Fish Spawning Aggregation Surveys
Puerto Rico

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Background

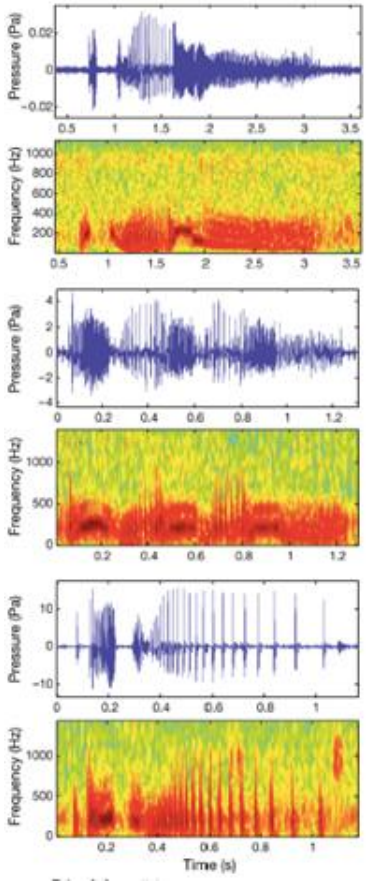
- 2004 surveys to locate reef fish FSAs
- 2007 passive acoustic monitoring (PAM)
  - D. Mann, CCRI
- 2010 surveys standardized
  - CCRI, NOAA
- 2012 PAM at FSA sites in the US Caribbean
  - CCRI, SEAMAP-C, CFMC

I. Red hind FSA surveys Objectives

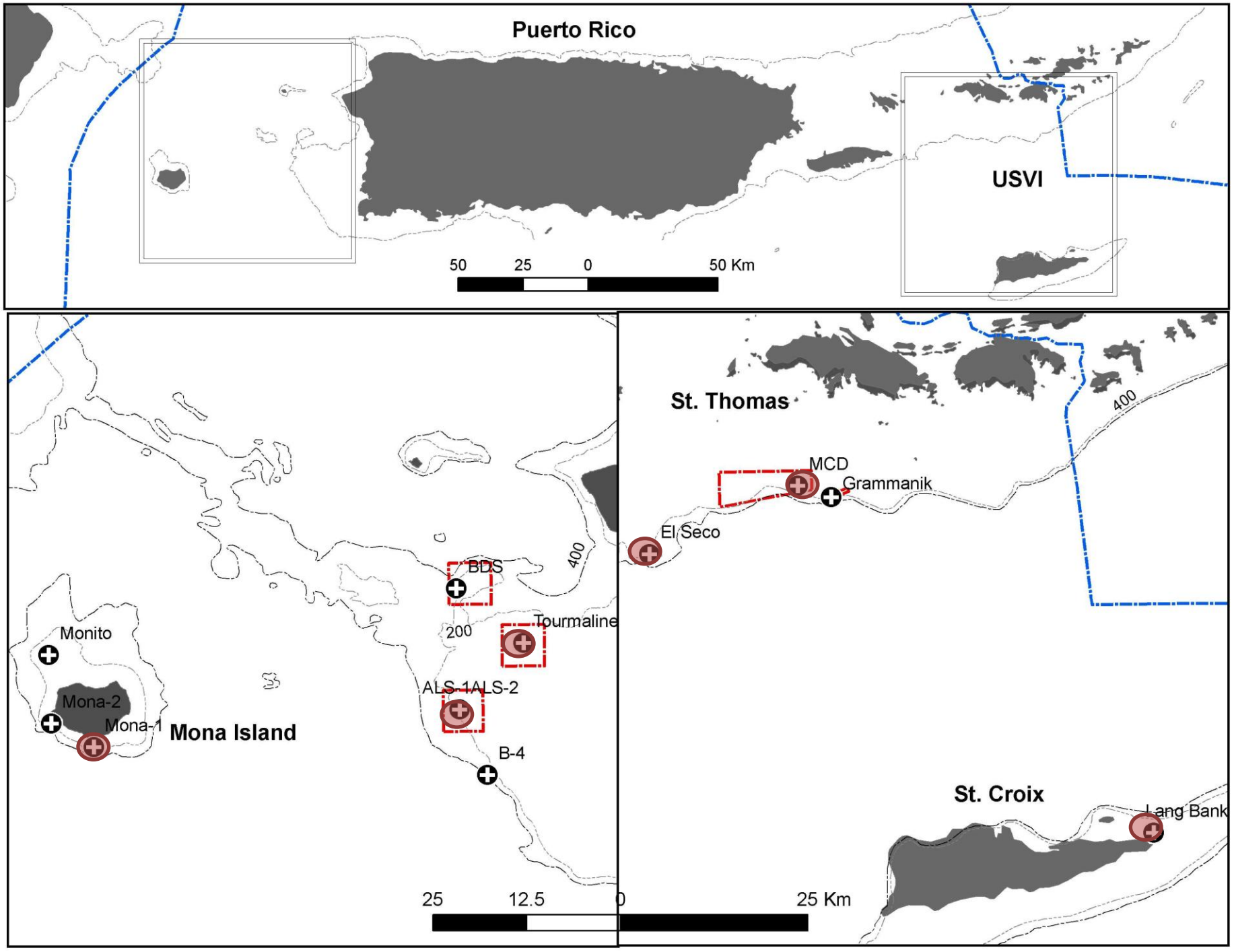
- Test feasibility of PAM in assessments
- Survey red hind (*Epinephelus guttatus*) FSA
  - Abundance
  - Size structure
  - Spawning stock
- Spatial distribution

Experimental Design

- Fixed site PAM at red hind FSA
  - DSGs at known sites in Puerto Rico & USVI
  - Location of DSG needs prior surveys
- Underwater visual surveys conducted within range of DSG
- During reproductive season (3-4 months) when there is a closed season (No TIP data)
- Repeated yearly

