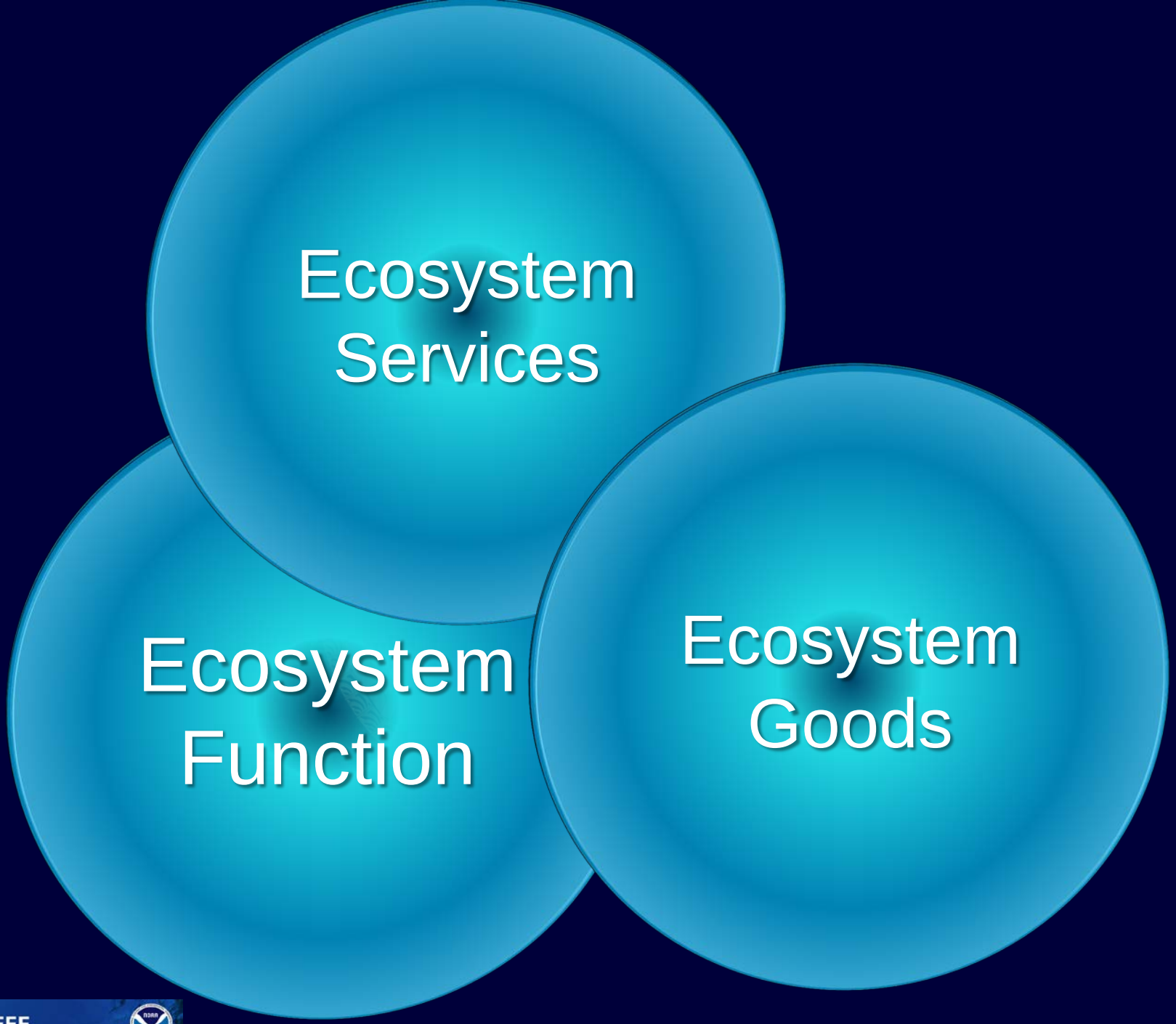
NOAA CORAL REEF CONSERVATION PROGRAM

Coral Reef Conservation Program Ecosystem Science Evaluation

Fishery Species Life History and Ecology

Dr. Ron Hill
NOAA Fisheries SEFSC-Galveston

Thursday, 25 August 2016


Ecosystem Services
Ecosystem Function
Ecosystem Goods

Managers and Stakeholders

Coral Reef + MPA Managers + Fishery Managers

- NMFS HQ & SE/PI Regional Offices
  - Sustainable Fisheries-Stock assessment scientists/managers
  - Habitat Conservation-Essential Fish Habitat (EFH)
  - Protected Resources-ESA, critical habitat
- Federal or State/territorial management agencies
  - Environmental
  - Resource management
- MPA Managers
- Stakeholders
  - Fishing communities
  - Diving communities

Reef Herbivory/Grazing

- The importance of parrotfish (fam. Scaridae) on the maintenance and recovery of coral-dominated reefs (2011-2012), Benjamin Ruttenberg (NMFS)
- Impacts of fishing on parrotfish grazing in St. Croix –A case study on the ecological impacts of fishery management actions (2015), Margaret Miller (NMFS)

Fishery Specific Projects

- Improving trap designs to reduce bycatch mortality of reef herbivores (2010), Ron Hill (NMFS)

Reef Carnivores
(Spawning Aggregation Research)

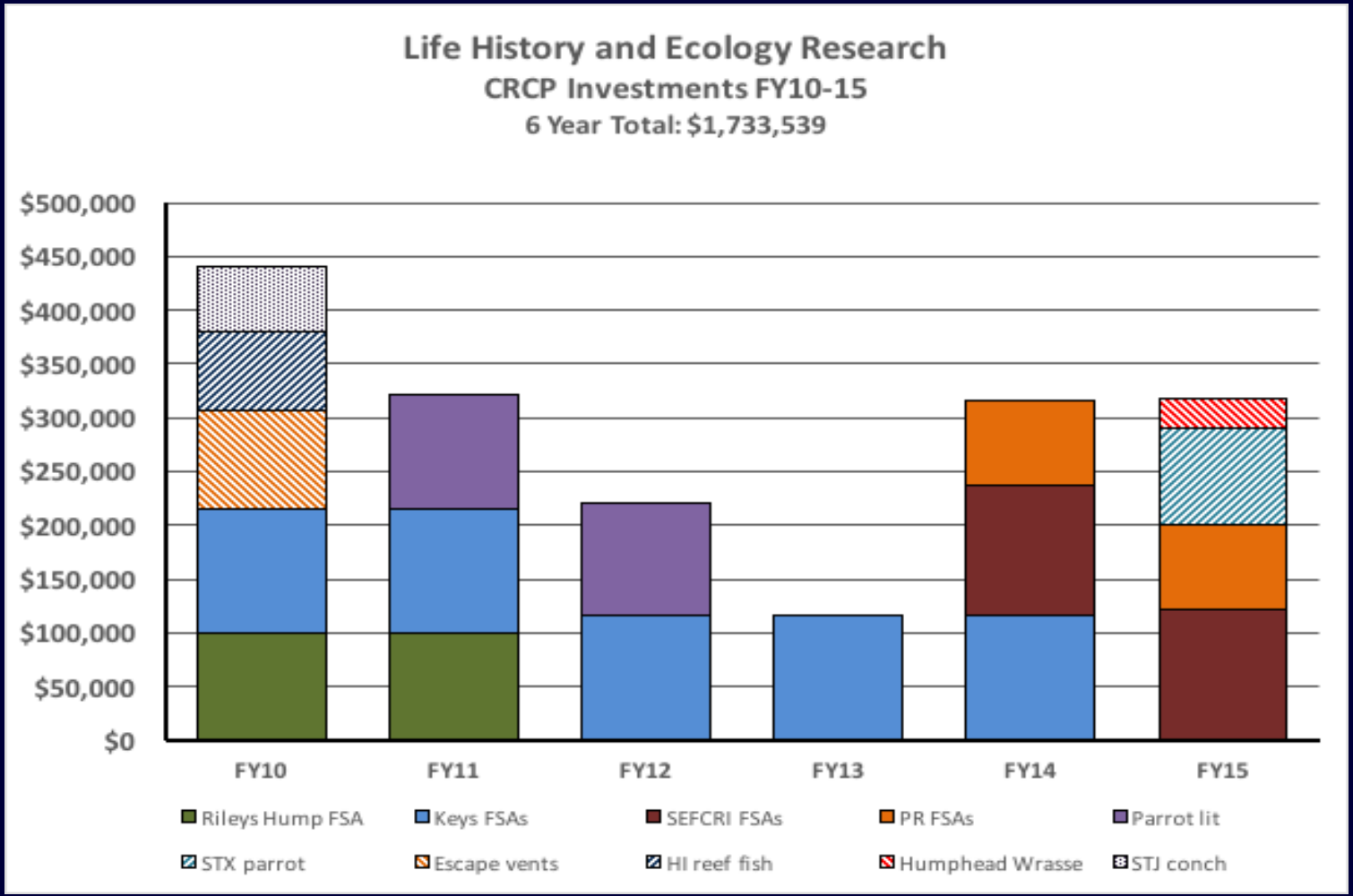
- Assessing the locations and status of reef fish spawning aggregations in the Florida Keys (2010-2014), Todd Kellison (NMFS)
- Assess Status and Location of Reef Fish Spawning Aggregations in the Southeast Florida Coral Reef Initiative (SEFCRI) Region (2014-2015), Chris Taylor (NOS)
- Coupling of passive and active acoustics to assess grouper aggregations in the Tortugas Ecological Reserve (2010-2011), Mike Burton (NMFS)
- Defining spawning dynamics to manage and conserve reef fish populations (2014-2015), Ron Hill (NMFS)

