Integrating Local Ecological Knowledge with Science to Refine Traditional Community-Based Fishing Moon Calendars

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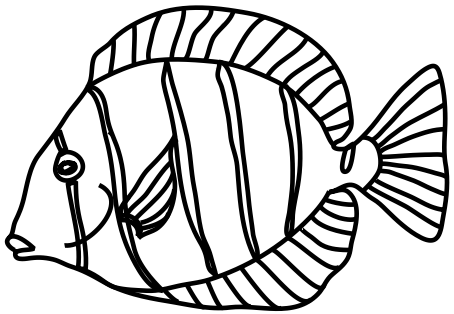
DAR

CONSERVATION INTERNATIONAL



Fisheries Ecology Research Lab

Importance of Local Stewardship & Management

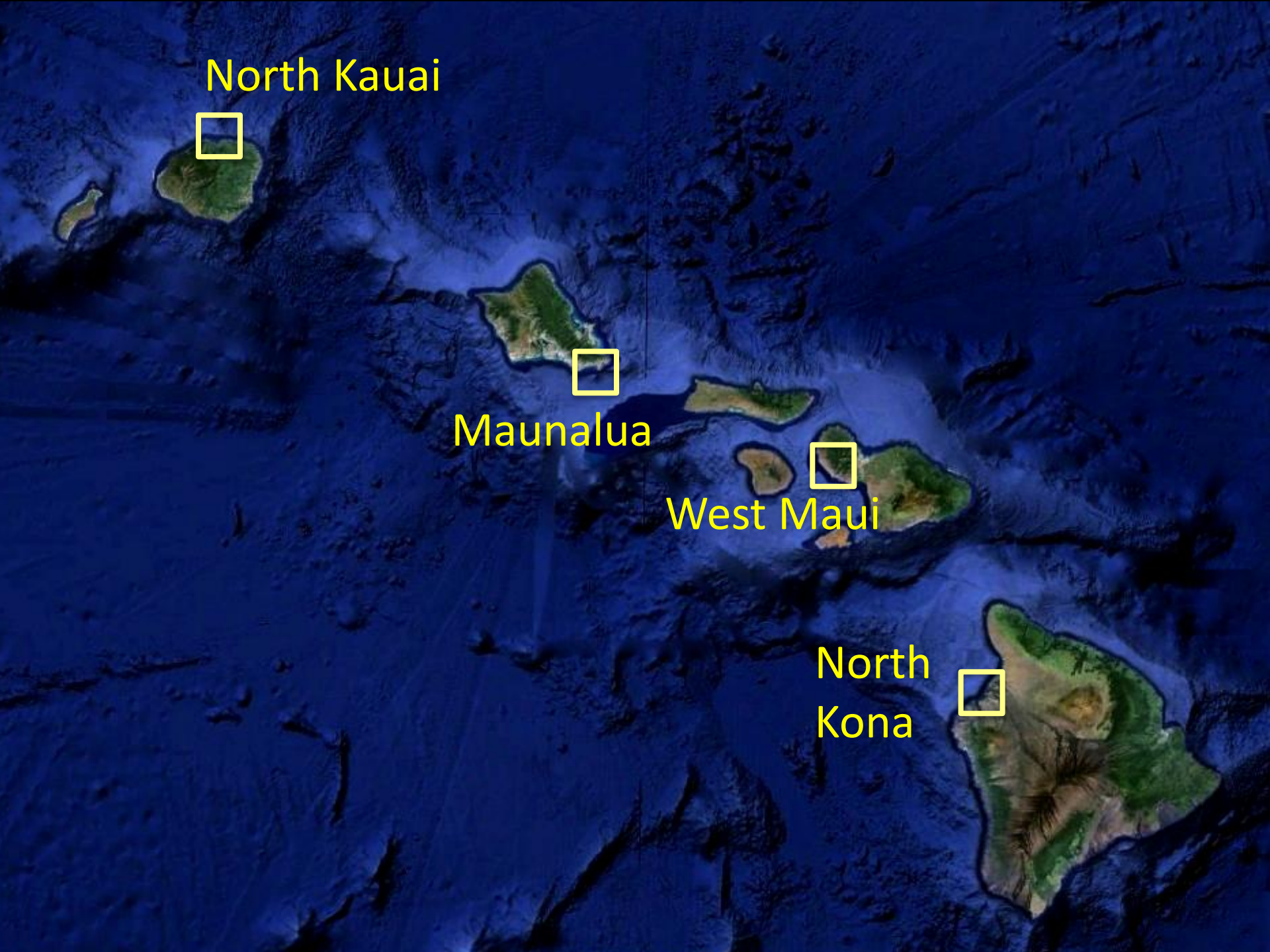
- Timing of natural cycles differs between locations
- Each bay is has different history & challenges
- Fish reproductive patterns have evolved to match local conditions
- Predictable based on lunar phase

Hawaiian Moon Calendar

- Traditionally
  - Dictated harvest & no take times or kapus
- Contemporary
  - Integrated approach to local resource monitoring

Project Goals

- Develop monitoring methods for assessing fish biology & spawning seasons
- Determine reproductive characteristics for priority species
- Assess spatial & temporal reproductive variability
- Develop outreach and education tools (Moon Calendars)


North Kauai
Maunalua
West Maui
North
Kona

DEVELOP MONITORING METHODS FOR ASSESSING FISH BIOLOGY & SPAWNING SEASONS

Photo credit: Chad Wiggins

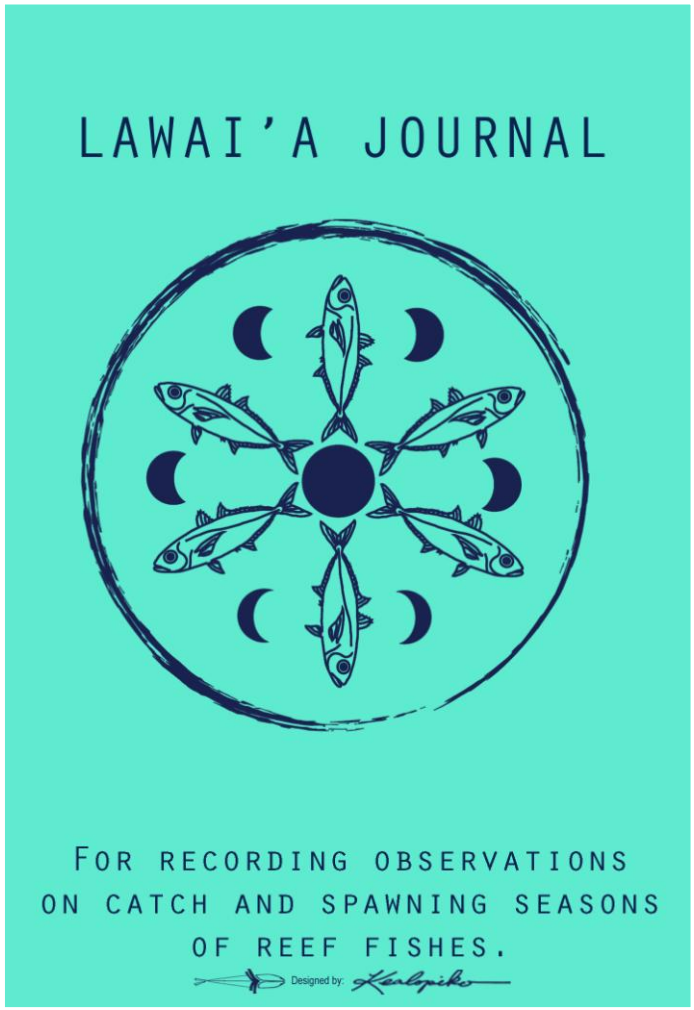
Incorporating Local Knowledge

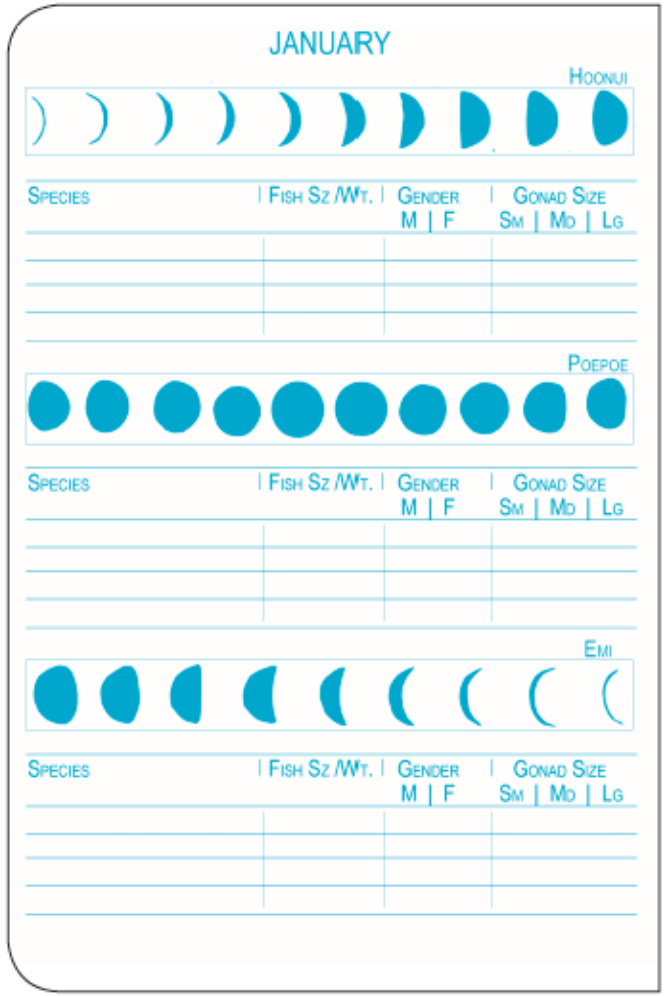
- Surveys & observer participation
- Harvested & ecologically important species identified
- Typical fishing practices
- Local threats

Photo credit: Chad Wiggins

Involving the Fishing Community

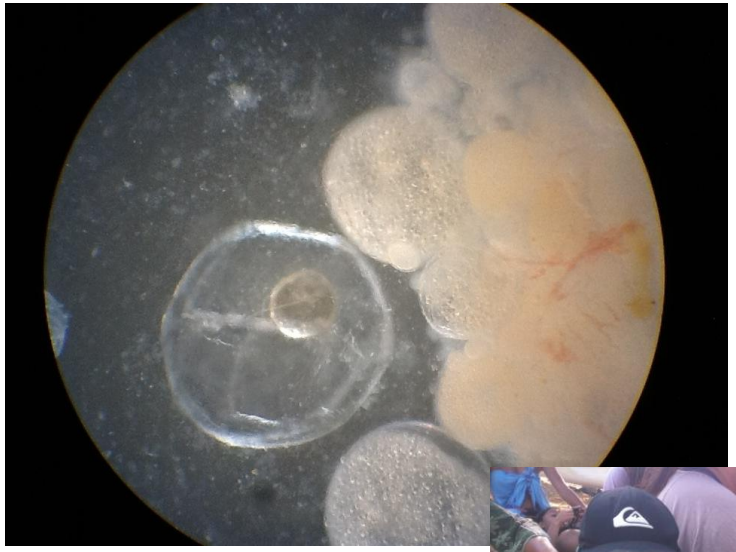
Fishermen Logbooks

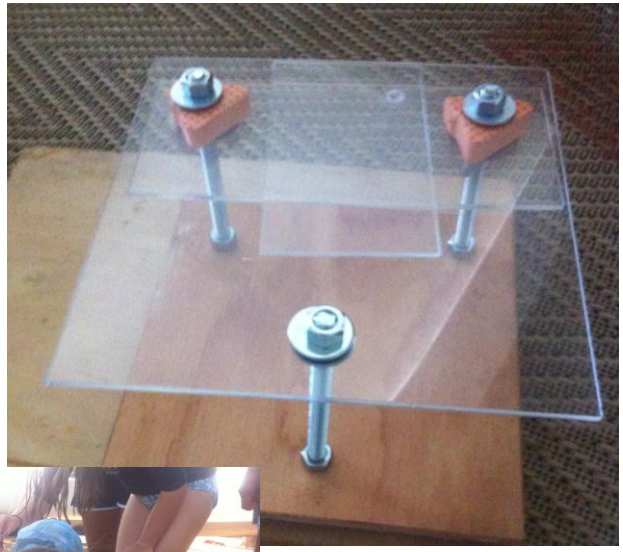




Developing New Tools

- Field microscope for fish eggs





Gathering Spawning Seasons Data

- Training workshops
- Fishery monitors - collect biological information & gonad samples for scientific assessment

