Ciguatera Fish Poisoning: Past, Present, Future

- Historical
- Etiology /Ecology
- Modern / Hawaiian Findings
- Perspective for the Future
  - Bad News
  - Good News

Acknowledgements

GEOHAB/BHAB Initiative of the International Oceanographic Commission, Scientific Committee on Oceanographic Research (SCOR/UNESCO)

This research was funded by National Science Foundation Grants OCE004-32479, OCE08-52301, and OCE11-29119

Ciguatera Fish Poisoning

- Occurs in tropical and subtropical regions
- Vector is exclusively reef fish
- Affects hundreds of thousands of people annually
- Underreported; misdiagnosed

Autumn 1525

de ellas ballabamos enlas nida les muchos vebos enesta ysla sepesco vn pescado
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Urdaneta, 1580

Benthic Hazardous Algae

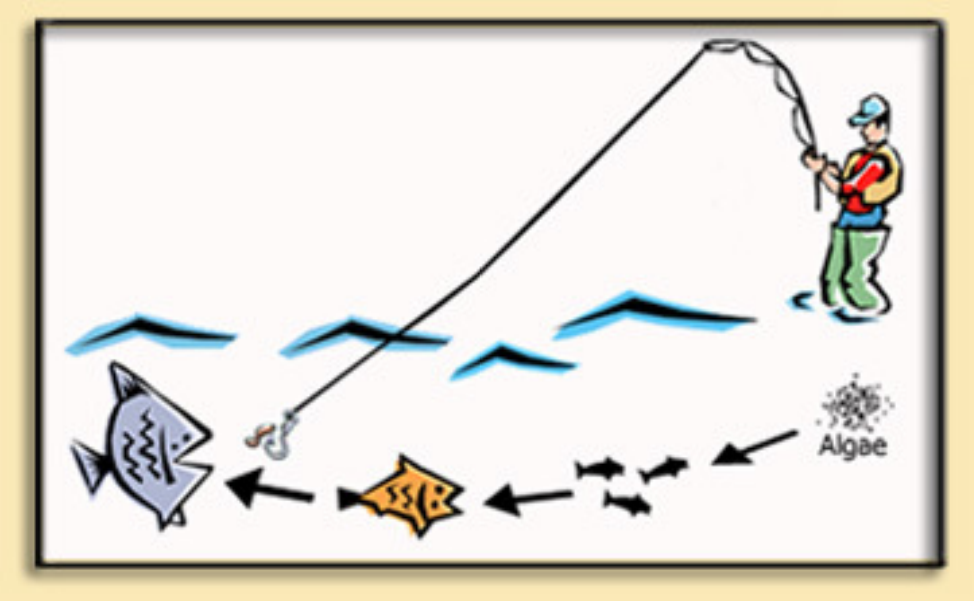
- Oceans & Human Health Perspective
- Gambierdiscus ecophysiology
- Ciguatoxin(s)
- CFP Prevalence
- CFP & Climate Change

Ciguatera Sequence

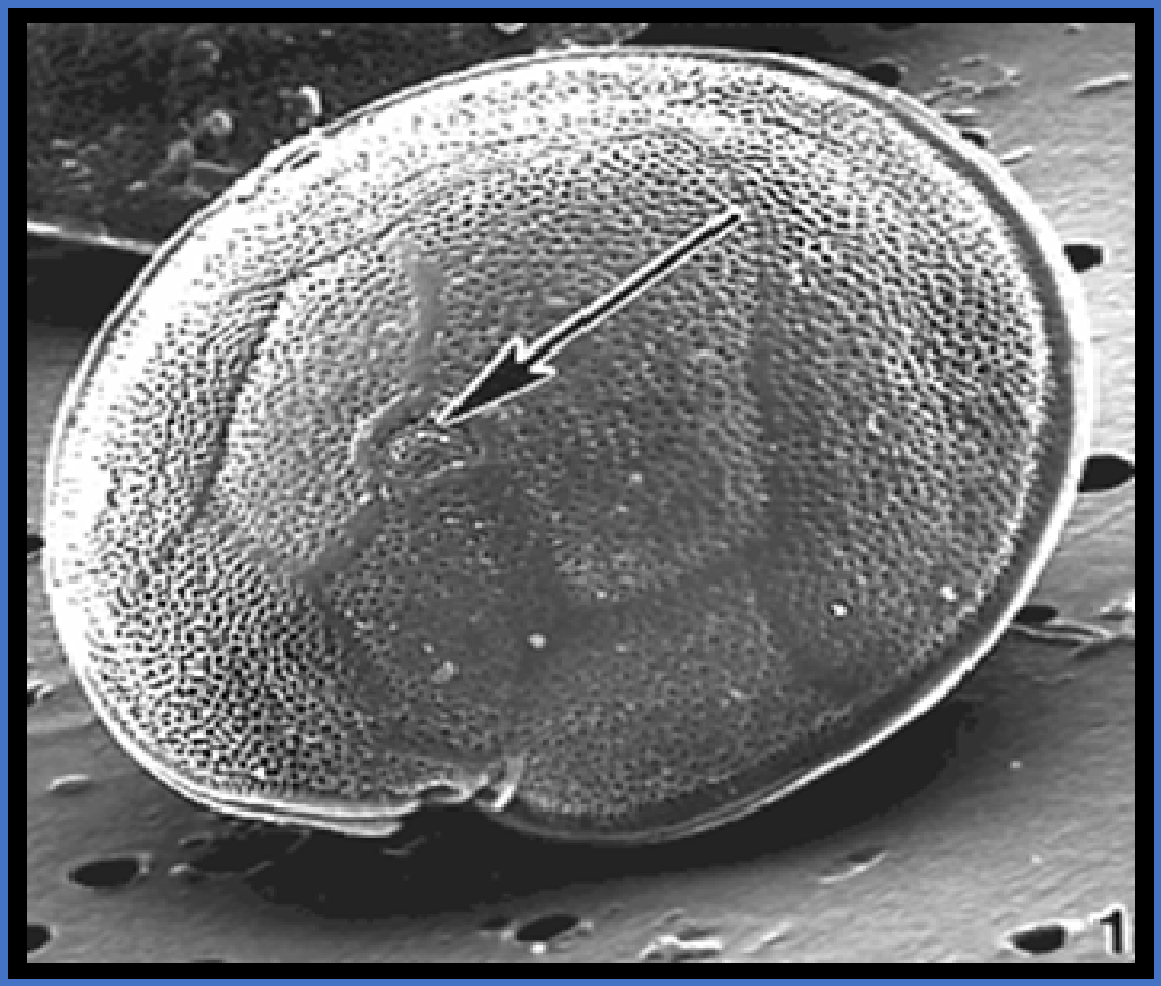
Environmental conditions → *Gambierdiscus*

Gambierdiscus → Macroalgae → Herbivorous Fish → Carnivorous Fish → Fishing Pressure

Fish → Humans



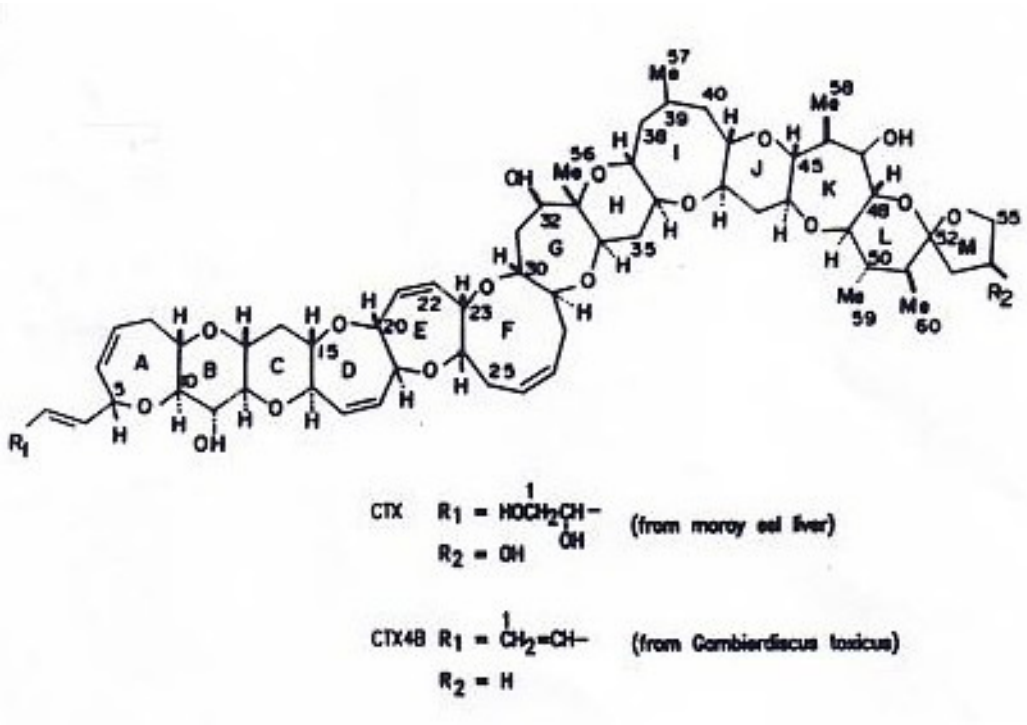
Gambierdiscus spp.