Pacific Island Fisheries Science Center (PIFSC) & Southeast Fisheries Science Center (SEFSC)

Life History/Ecology

- Biological and ecological assessment of humphead wrasse, *Cheilinus undulatus*, from fisheries independent and dependent surveys on Saipan (2015), Mike Trianni (NMFS)
- Recovery of queen conch, *Strombus gigas*, populations in the US Virgin Islands (2005-2010), Jennifer Doerr (NMFS)
- Reef fish life history information for the Hawaiian Archipelago (2010), Ivor Williams (NMFS)

Life History and Ecology Expenditures



Hatched/patterned bars represent 1-year projects during this period

Reef Herbivory
Critical Ecological Process

Parrotfish grazing -

- Maintain benthic habitat quality and support resilience
  - Acroporid Critical Habitat (ESA) = Settlement substrate
  - Maximum Sustainable Yield (MSY) = Ecologically sustainable fisheries?
- Grazing poorly characterized
  - Algal species controlled?
  - Habitat effects?
  - Other grazing taxa contributions?

- Project goals:
  - Quantify diet and habitat niche for each species in Florida Keys and St. Croix
  - Model rates/distributions/abundances/landings to allow ‘testing’ of different management (*i.e.*, take) scenarios on total grazing function

Parrotfish grazing

(B. Ruttenburg, T. Adam, & M. Miller)

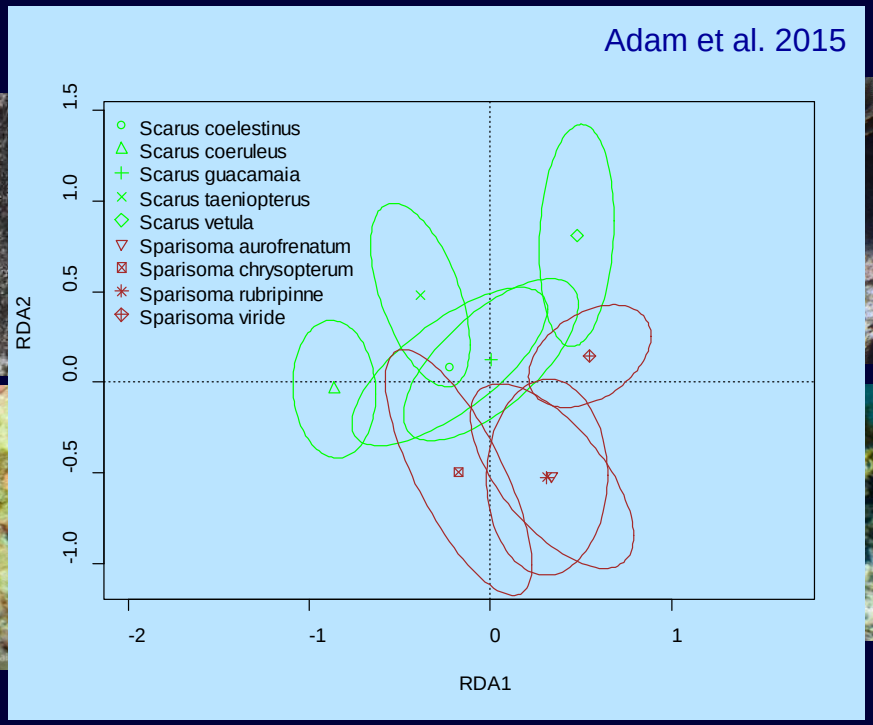
- Literature review/gap analysis
  - Grazing function
  - Contributions to reef resilience
- Field observations of behaviors
  - Species-, size-, habitat-specific
  - St. Croix (fished) vs Florida Keys (unfished)
- Reef-scale grazing estimates
  - Regulatory scenarios to balance fishery yields and reef ecosystems function
  - Species- and habitat-specific take

Behavioral studies: Florida Keys and St. Croix

Parrotfish with similar diets forage over different spatial scales, prefer different habitats, and target different substrates

Grazers

Macroalgae browsers



Spatially extensive

Boulder and rubble

Spatially intensive

High relief

Species-specific management might limit conflicts between fisheries and ecosystem function goals

Products and dissemination (so far)

- Inform Managers - presentation/discussion
  - Buck Is. Reef Nat. Monument (Z. Hillis-Starr)
  - NMFS-SERO (J. Moore, A. Herndon & B. Arnold)
  - USVI Division of Fish and Wildlife (T. Dolan)
- 2 public outreach presentations
- 8 scientific presentations (1 in Curacao, 1 in USVI)
- 2 peer-reviewed publications (2 in prep)
- Management 'white paper' (distilling peer-review results)

- Archived data set (NODC accession 0127525) on grazing from Florida Keys
- TOOLS: calculations and models to convert parrotfish species size and abundance to reef-scale grazing metrics.

Managing herbivores for their impacts on Caribbean coral reef ecosystems: A summary report for managers and practitioners

- **Herbivory is a key process** on coral reefs that can facilitate coral success

- These benefits are most effectively realized in cases where other chronic stressors, such as sedimentation and pollution are also limited; **reducing other stressors is also extremely important**.

- **All herbivores are not created equal**. Understanding how different species of herbivores affect reef ecosystems is critical for developing effective management strategies; e.g., parrotfishes are effective at controlling algae and facilitating corals but different species of parrotfishes have unique and complementary impacts on reef ecosystems.