Hā‘ena Nov 2014

Assessment Methods

- GSI – Gonadosomatic Index

  GSI=(Gonad Wt./Fish Wt.)*100

- Histology

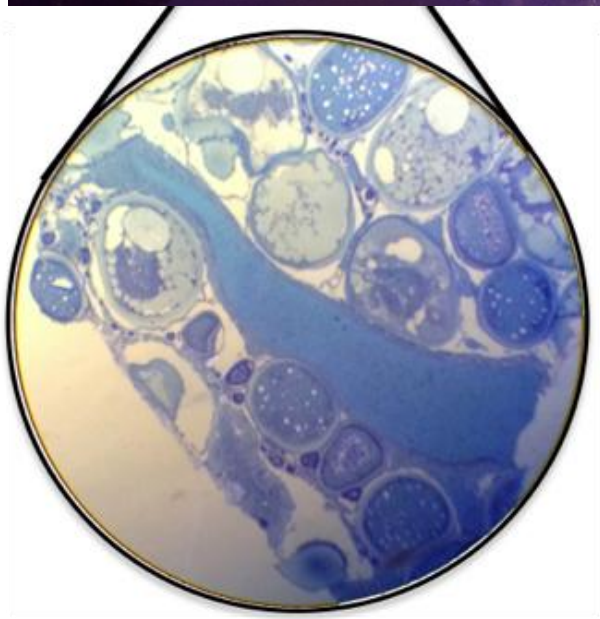
  Size at maturity

  Spawning Fraction= % spawners/day (Hunter and Macewicz 1983)

- Endocrinology

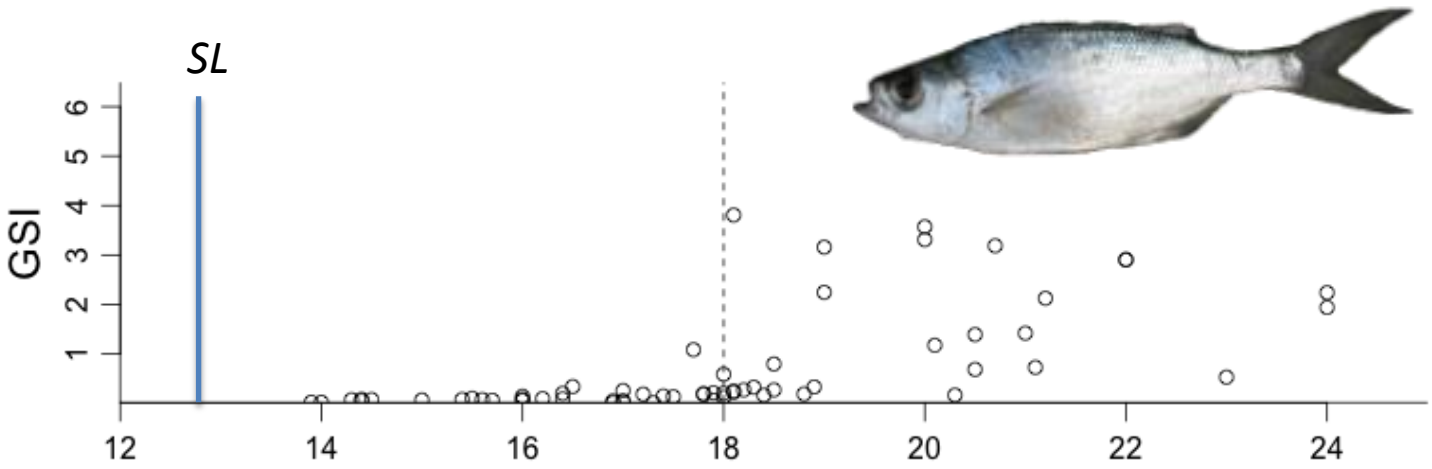
- Fecundity

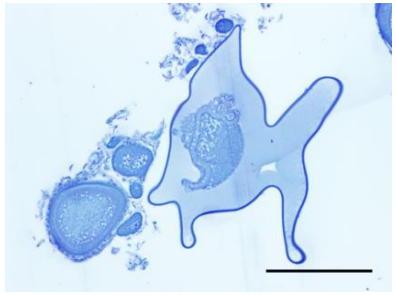
  $FB=N(M_G)M_{SUB}^{-1}$

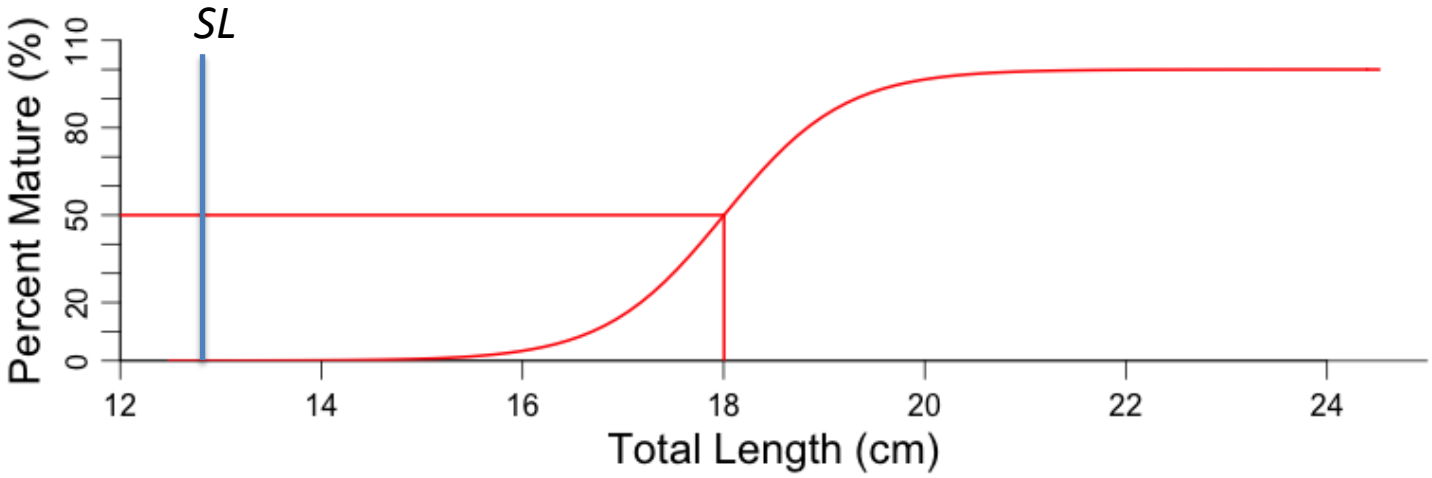


WHAT ARE THE BEST METHODS FOR MONITORING SPAWNING SEASONS?

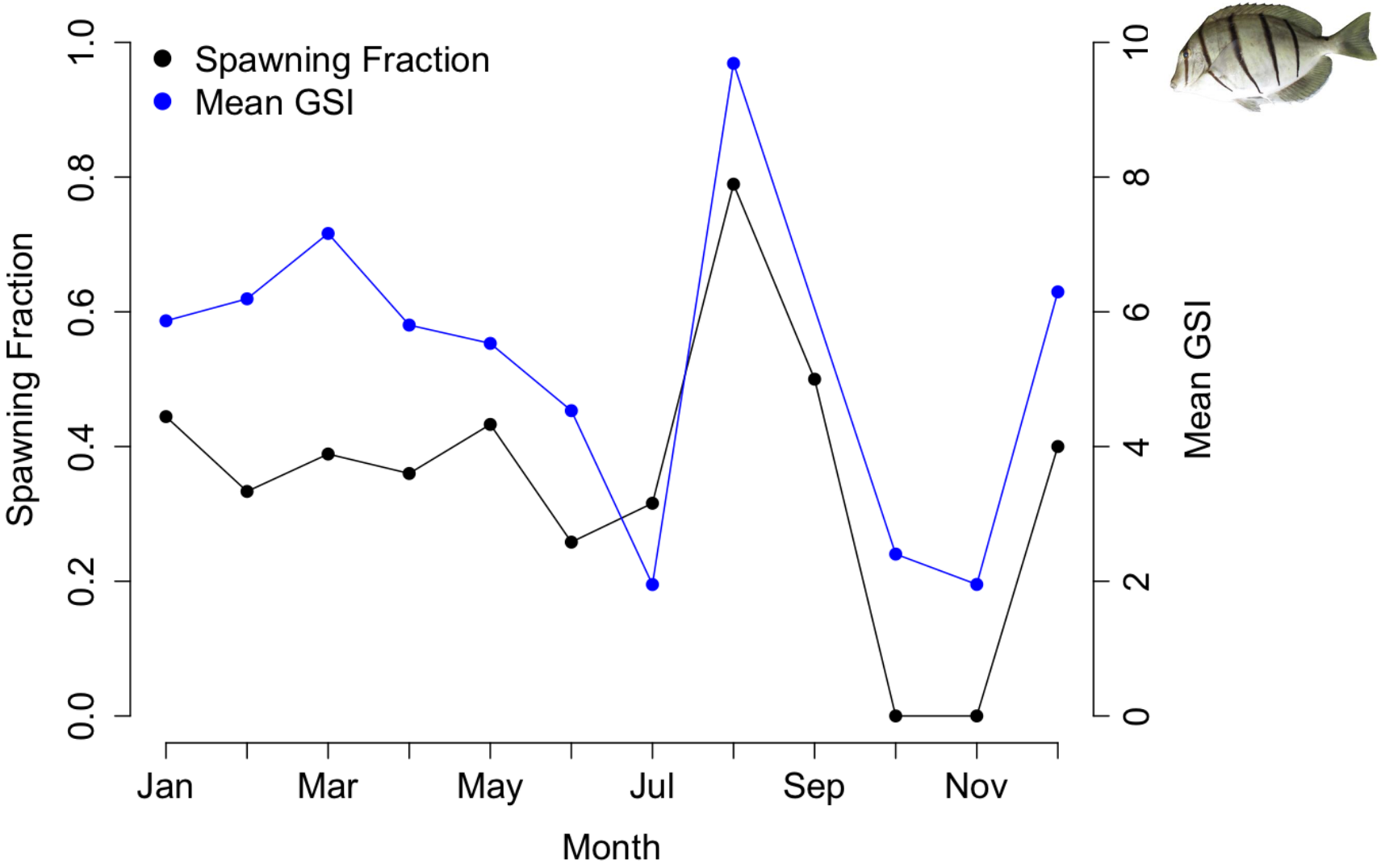
Comparing Methods to Assess Size at Maturity