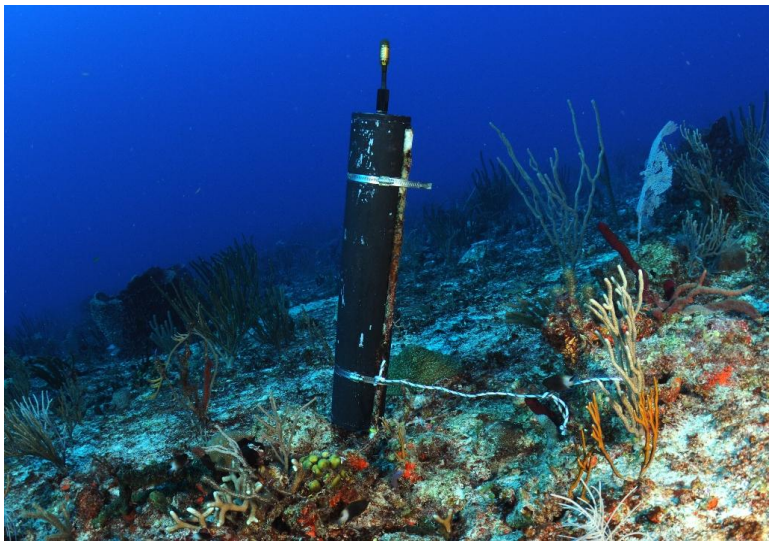


E. guttatus acoustic signal

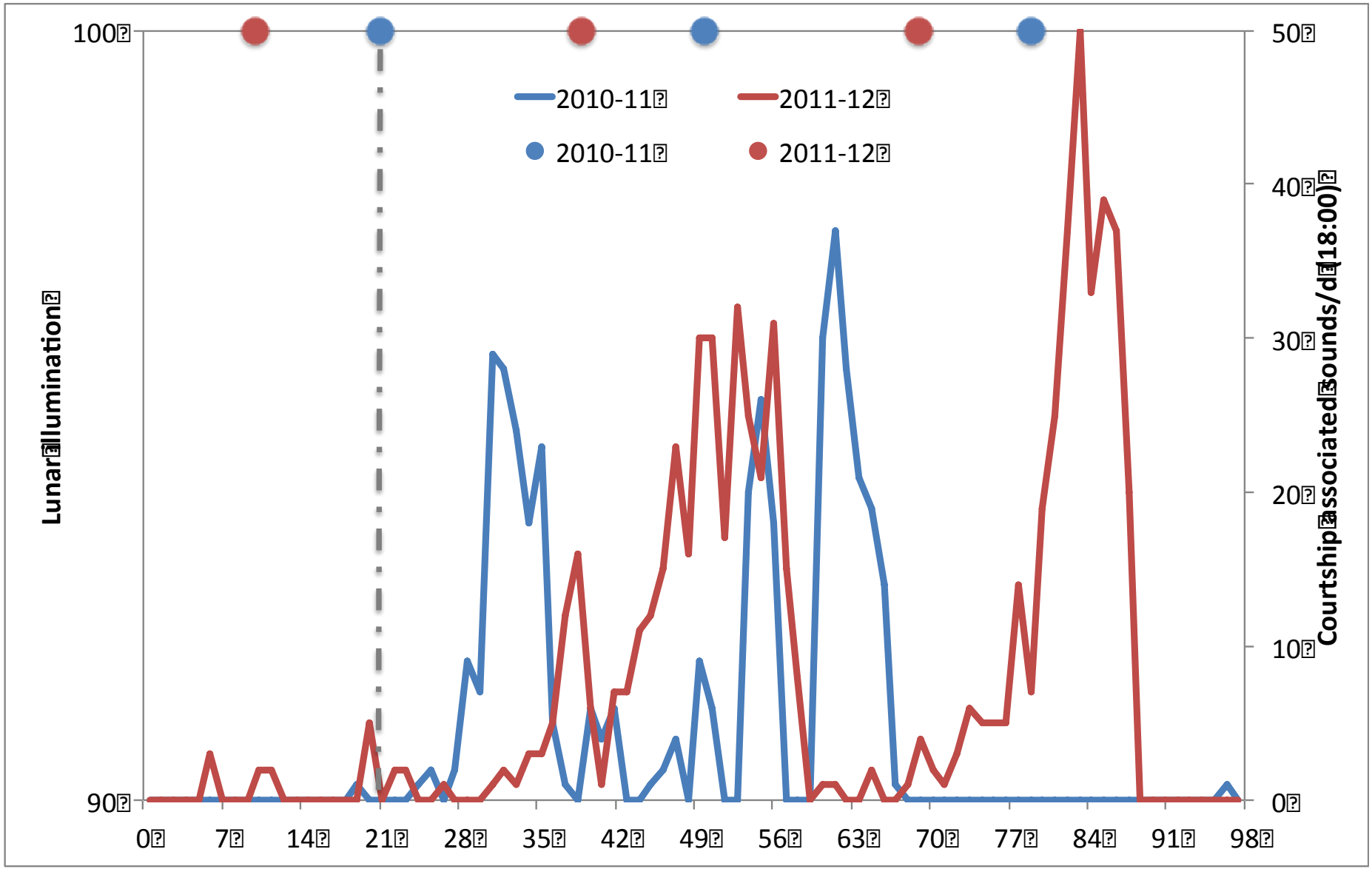

Puerto Rico
USVI
50 25 0 50 Km
St. Thomas
400
MCD
Grammanik
El Seco
BDS
200
Tourmaline
ALS-1ALS-2
B-4
Monito
Mona-2
Mona-1
Mona Island
St. Croix
Lang Bank
25 12.5 0 25 Km

Passive Acoustic Monitoring

- DSG- Digital spectrogram long-term acoustic recorders for low frequency ambient sound
- Sampling schedule of 20 seconds every 5 minutes on32-GB SDHC flash memory cards
- Files digitized at a sample rate of 10 KHz
- Deployments usually 6 months & HOBO temp loggers



PAM time series at Abrir la Sierra, PR (2010-12)



