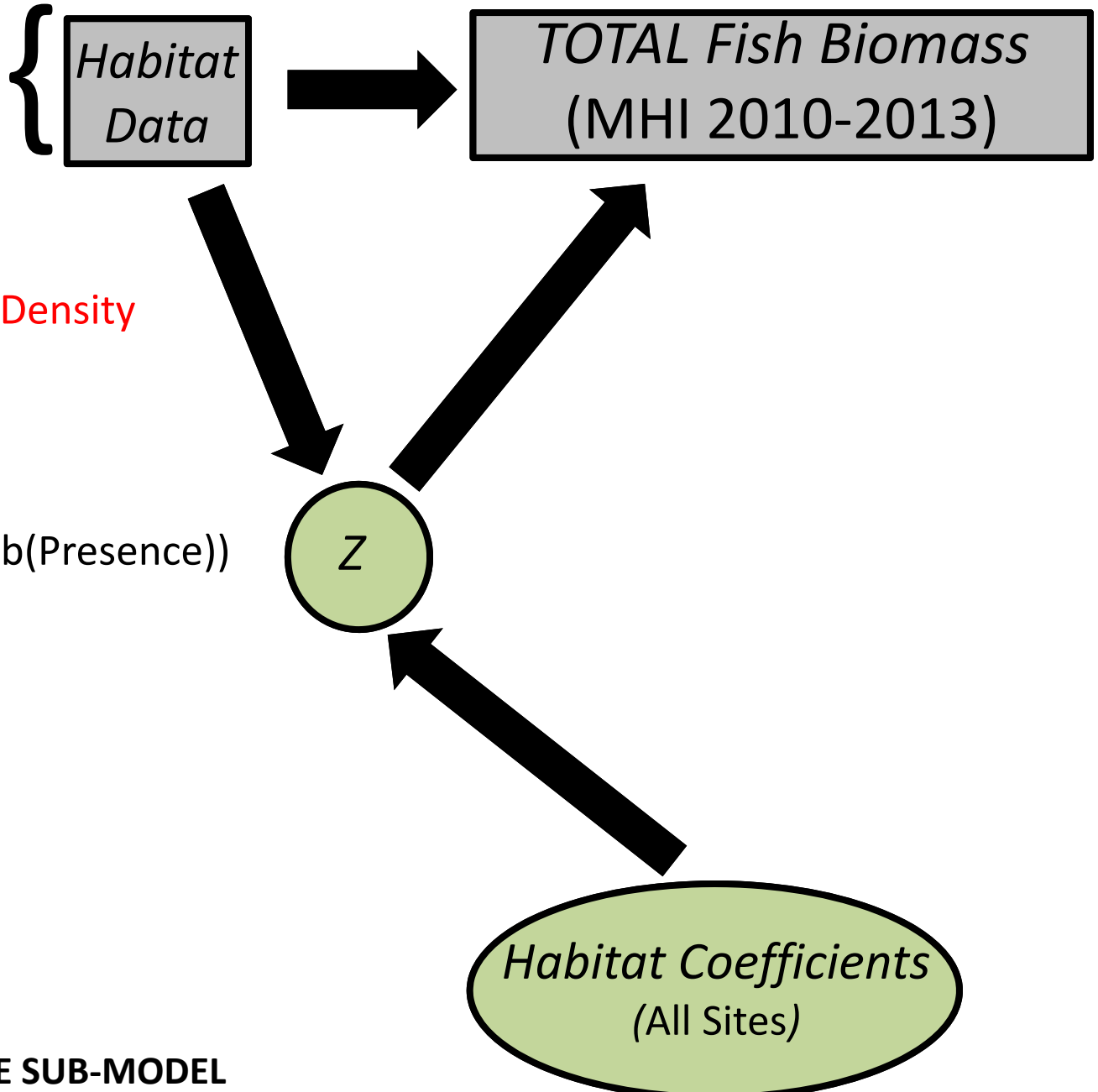
(1) presence/absence vs (2) abundance

Allows for hierarchical analyses

– Organize the analysis such that parameters are estimated according to spatial groupings