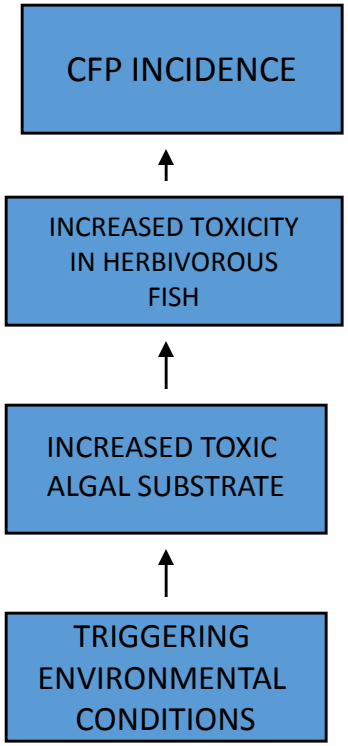
Why is Progress so Slow?

- Detection
- Diagnosis
- Reporting
- Societal Initiatives & Capabilities

Ciguatoxin Molecule



Uncertainties in the CFP Cycle



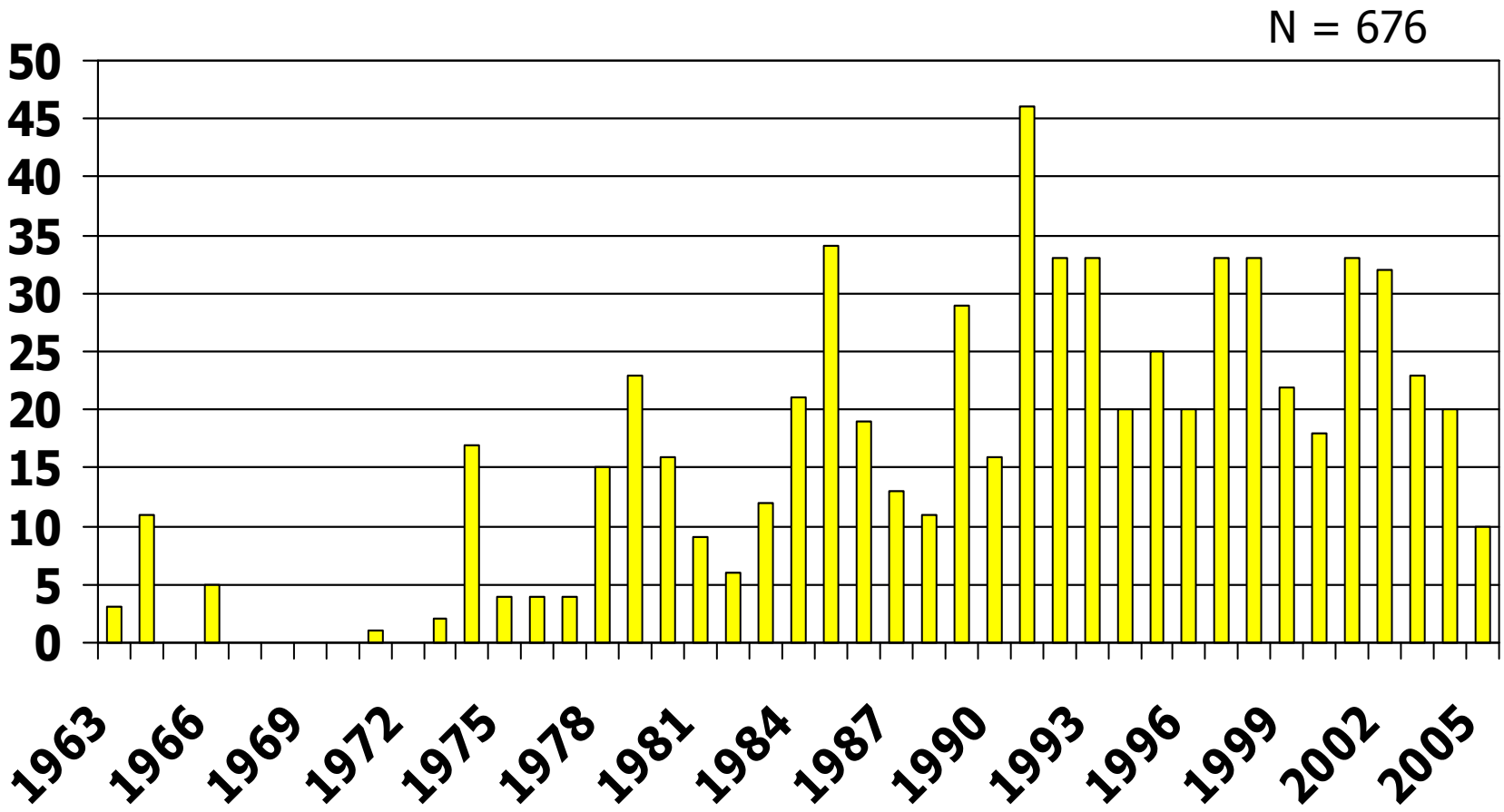
- **Increased proportions of toxic fish?**
- **Increased toxicity in the fish present?**
- **Increased fish harvesting and consumption by humans?**

- **Due to fish eating more toxic algal substrate?**
- **Due to different grazing patterns?**
- **Due to progressive toxin accumulation in older fish?**

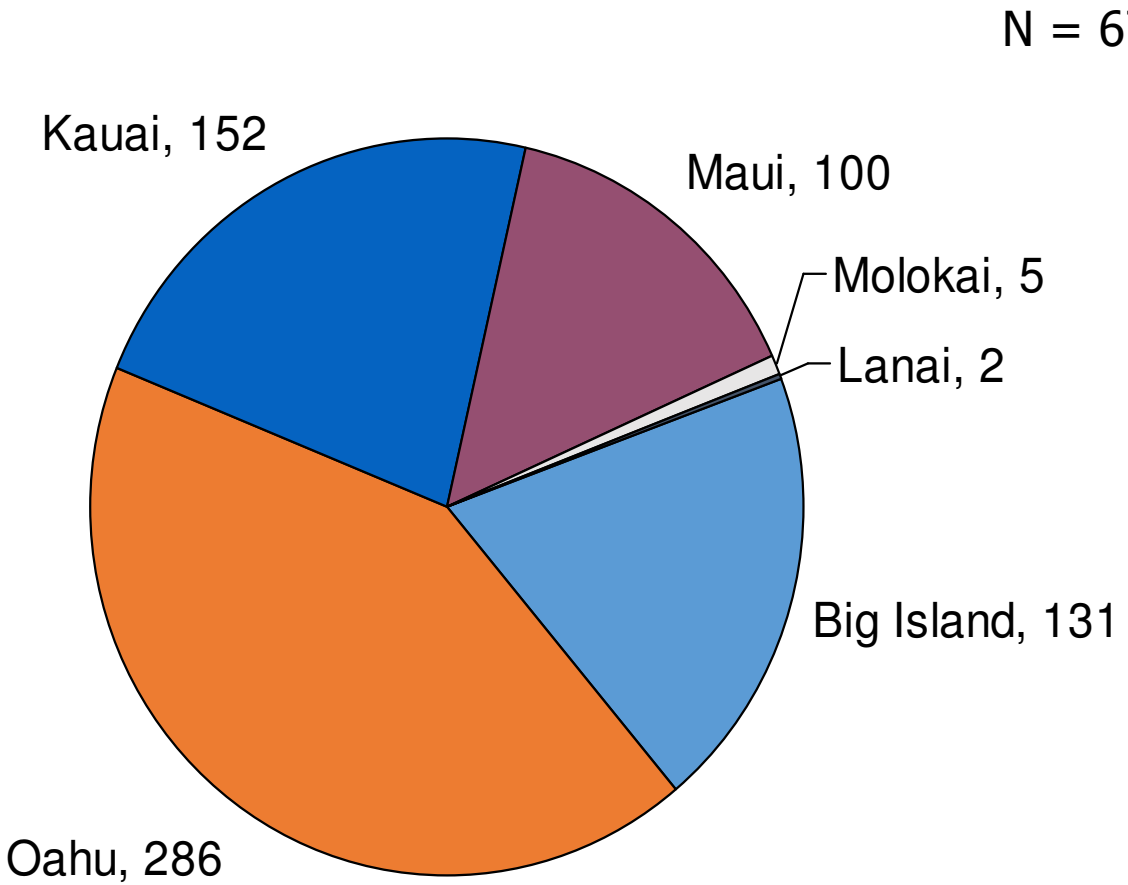
- **Due to increased G. toxicus biomass?**
- **Due to increased specific toxicity of G. toxicus biomass present?**
- **Due to specific G. toxicus clone that produces CTX?**