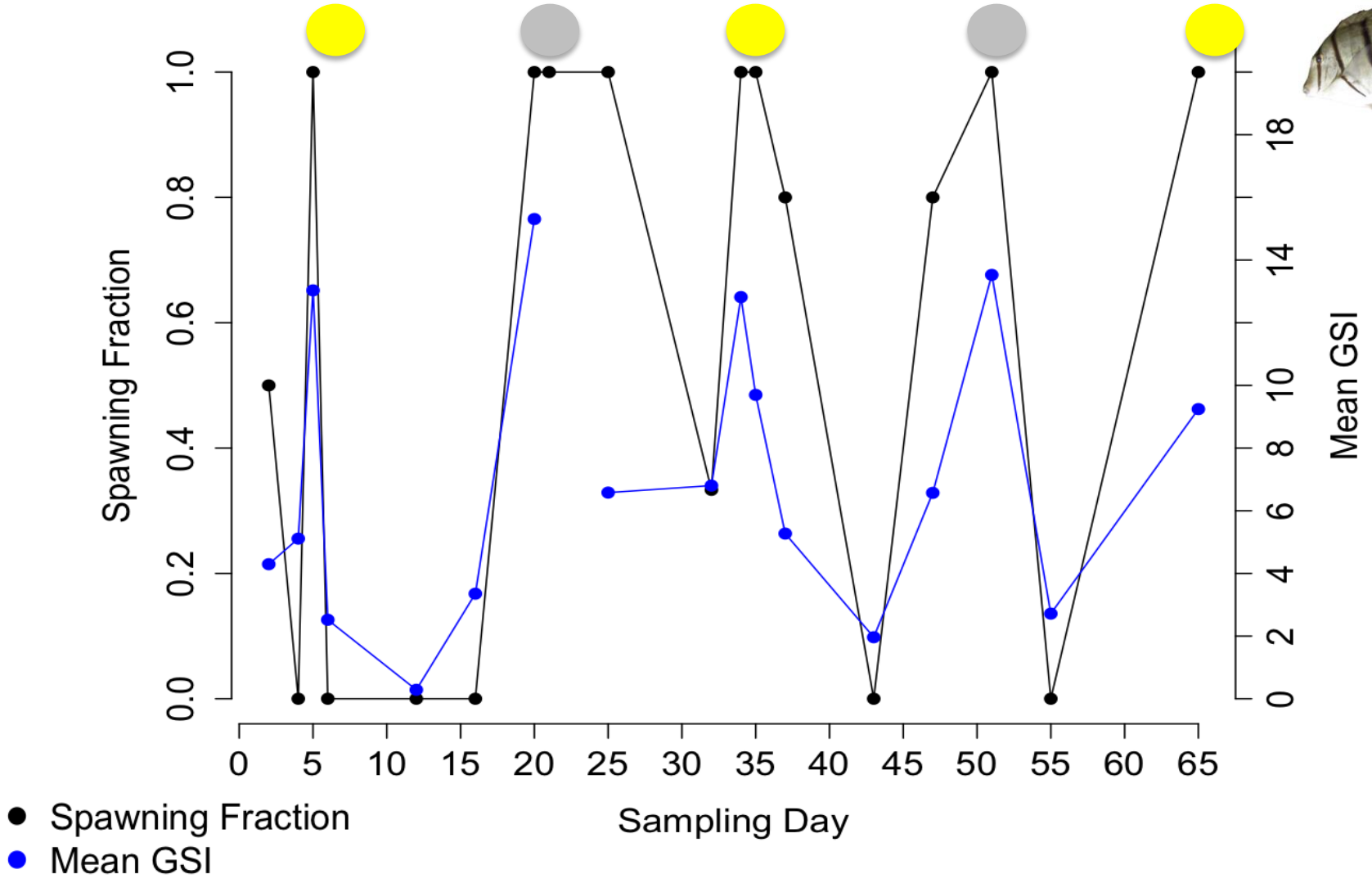




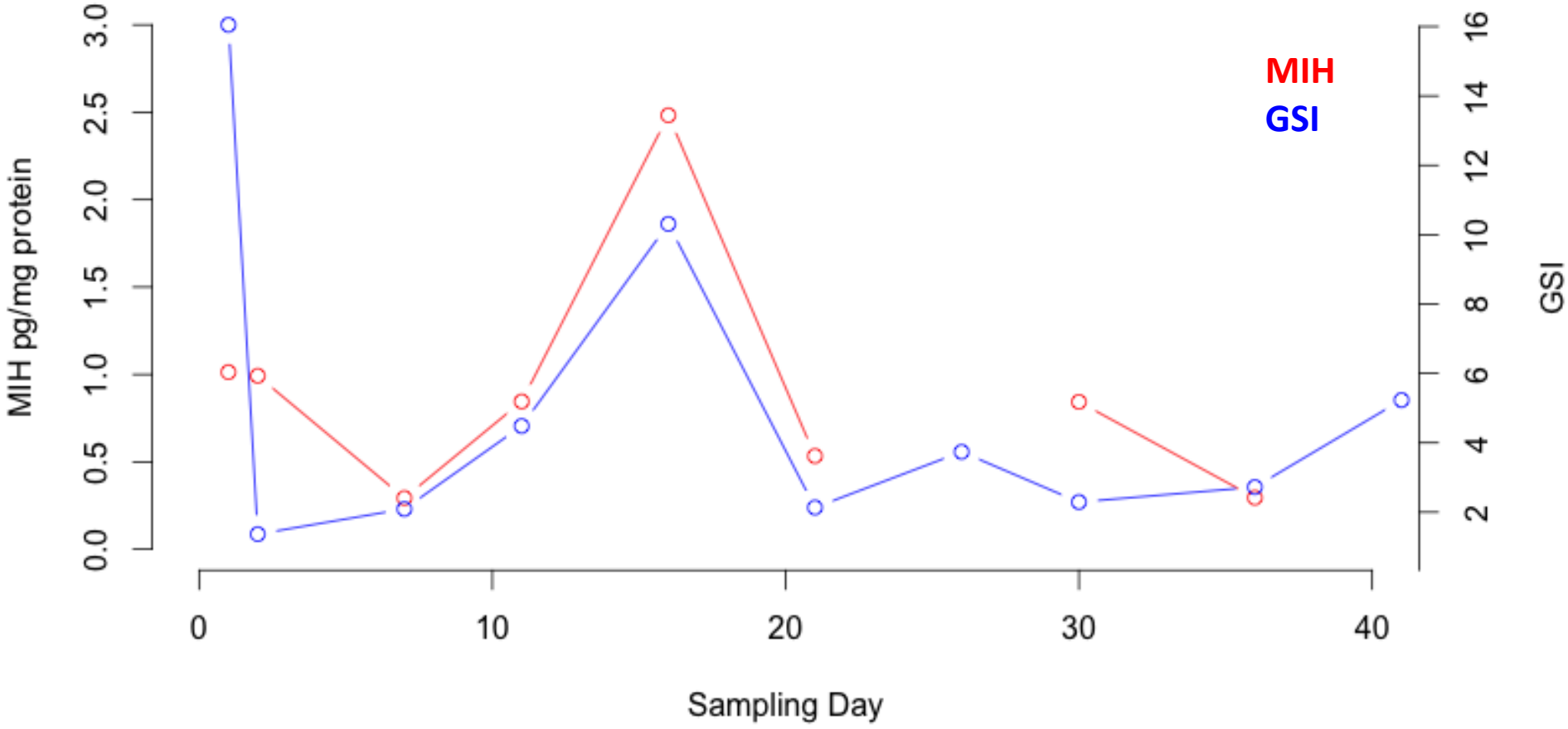
Spawning Seasons for Manini Maunalua Bay



Spawning Pattern for Manini Maunalua Bay



Endocrine Assessment



Comparing Methods Conclusions

What are the best methods for monitoring spawning seasons?

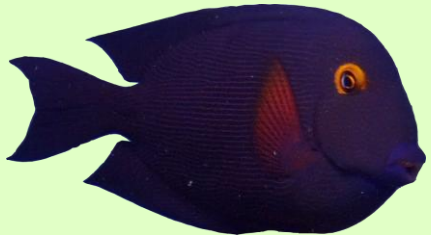
GSI methods adequate to determine spawning seasons & size at maturity

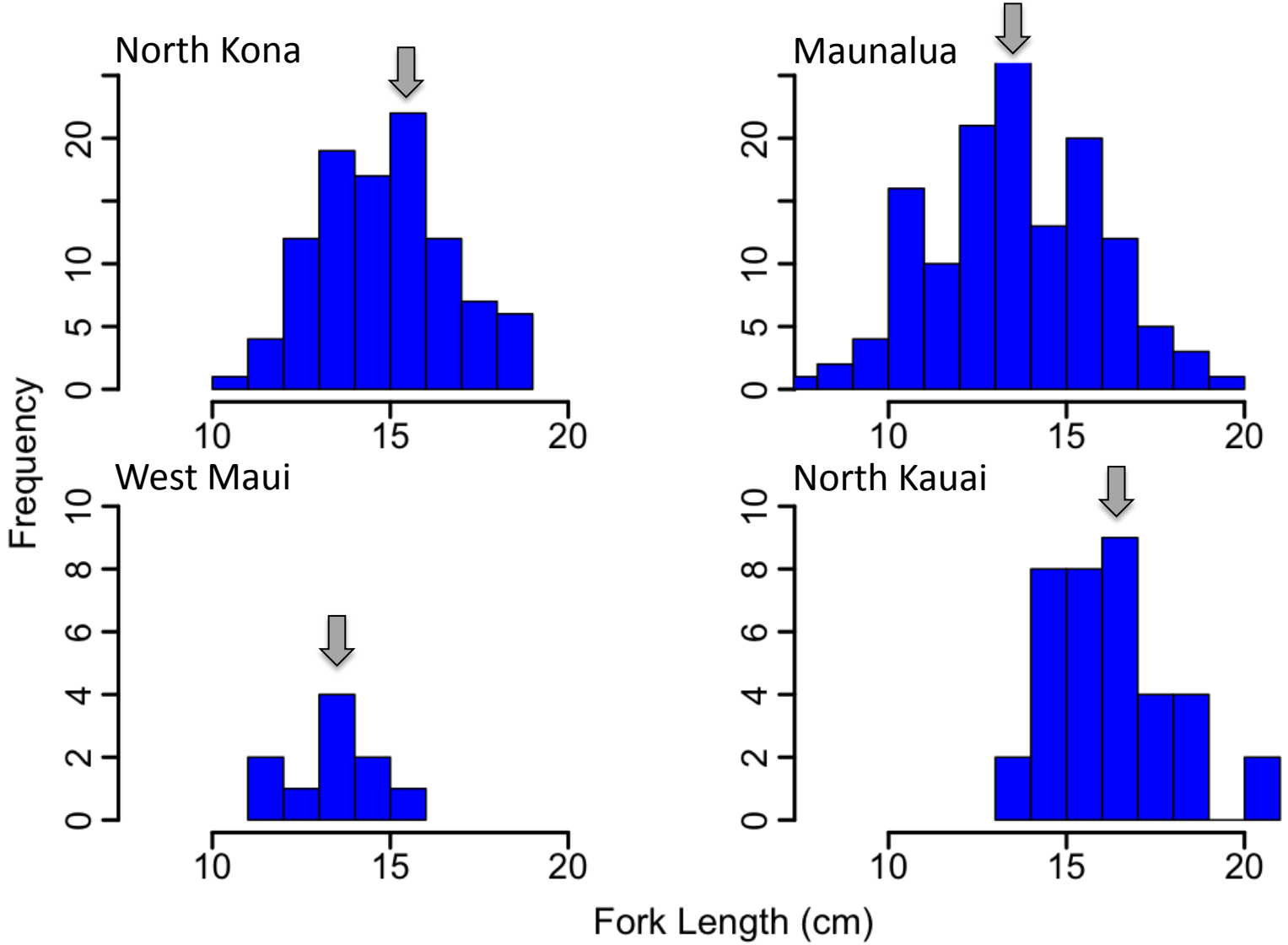
DETERMINE REPRODUCTIVE CHARACTERISTICS FOR PRIORITY SPECIES

Integrated Monitoring Fills Information Gaps

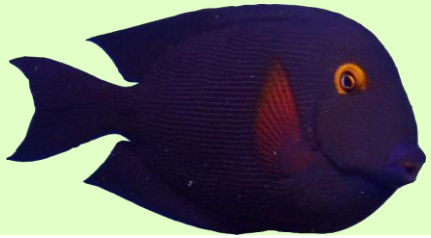
- 2500 fish from over 50 species
  - Spawning information for 10 species
  - Detailed reproductive information for 4 species
    - *Acanthurus triostegus (manini)*
    - *Ctenochaetus strigosus (kole)*
    - *Kuhlia xenura (aholehole)*
    - *Cephalopholis argus (roi)*