- A combination of **species-specific and/or spatial management of herbivore populations could reduce trade-offs** between sustaining a fishery while also maintaining high grazing rates

- Parrotfishes and other herbivores are attracted to reefs with high levels of architectural complexity and help sustain them via the positive impacts of herbivores on coral growth. **Maintaining or restoring architectural complexity is critical for recovering Caribbean coral reefs.**

Managing herbivores for their impacts on Caribbean coral reef ecosystems:
A summary report for managers and practitioners

Prepared for NOAA's Coral Reef Conservation Program

Thomas C. Adam, Deron E. Burkepile, Benjamin I. Ruttenberg, and Michelle J. Paddack

Future

- Continued field work in St. Croix –
  - Fishery species
    - depleted species and populations
- Model grazing effects
  - Current work ‘rolling up’ individual bite rates to assemblage-scale grazing metric and model scenarios to scale it with targeted removals

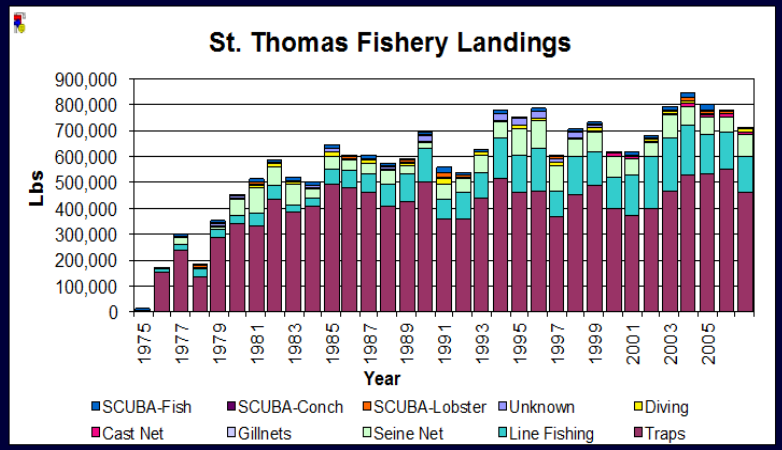
Key Contributions and Strengths

- Partnership (SE Regional Office, CRCP and SEFSC) to provide new, more nuanced science to inform a biological opinion resulting from the continued authorization of the US Caribbean Reef Fish Fishery (i.e. parrotfish fishery).
- Assessed and filled knowledge gap: species-specific differences in parrotfish function
- Fishery management strategy evaluation tool: balance goals of maintaining a fishery AND maintaining benthic habitat quality and resilience

Reducing Ecosystem Effects of Commercial Fish Trap Fishing:
Reducing Bycatch of Herbivorous Fishes in Coral Reef Trap Fisheries in the USVI (R.L. Hill & J. C.Doerr)

2010

- Herbivores taken as bycatch in STT fish traps
  - Fish Traps ~70% of fishery landings
  - TM: MARFIN (STFA Bycatch Study)
  - MARFIN: 2006-2008; 62,599 hauls/761 trips/67k kg
- Cooperative Research Program STFA (Olsen)
  - Test escape vent designs
  - Field test vents in commercial fishery
  - CRP: 2010-2013
- CRCP (Hill & Doerr)
  - Test escape vent designs/placement
  - Fish behavior
  - Traps as Marine Debris



St. Thomas Fishermen's Association

NOAA CORAL REEF CONSERVATION PROGRAM

Blue Tang
Acanthurus coeruleus

Bycatch %: 15.8%

Bycatch Mortality: 19.0%

Doctor/Ocean Surgeonfish
Acanthurus chirurgus/bahianus

Bycatch %: 7.8%

Bycatch Mortality: 22.0%

Bycatch Study Results

- No parrotfish as bycatch in study

Banded Butterflyfish
Chaetodon striatus

Bycatch %: 3.4 %

Bycatch Mortality: 54 %

Rock Beauty
Holacanthus tricolor

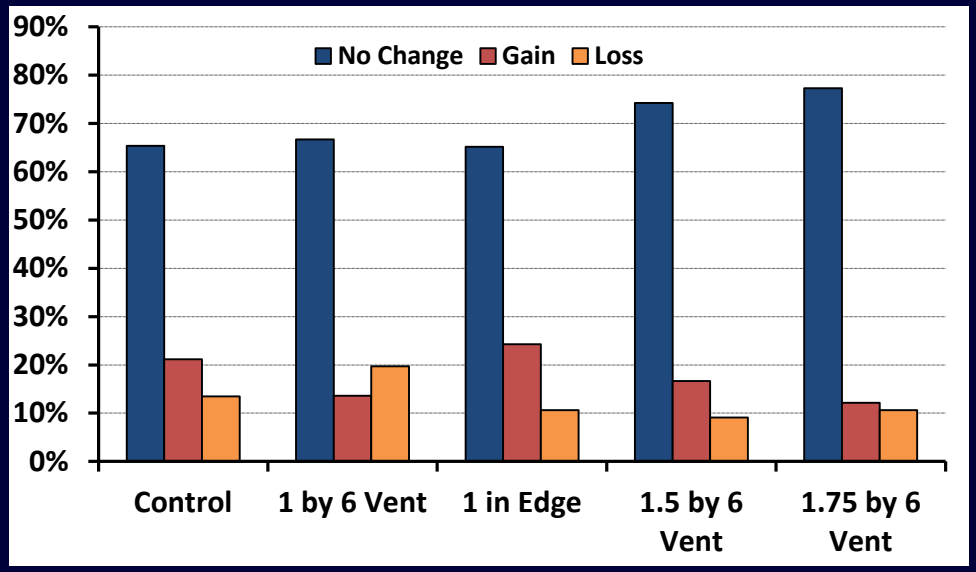
Bycatch %: 0.56%

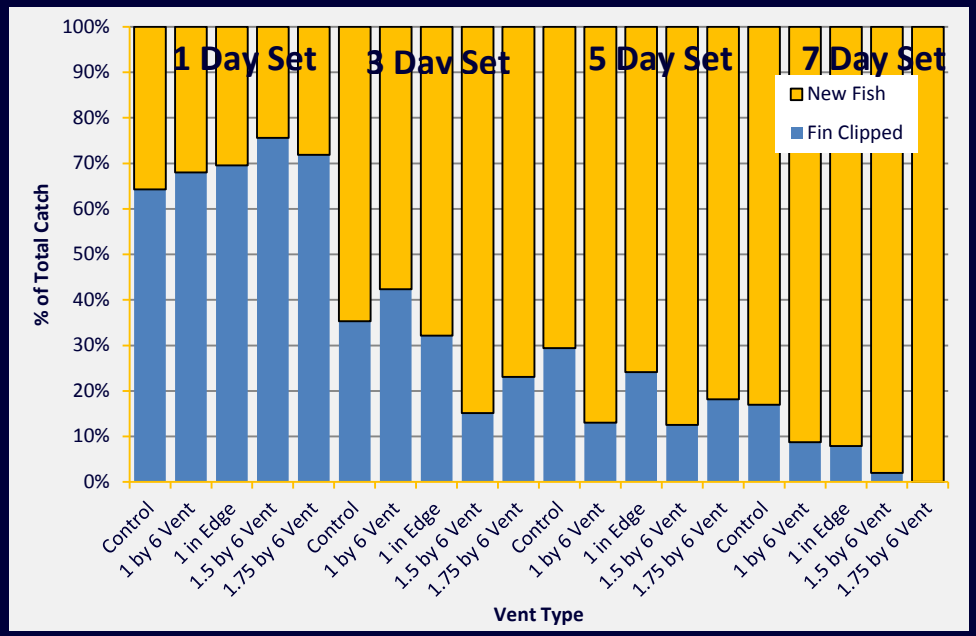
Bycatch Mortality: 79 %

Reducing Bycatch

Findings

- 3.5 x 14.6 cm escape vent
  - (1 3/8 x 6 inches)
  - Bycatch reduced (CPUE)
- Fishery Information
  - No loss during hauling
  - Retention rates low
  - Seasonal variation in **effort**
  - **Gear selectivity defined**
  - **Calculate mortality rates**