exity
oral Cover
over
n Population Density

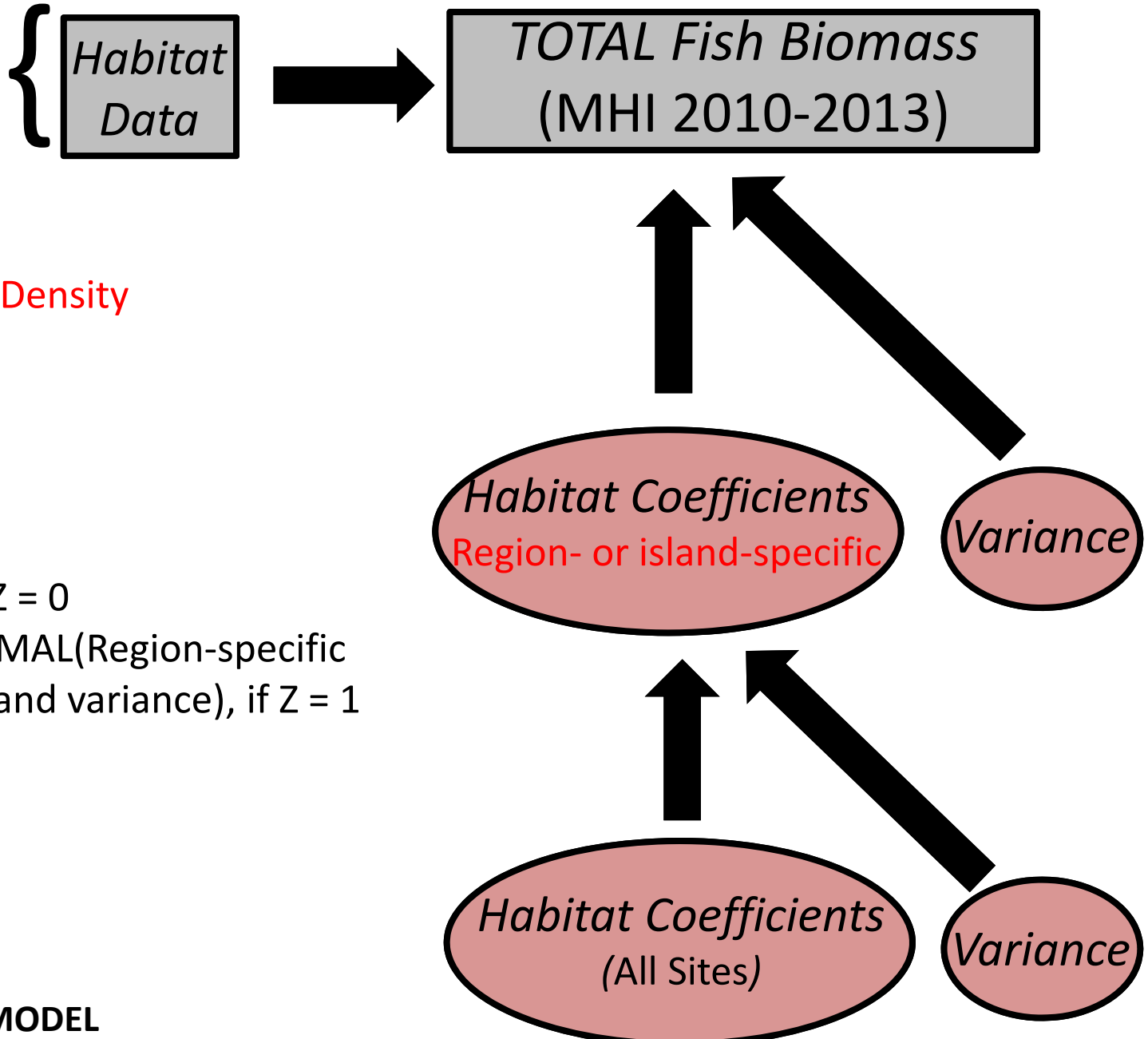
RNOULLI (Prob(Presence))