C. strigosus - Kole

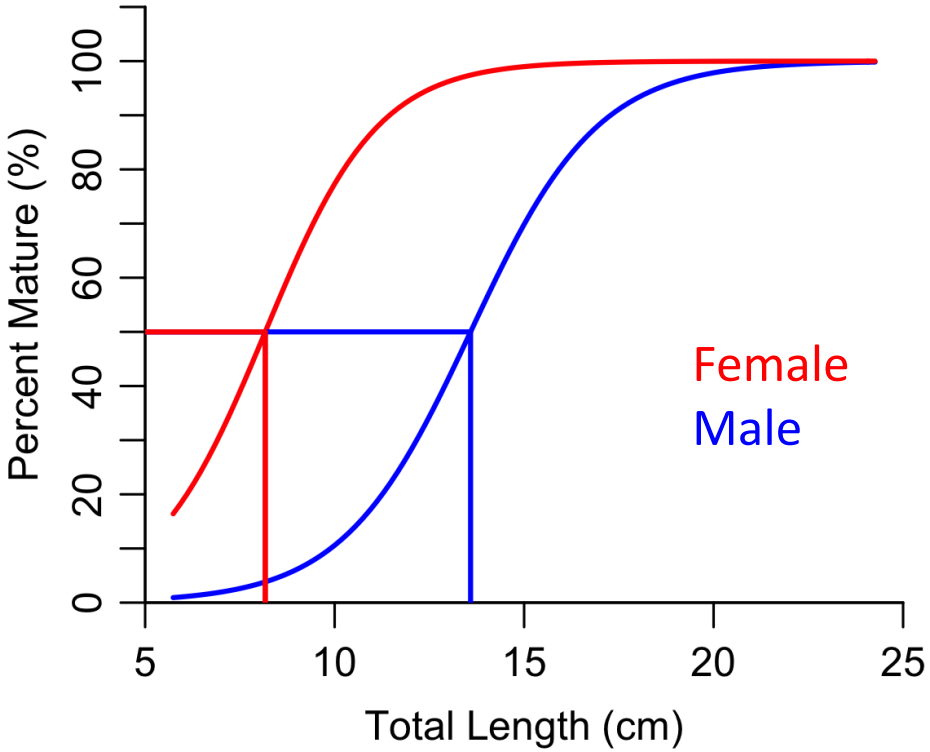




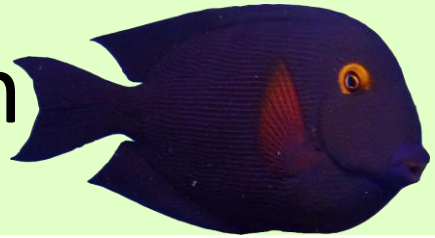
C. strigosus – Size at Maturity

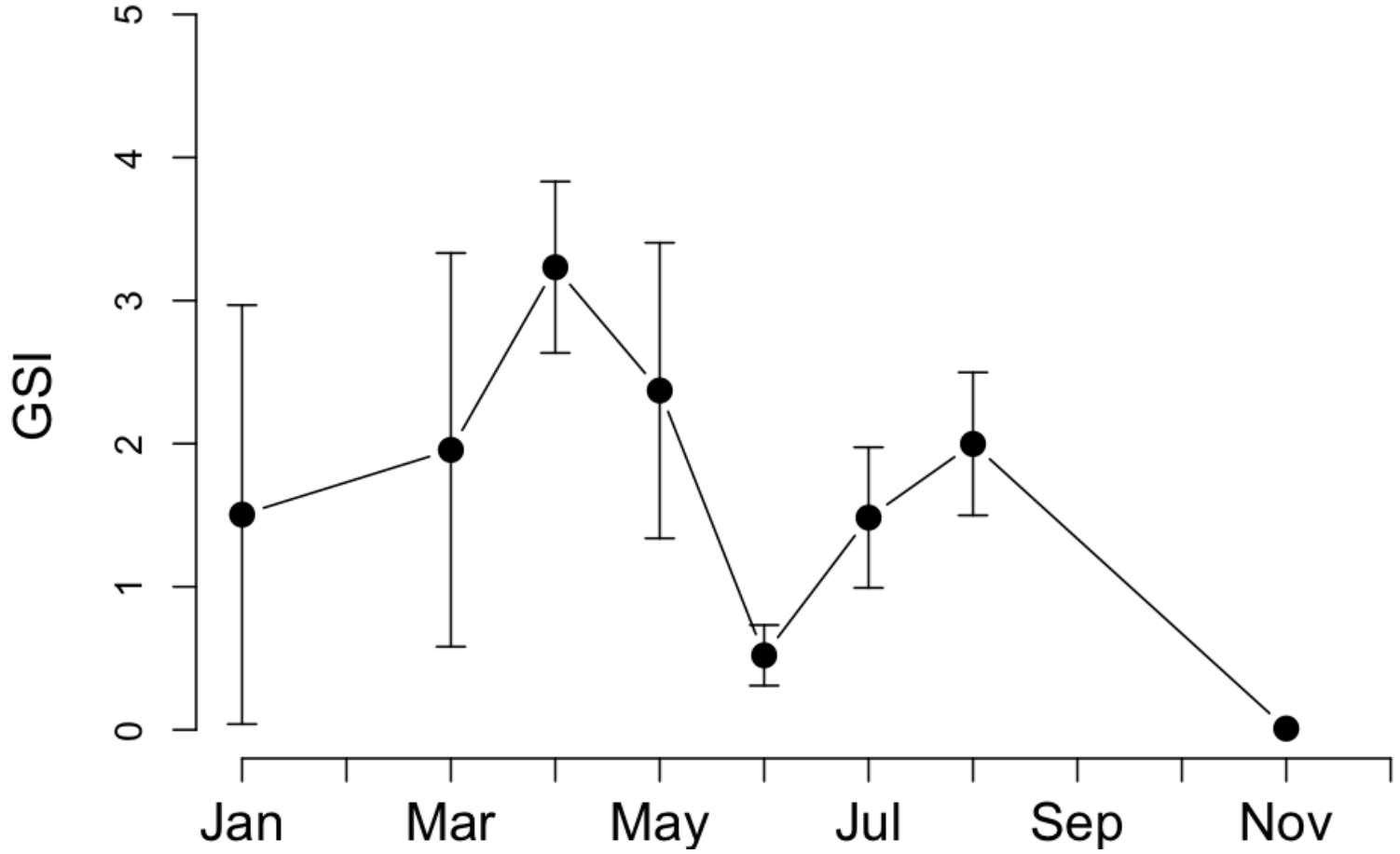


- Female L_{50} = 8.1 cm (n=88)
- Male L_{50} = 13.6 cm (n=122)
  - Maunalua Bay = 11.9 cm
  - North Kona= 14.6 cm



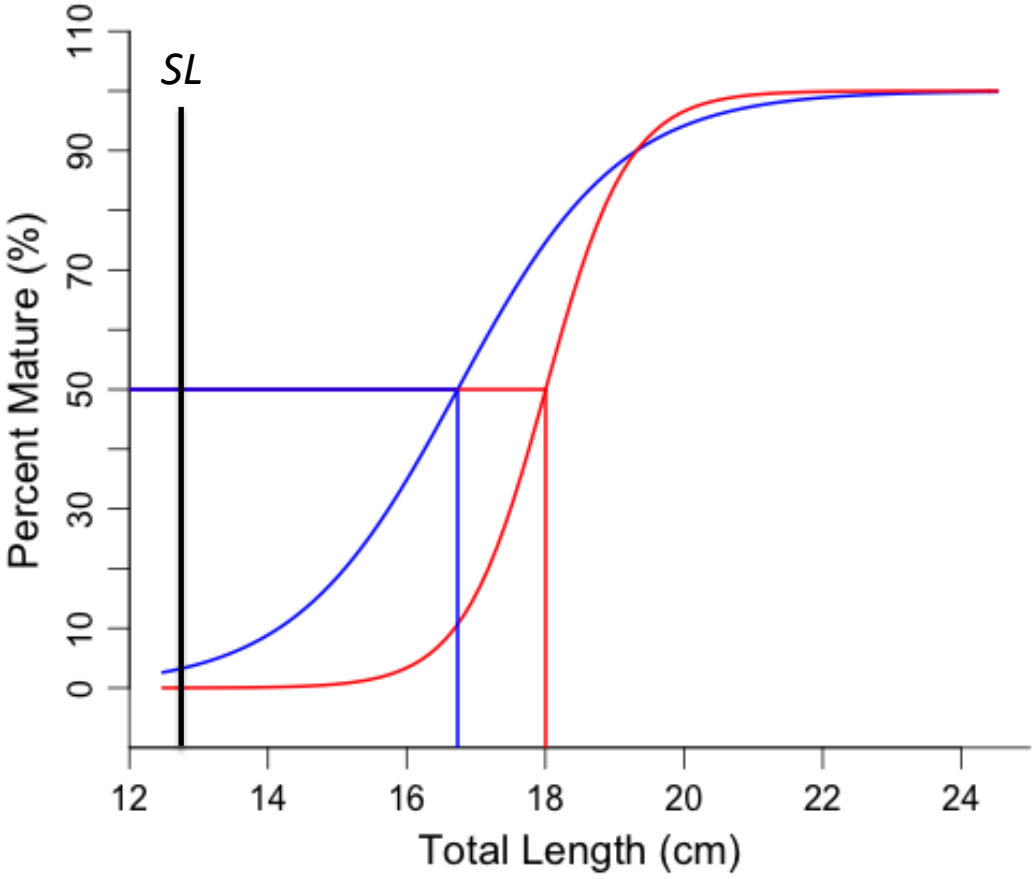
C. strigosus – Spawning Season





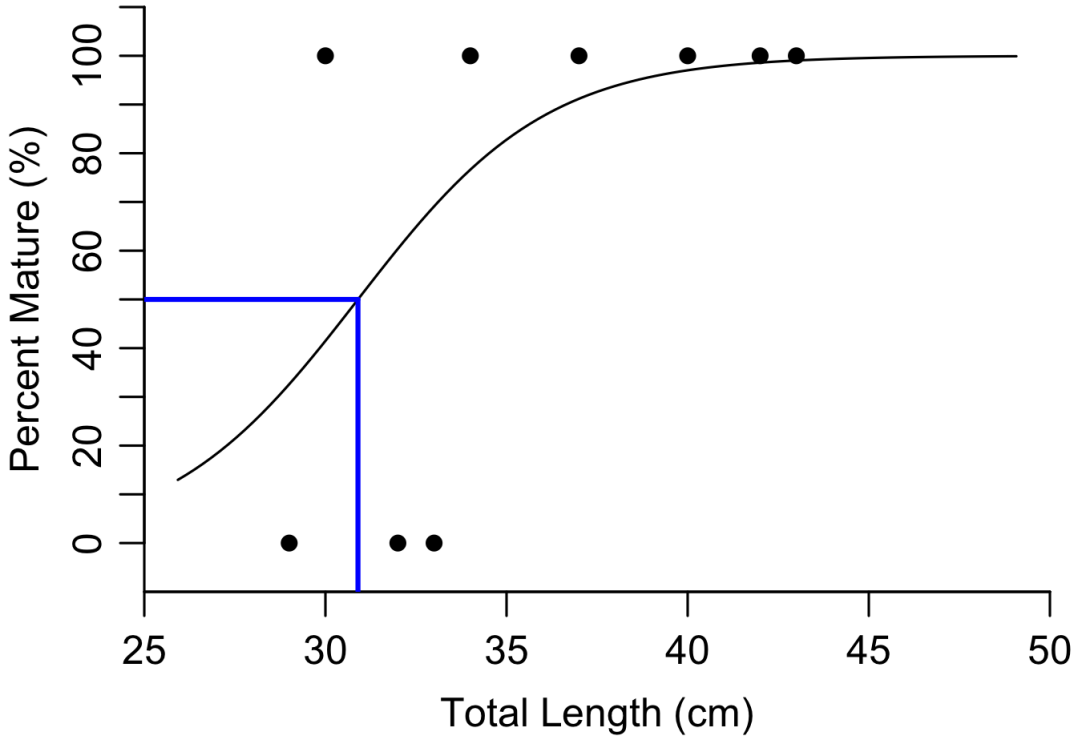
K. xenura - Aholehole

- Female L_{50} =18 cm (n=119)
- Male L_{50} =16.5 cm (n=70)
- Continuing Research
  - Comparing locations and habitat use

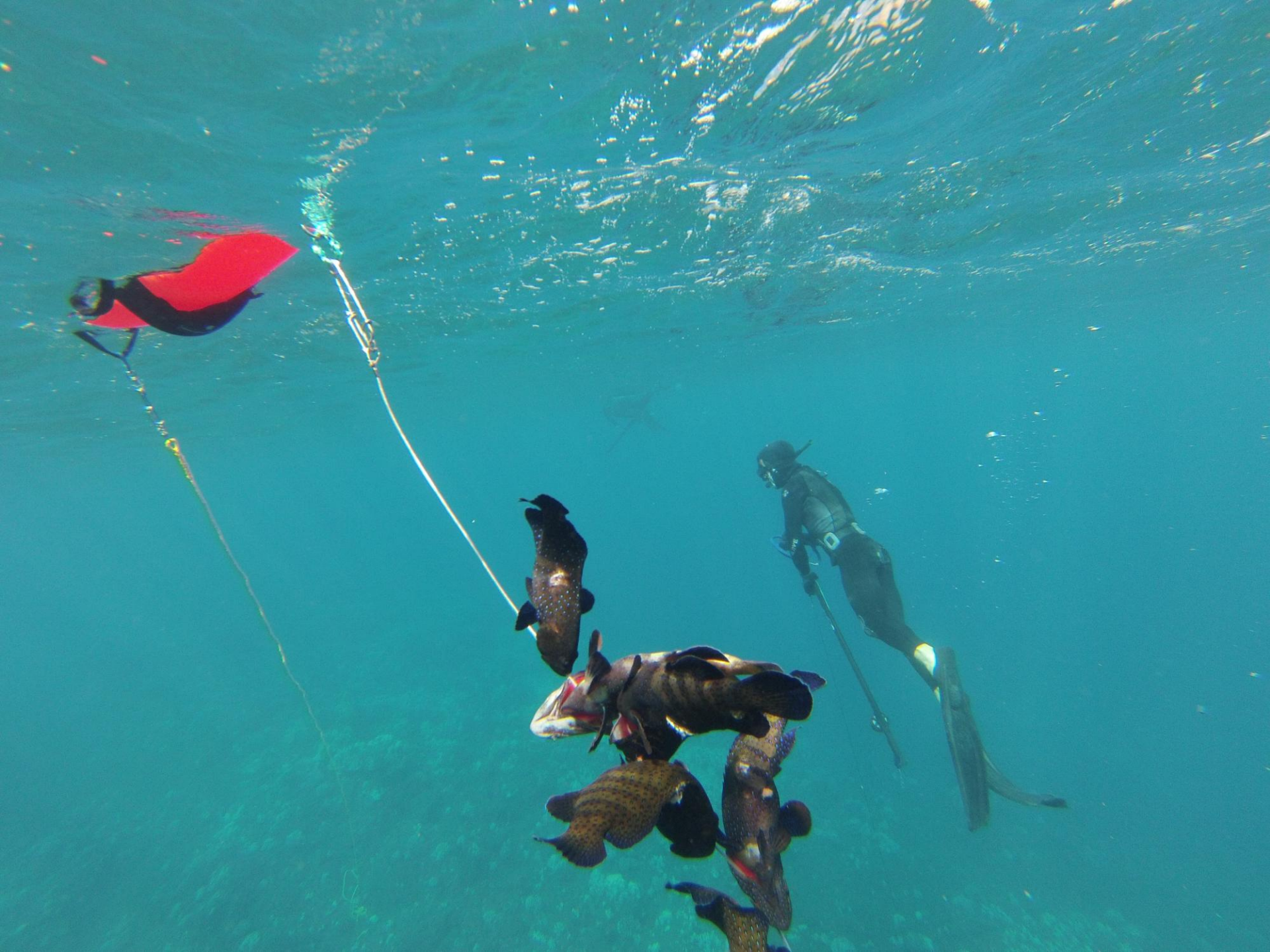


Naso unicornis - Kala

- 27 kala sampled
  - 12 female
  - 15 male
- Female L_{50}= ~31cm
- Spawning in August

