

OVERVIEW OF LIFE HISTORY BIO-SAMPLING IN THE PACIFIC TERRITORIES



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**NOAA, PIFSC, FRMD, Life History Program
Bio-Sampling External Review**

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NOAA FISHERIES

LIFE HISTORY OBJECTIVES

Goal: to provide new & updated life history information in support of stock assessment & management.

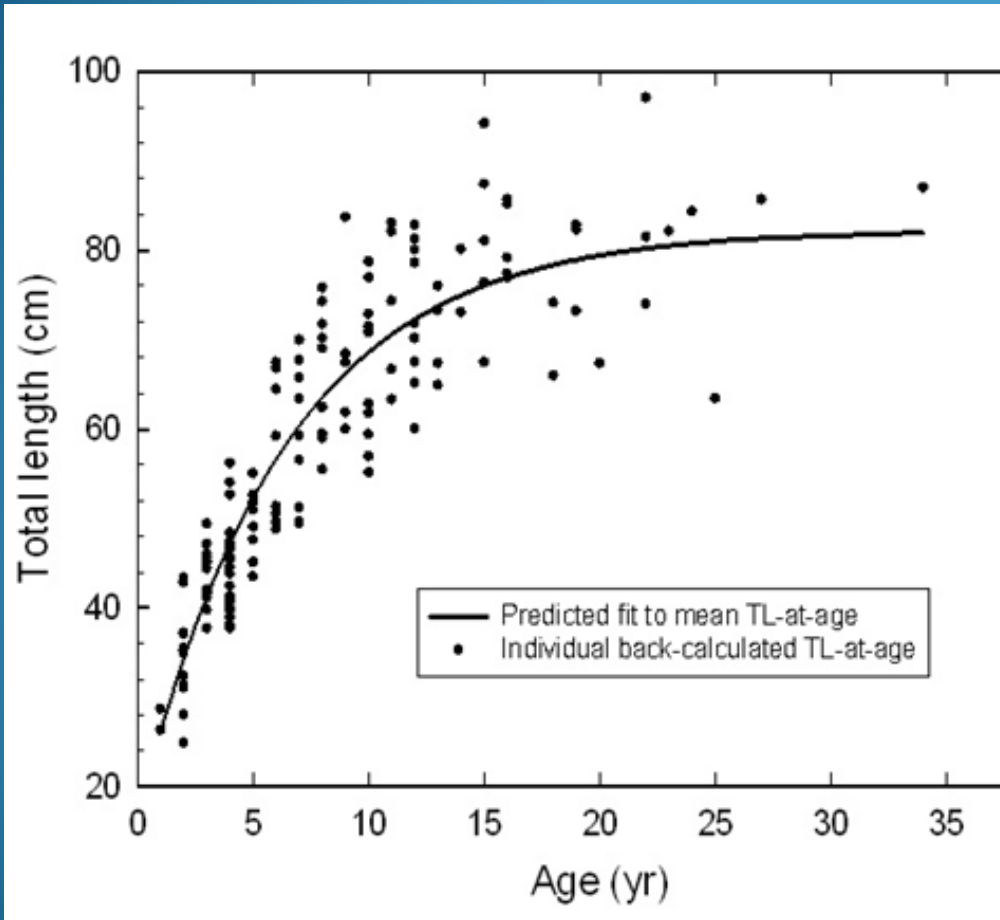
Implimentation:

- Initial training of bio-sampling teams
- Bio-Sampling adapted to local culture & fishing industry
- Improved access to sample fisheries landings
- Identification of fishes raised to species level
- Target top landed insular species most available in markets
- Equipment/supplies support for life history sampling
- Build capacity to conduct life history studies in Territories