NOAA CORAL REEF CONSERVATION PROGRAM

Escape Vent Results: Bycatch Reduction & Target Size Increase

Rock beauty (-71%)
Banded Butterfly (-73%)

Blue Tang
Acanthurus coeruleus

RESULTS		
Size (TL) vs Control:		103.8%
	n=	311/75
Change in CPUE:		-81%
Catch > L_{repro}:		100%

Doctor/Ocean Surgeonfish
Acanthurus chirurgus/bahianus

		RESULTS
Size (TL) vs Control:		102.9%
	n=	135/92
Change in CPUE:		-45%
Catch > L_{repro}:		100%

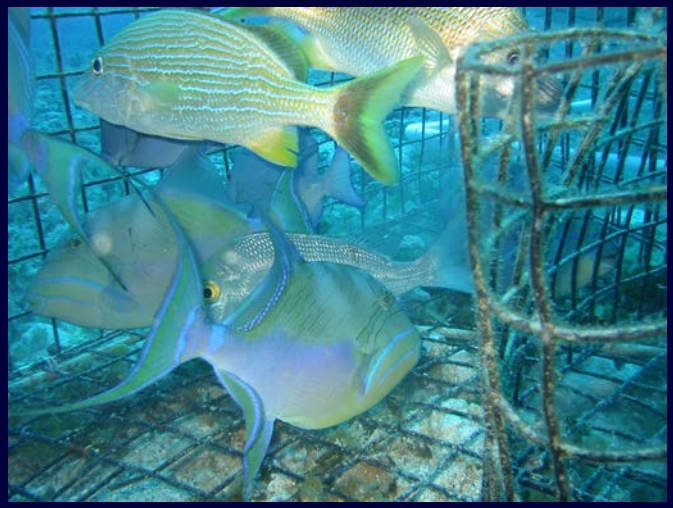
Stoplight Parrotfish
S. viride

RESULTS		
Size (TL) vs Control:		105.1%
	n=	55/55
Change in CPUE:		-20%
Catch > L_{repro}:		100/100%

Redtail Parrotfish
S. chrysopterum

		RESULTS
Size (TL) vs Control:		101.1%
	n=	55/32
Change in CPUE:		-53%
Catch > L_{repro}:		???%

Products and Dissemination



- Escape vent (3.5 x 14.6 cm) design success
  - Retrofit to existing traps
  - Maintain catch of target species
  - **Fisher buy-in**
- Inform Managers - presentation/discussion
  - Caribbean Fisheries Management Council
    - NMFS-SERO
    - USVI Division of Fish and Wildlife
    - PR Dept. of Natural and Environmental Resources
- Multiple stakeholder/participant (outreach) presentations
- 5 scientific presentations (Gulf and Carib. Fish Inst, ICRS)
- 3 peer-reviewed publications in prep.

Caribbean Fisheries Management Council (CFMC) funded implementation ($5k)

- Expansion to St. Croix and Puerto Rico needed

Top Down Control - Predators

Problem

- Fishers know SPAGs
  - Scientists – not so much
  - Traditional Ecological Knowledge (TEK)
- Healthy reefs need large predators
  - Inverted biomass pyramid (NWHI)
  - Ecosystem resistance - invasive species (*e.g.*, Atlantic Lionfish)
- FSAs = Easy Fishery Targets
  - Depleted populations
  - Skewed sex ratios
  - Hyperstability masks depletions
  - Cultural transmission of spawning locations/timing/behaviors
  - Resident and transient spawning aggregations
- Common problem across Atlantic and Pacific regions
- Need temporal and spatial guidance for management

Fish Spawning Aggregation Research

- CRCP-funded FSA research
  - Tortugas South Ecological Reserve (Riley's Hump) (FY10-11)
  - Florida Keys (FY09-FY14)
  - Southeast Florida Coral Reef Initiative (SEFCRI) region, *i.e.*, southeastern FL(FY14-FY16)
  - Western and NE Puerto Rico (FY14-16)

- Primary Targets: Groupers and snappers
  - Important ecologically and economically
  - Soniferous – during courting and spawning

FSA Goals and Objectives

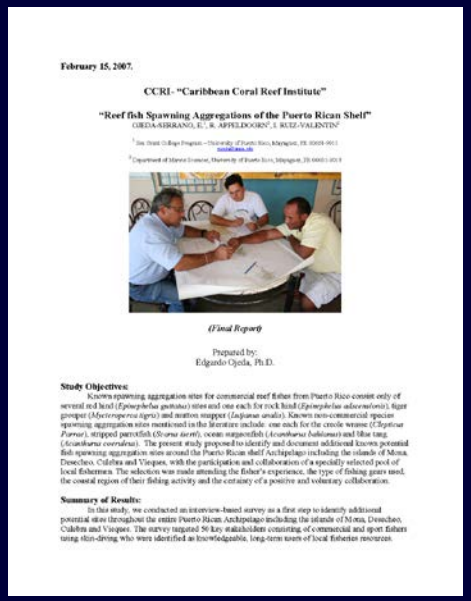
- Assess conditions at purported/historical fish spawning aggregations (FSAs)
  - Species, abundance, spawning stock, assessment proxy
  - Assess geomorphology and habitats
- Monitor temporal and spatial variation
- Locate and assess unknown FSAs

Purpose:

- Assess stocks (ecosystems)
- Provide guidance for management

Fish Spawning Aggregation Research

- Common methods
  - Literature reviews and TEK
  - **Aerial surveys**



February 15, 2007.

CCRI- "Caribbean Coral Reef Institute"

"Reef fish Spawning Aggregations of the Puerto Rican Shelf"

OJEDA-SERRANO, E.[1], R. APPELDOORN[2], I. RUIZ-VALENTÍN[1]

(Final Report)

Prepared by:
Edgardo Ojeda, Ph.D.

Study Objectives:

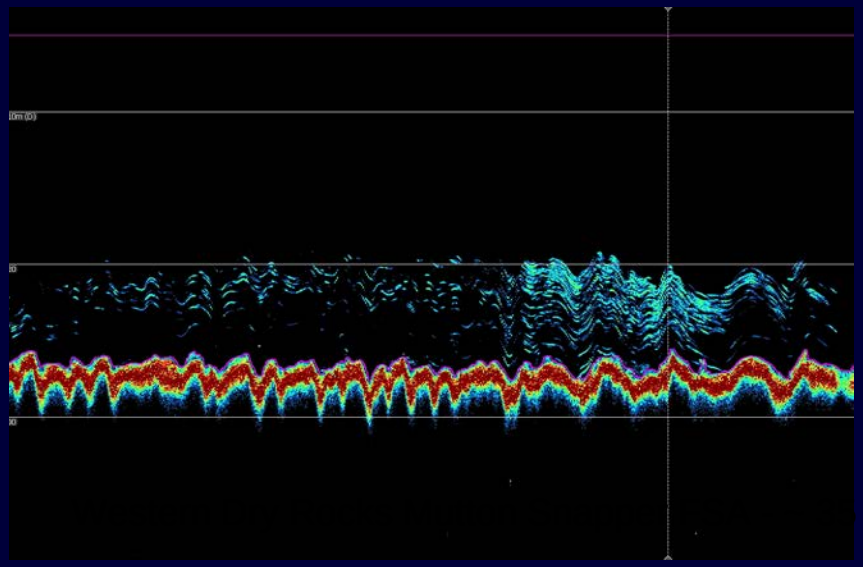
Known spawning aggregation sites for commercial reef fishes from Puerto Rico consist only of several red hind (*Epinephelus guttatus*) sites and one each for rock hind (*Epinephelus adscensionis*), tiger grouper (*Mycteroperca tigris*) and mutton snapper (*Lutjanus analis*). Known non-commercial species spawning aggregation sites mentioned in the literature include one each for the creole wrasse (*Clepticus Parrae*), striped parrotfish (*Scarus iserti*), ocean surgeonfish (*Acanthurus bahianus*) and blue tang, (*Acanthurus coeruleus*). The present study proposed to identify and document additional known potential fish spawning aggregation sites around the Puerto Rican shelf Archipelago including the islands of Mona, Desecheo, Culebra and Vieques, with the participation and collaboration of a specifully selected pool of local fishermen. The selection was made attending the fisher's experience, the type of fishing gears used, the coastal region of their fishing activity and the certainty of a positive and voluntary collaboration.

Summary of Results:

In this study, we conducted an interview-based survey as a first step to identify additional potential sites throughout the entire Puerto Rican Archipelago including the islands of Mona, Desecheo, Culebra and Vieques. The survey targeted 50 key stakeholders consisting of commercial and sport fishers using skin-diving who were identified as knowledgeable, long-term users of local fisheries resources.

Fish Spawning Aggregation Research

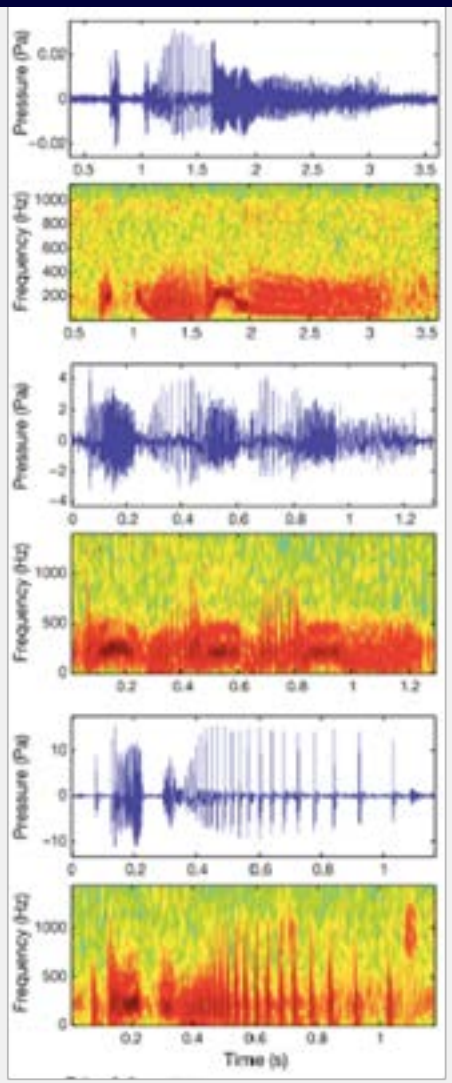
- Common methods
  - Literature reviews and TEK
  - Aerial surveys
  - **Active acoustics (sonar)**



boats

Fish Spawning Aggregation Research

- Development of new more efficient approaches
  - Acoustic (tagging) tracking - ping
  - Passive Acoustic Monitoring (PAM) - ambient sounds (*i.e.*, courting & spawning
  - PAM + Drifting/drifters, gliders, and sound samplers

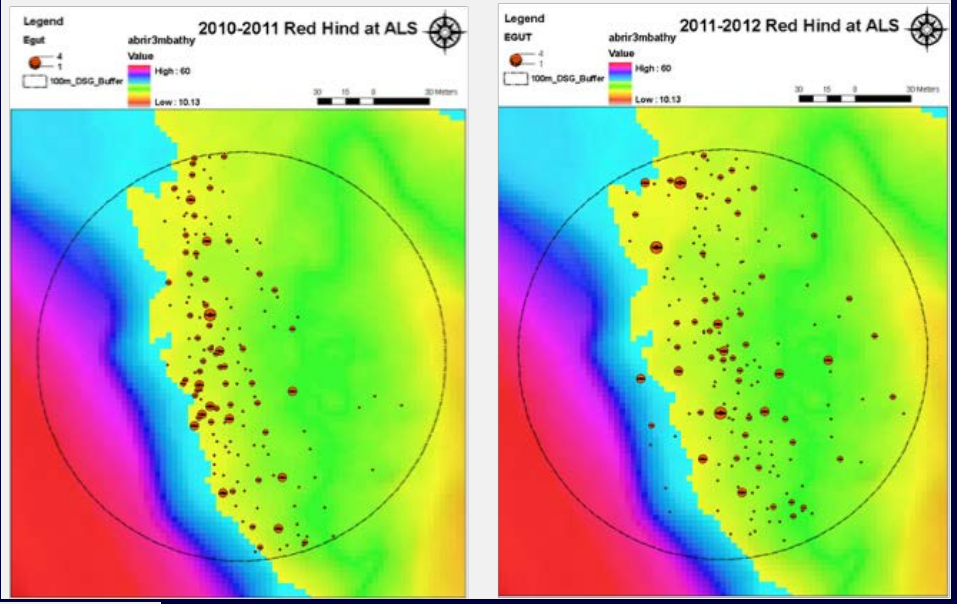


E. guttatus acoustic signals

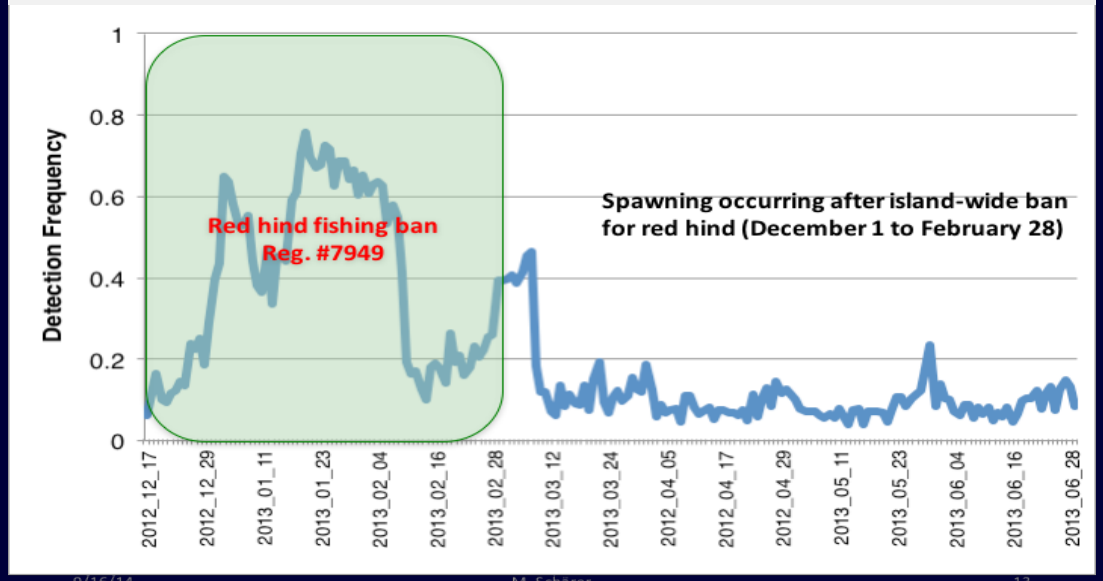
Findings

- Documentation of single species and multi-species spawning aggregations
- Reports of spatial habitat/area use
- Reports of temporal habitat/area use
- Support for current and improved management
- Documentation of signals that allow additional monitoring