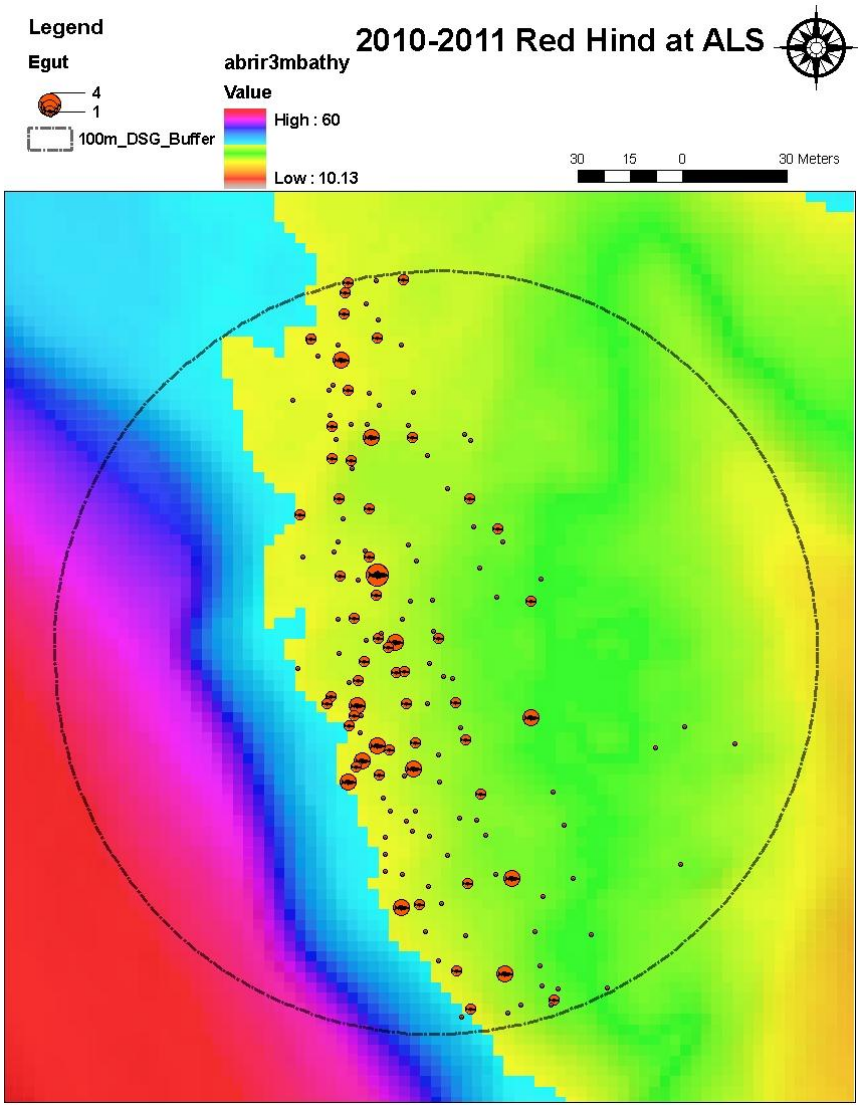
Drift GPS Surveys

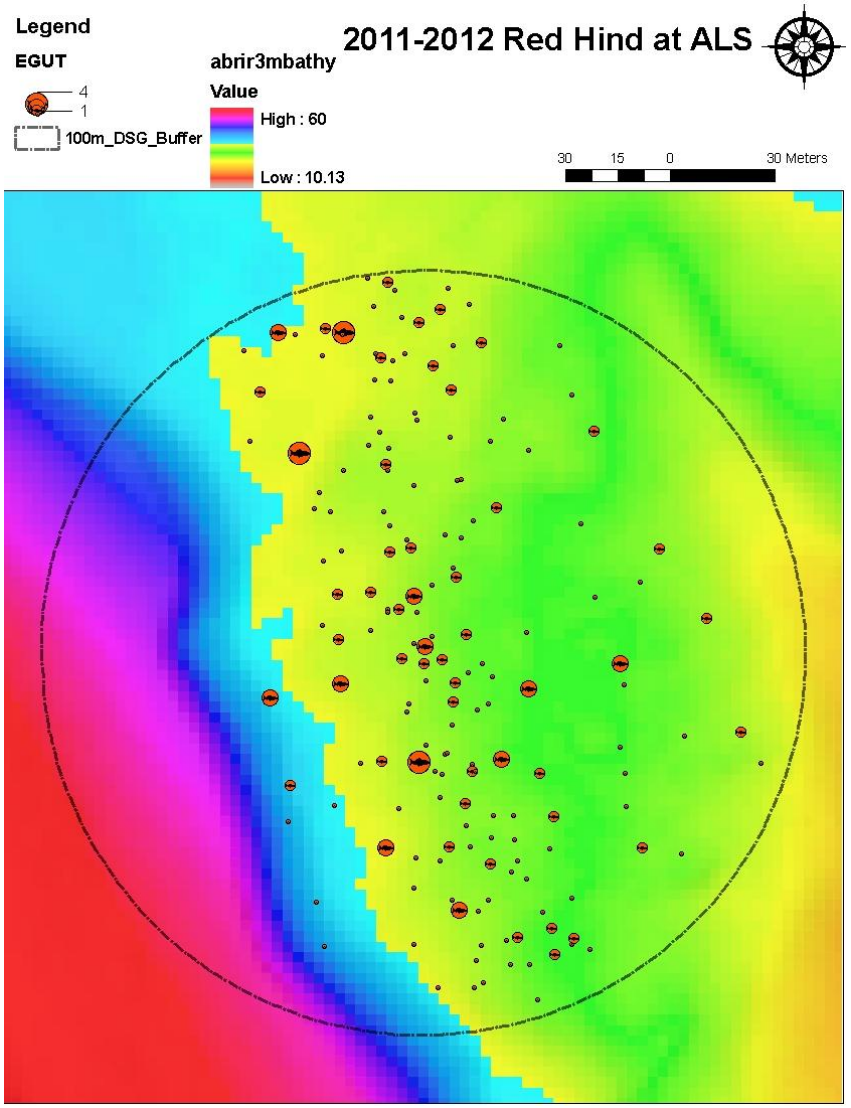
- Current determined direction (drop divers up-current)
- Handheld GPS on surface buoy
- Divers estimate size on each individual within 4-m wide area along drift direction
- Each individual assigned time to the nearest 30-sec.
- Duration between 20-30 minutes
- Distance between 500-800 meters
- 16:00 sampling

Belt vs Drift at Mona Island (2005 & 2010)

- Simultaneously conducted both methods in 330 & 216 sampling points
- Randomly stratified by depth/habitat (MMU 100m^2)
- Belt (30X2) 60m^2 and then a roving (5 min) for ‘large’ groupers, snappers and parrotfishes
- Sighting frequency of red hind was consistently higher in roving surveys when compared to belt transects