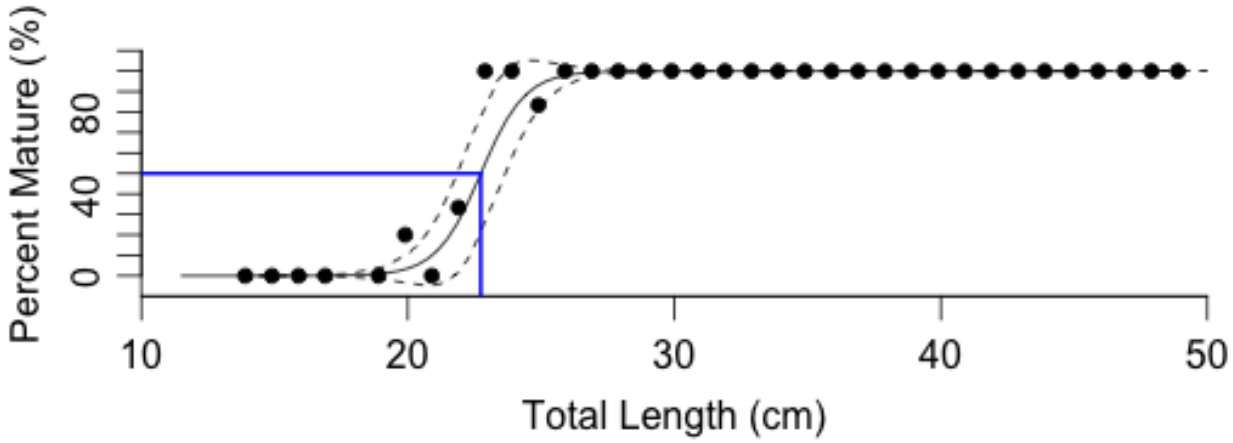


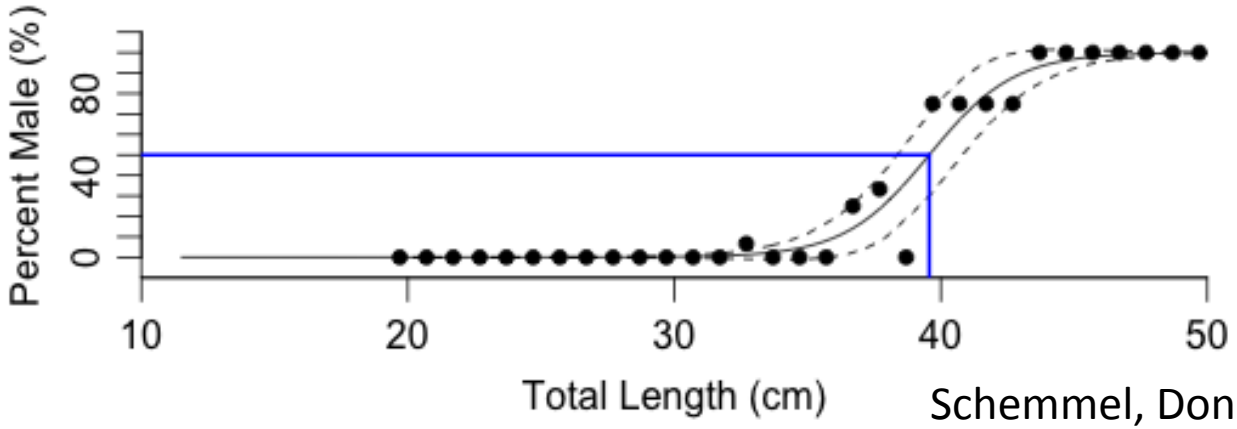
DeMartini et al 2014



C. argus - Roi

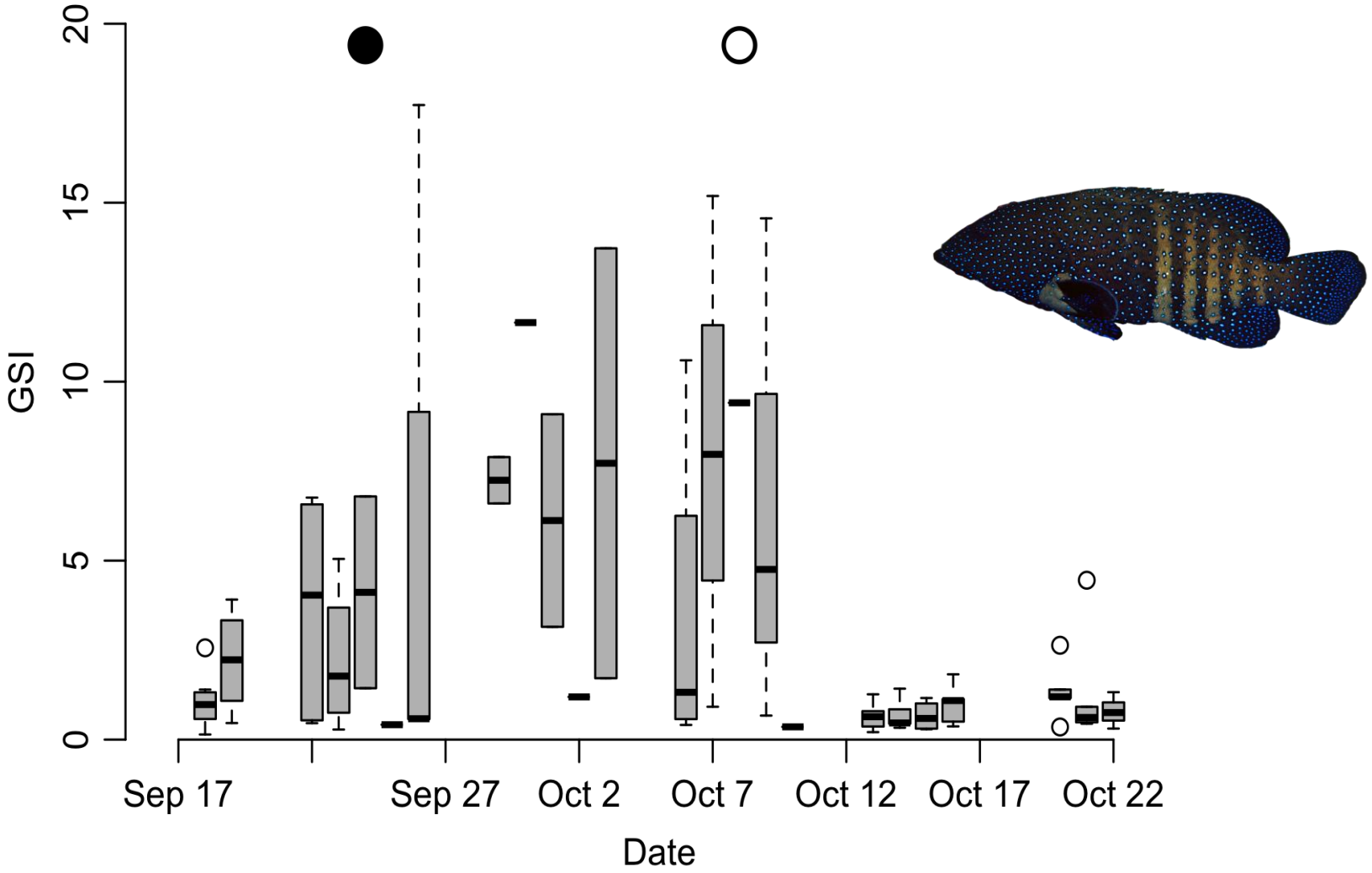
- Size & age at maturity: 22.7cm (9”) & 2.3 yrs
- Size & age at sex change: 41.5 cm (16.3”) & 13.3 yrs





Schemmel, Donovan et al. in review

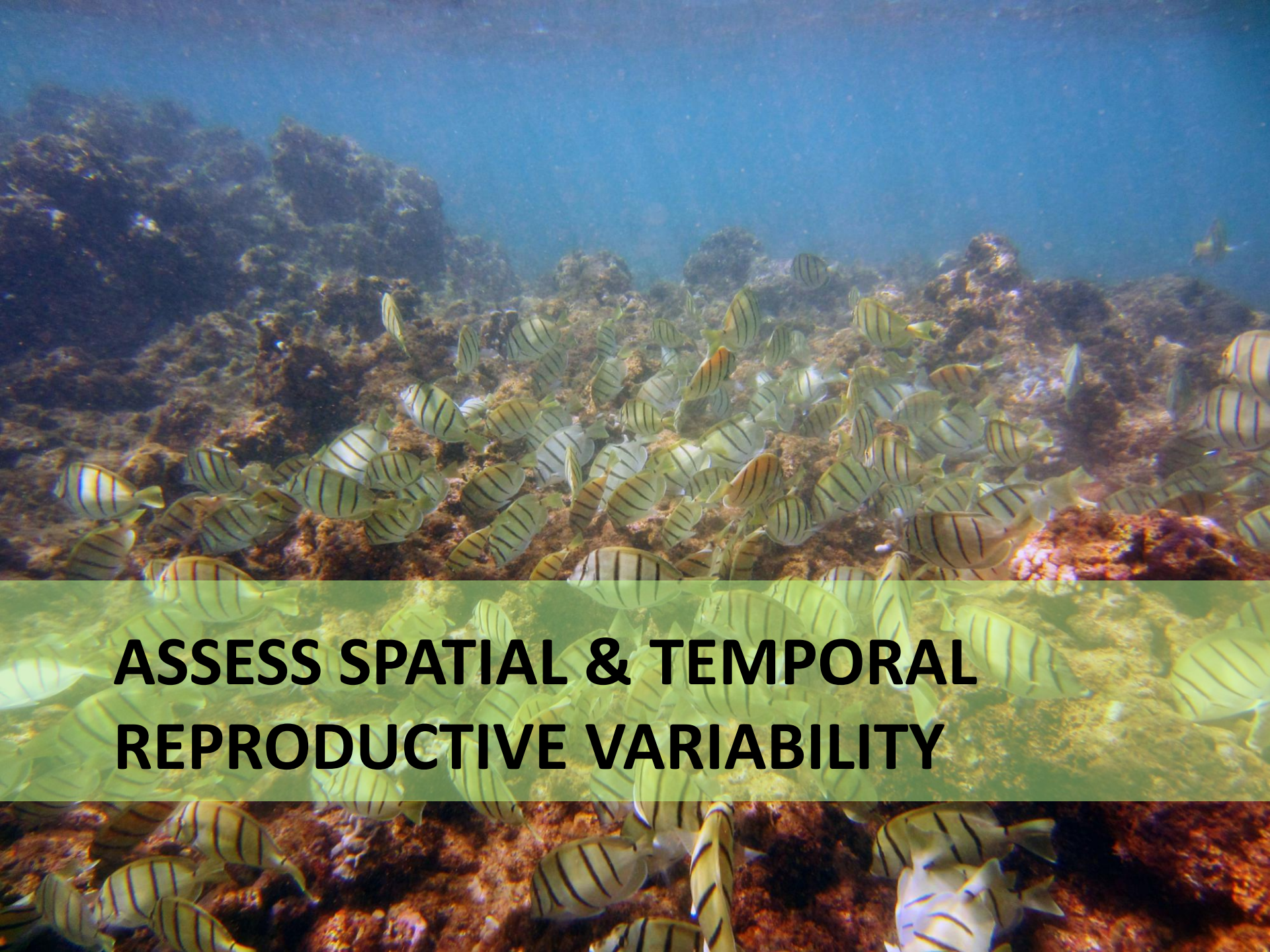
C. argus - Spawning Cycle



Schemmel, Donovan et al. in review

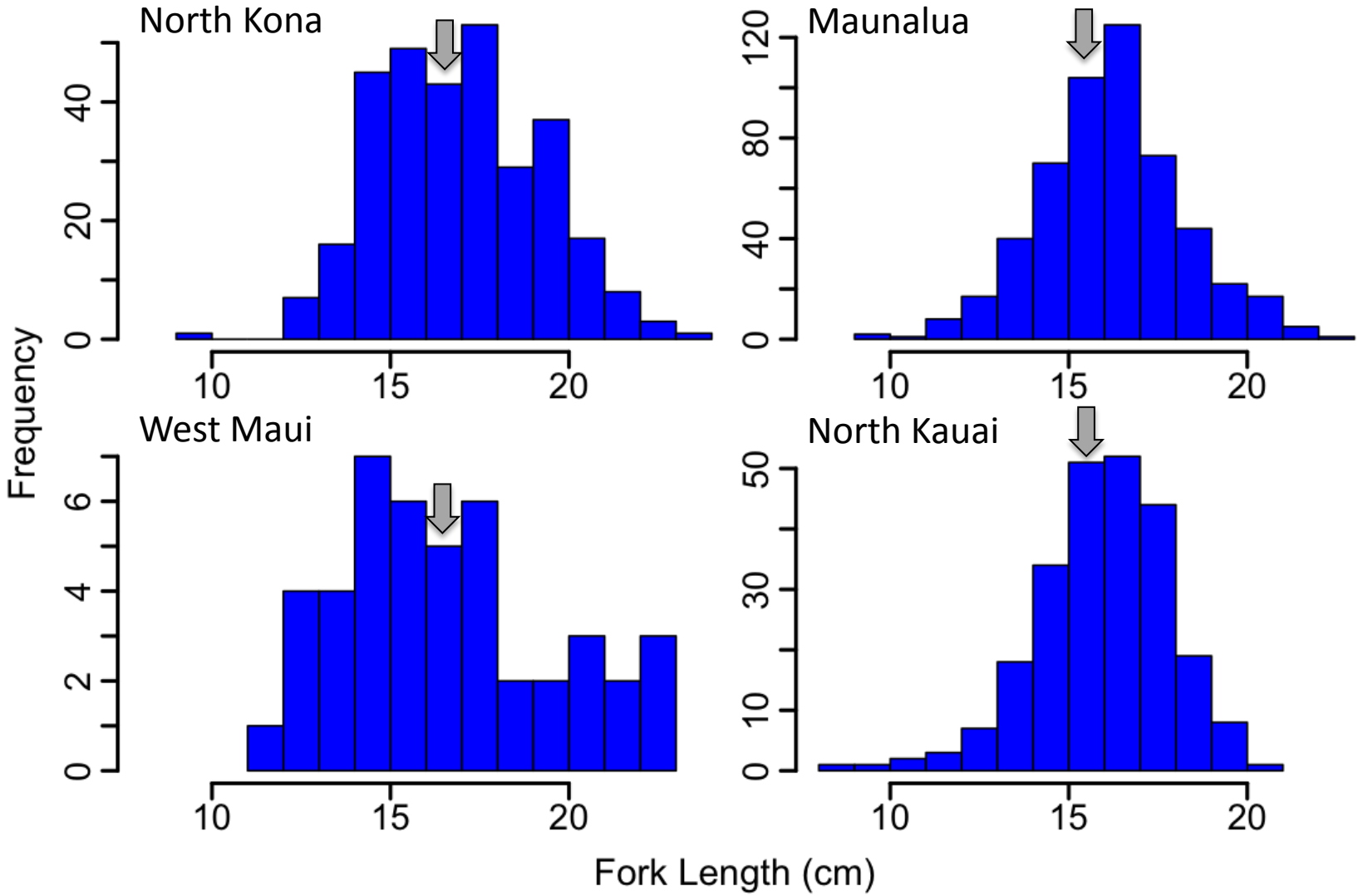
Priority Species Reproductive Assessments Conclusions