Spatial distribution of red hind Abrir la Sierra 2011 & 2012



Automated detection system (UPR-RP)
ARBIMON – ROI detection at Abrir la Sierra, PR 2013



Spatial Inconsistencies:
Spawning area for red hind actually extends beyond MPA boundary; protective management is lacking

Temporal Inconsistencies:
Spawning is more protracted than previously known; protective management is lacking

Challenges/Future

- TEK sparse
- Research window narrow (days each year)
- Diver surveys personnel/weather/funding dependent
- Technologies need consistent funding
- Time is short for many aggregations
- Continued effort and development of techniques

Applications of findings

- Spatial Planning and Regulation Development
  - Florida Keys National Marine Sanctuary
  - Florida Fish and Wildlife Conservations Commission
  - DOI National Park Service
  - PR DNER
  - CFMC, GMFMC, SAFMC
- Stock assessment efforts

Humphead Wrasse
(*Cheilinus undulatus*)

- Problem:
  - In coral reef ecosystems throughout the Indo-Pacific region.
  - IUCN-listed as endangered; recently evaluated under ESA review,
    - information from CNMI limited to non-targeted or qualitative observations; need directed studies.

- Goal: Identify juvenile areas/habitats in Saipan Lagoon

Humphead Wrasse
(*Cheilinus undulatus*)

- Funding:
  - Field observations
    - Planning
    - Conducting
    - Managing data
  - Products:
    - GPS locations and images of preferred habitats
    - Estimates of juvenile abundances

- Outcomes and dissemination
  - Georeferenced data set
  - Project report
  - Scientific manuscript
  - All info/data to CNMI fishery research and management agency

Humphead Wrasse
(*Cheilinus undulatus*)

Challenges

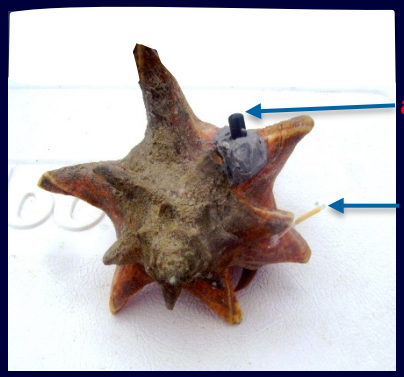
- Adverse weather conditions (significant typhoon damage)
- Insure that information is collected and provided in an objective manner, e.g., direct access to data

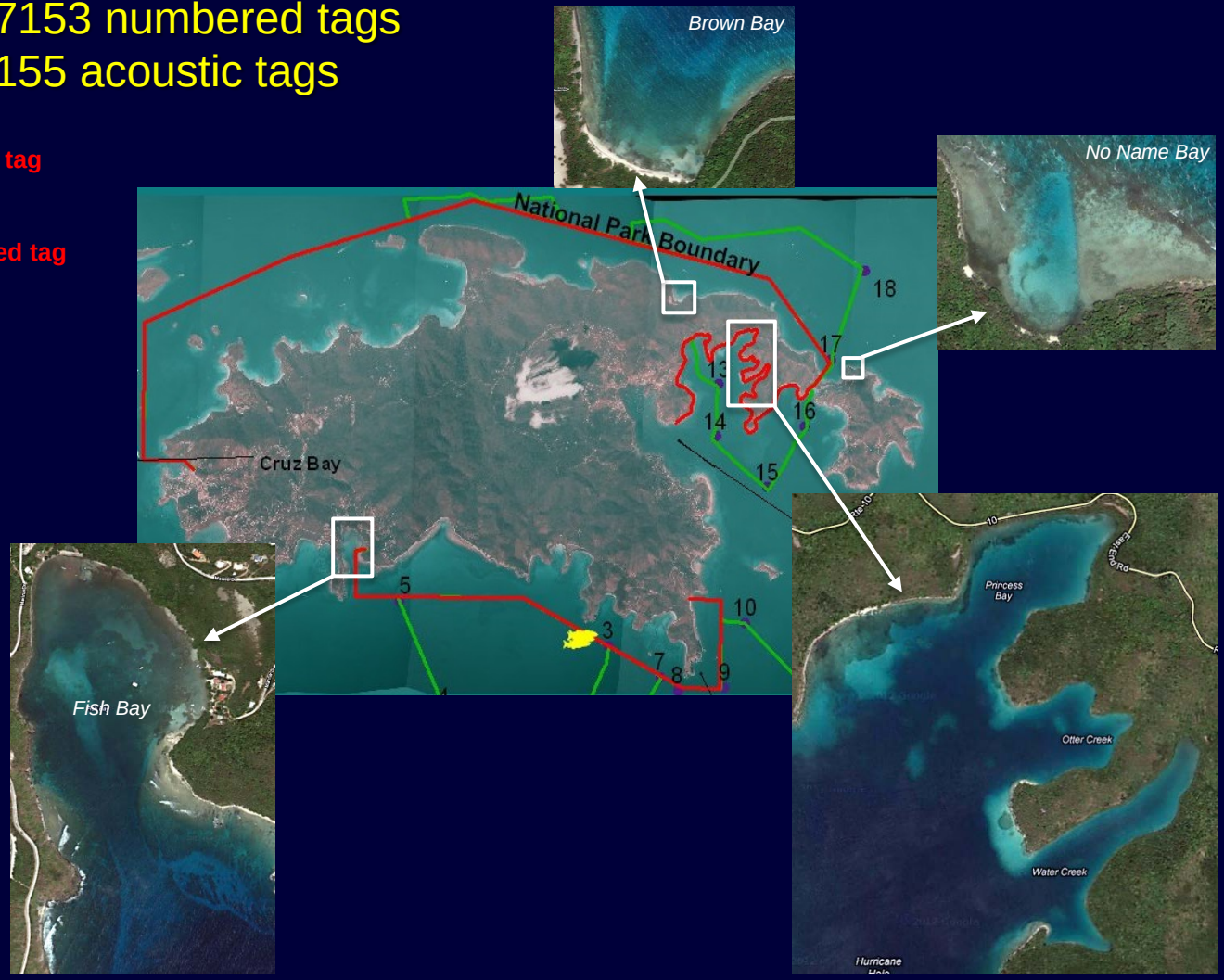
Future

- Conduct similar surveys in other US coral reef areas to complete the picture of important habitats for the species