Spatial distribution of red hind Abrir la Sierra 2011 & 2012





Surveys Evaluation

Pros

- Area surveyed is known
- No mortality
- Reduced effort when fish aggregate

Cons

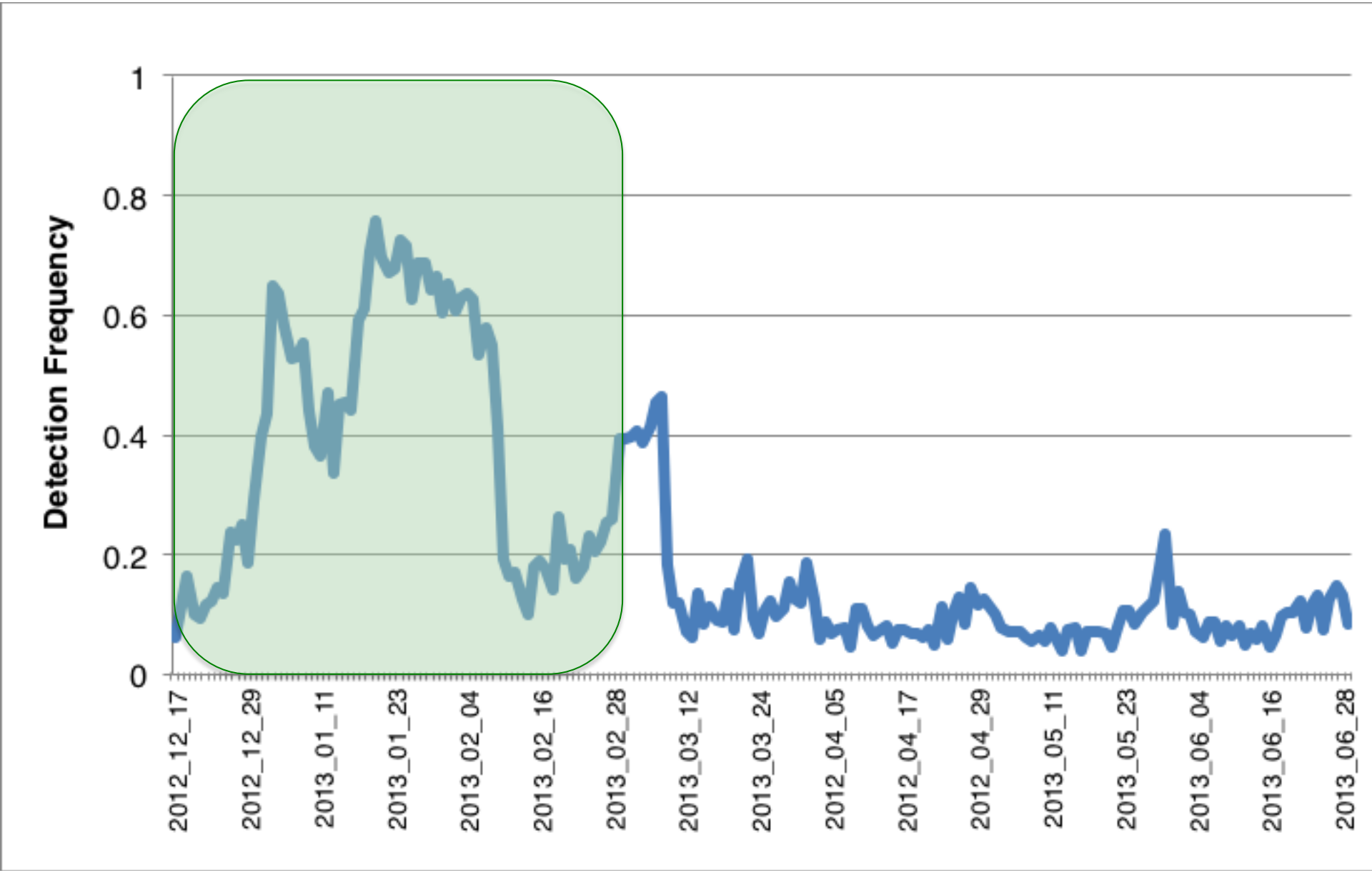
- Limited cover spatially
- Diving limitations (weather, depth, current and visibility)
- Only during reproductive season

PAM Evaluation

- High temporal resolution
- Simultaneous data collection
- Not limited by weather, depth or visibility

- Data processing can be laborious
- Must know species behavior
- DSG location within 300m of fish courtship arena