- **Do certain conditions stimulate the growth of G. toxicus?**
- **Do certain conditions change the macroalgae where the G. toxicus grows?**
- **Do certain conditions stimulate the specific toxicity of G. toxicus?**

eported Ciguatera Incidents awaii – 1963 to 2005

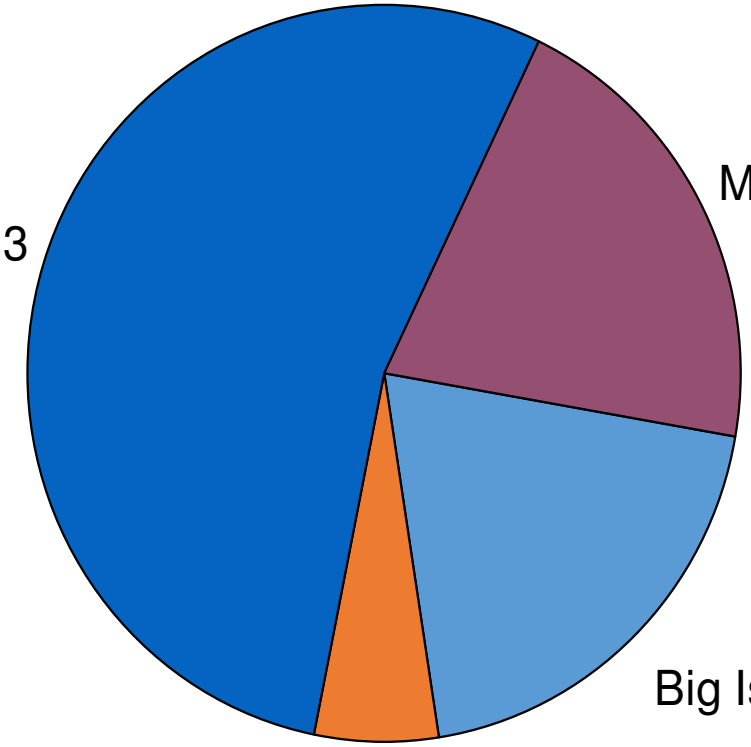


Ciguatera Incidents By Island



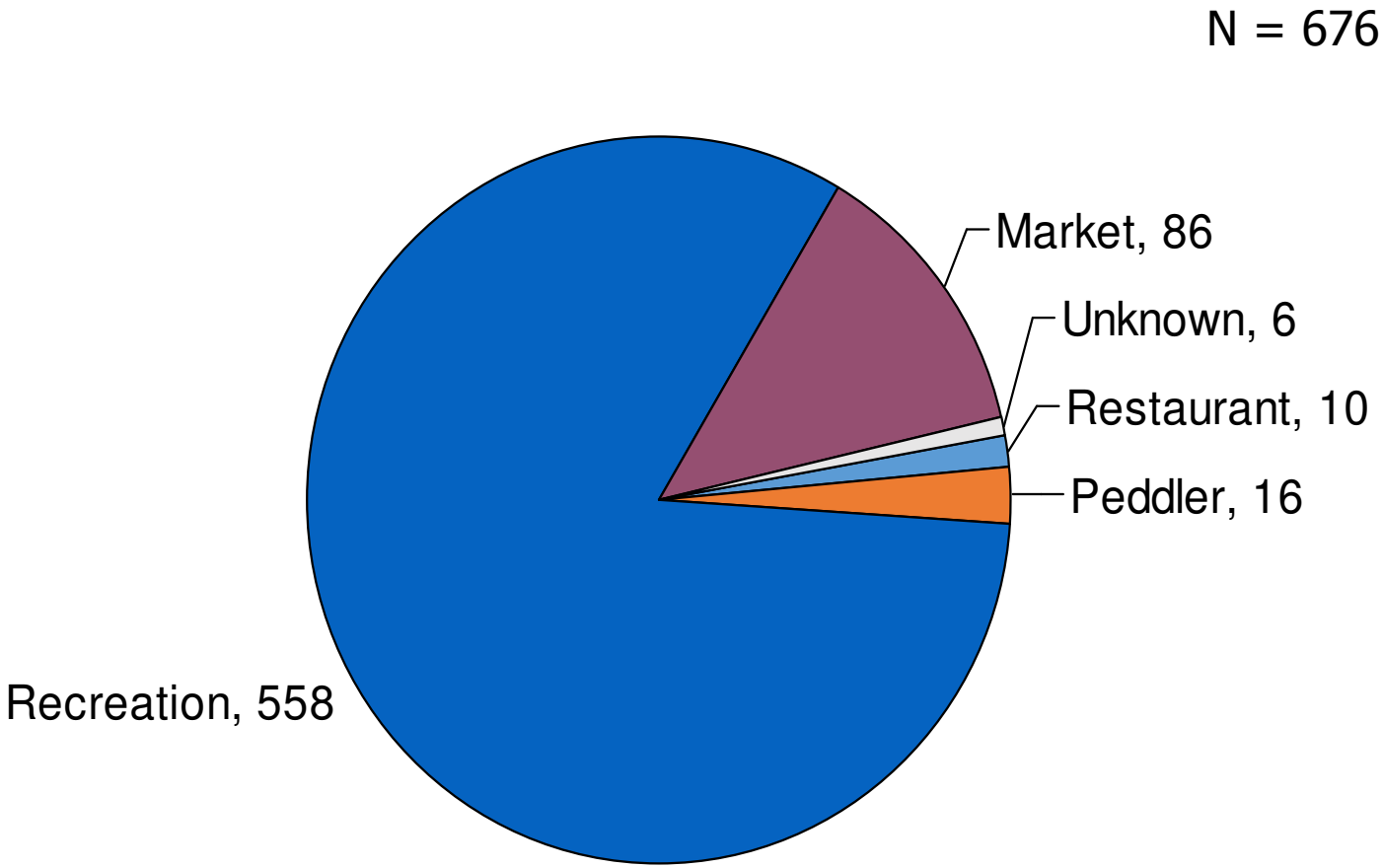
Ciguatera Incidence By Island

N = 676

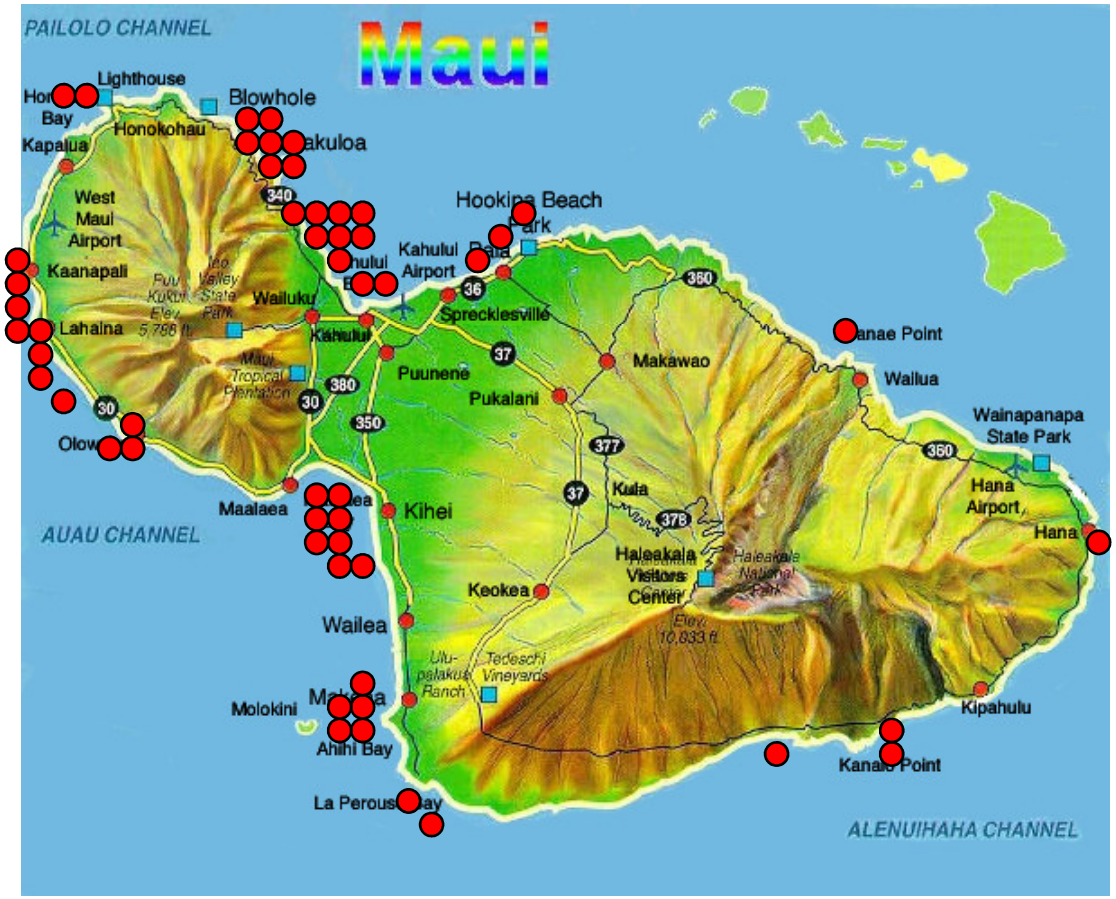


- Per 1985 100,000 resident population
- Molokai and Lanai excluded

Fish Source for Ciguatera Incidents

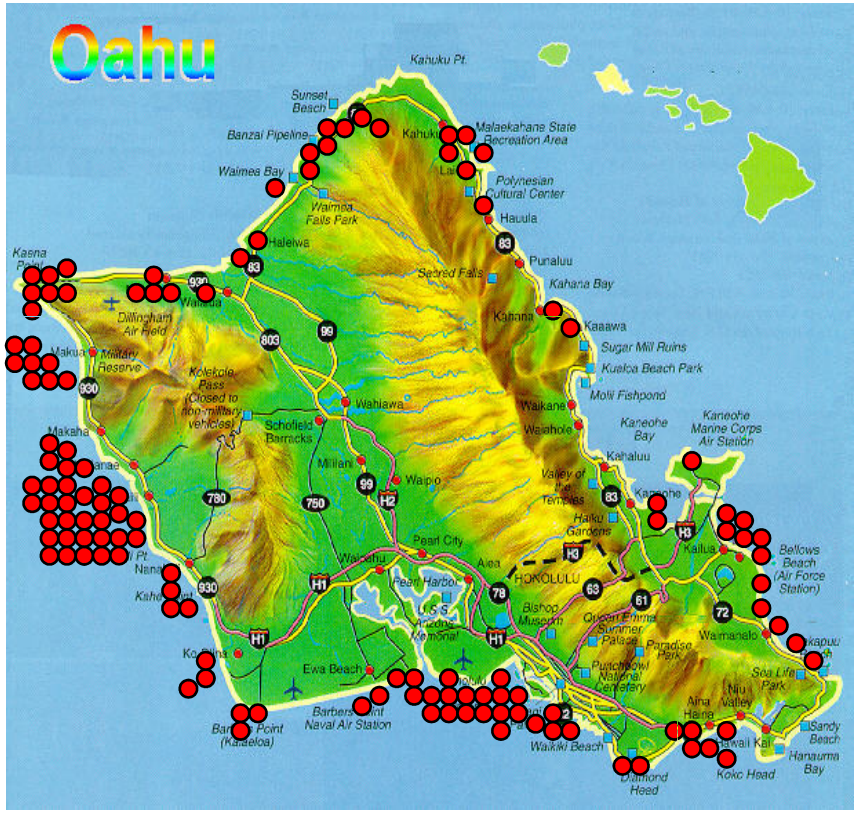


atch Sites for Incident-Related Fish
aui - 1963 to 2005



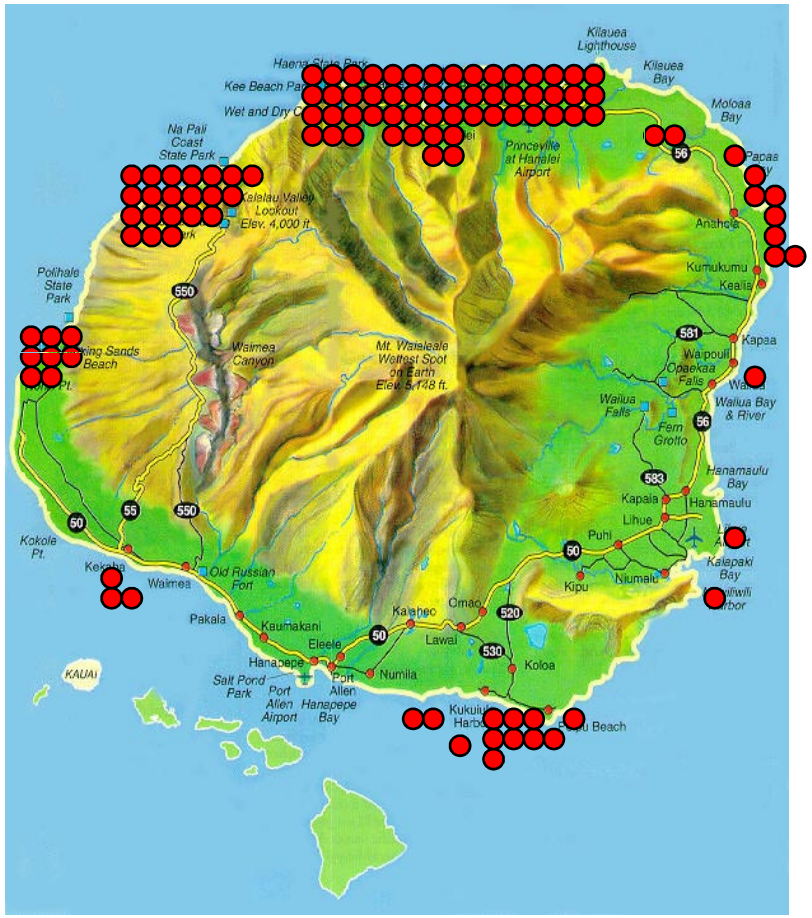
- 57 incidents associated with Maui catch sites
- 53 with specific location