NCE/ABSENCE SUB-MODEL

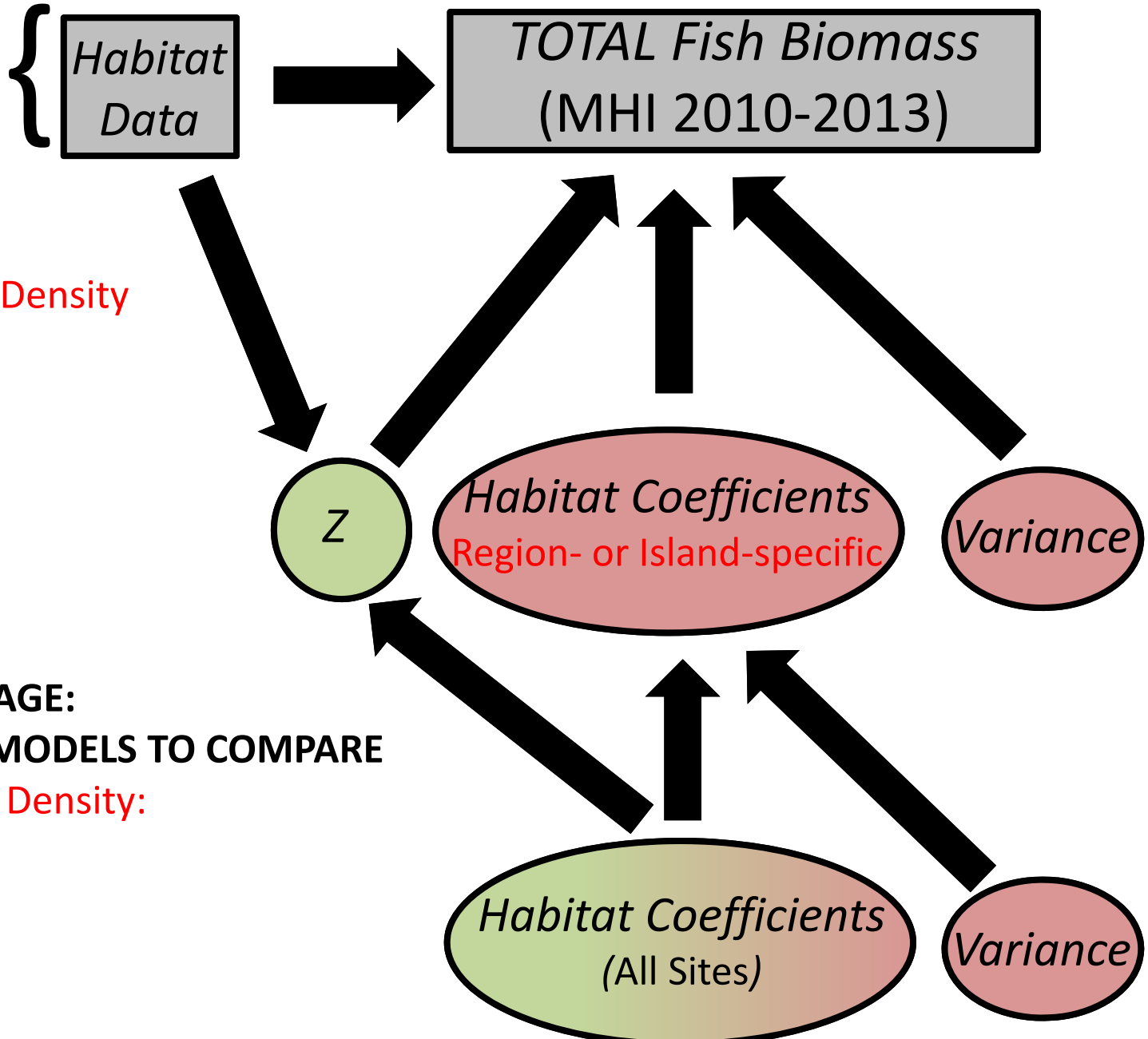
exity
oral Cover
over
n Population Density