St. John Queen Conch Research

- 7153 numbered tags
- 155 acoustic tags

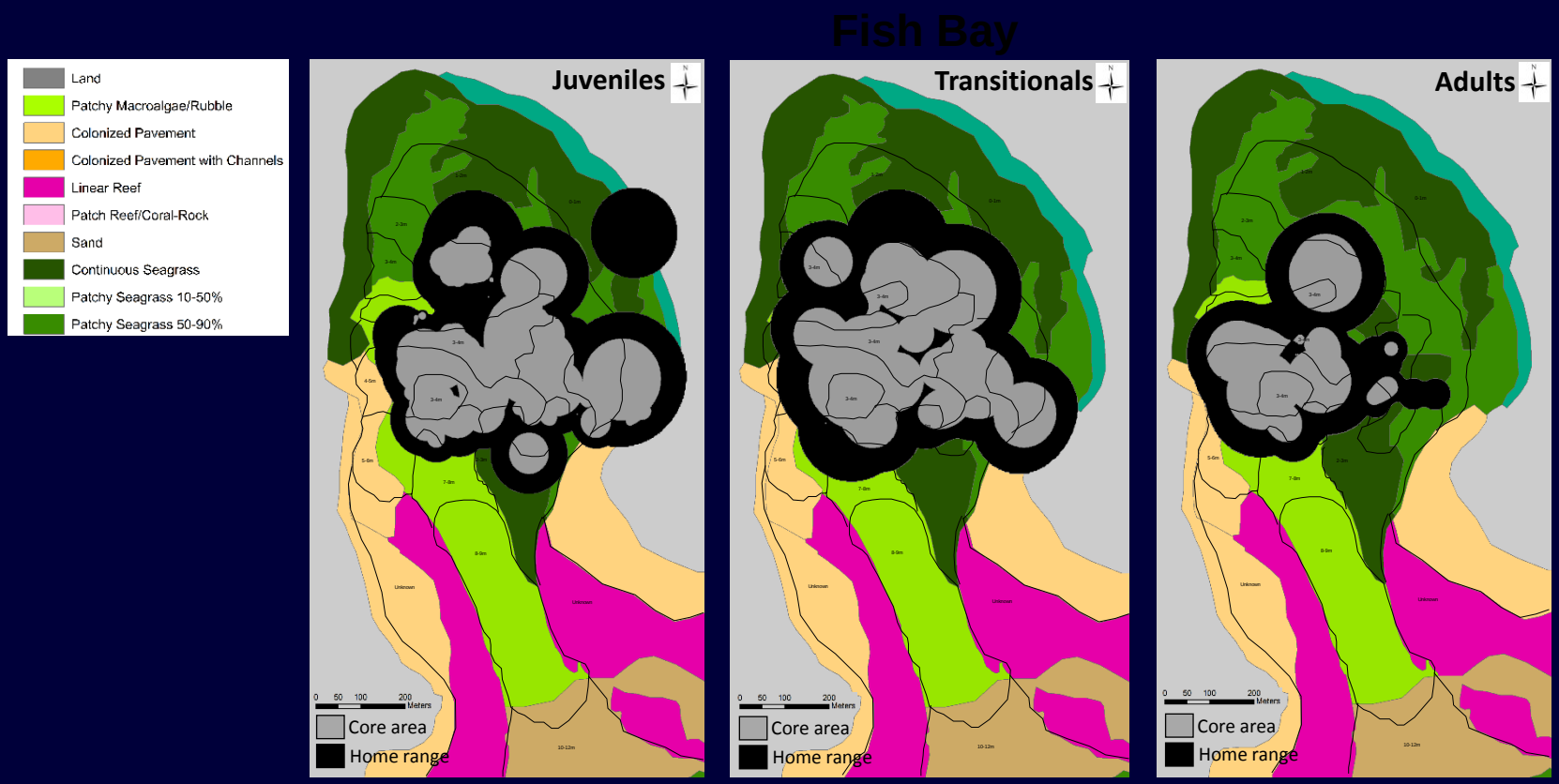




- Habitat use, fine-scale and island-wide movements
  - numbered tagging and acoustic tracking
  - mark and recapture (growth, survival, ingress/egress)
  - territorial, National Park, National Monument

Home Range/Habitat Use

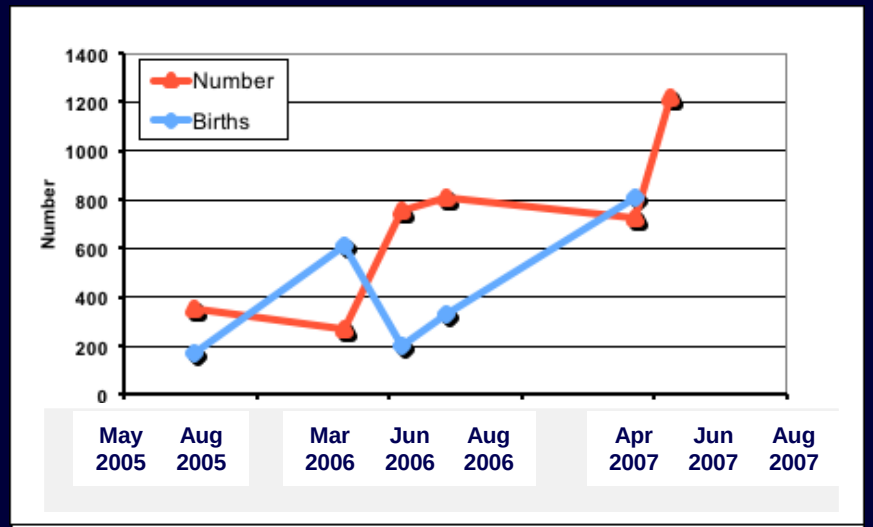
- Juveniles: 30% macroalgae, 70% seagrass, 1-3 m
- Adults: 69% macroalgae, 2-9 m
- Shift in habitat use patterns during maturation