atch Sites for Incident-Related Fish
ahu - 1963 to 2005



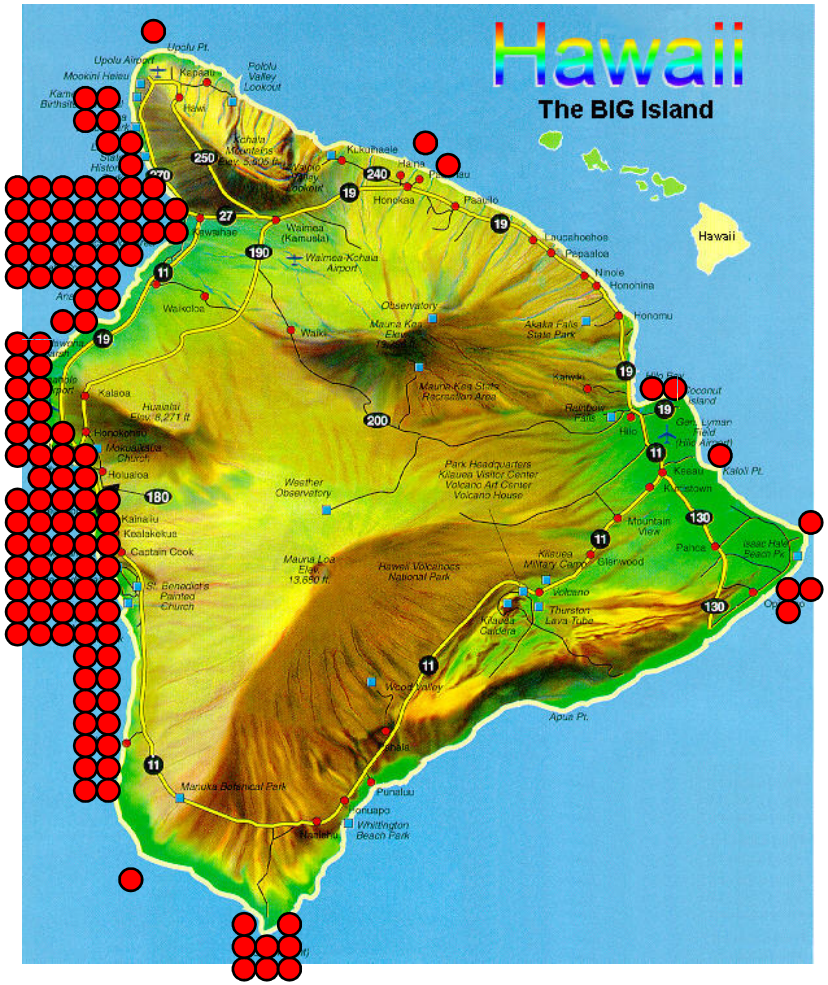
- 127 incidents associated with Oahu catch sites
- 125 with specific location

atch Sites for Incident-Related Fish
auai - 1963 to 2005



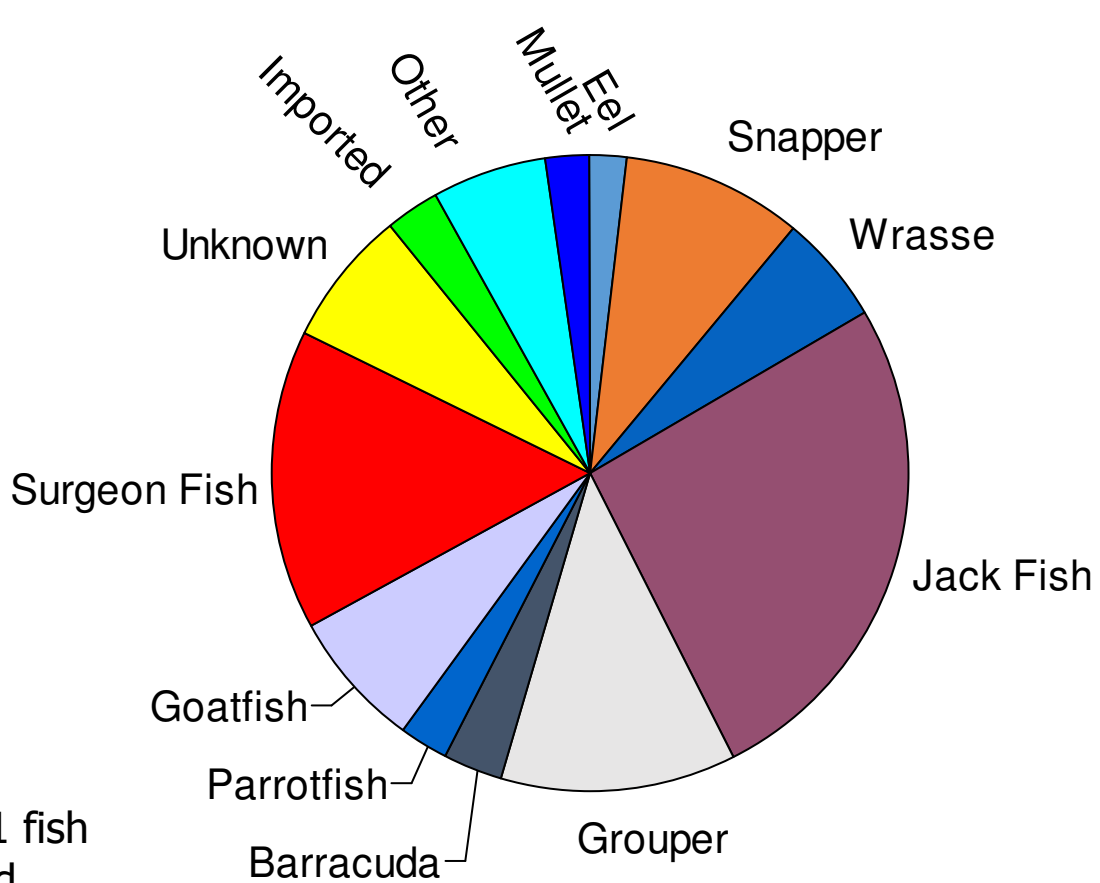
- 118 incidents associated with Kauai catch sites
- 113 with specific location

atch Sites for Incident-Related Fish
ig Island - 1963 to 2005



- 136 incidents associated with Hawaii catch sites
- 131 with specific location

iguatera Incidents
y Type of Fish Consumed



Incidents involving consumption of >1 fish type were excluded

iguatera Fish Poisoning

op 5 Offenders – Locally Caught Fish

	1	2	3	4	5
Incident	Jack	Surgeon	Grouper	Snapper	Wrasse
Hospital	Wrasse	Jack	Snapper	Grouper	Surgeon