S { 0, if Z = 0
~ NORMAL(Region-specific mean and variance), if Z = 1



DANCE SUB-MODEL

exity
oral Cover
over
n Population Density



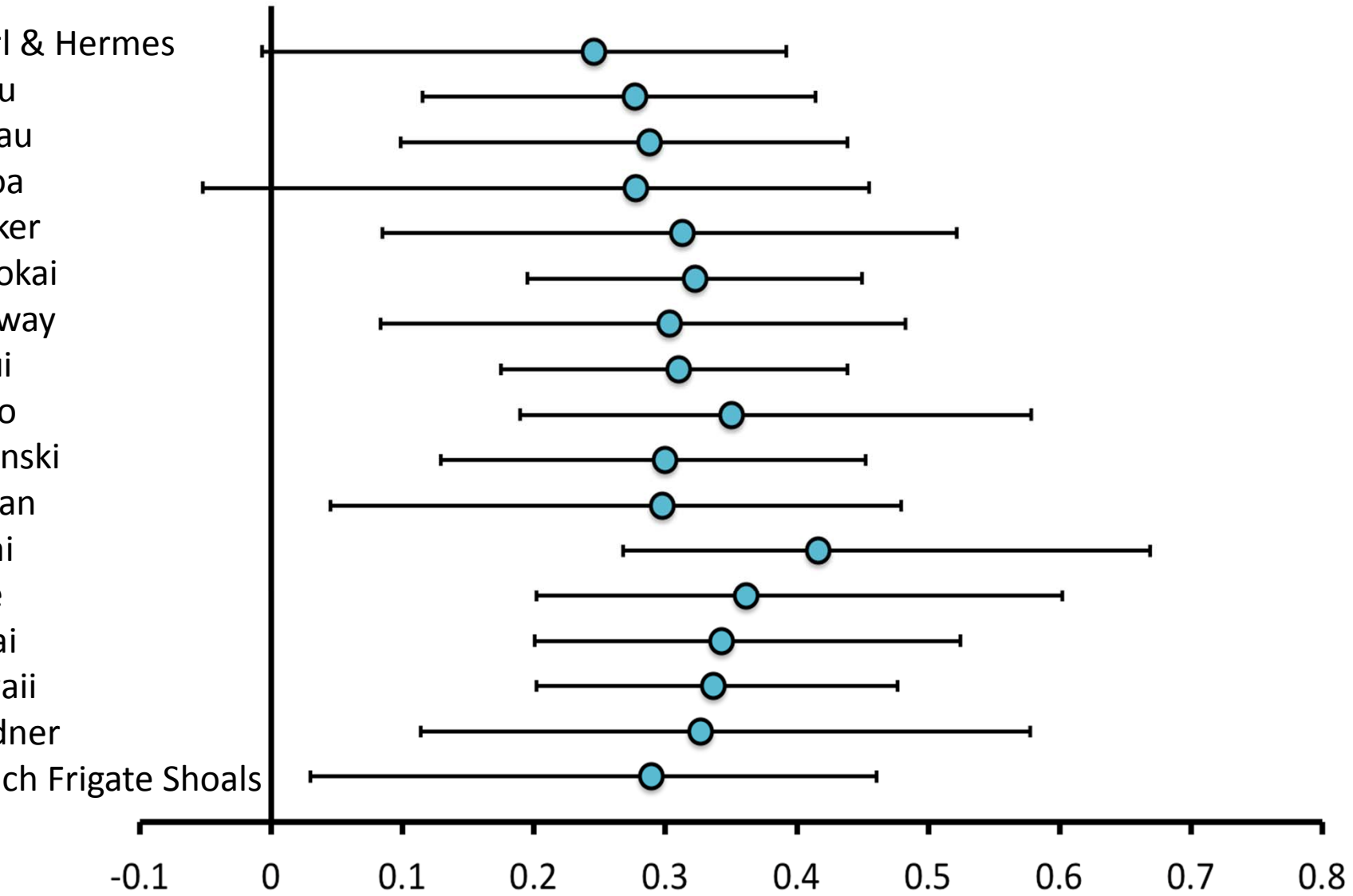
HOME MESSAGE:
ARE FOUR MODELS TO COMPARE
n Population Density:
0km radius
00km radius
ns:
HI/NWHI