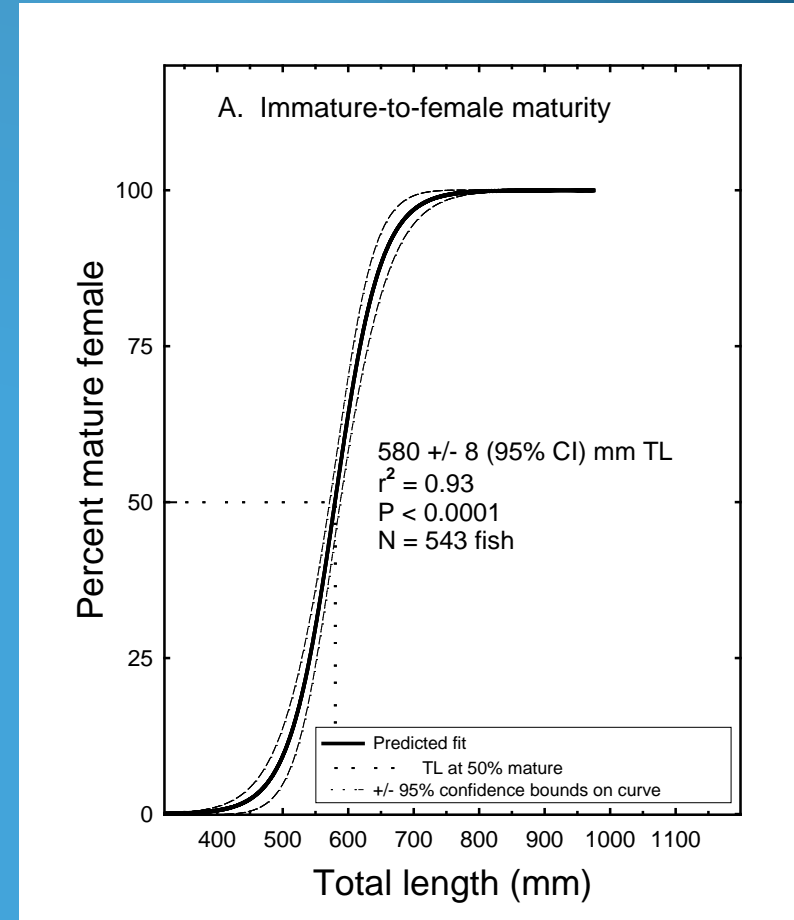


LIFE HISTORY PRODUCTS

Length-at-Age Growth Curve



Maturity Ogive



SAMPLING DESIGN

Tactics Employed:

- Size-stratified random monthly sampling of targeted species for life history studies
- Sampling over at least a 2 year interval
- During 2nd year, make-up any monthly deficits in sample numbers per size interval
- Ideally 20 specimens per month per size interval
- Opportunistically sample tails of length distribution



NOAA FISHERIES

SUPPLEMENTAL SAMPLING

NOAA Research Cruises

American Samoa – March-April 2012

CNMI & Guam – June-August 2014

Contractors

University of Guam –Parrotfish Life History Study

PIFG - Guam Bottomfishers – Eteline Snapper Sampling

Additional Funding

Western Pacific Regional Fishery Management Council

SPECIES SELECTION

Rationale:

- Input from Council, Bio-Samplers & Agencies
- Coral reef fish & bottomfish most data-poor
- Commercial importance (primarily top 25 landed)
- Little to no previous life history information
- Availability over spawning/non-spawning season
- Availability over size range of species

COMMERCIALLY IMPORTANT SPECIES GROUPS TARGETED



Epinephelinae
(groupers)



Lethrinidae
(emperors)



Lutjanidae
(snappers)



Mullidae
(goatfish)



Holocentridae
(soldierfish)



Siganidae
(rabbitfish)



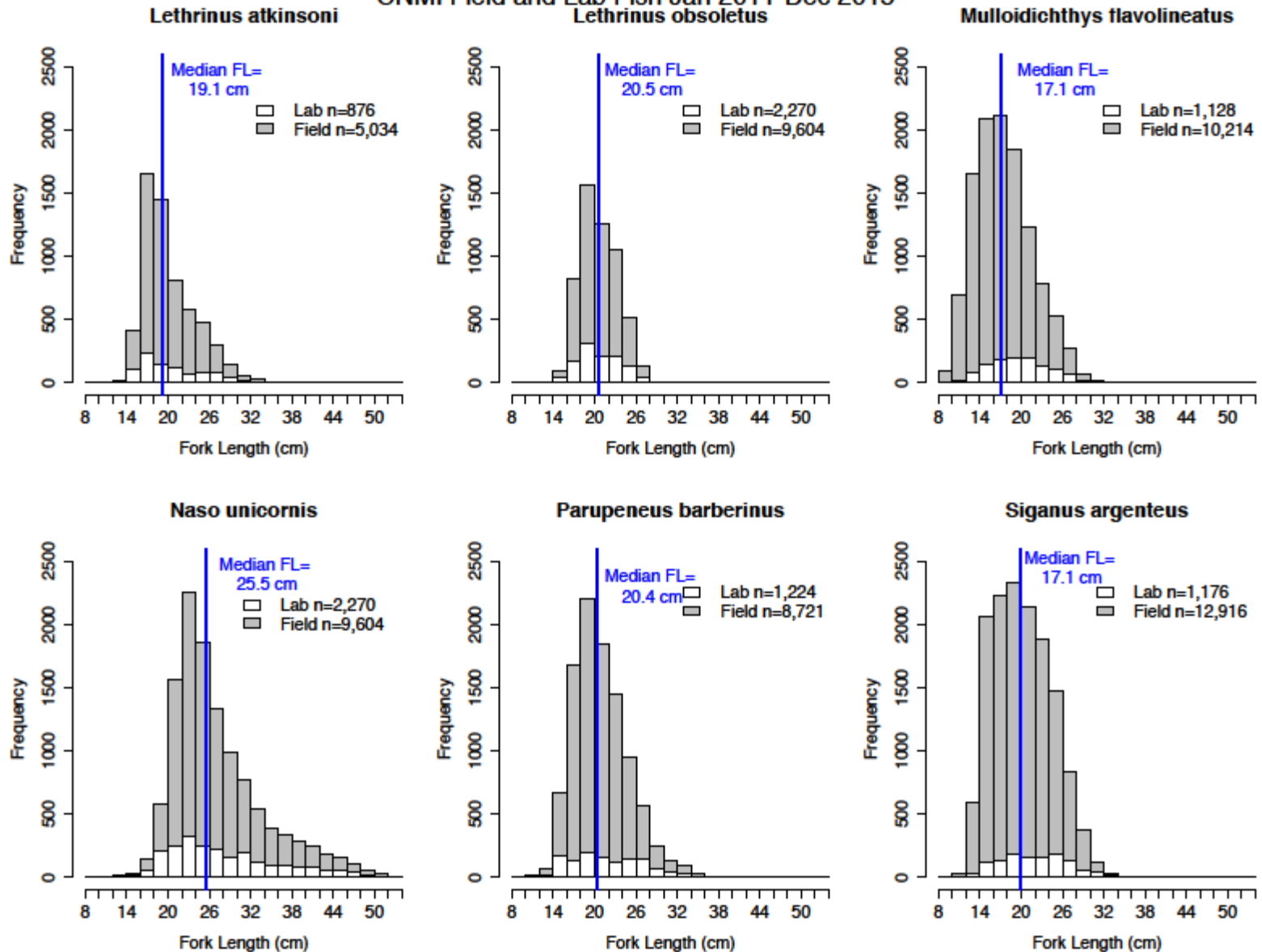
Acanthuridae
(surgeonfishes)