Jacks









Surgeon Fish



Grouper





Snappers

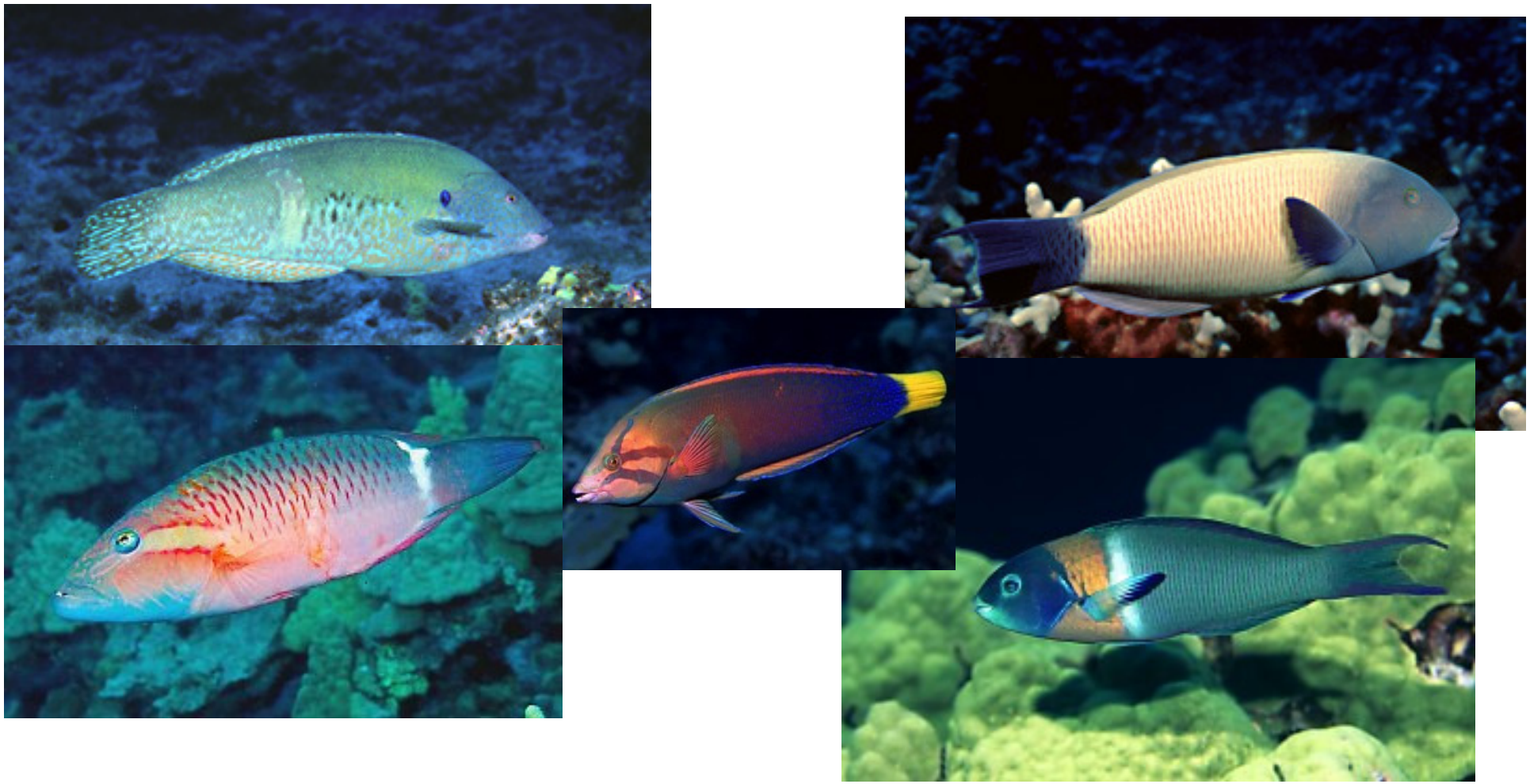




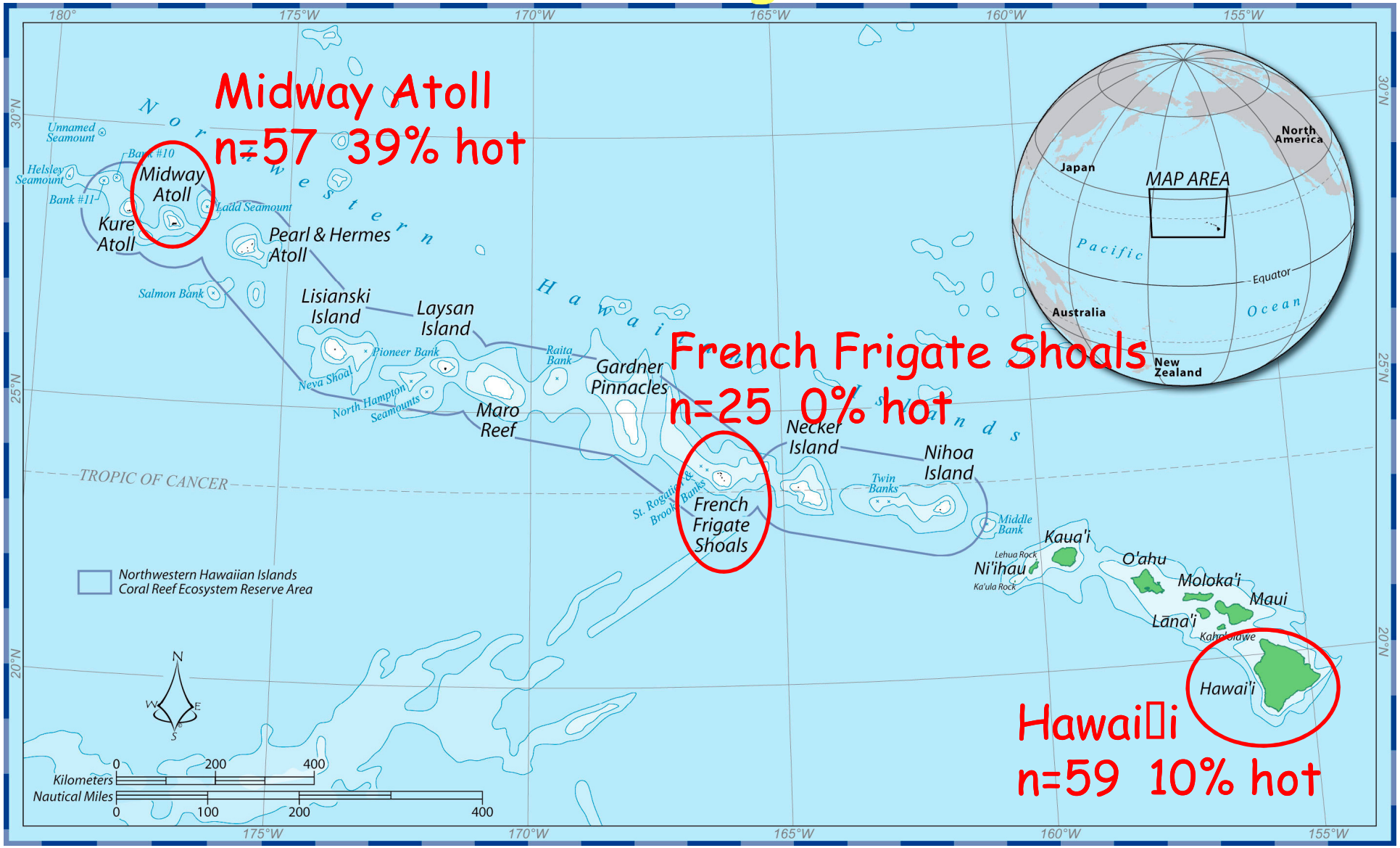




Wrasses



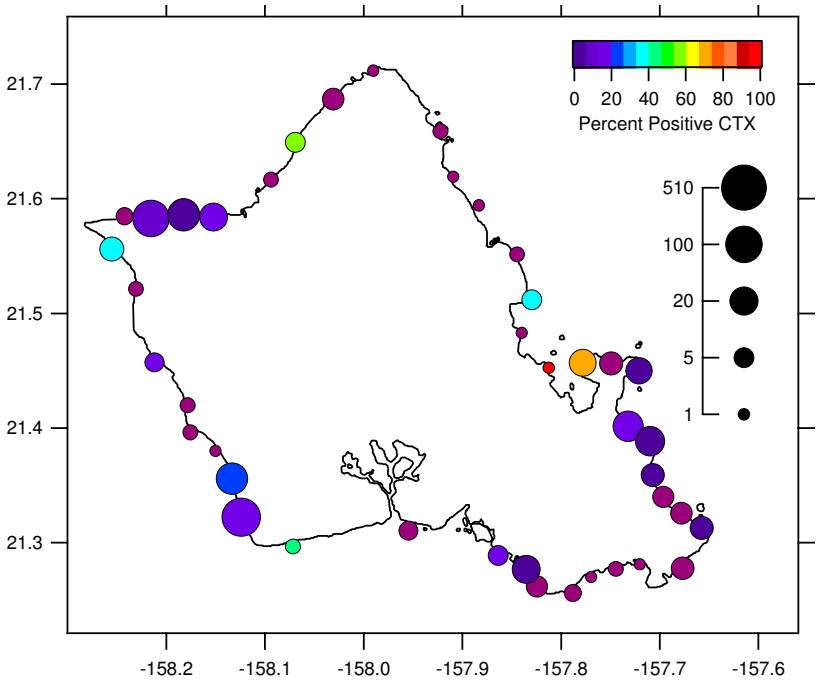
Interesting Results

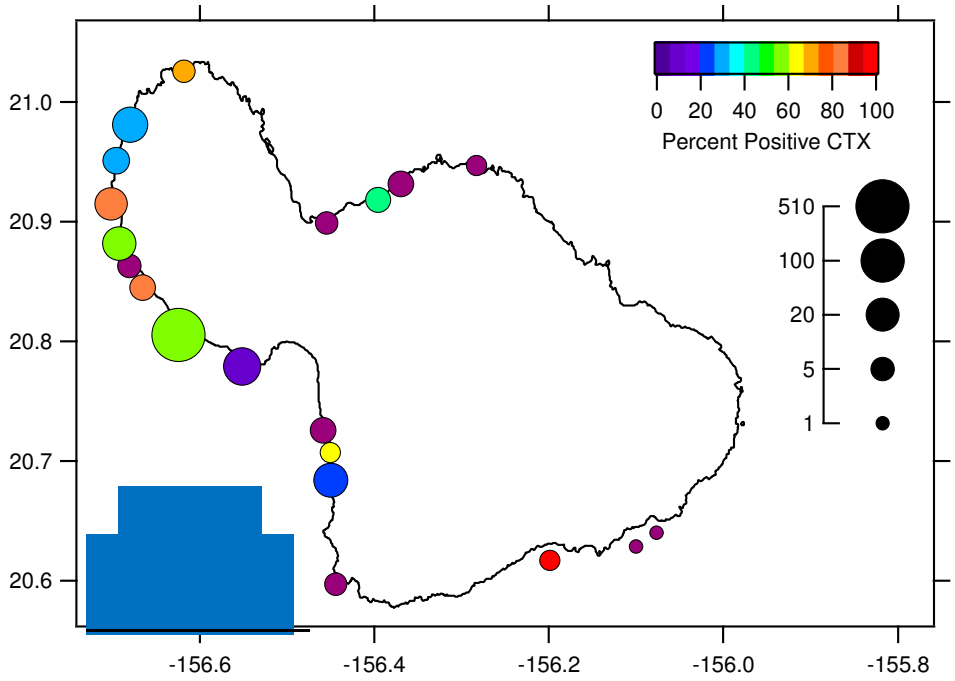


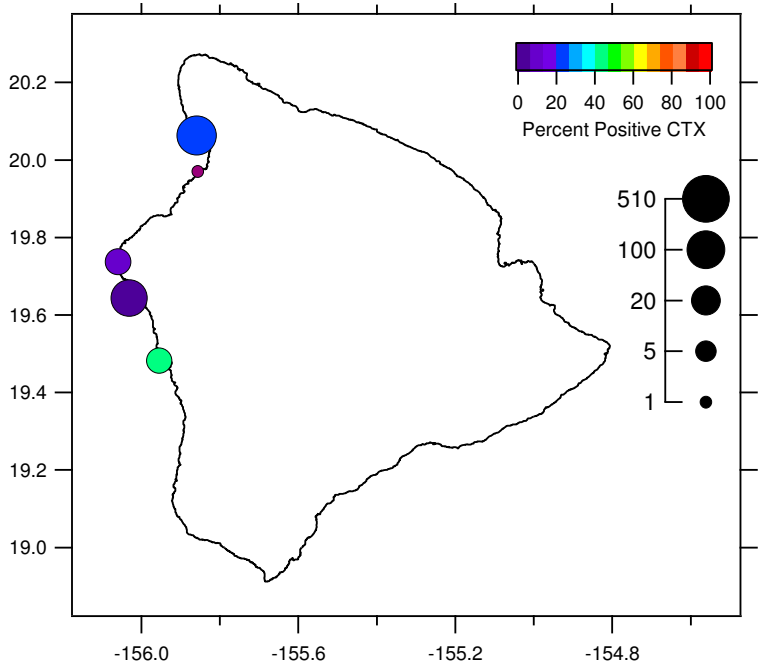