odel Comparison

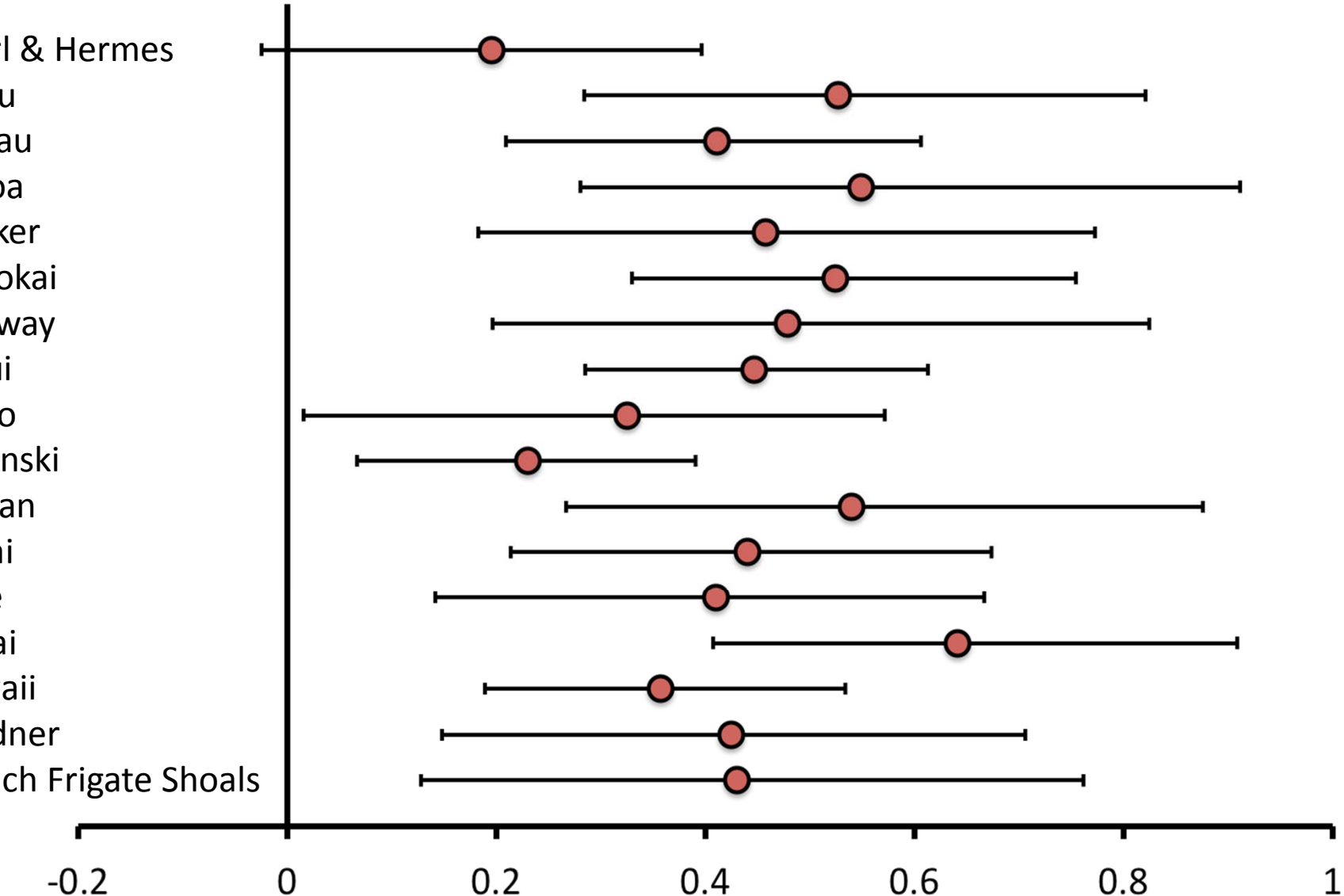
HOME MESSAGE:
IE BEST MODEL USED HUMAN IMPACTS ON A 200KM SCALE
ND HABITAT RELATIONSHIPS ON AN ISLAND-SCALE

. BIOMASS	Individual Islands		NWHI vs MHI	
	20km	200km	20km	200km
eviance (i.e., odel fit)	2163	2162	2250	2258
(i.e., model nplexity)	39.24	36.26	7.899	11.84
leviance + enalty)	2202	2198	2258	2270