- Community monitoring provides life history information for commonly harvested species
- Generates database of spawning information for harvested fish.
- Database can be used to compare spawning information between location & years



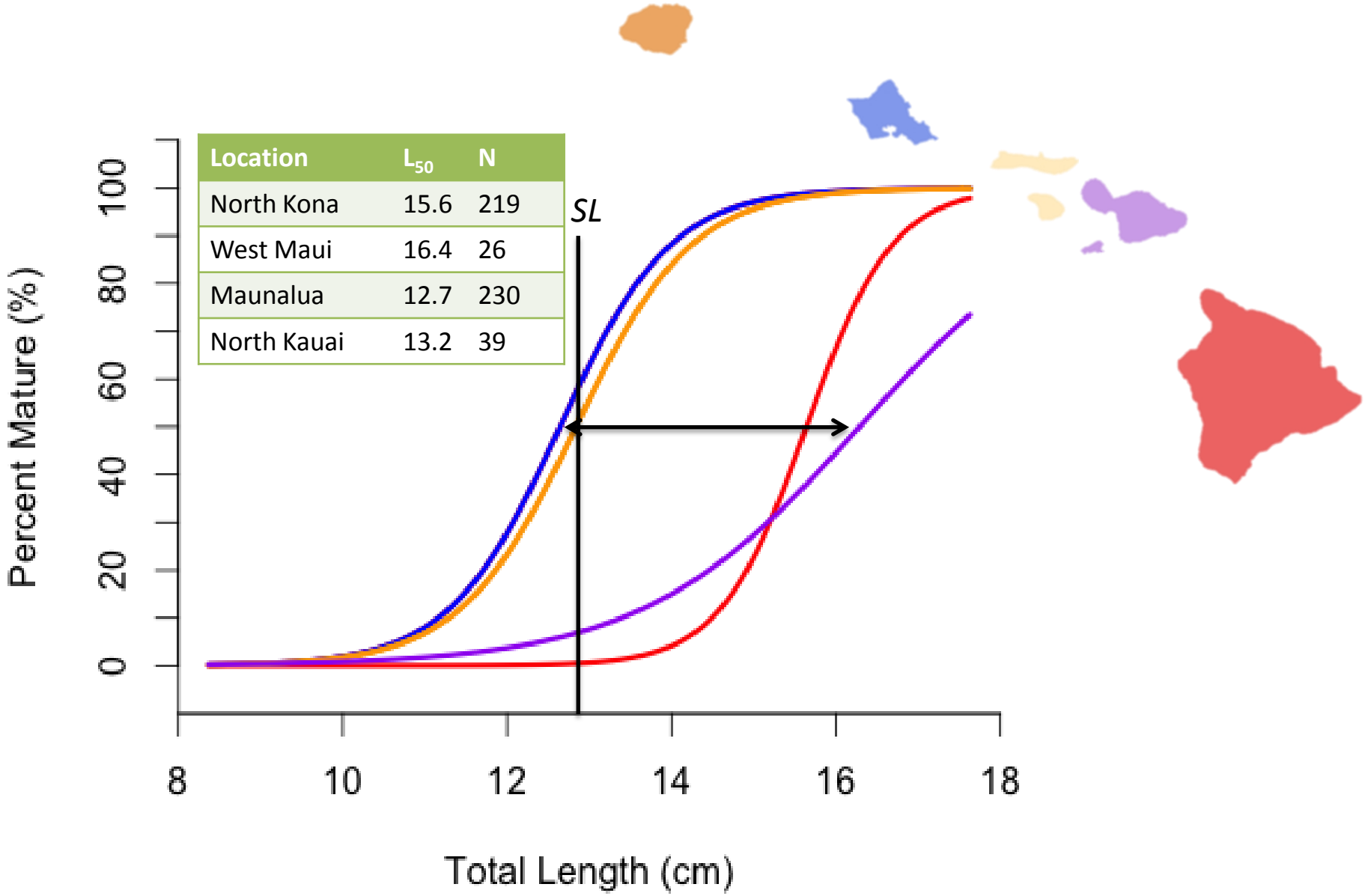
ASSESS SPATIAL & TEMPORAL REPRODUCTIVE VARIABILITY

A. triostegus - Manini

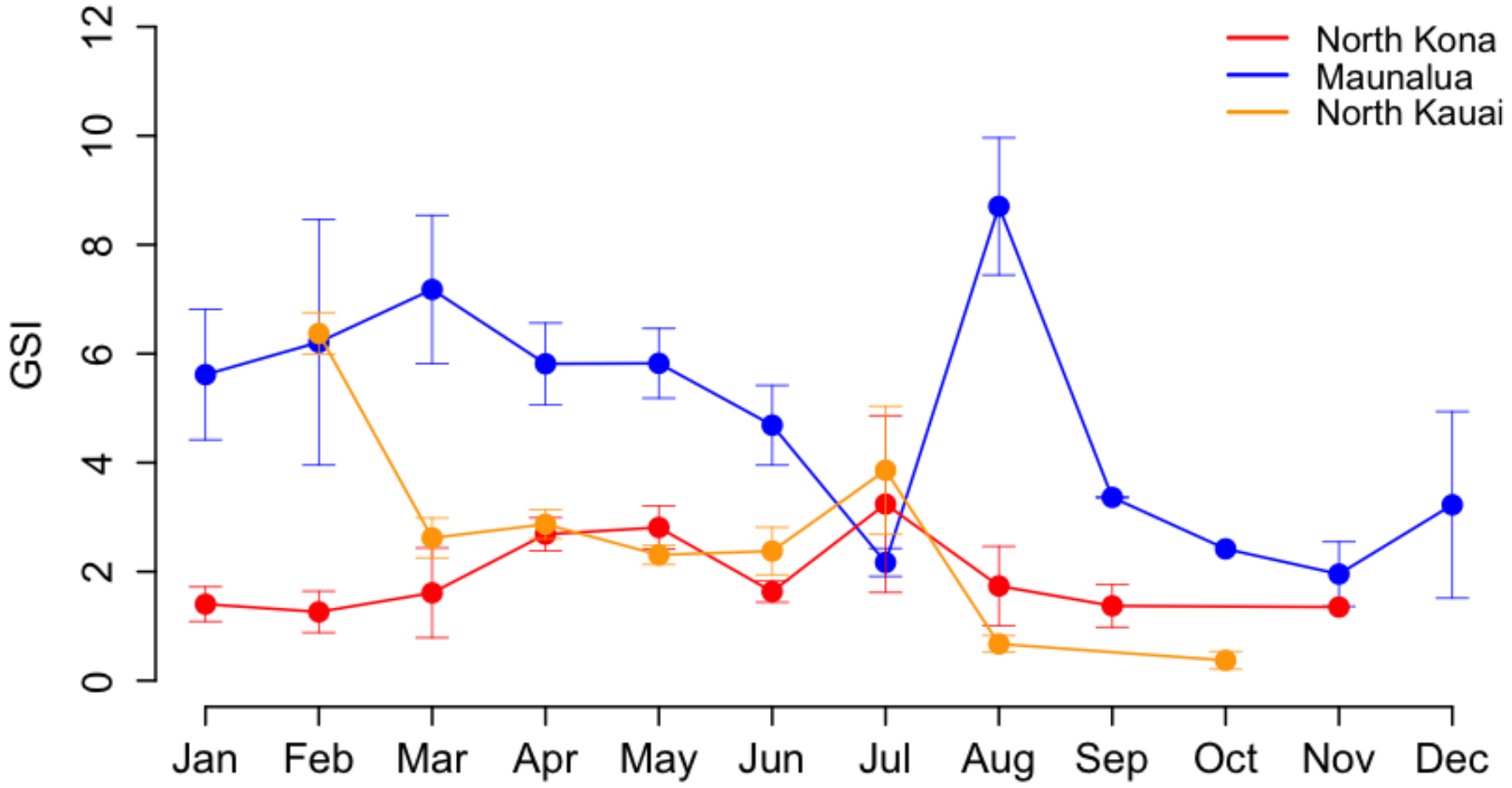


Differences in Manini Size at Maturity (L_{50})

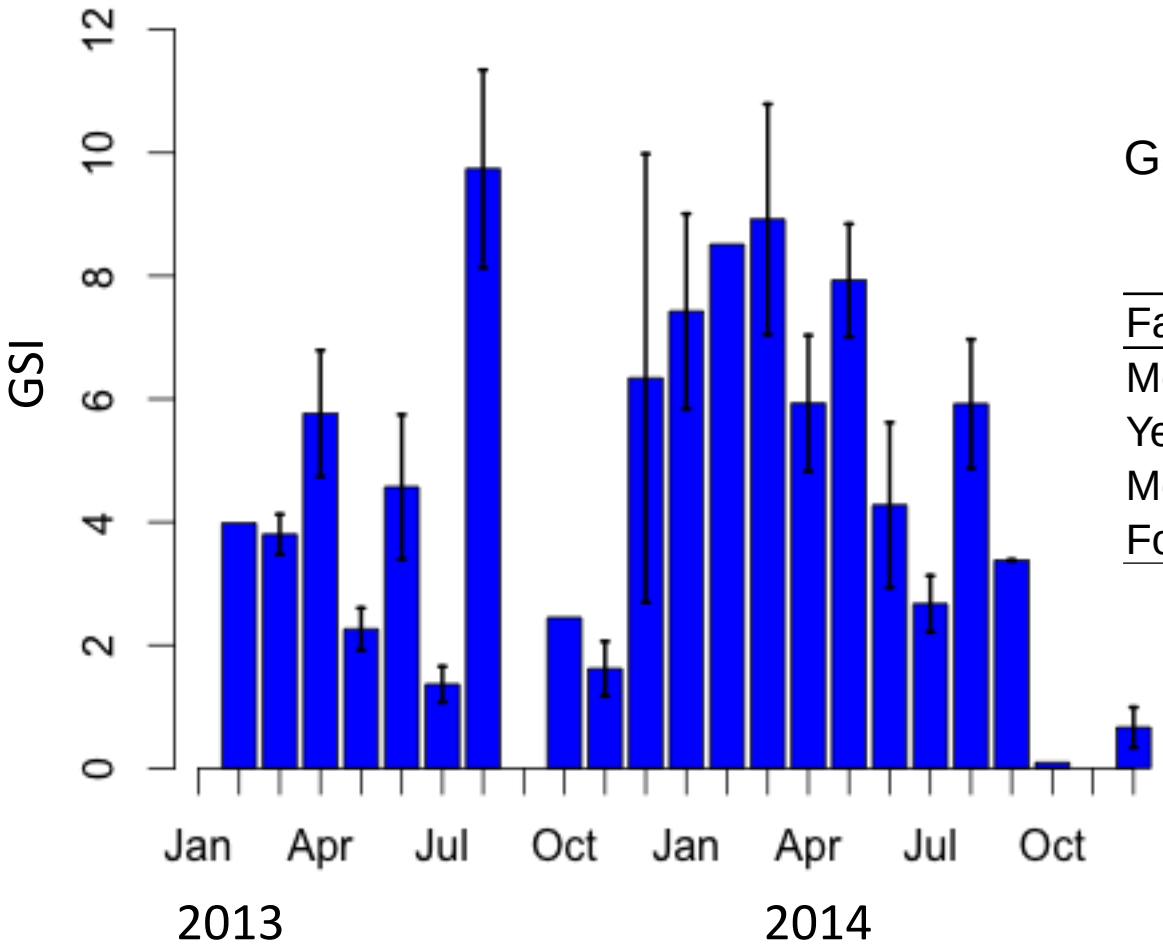
Location	L_{50}	N
North Kona	15.6	219
West Maui	16.4	26
Maunalua	12.7	230
North Kauai	13.2	39