ARBIMON – ROI detection at Abrir la Sierra, PR 2013

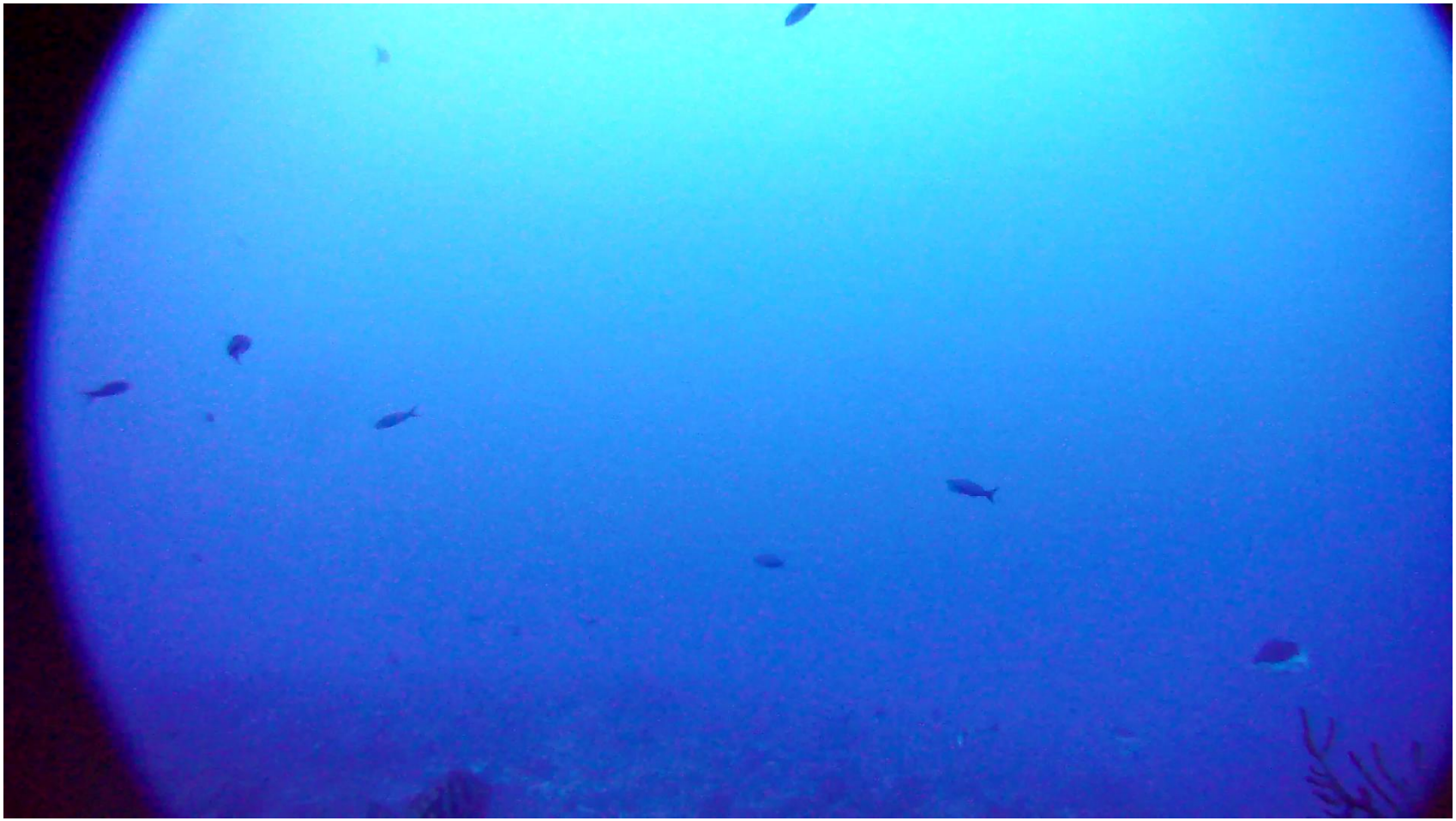


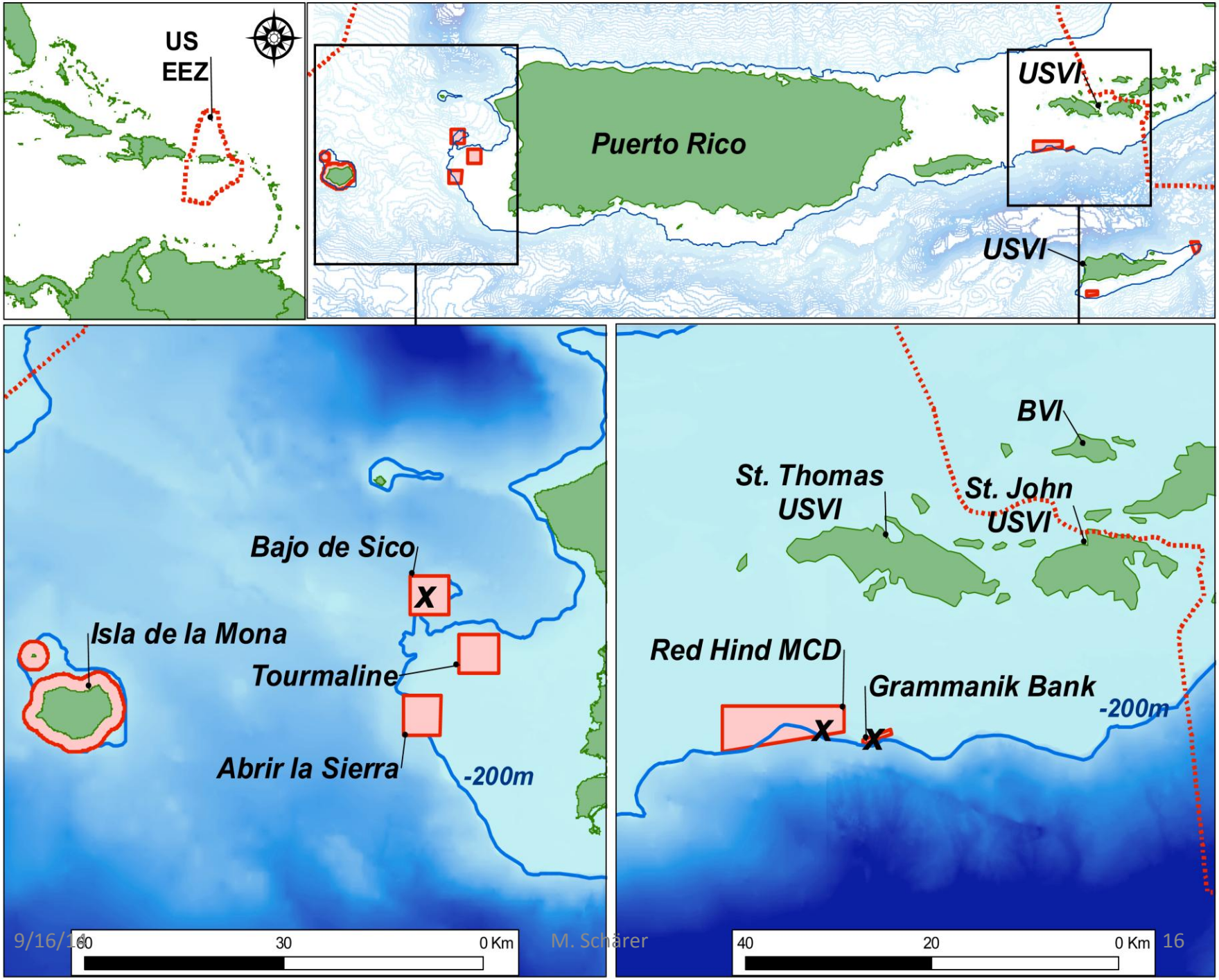
II. Nassau grouper FSA surveys
Objectives

- Test feasibility of PAM in assessments
- Survey Nassau grouper (*Epinephelus striatus*) FSA
  - Abundance
  - Size structure
  - Spawning stock
- Spatial distribution
- Acoustic tagging
  - *In situ*