Habitat Coefficients: Depth



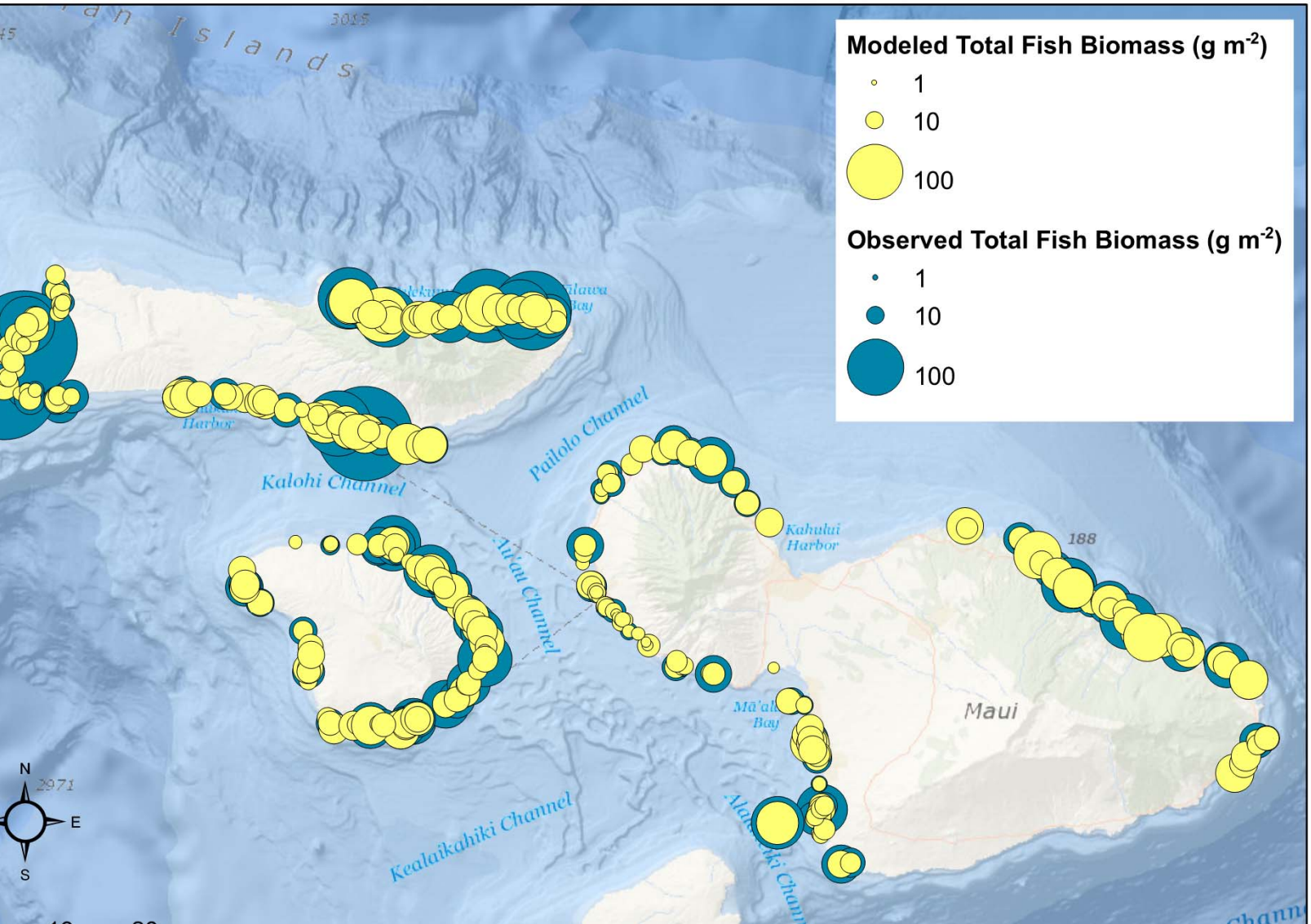
Habitat Coefficients: Complexity



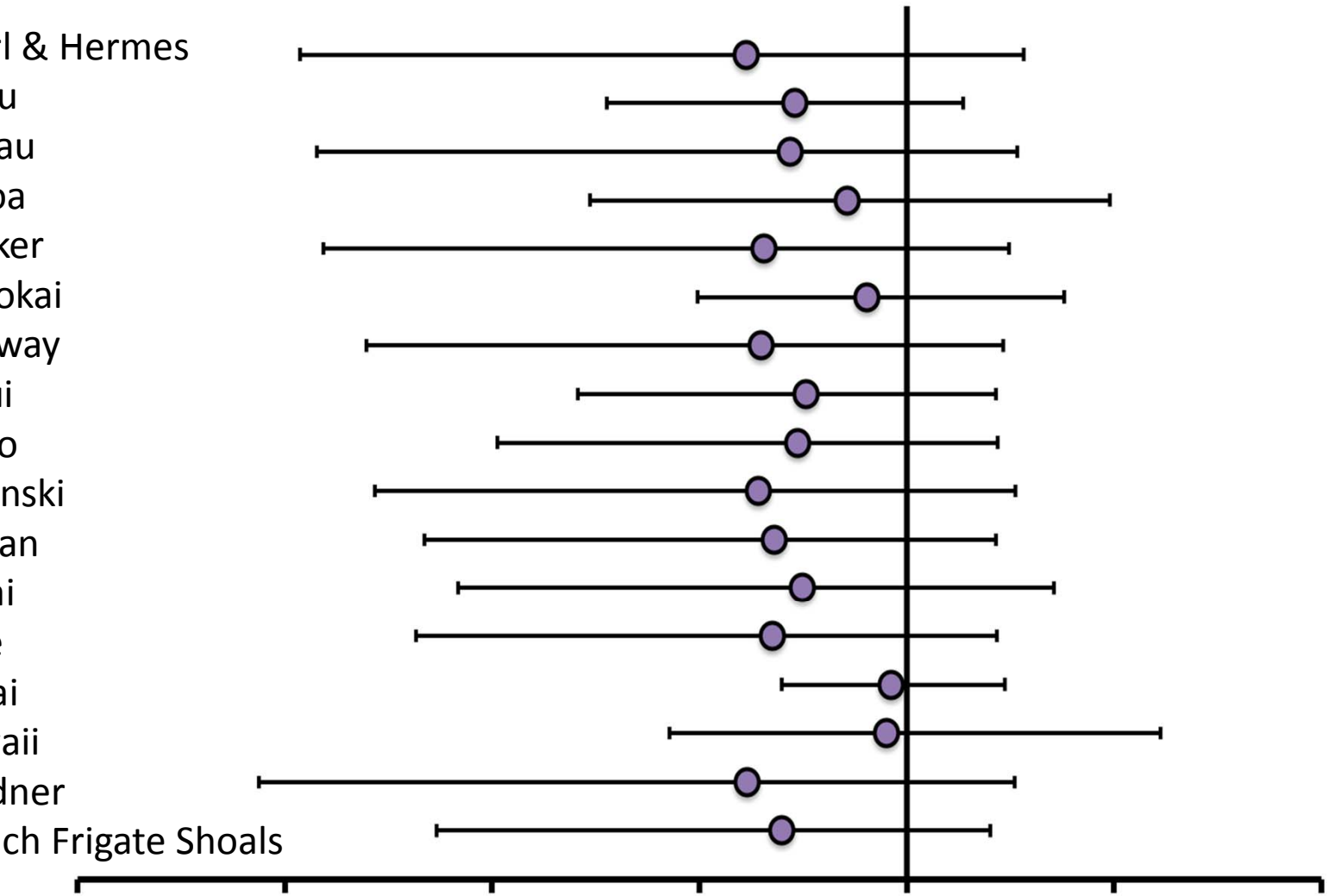
lodel Validation

TAKE HOME MESSAGE:

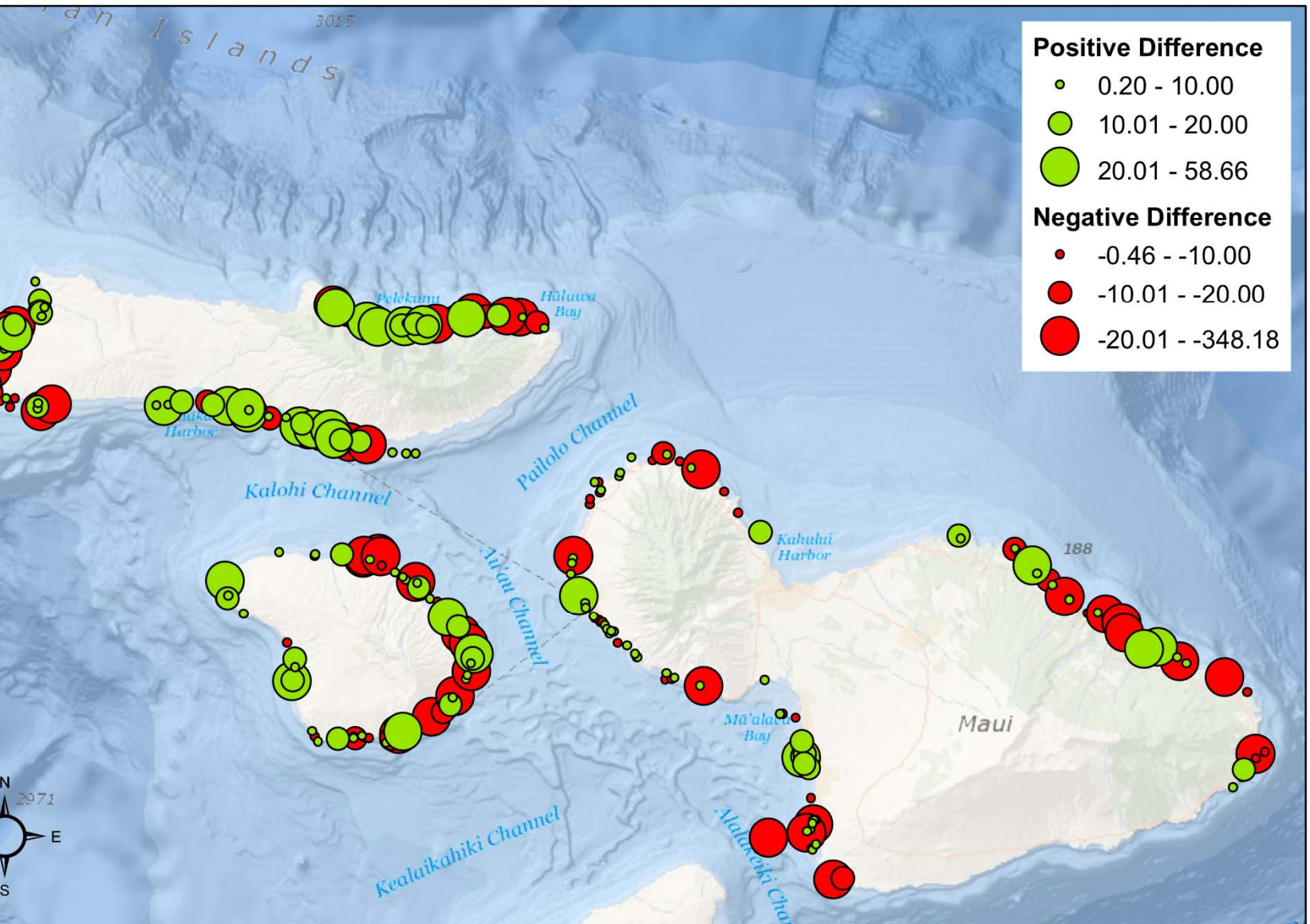
- **MODELS ARE NOT PERFECT**
- **ROOM FOR IMPROVEMENT**



Human Population Density → 0



Local human impact



exity
oral Cover
over
N Population Density

Habitat Data

SPECIES Biomass

Z

Habitat Coefficients (REGION-specific)

Variance

Habitat Coefficients (All Sites)

Variance

Species-level Model Comparisons

	Individual Islands		NWHI vs MHI	
	20km	**200km**	**20km**	**200km**
al Fish Biomass		X		
carus rubroviolaceus		X		
aranx melampygus		X		
arupeneus porphyreus	X			
laso unicornis	X			
Mulloidichthys vanicolensis		X		
hlorurus spilurus	X			
canthurus triostegus sandvicensis	X			
canthurus achilles	X			
olydactylus sexfilis	NA			
Acanthurus dussumieri	X			

Next Steps

Incorporate intra-island (e.g., “sectors”) groups into hierarchical analysis

Add oceanographic data

Develop a framework for optimizing species-specific models

Work more closely with DAR

MAHALO!

CRED
CRED Fish Team
DAR
NOAA
Reef Smart

Questions??

Email: kelvin.gorospe@noaa.gov