Spatial Differences in Manini Spawning Seasons



Temporal Variability in Manini Spawning Seasons in Maunalua



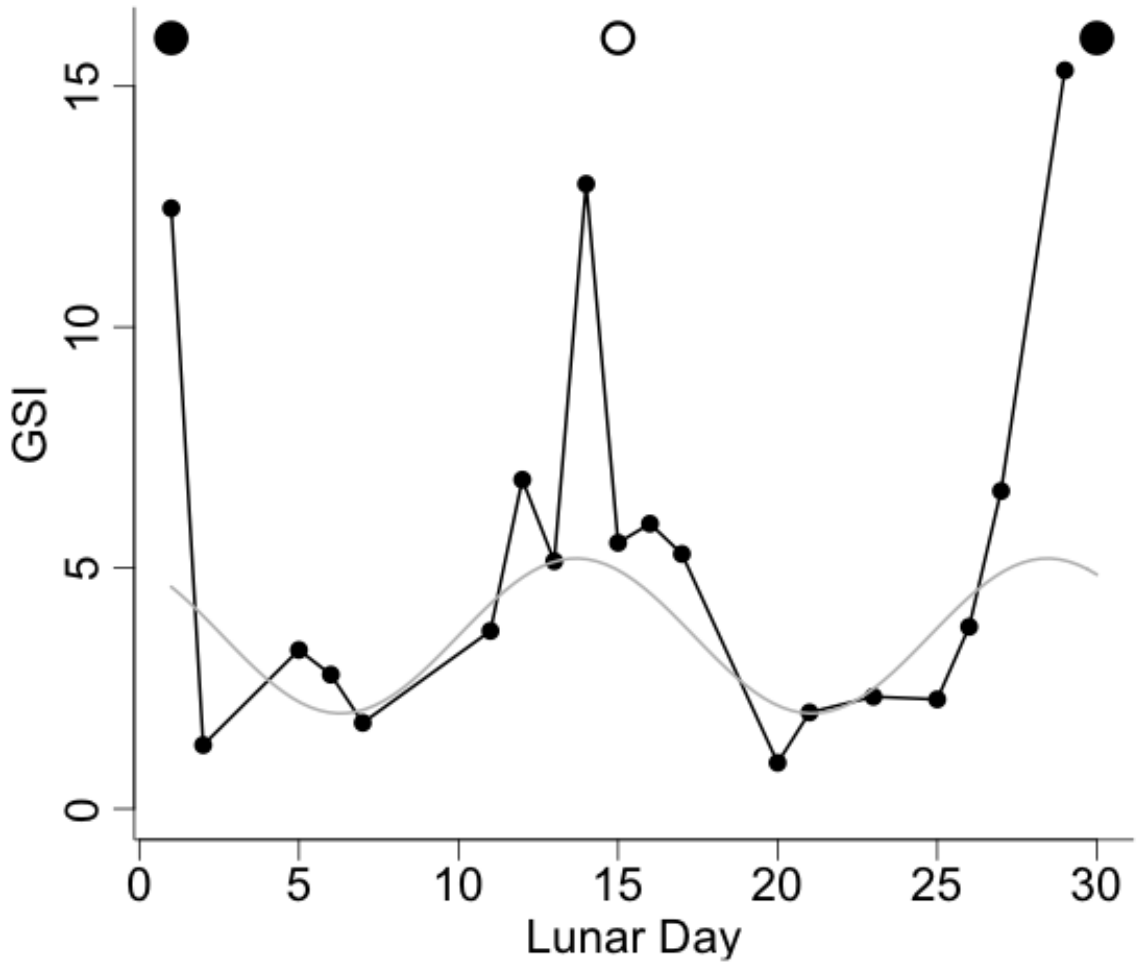
Maunalua Bay
Generalized Linear Model
GSI~Year*Month+Fork Length+ε

Factors	Chisq	DF	P-Value
Month	37.00	11	<0.01
Year	6.73	1	0.01
Month*Year	40.09	1	<0.01
Fork Length	39.02	9	<0.01

Comparing Between Locations– Organized Sample Collection

- Samples collected April-May (~3 days)