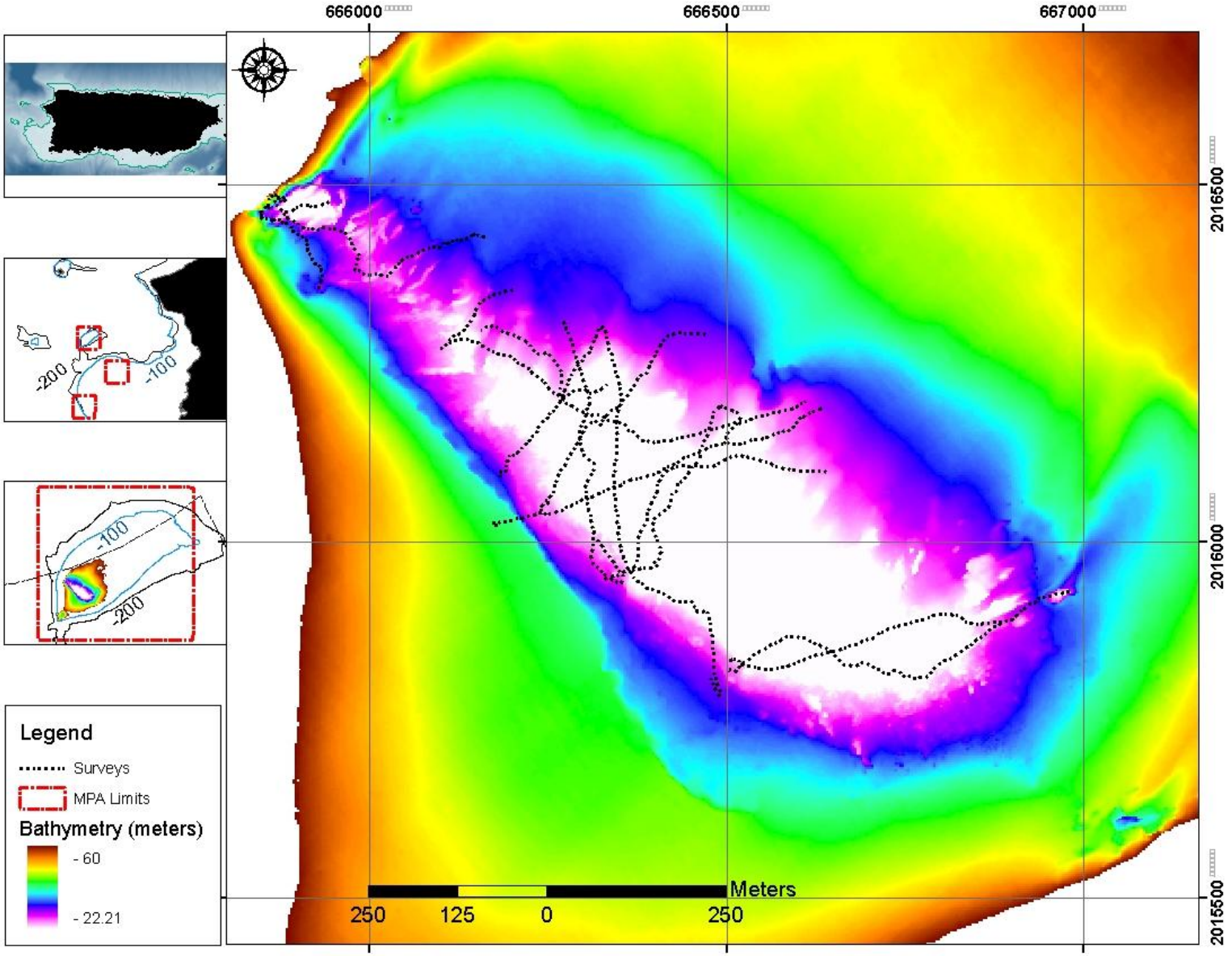
Experimental Design

- Fixed sampling at two Nassau grouper FSA
  - known sites (50-70m)
- Repeated surveys over time
  - Abundance (max number)
  - Size structure (video with laser calipers)
  - Reproductive condition (color phases)
- Surveys during reproductive period
- Synchronous audio & video in situ between surveys

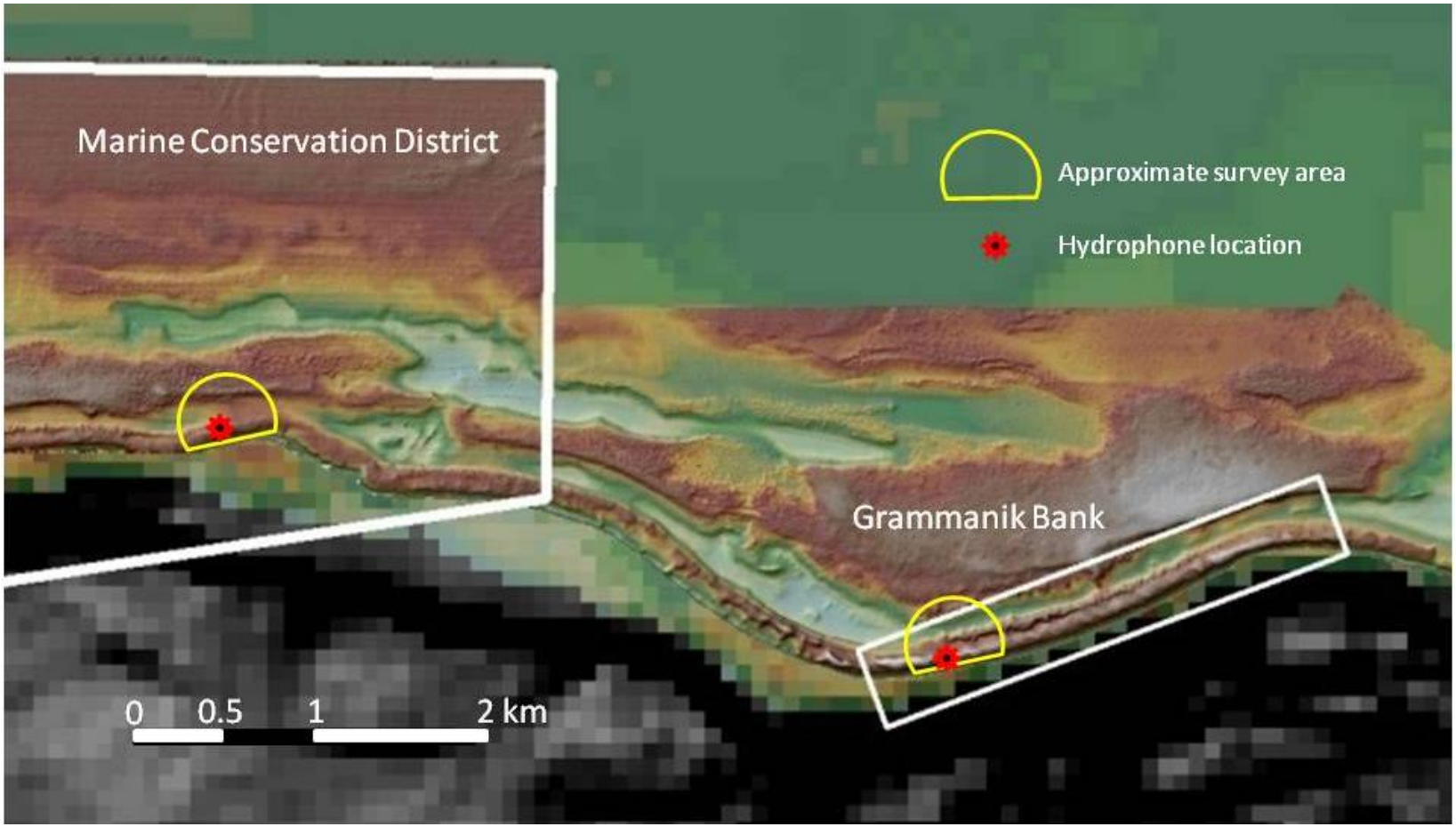



US
EEZ
Puerto Rico
USVI
USVI
Bajo de Sico
X
Isla de la Mona
Tourmaline
Abrir la Sierra
-200m
60
30
0 Km
BVI
St. Thomas
USVI
St. John
USVI
Red Hind MCD
Grammanik Bank
X
X
-200m
40
20
0 Km