Labridae
(parrotfishes)

EXAMPLE OF LIFE HISTORY SAMPLING

CNMI Field and Lab Fish Jan 2011-Dec 2015



SCHEMATIC OF SAMPLE EXTRACTION AND PROCESSING

Whole Specimen



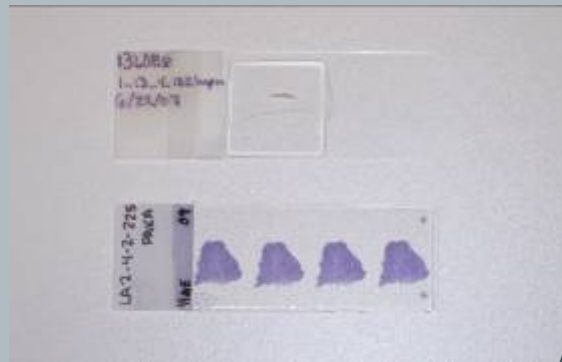
Otolith Extraction



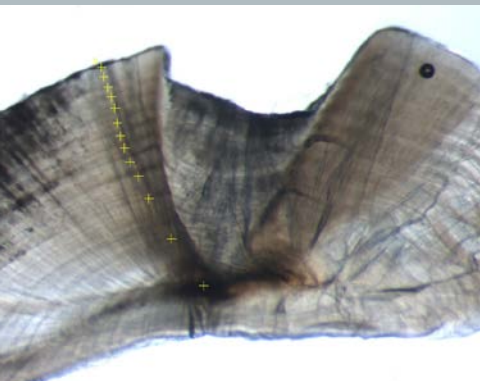
Gonad Extraction



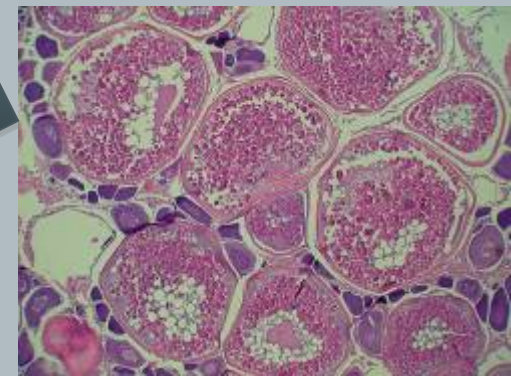
Processed Samples



Transverse Section



Histology Image



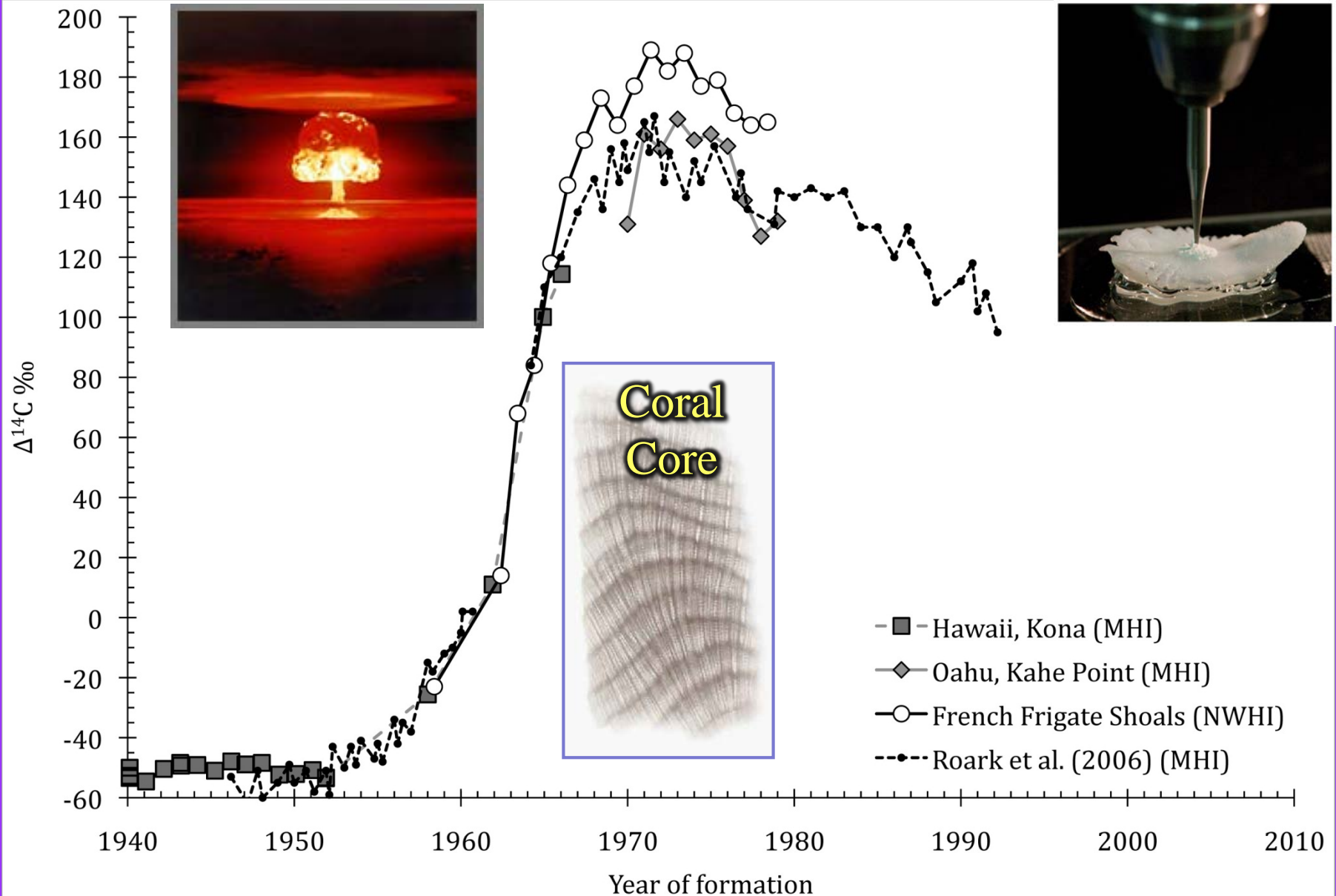
LAB PROCESSING OF OTOLITH SAMPLES: Annual & Daily Growth Marks