http://www.noaanews.noaa.gov/stories2006/s2644.htm

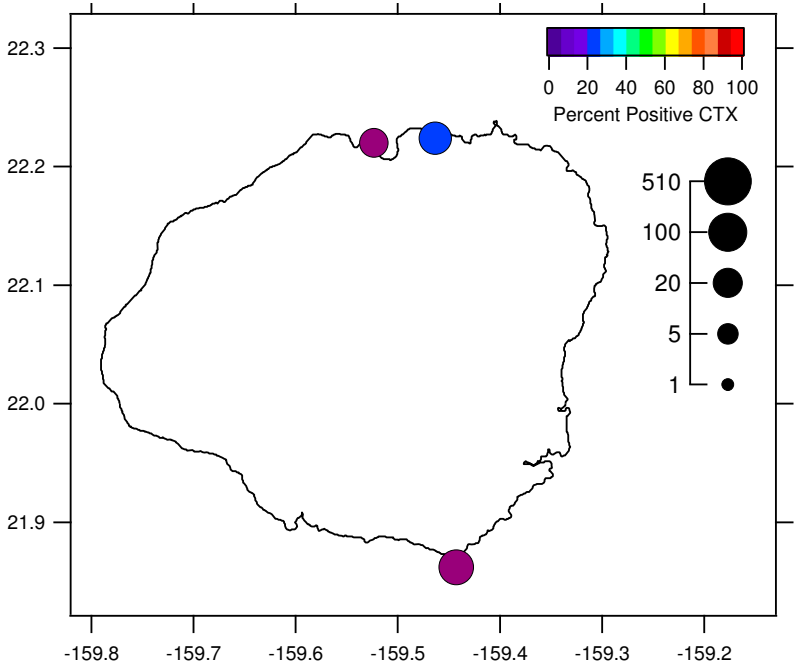
Summary of Results
N2a Bioassay

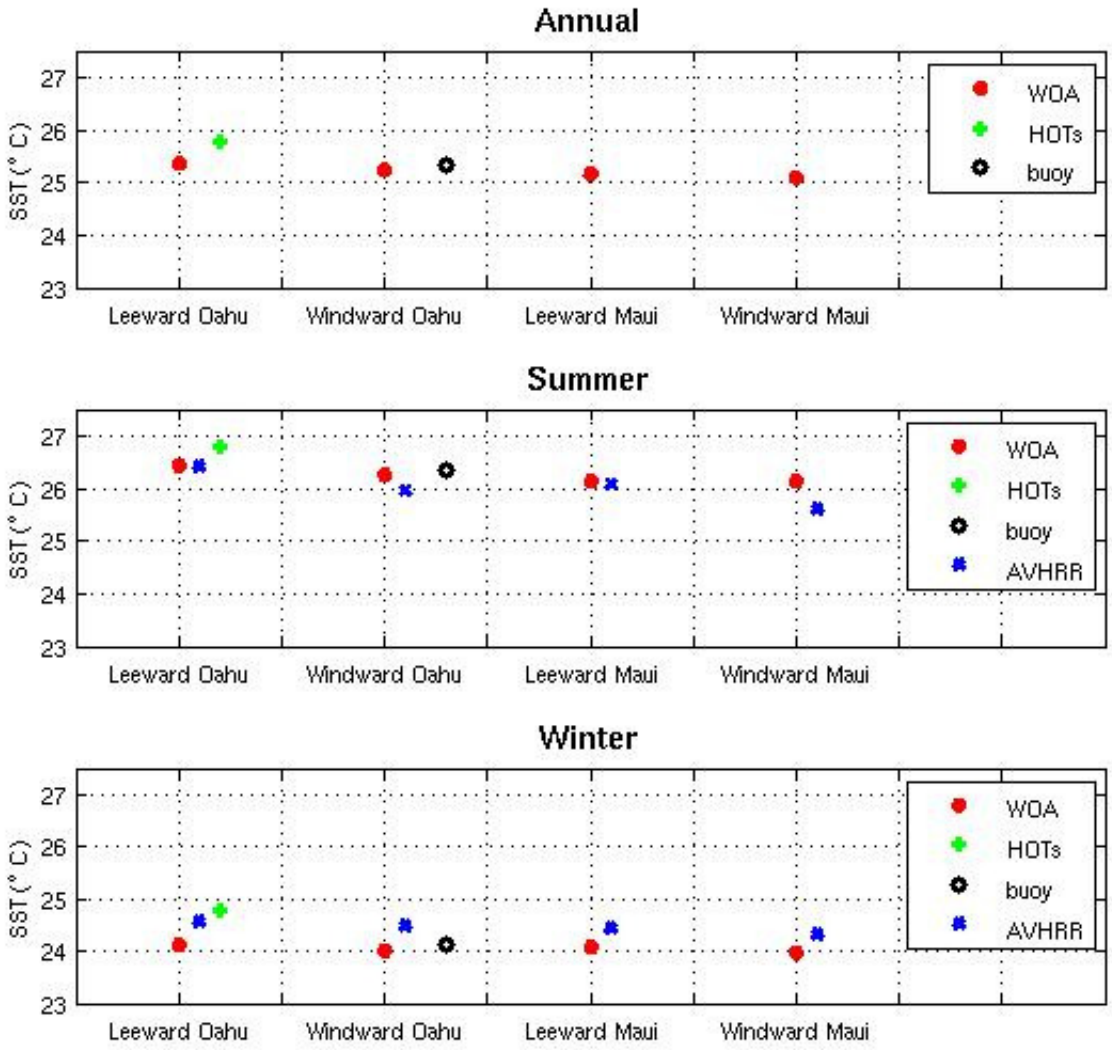
UHM HOT FISH	MHI n = 112	NWHI n = 182	TOTAL
CARNIVORES	15%	20%	18%
HERBIVORES	11%	17%	14%
ALL	13%	18%	**16%**