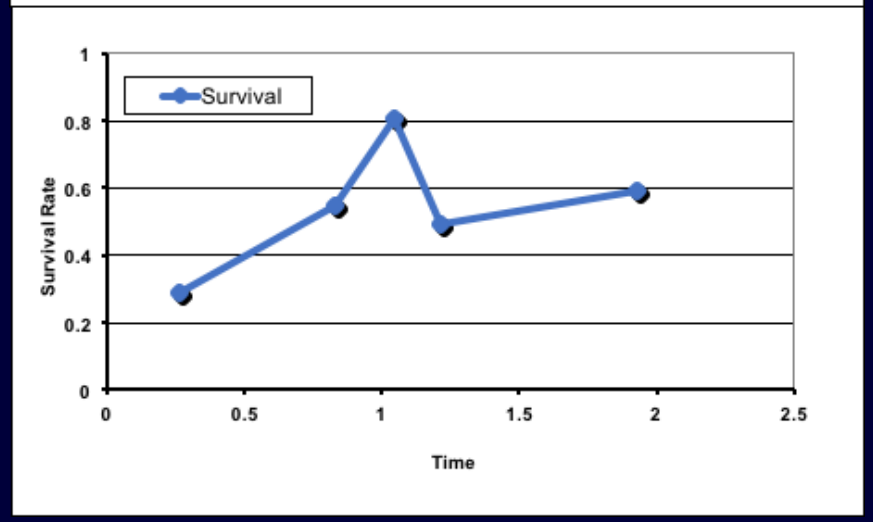


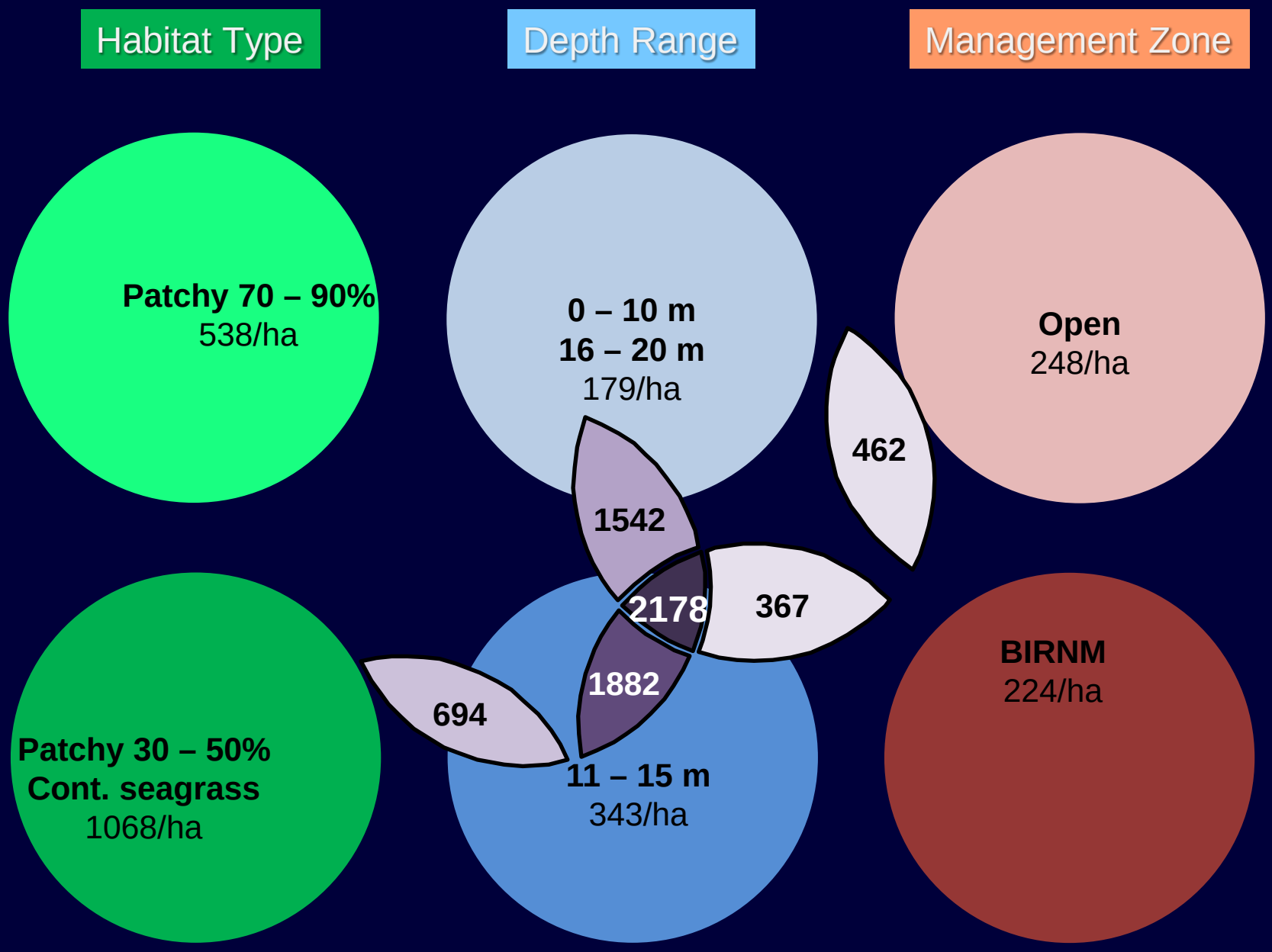
Mark-and-recapture analysis:

- Abundance/number:
  - Increases
- Births/recruitment:
  - 2 pulses – June '06/'07
- Survival rate:
  - Increase with recruitment
  - Too soon to see '07

- Final analysis:
  - Additional years (to FY-10)
  - Additional management areas

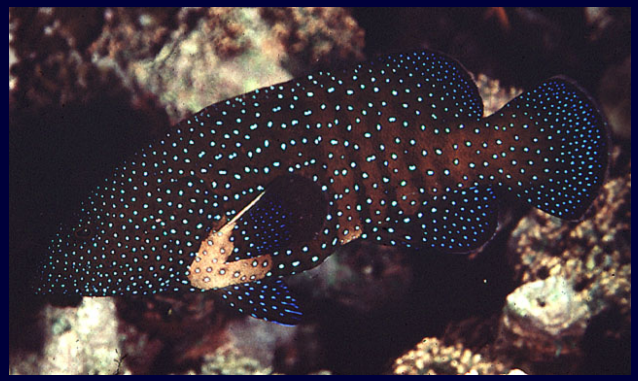





Habitat Type
Depth Range
Management Zone
Patchy 70 – 90%
538/ha
0 – 10 m
16 – 20 m
179/ha
Open
248/ha
462
1542
2178
367
1882
694
Patchy 30 – 50%
Cont. seagrass
1068/ha
11 – 15 m
343/ha
BIRNM
224/ha

Peacock Grouper

(*Cephalopholis argus*)



Reef fish life history information for the Hawaiian Archipelago

Components:

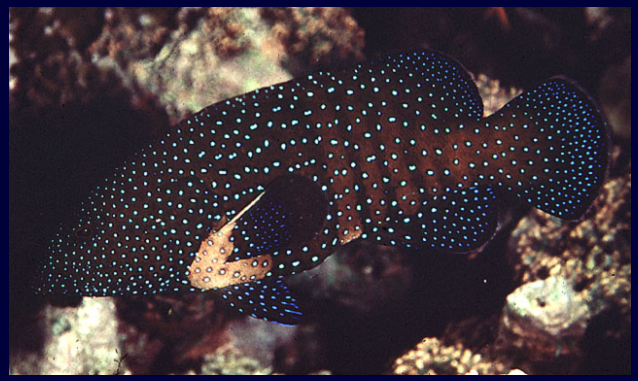
- Catalogue reef fish specimens held by Hawaii institutions
- Estimate life history parameters
  - Peacock grouper (*Cephalopholis argus*), introduced grouper
  - Growth rate
  - Longevity
  - 10 locations in the Main Hawaiian Islands

Outputs:

- Catalogue of specimens
- Locally-relevant life history parameters for growth and longevity arguably the dominant shallow water reef piscivore in Hawaii
- Documented high variability in life history parameters among habitats and locations; seen as more common than traditionally believed

Peacock Grouper

(*Cephalopholis argus*)

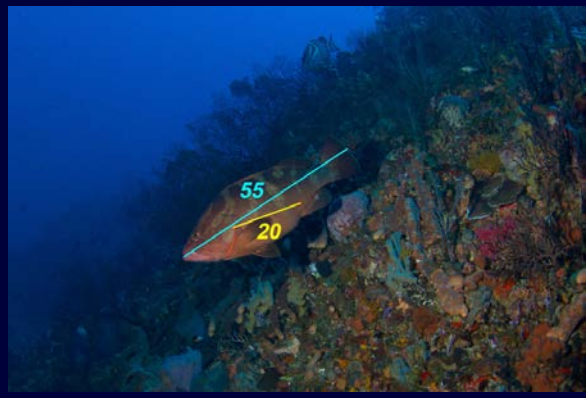


Utility and dissemination:

- Catalogue makes specimens information widely available
- Life history parameters
  - Peacock grouper grow much larger than in its native locations
  - Model removals
  - Presentations (4) – e.g., scientist/fishermen exchange
  - Publications (2)

Future:

- Met Hawaiian priority for life history needs in RFP
- No plans for additional work

Research Connectivity

- 2004 surveys to locate reef fish FSAs
- 2007 GCFI informal meeting (FSA-folks)
  - UPR, CFMC, NOAA NMFS/NOS, USF …
- 2007 passive acoustic monitoring (PAM)
  - D. Mann (USF, Loggerhead), CCRI
- 2010 surveys standardized
  - CCRI, NOAA
- 2012 PAM at FSA sites in the US Caribbean
  - CCRI, SEAMAP-C, CFMC