Traditional Otolith Processing for Age Determination from Transverse Sections:



- Otoliths weighed, measured & sectioned in-house or by fish ageing contract service
- Sections cut thicker for visualizing annual growth marks
- Thin sections require extra grinding/polishing to enhance visibility of daily growth increments (DGIs)
- Our experience found capable contractors limited

Bomb Radiocarbon Dating of Long-Lived Fish



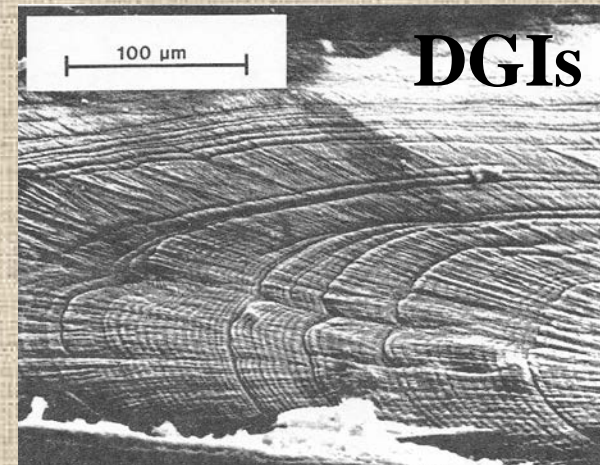
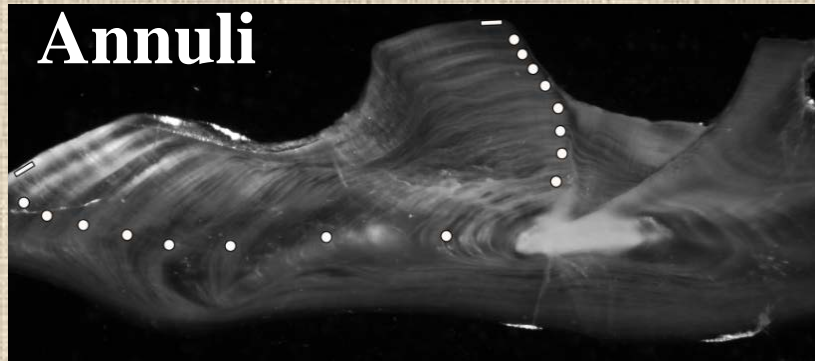
PROCESSING OF GONAD SAMPLES: Histology