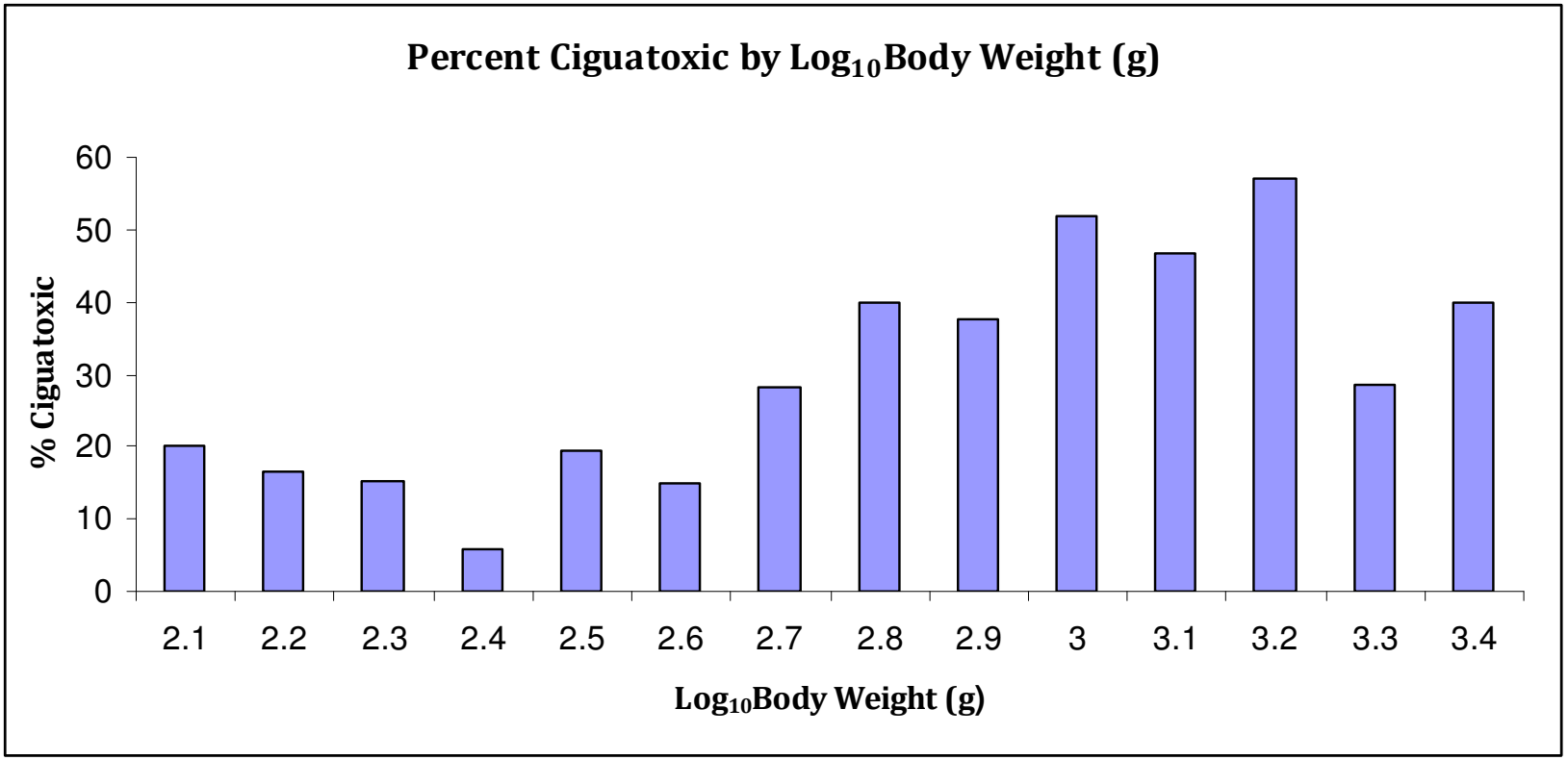

0 20 40 60 80 100
Percent Positive CTX
510
100
20
5
1
21.7
21.6
21.5
21.4
21.3
-158.2
-158.1
-158.0
-157.9
-157.8
-157.7
-157.6


0 20 40 60 80 100
Percent Positive CTX
510
100
20
5
1
21.0
20.9
20.8
20.7
20.6
-156.6
-156.4
-156.2
-156.0
-155.8

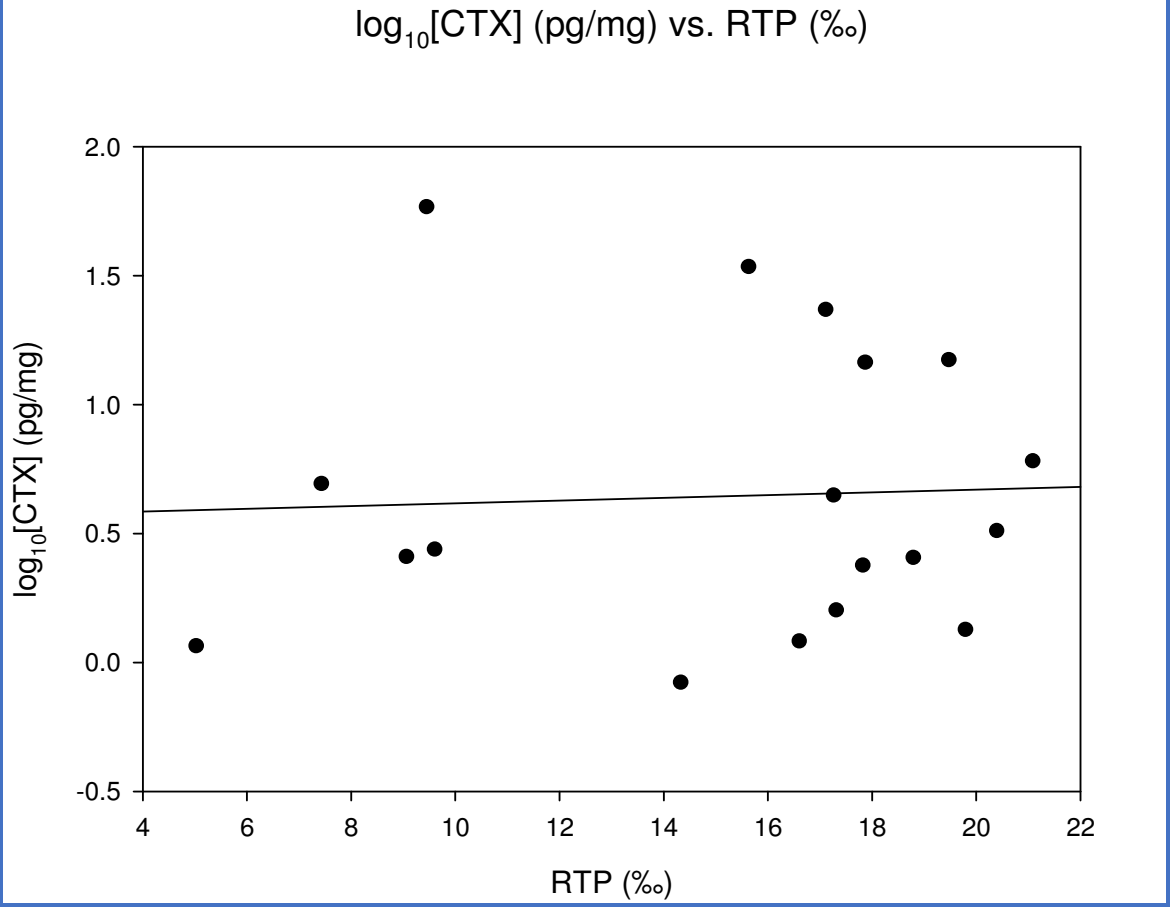

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19.6
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19.2
19.0
-156.0
-155.6
-155.2
-154.8


0 20 40 60 80 100
Percent Positive CTX
510
100
20
5
1
22.3
22.2
22.1
22.0
21.9
-159.8
-159.7
-159.6
-159.5
-159.4
-159.3
-159.2


Annual
SST (° C)
27
26
25
24
23
Leeward Oahu
Windward Oahu
Leeward Maui
Windward Maui
WOA
HOTs
buoy
Summer
SST (° C)
27
26
25
24
23
Leeward Oahu
Windward Oahu
Leeward Maui
Windward Maui
WOA
HOTs
buoy
AVHRR
Winter
SST (° C)
27
26
25
24
23
Leeward Oahu
Windward Oahu
Leeward Maui
Windward Maui
WOA
HOTs
buoy
AVHRR