Bajo de Sico, Puerto Rico



Red Hind Bank MCD & Grammanik Bank, USVI



Video surveys within courtship arena

- No surface buoy at FSA due to depth & current
- CCR-Divers record each individual with video
- Lasers on side of the body perpendicular
- Duration between 10-20 minutes
- Distance between 200-500 meters
- Late afternoon sampling


GoPro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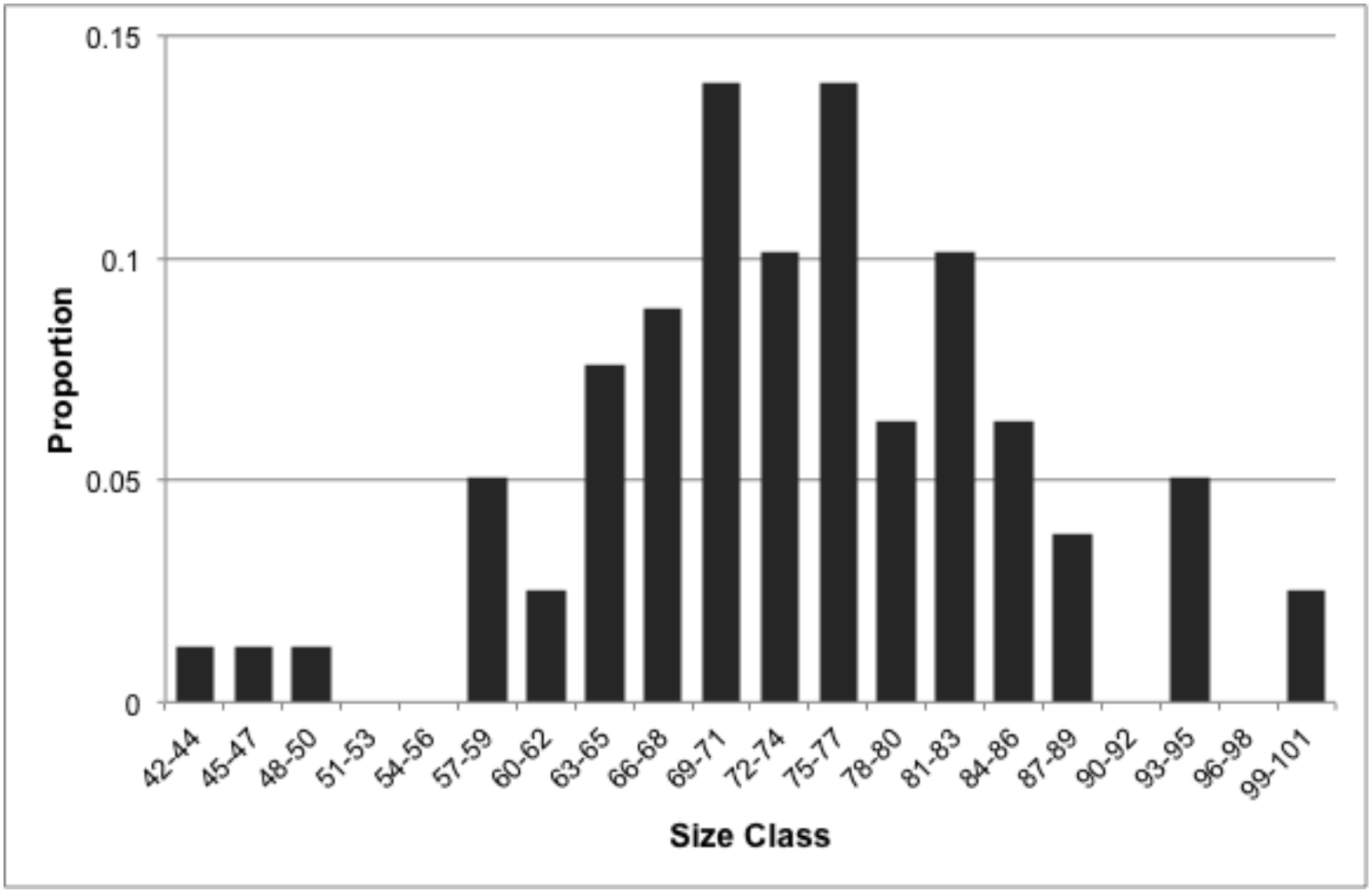
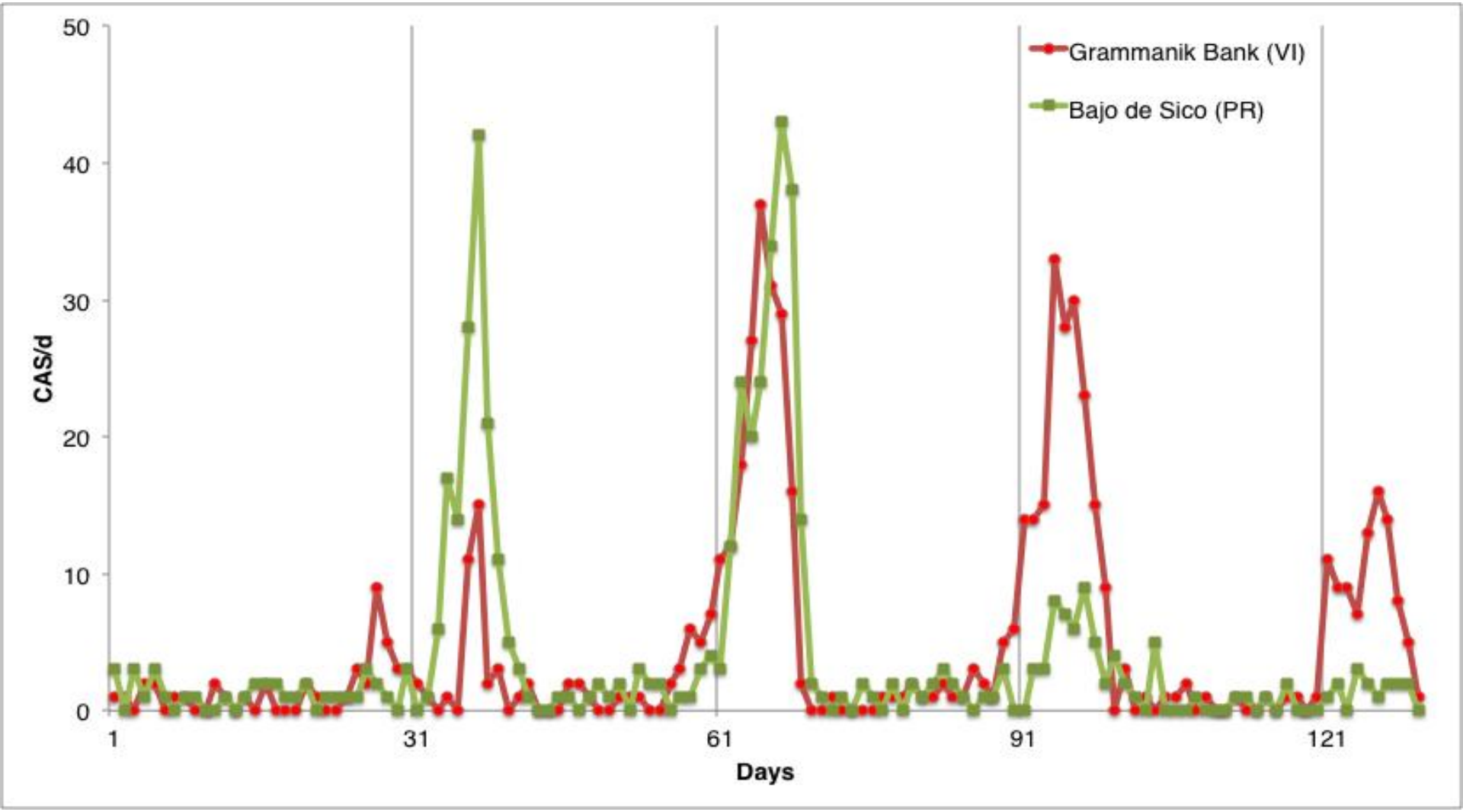
55
20