- Gonads weighed then subsample fixed in the field, preserved ~3 months in Formalin
- Histology preps contracted to UH Medical School
- Histology slides received back are stained H&E thin-sections mounted on glass slides ready to be evaluated



OTOLITH ANALYSIS: Growth Marks



Lab Analysis:

1. Hi-power microscope counts of daily growth increments (DGIs)
2. Lower-power counts of presumed yearly growth marks (annuli)
 - If possible, DGI data used to identify first annulus
 - Marginal increment analysis to support annual deposition
 - 2 age readers, at least 3 blind counts per otolith

Data Analysis:

1. Variance of within/between-reader age estimates assessed
2. vonB growth function generated from length-at-age data

ANALYSIS OF OTOLITHS: Bomb Radiocarbon $\Delta^{14}\text{C}$ Dating

Analytical Assumptions:

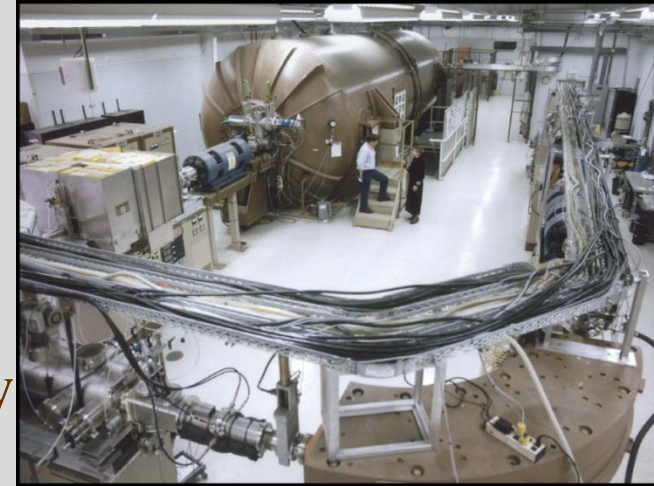
1. ^{14}C in otolith core fixed at deposition
2. Regional $\Delta^{14}\text{C}$ coral reference series

Lab Analysis:

1. $\Delta^{14}\text{C}$ measured at Woods Hole facility

Data Analysis:

1. Corrected $\Delta^{14}\text{C}$ values provided by Woods Hole
2. $\Delta^{14}\text{C}$ values projected back onto regional coral reference series to derive birth year and thus age
3. Auxiliary age data used to determine whether birth year coincides with rise or decline portion of $\Delta^{14}\text{C}$ reference series



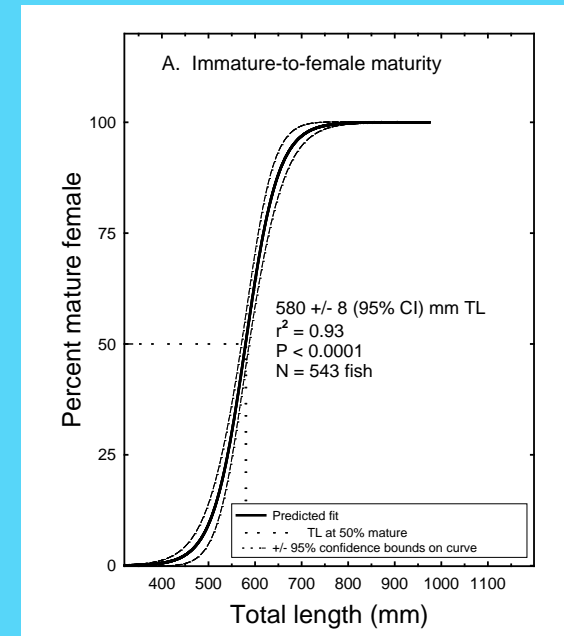
ANALYSIS OF GONADS: Gonad Histology to Determine Length at 50% Maturity (L_{50})

Lab Analysis:

- Histology criteria based on standard protocols (Brown-Peterson et al. 2011)
- Microscopic evaluation of each slide to determine reproductive stage & maturity status