Percent Ciguatoxic by Log10Body Weight (g)
% Ciguatoxic
60
50
40
30
20
10
0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3
3.1
3.2
3.3
3.4
Log10Body Weight (g)

CTX Concentration vs Relative Trophic Position



CTX Potency, Threshold & Links

CTX Human Threshold Concentration 0.1 – 4 ppb

Upcoming EU & USFDA Limit ➔ 0.01ppb

BHAB Conference: New Zealand, October 2014

Link to Hawaii Research & Information

www.fish4science.com

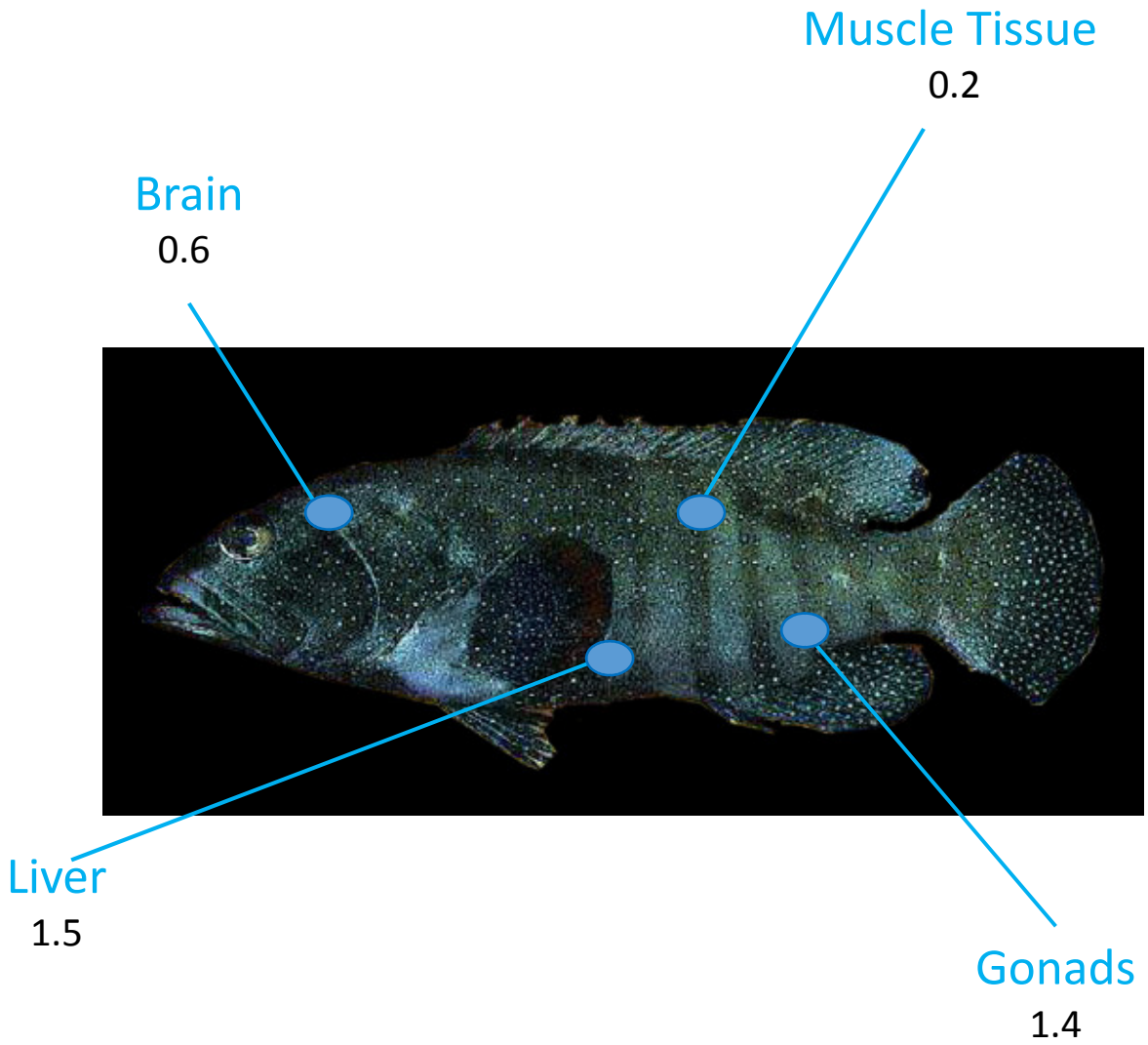
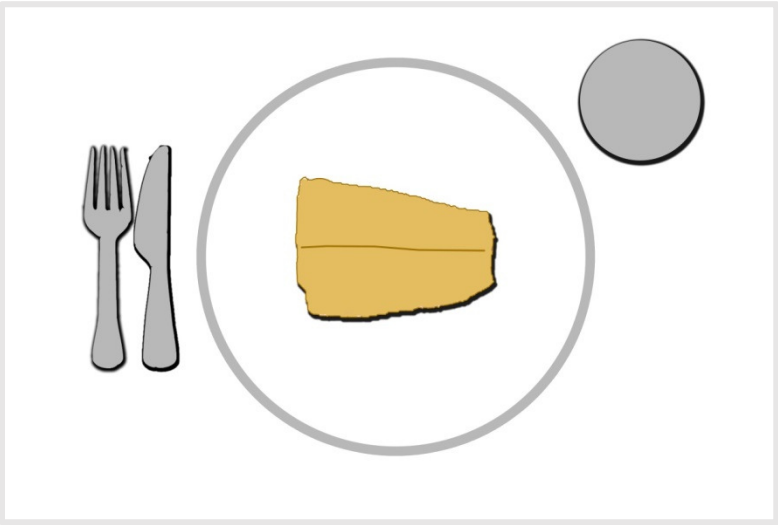
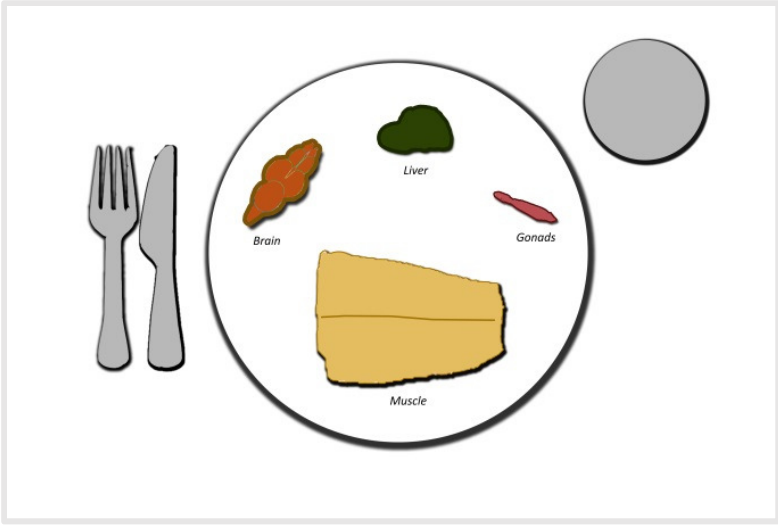


Figure 1.1 Distribution of average CTX Concentration (ng/g) in ten samples of *C. argus*



= 26.4 ng [CTX]



= 34.6 ng [CTX]

Replacing less than 5% of serving of muscle with an equivalent weight of internal tissues yields a 24% increase in CTX load

Gambierdiscus Transport via Ships' Ballast Water

Test Conditions: 4 T's 22.C-29.0°C, Darkness

Findings

- Survival & Growth Rates: Controls = Tests
- No Gambierdiscus in Ballast Waters
- No Cyst Development

Conclusions

- Ballast Water Will Allow Oceanic Translocation of *Gambierdiscus*
- Current U.S. Protocols Prevent this Occurrence

Neurotoxin Prevalence in Marine Turtle Tissues

TESTED

- Tissues: Muscle & Liver
- 72 Samples, 38 individuals, 3 species

FOUND

- 12 Samples (32%): Positive for Na^+-Channel Neurotoxin Presence
- Feeding Behavior ➔ Grazing on Near-shore Macroalgae
- 2 species: Green (10/29) > Hawksbill (2/4) > Olive Ridley (0/5)
- Livers (10/28) > Muscles (8/38) > Both (6/32)
- First Demonstration of Na^+-Channel Neurotoxicity (CTX) in Marine Turtles

Neurotoxin Prevalence in Stranded Marine Cetaceans

TESTED

- Tissues: Muscle, Liver, Brain, Testes
- 89 Samples, 34 individuals, 13 species

FOUND

- 14 Samples (16%):Positive for Na-Neurotoxin Presence
- Feeding Behavior → Grazing on Near-shore Fishes
- 6 species
- Livers (7) > Muscles (4) > Brain (3) > Tests (0)
- Positive Association ≠ Causal Factor

Ciguatera: Societal Impacts

- Reduction in primary food source
- Increased health-related costs
- Revenue Loss of reef-fish sales to extent markets
- Loss of tourism
- Depopulation via migration
  - Rongo et al. (2009): Polynesian voyages of discovery
- Societal changes in eating habits
- Societal changes in family/festival activities

Ciguatera: Perspective with Climate Changes

Greater Geographic Range of Incidence

Probability for Higher Biomass of Toxin Producers

Greater Toxicity Quota from *Gambierdiscus* Biomass

Coming Good News: Technological Response from Science

Overview of Research Design