Manini Spawning Periodicity – Locations Combined

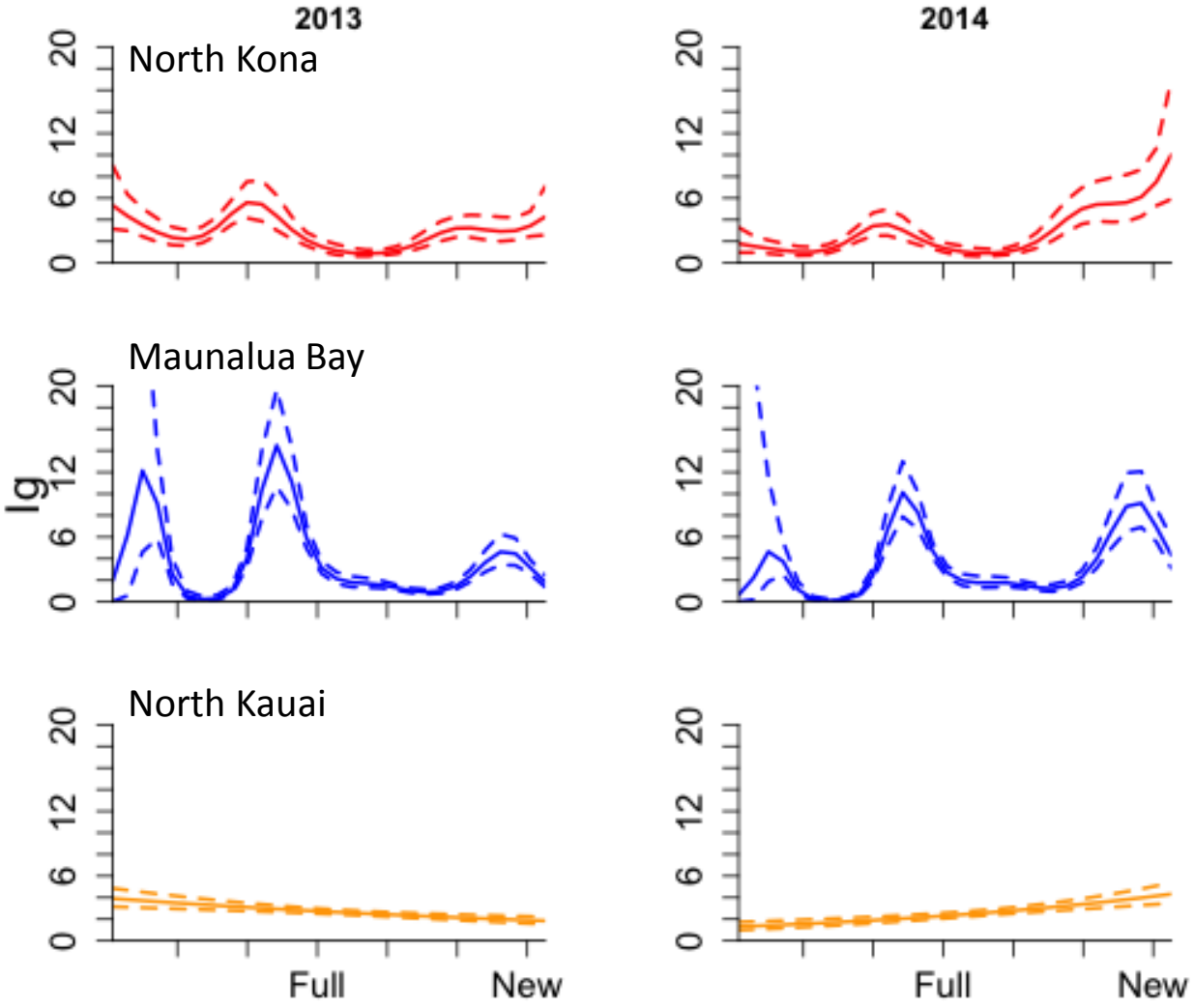


Comparing Spawning Patterns

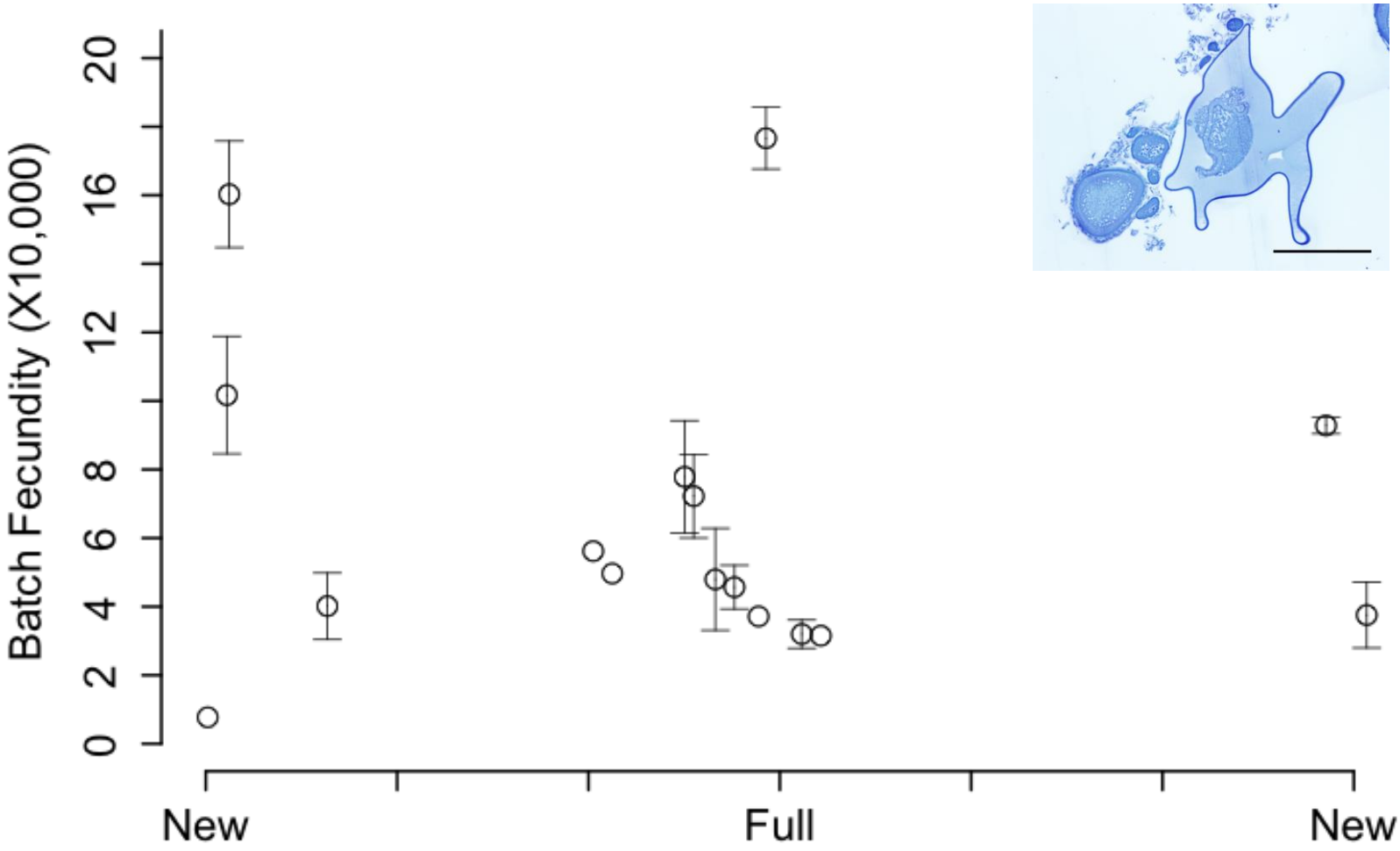
- Generalized Additive Mixed Models

$GSI=R*FL+s(LD_R)+s(LD_Y)+\beta_{gear}+\varepsilon$

- Variability between locations & years

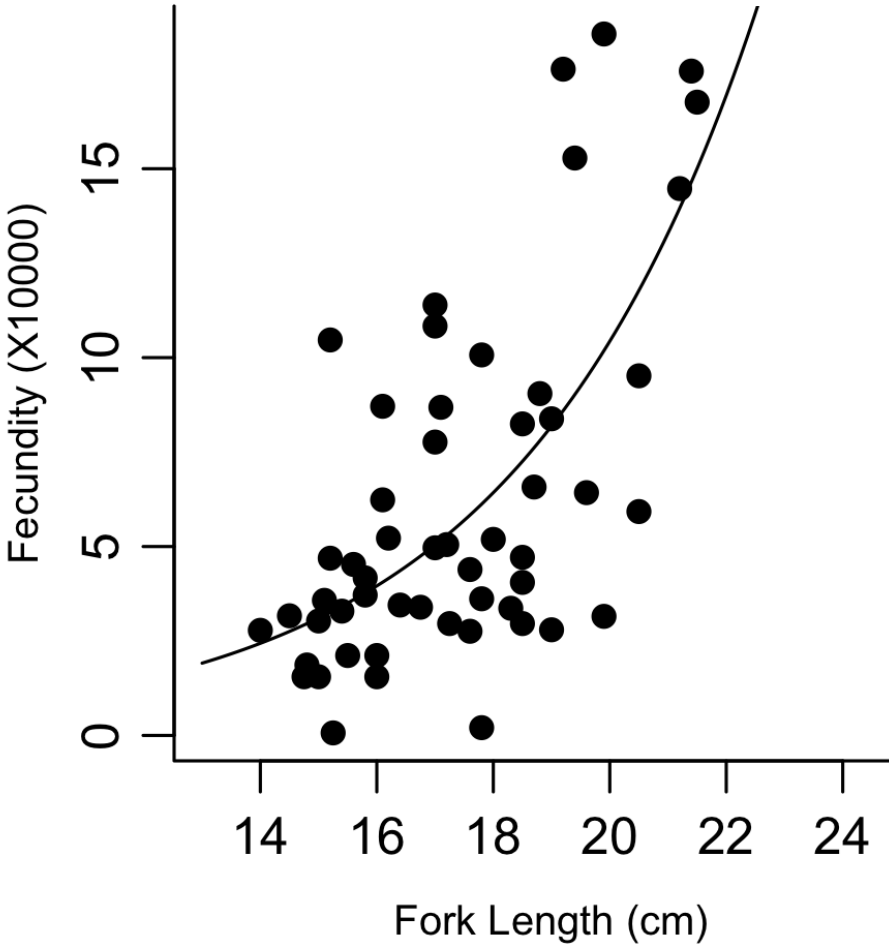


Fecundity & Lunar Phase: Maunalua

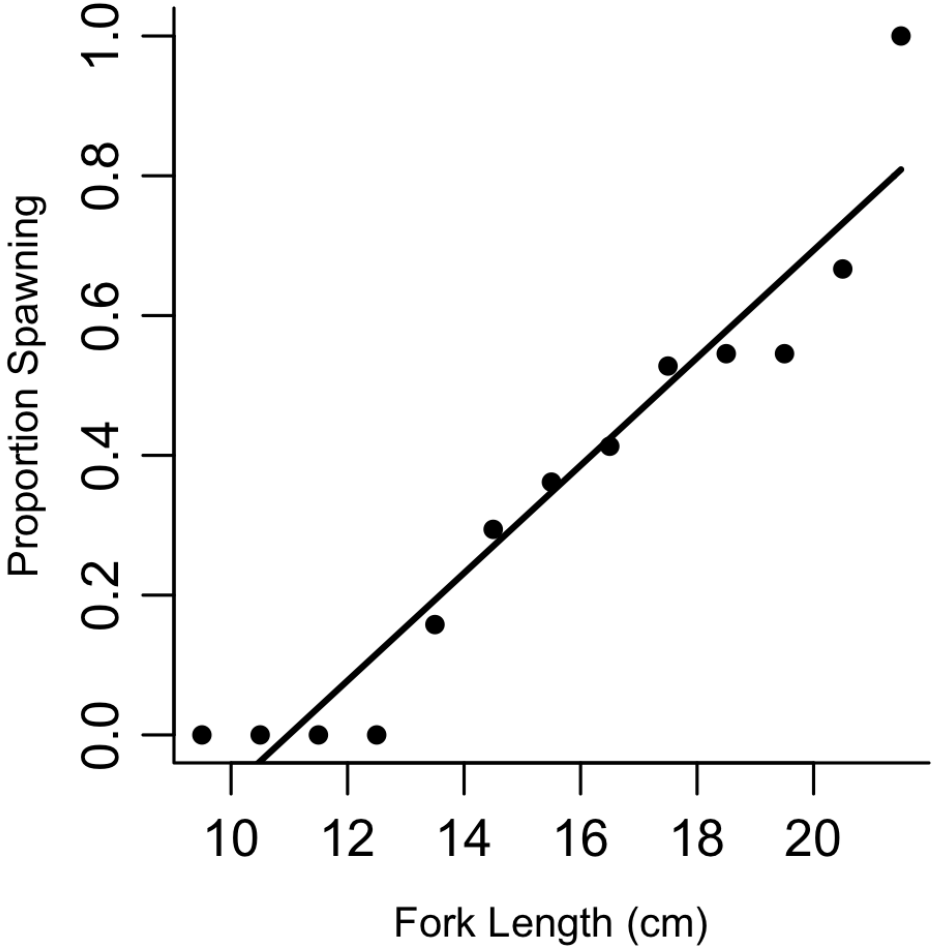


Size & Reproductive Output

$Y=0.08+e^{(0.24*FL)}$ $p<0.01$



$y=-0.85+0.08*FL$ $p<0.01$ $R^2=0.93$



Small Fish, Big Results

- Size at maturity varies by location
- Spawning seasons & reproductive output vary by year
- Semilunar spawning
  - Pattern variable by location and year
- Fish size important management consideration

DEVELOP OUTREACH & EDUCATION TOOLS

Gather & Share Information: Social Media

- Spawning season information

  >100 posts to Facebook/Spawning Seasons

  500 followers

  Reach >1,400

- Share pono practices

Education & Outreach

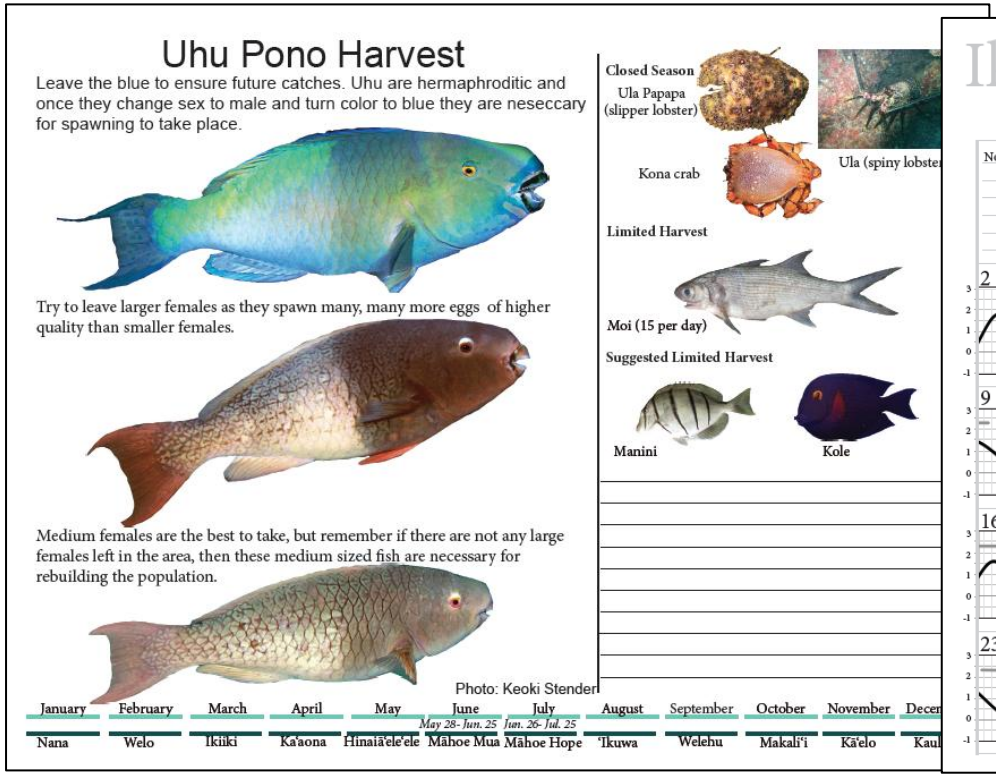
- 40 outreach & educational events
  - Fishing tournaments, schools, community events, workshops, summer camps, conferences

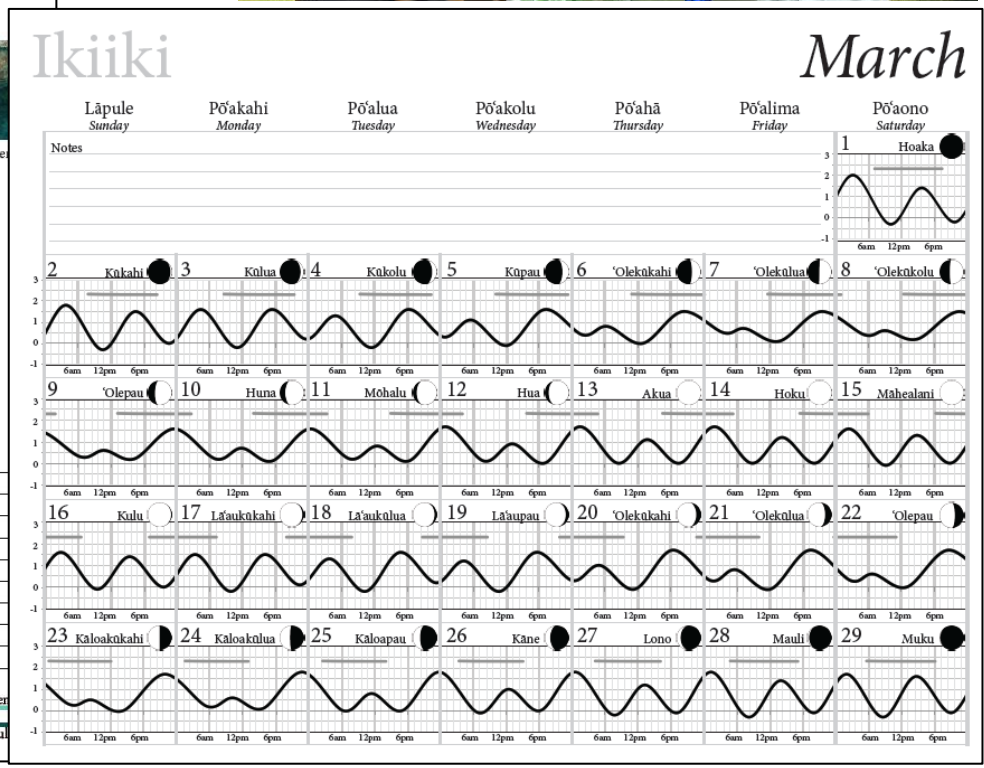
Sustainable Fishing Practices

- Linking fishing practices with biological information to inform local management
- Share sustainable practices for each community through Moon Calendars

Moon Calendars

- Moon calendars developed for Malama Maunalua, Polanui (West Maui), Hui Aloha Kīholo



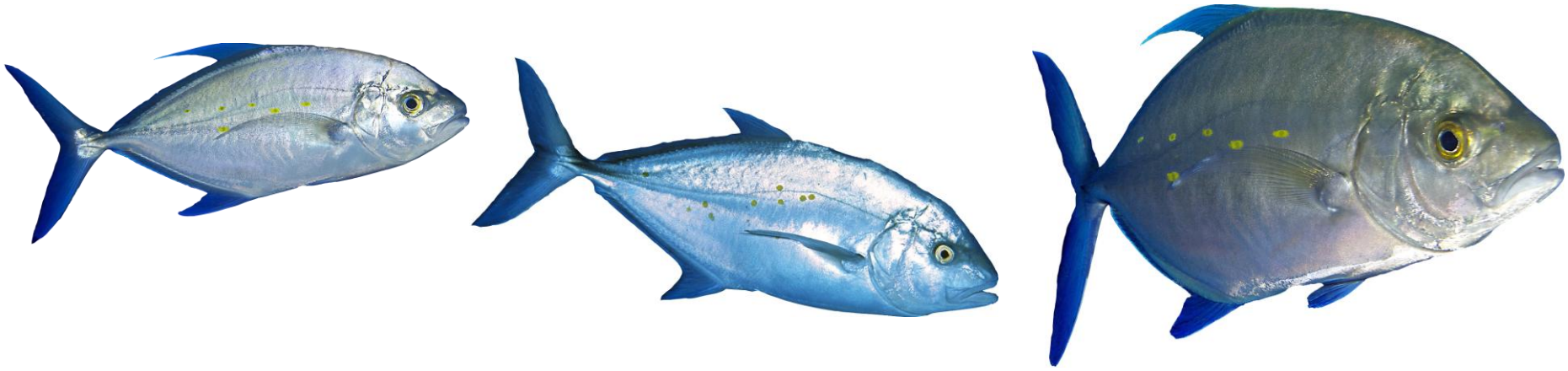


Conclusions

- Project gathers life history information necessary for management
- Links local practices with biological information
- Facilitates behavioral changes towards marine stewardship & sustainable harvest
- Builds trust between resource users, scientists, & regulating agencies

Recommendations & Future Directions

- Engage fishing community
- Increased awareness of reproductive biology for setting regulations
- Sharing with communities the knowledge & tools to monitor spawning seasons & size at maturity
- Continue monitoring spawning seasons



Mahalo

Fishermen

Fishery Monitors:

- Bart Wilcox
- Yumi Yasutake
- Linda Castro
- Kekaulike Tomich

Communities

- Hui Aloha Kiholo
- Malama Maunalua
- Polanui
- Maui Nui

Funding

- DAR- Coral Reef Working Group
- Conservation International Hawai'i
- West Marine

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- The Nature Conservancy

Fisheries Ecology Research Lab & Volunteers

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Above & Beyond Volunteers

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Fisheries Ecology Research Lab

Hui Aloha Kiholo

mālama maunalua

Maui Nui Marine Resource Council

DAR

University of Hawai'i

Conservation International

The Nature Conservancy

Protecting nature. Preserving life.