Data Analysis:

- Calculate % mature per length class; mean estimates weighted by sample sizes within length classes
- L_{50} derived from fit of logistic equation to % maturity data
- GSI data also used to determine spawning period



CURRENT RESULTS-Guam

Species	T_{max}	L_{∞}	k	t_0	A_{50}	$A\Delta_{50}$	L_{50}	$L\Delta_{50}$
<i>Calatomus carolinus</i>	3 ^d	263 ^d	0.91 ^d	-0.065 ^d	1.14 ^d		16.8 ^d	21.3 ^d
<i>Chlorurus frontalis</i>	11 ^d	372 ^d	0.71 ^d	-0.058 ^d	1.55 ^d		24.0 ^d	34.3 ^d
<i>Chlorurus microrhinos</i>	11 ^d	457 ^d	0.34 ^d	-0.097 ^d	3.7 ^d		30.8 ^d	37.8 ^d
<i>Chlorurus spilurus</i>	9 ^d	218 ^d	0.95 ^d	-0.075 ^d	1.3 ^d		14.4 ^d	20.7 ^d
<i>Naso unicornis</i>	23 ^d	493 ^d	0.22 ^d	-0.48 ^d	4.0 ^d	NA	29.2 ^d	NA
<i>Scarus altipinnis</i>	14 ^d	339 ^d	0.66 ^d	-0.069 ^d	2.89 ^d		25.1 ^d	33.7 ^d
<i>Scarus forsteni</i>	12 ^d	281 ^d	0.88 ^d	-0.062 ^d	1.79 ^d		21.6 ^d	27.1 ^d
<i>Scarus psittacus</i>	6 ^d	207 ^d	0.91 ^d	-0.083 ^d	1.36 ^d		10.3 ^d	19.3 ^d
<i>Scarus rubroviolaceus</i>	6 ^d	376 ^d	0.66 ^d	-0.062 ^d	1.91 ^d		27.1 ^d	32.9 ^d
<i>Scarus schlegeli</i>	8 ^d	252 ^d	1.03 ^d	-0.06 ^d	1.99 ^d		19.7 ^d	22.0 ^d

CURRENT RESULTS-CNMI

Species	T_{max}	L_{∞}	k	t_0	A_{50}	$A\Delta_{50}$	L_{50}	$L\Delta_{50}$
<i>Lethrinus atkinsoni</i>							21.3 ^b	X ^a
<i>Lethrinus obsoletus</i>	15 ^b	X ^a	X ^a	X ^a	X ^a	X ^a	X ^a	X ^a
<i>Naso unicornis</i>						NA	23.8 ^b	NA
<i>Siganus argenteus</i>	7 ^c	274 ^c	0.9 ^c	-0.3 ^c	1.3 ^c	NA	21.8 ^c	NA

CURRENT RESULTS-AM SAMOA

Species	T_{max}	L_{∞}	k	t_0	A_{50}	$A\Delta_{50}$	L_{50}	$L\Delta_{50}$
<i>Myripristis berndti</i>						NA	16.6 ^b	NA
<i>Naso unicornis</i>	X ^a	X ^a	X ^a	X ^a	X ^a	NA	X ^a	NA
<i>Sargocentron tere</i>						NA	15.0 ^b	NA

Regional Differences in L_{50}

Bluespine unicornfish, *Naso unicornis*

HI (DeMartini et al. 2014)

Female $L_{50} = 35.5$ cm FL

Male $L_{50} = 30.1$ cm FL

Guam (Taylor et al. 2014)

Female $L_{50} = 29.2$ cm FL

Male $L_{50} = 27.1$ cm FL

Pohnpei (Taylor et al. 2014)

Female $L_{50} = 31.2$ cm FL

Male $L_{50} = 26.9$ cm FL



Species ID Verification

DNA-based barcode analyses



- Collection of 5 fin clips per species from adult specimens through Bio-Sampling
- mtDNA extracted from fin clips and sequenced to confirm species match
- Species DNA analyses conducted by John Hyde (SWFSC La Jolla) and Brian Bowen (HIMB)
- DNA sequences for 35 species run; no evidence thusfar of miss-IDs or cryptic species in Western Pacific
- Further progress has stalled

CAPACITY BUILDING

American Samoa:

DMWR staff training in gonad histology-
Nov 2015

CNMI:

Bio-Sampling and DFW staff training in gonad
histology-Dec 2014

Bio-Sampling and DFW staff training in otolith
preparation and reading-Nov 2015 & Jan 2016

Guam:

Bottomfish ageing project

S-K Grant for University of Guam (2014-on) for
C-14 & development of otolith ageing lab