Length frequency distribution Nassau grouper (2013)

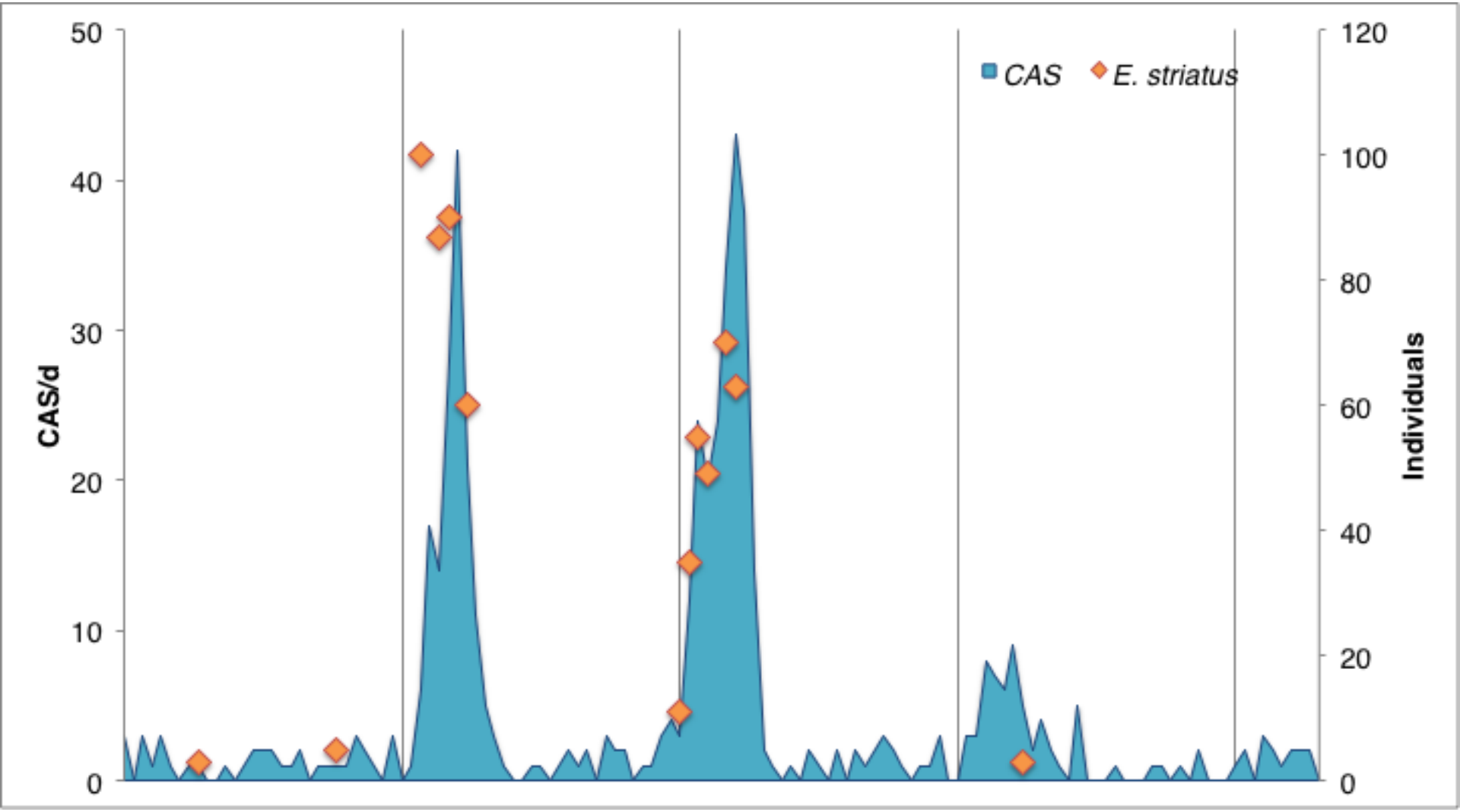


Technical diving (CCR) gear & training

Passive Acoustic Monitoring Nassau grouper 2013



PAM vs UVC, Bajo de Sico (2013)



Surveys Evaluation

Pros

- Area surveyed is known
- No mortality
- Reduced effort when fish aggregate
- Video provides size accuracy

Cons

- Limited cover spatially
- Diving limitations (weather, depth, current and visibility)
- Bias to reproductive season

PAM Evaluation

- High temporal resolution
- Simultaneous data collection
- Not limited by weather, depth or visibility

- Data processing is laborious
- Must know species behavior
- DSG location within 300m

Conclusion

- Consistent effort required during short periods
- No need to know all species for ID
- Useful for multi-species FSA with known acoustic signals
- Long-term standardized data is essential
- Verify with non-reproductive season surveys