STATUS OF LIFE HISTORY STUDIES

- Large backlog of otolith & gonad samples at PIFSC
- Primarily focus on reef fish life history studies
- Increasing efforts to age deepwater bottomfish species
- Need samples from smallest and largest sizes of targeted bio-sampling species; not usually landed in the fishery
- Recent collaboration with SPC and Western Australian scientists will improve otolith age & growth determination and standardize ageing protocols
- Continuing life history capacity building

FUTURE DIRECTIONS

- Capacity Building including PIFSC
- Regional Comparisons
- Sampling Unfished/Lightly Fished Populations
- International Collaborations
- Connectivity/Stock Structure
- Multi-Species Groupings by Similar Life Histories

TOP 25 SPECIES BY PACIFIC TERRITORY

AMERICAN SAMOA

- 1 *Acanthurus lineatus*
- 2 *Ctenochaetus striatus*
- 3 *Naso lituratus*
- 4 *Lutjanus kasmira*
- 5 *Sargocentron tiera*
- 6 *Chlorurus japanesis*
- 7 *Lethrinus rubrioperculatus*
- 8 *Naso unicornis*
- 9 *Scarus rubroviolaceus*
- 10 *Panulirus pencillatus*
- 11 *Scarus oviceps*
- 12 *Myripristis berndti*
- 13 *Acanthurus nigricans*
- 14 *Lutjanus gibbus*
- 15 *Lethrinus xanthochilus*
- 16 *Epinephelus melanostigma*
- 17 *Myripristis amaena*
- 18 *Acanthurus guttatus*
- 19 *Panulirus sp.*
- 20 *Myripristis murdjan*
- 21 *Scarus frenatus*
- 22 *Selar crumenophthalmus*
- 23 *Parupeneus bifasciatus*
- 24 *Variola albimarginatus*
- 25 *Scarus globiceps*

CNMI

- 1 *Naso literatus*
- 2 *Acanthurus lineatus*
- 3 *Siganus argenteus*
- 4 *Mulloidichthys flavolineatus*
- 5 *Naso unicornis*
- 6 *Siganus spinus*
- 7 *Parupeneus barberinus*
- 8 *Selar crumenophthalmus*
- 9 *Scarus ghobban*
- 10 *Lethrinus atkinsoni*
- 11 *Lethrinus obsoletus*
- 12 *Mulloidichthys vanicolensis*
- 13 *Scarus rubroviolaceus*
- 14 *Chlorurus sordidus*
- 15 *Siganus punctatus*
- 16 *Sargocentron spiniferum*
- 17 *Myripristis murdjan*
- 18 *Scarus psittacus*
- 19 *Acanthurus nigricauda*
- 20 *Cheilinus trilobatus*
- 21 *Hipposcarus longiceps*
- 22 *Panulirus penicillatus*
- 23 *Leptoscarus vaigiensis*
- 24 *Calotomus carolinus*
- 25 *Myripristis violacea*

GUAM

- 1 *Naso unicornis*
- 2 *Naso literatus*
- 3 *Acanthurus lineatus*
- 4 *Scarus altipinnis*
- 5 *Lethrinus rubrioperculatus*
- 6 *Myripristis berndti*
- 7 *Siganus argenteus*
- 8 *Acanthurus nigricauda*
- 9 *Hipposcarus longiceps*
- 10 *Epinephelus fasciatus*
- 11 *Scarus schlegeli*
- 12 *Siganus punctatus*
- 13 *Monotaxis grandoculis*
- 14 *Scarus rubroviolaceus*
- 15 *Lethrinus obsoletus*
- 16 *Scarus forsteni*
- 17 *Pristipomoides auricilla*
- 18 *Lutjanus gibbus*
- 19 *Panulirus penicillatus*
- 20 *Parupeneus insularis*
- 21 *Siganus spinus*
- 22 *Lethrinus atkinsoni*
- 23 *Chlorurus microrhinus*
- 24 *Chlorurus sordidus*
- 25 *Kyphosus cinerascens*

AMERICAN SAMOA SPECIES TARGETED FOR LIFE HISTORY STUDIES

SPECIES NAME	ENGLISH NAME	HABITAT
<i>Lethrinus xanthochilus</i>	Yellowlip Emperor	Bottomfish
<i>Lutjanus gibbus</i>	Humpback Snapper	Bottomfish
<i>Lutjanus rufolineatus</i>	Moluccan Snapper	Bottomfish
<i>Myripristis amaena</i>	Brick Soldierfish	Reef fish
<i>Myripristis berndti</i>	Bigscale Soldierfish	Reef fish
<i>Myripristis murdjan</i>	Blotcheye Soldierfish	Reef fish
<i>Naso unicornis</i>	Bluespine Unicornfish	Reef fish
<i>Sargocentron caudimaculatum</i>	Tailspot Squirrelfish	Reef fish
<i>Sargocentron spiniferum</i>	Sabre Squirrelfish	Reef fish
<i>Sargocentron tiera</i>	Blue-Lined Squirrelfish	Reef fish
<i>Scarus rubroviolaceus</i>	Redlip Parrotfish	Reef fish

CNMI SPECIES TARGETED FOR LIFE HISTORY STUDIES

SPECIES NAME	ENGLISH NAME	HABITAT
<i>Acanthurus nigricauda</i>	Blackstreak Surgeonfish	Reef fish
<i>Calotomus carolinus</i>	Stareye Parrotfish	Reef fish
<i>Cheilinus undulatus</i>	Napoleon Wrasse	Reef fish
<i>Chlorurus spilurus</i>	Pacific Bettlehead Parrotfish	Reef fish
<i>Lethrinus atkinsoni</i>	Yellowtail Emperor	Reef fish
<i>Lethrinus obsoletus</i>	Yellowstripe Emperor	Reef fish
<i>Monotaxis grandoculis</i>	Bigeye Emperor	Reef fish
<i>Mulloidichthys favolineatus</i>	Yellowstripe Goatfish	Reef fish
<i>Mulloidichthys vanicolensis</i>	Yellowfin Goatfish	Reef fish
<i>Naso unicornis</i>	Bluespine Unicornfish	Reef fish
<i>Parupeneus barberinus</i>	Dash-dot Goatfish	Reef fish
<i>Sargocentron spiniferum</i>	Sabre Squirrelfish	Reef fish
<i>Sargocentron tiera</i>	Blue-Lined Squirrelfish	Reef fish
<i>Siganus argenteus</i>	Forktail Rabbitfish	Reef fish
<i>Siganus spinus</i>	Scribbled Rabbitfish	Reef fish

GUAM SPECIES TARGETED

SPECIES NAME	ENGLISH NAME	HABITAT
<i>Calatomus carolinus</i>	Stareye Parrotfish	Reef fish
<i>Chelinus undulatus</i>	Napoleon Wrasse	Reef fish
<i>Chlorurus frontalis</i>	Tan-Faced Parrotfish	Reef fish
<i>Chlorurus microrhinus</i>	Pacific Steephead Parrotfish	Reef fish
<i>Chlorurus spilurus</i>	Pacific Bullethead Parrotfish	Reef fish
<i>Etelis coruscans</i>	Flame Snapper	Bottomfish
<i>Hipposcarus longiceps</i>	Pacific Longnose Parrotfish	Reef fish
<i>Monotaxis grandoculis</i>	Bigeye Emperor	Bottomfish
<i>Pristipomoides filamentosus</i>	Pink Snapper	Bottomfish
<i>Pristipomoides zonatus</i>	Oblique-Banded Snapper	Bottomfish
<i>Scarus altipinnus</i>	Filament-Fin Parrotfish	Reef fish
<i>Scarus forsteni</i>	Rainbow Parrotfish	Reef fish
<i>Scarus psittacus</i>	Palenose Parrotfish	Reef fish
<i>Scarus rubroviolaceus</i>	Redlip Parrotfish	Reef fish
<i>Scarus schlegeli</i>	Yellowband Parrotfish	Reef fish
<i>Variola louti</i>	Lyretail Grouper	Bottomfish

BIO-SAMPLING: FIN CLIPS PROCESSED

**Extracted mtDNA Barcode Sequenced at SWFSC La Jolla to
Confirm 34 Species Identifications Sampled from Guam**

- **Acanthuridae (surgeonfish): 3 species**
- **Exocoetidae (flying fish): 1 species**
- **Epinephelinae (groupers): 3 species**
- **Carangidae (jacks): 2 species**
- **Kyphosidae (rudderfish): 1 species**
- **Labridae (parrotfish 7 wrasses): 3 species**
- **Leiognathidae (slipmouths): 1 species**
- **Lethrinidae (emperors): 4 species**
- **Lutjanidae (snappers): 10 species**
- **Mullidae (goatfishes): 3 species**
- **Priacanthidae (bigeyes): 1 species**
- **Siganidae (rabbitfish): 2 species**

A DNA barcode is a
short gene sequence
taken from
standardized portions
of the genome,
used to identify species

The Barcoding Process for Species Identifications



Specimen or Tissue Sample



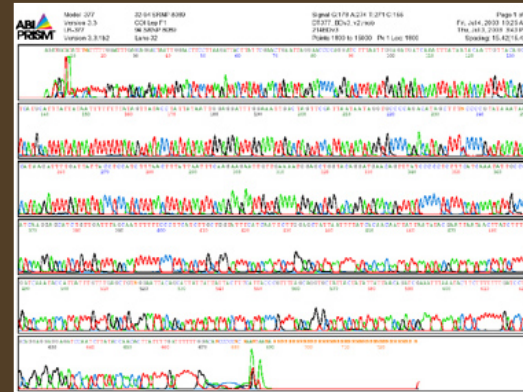
Extract DNA



PCR COI



Sequence COI



DNA Barcode

