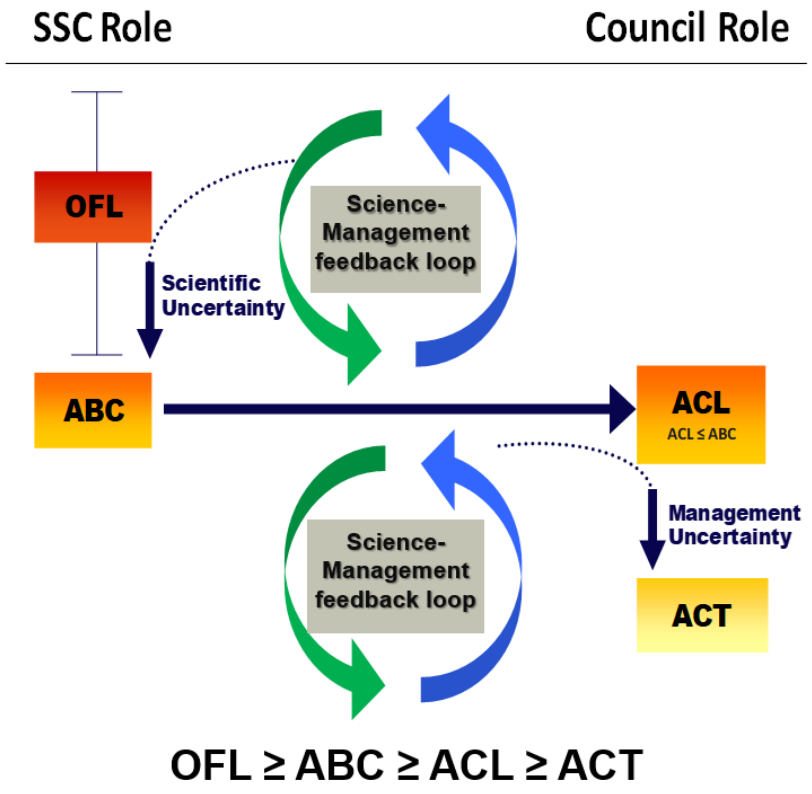
Deepwater Snappers and Reef Fishes in the U.S. Caribbean: Ageing Validation Using Bomb Radiocarbon and Longevity Estimates

Virginia Shervette and Jesús Rivera Hernández, University of South Carolina
Kate Overly, NMFS Panama City
Noemí Peña Alvarado and Wilson Santiago Soler, Puerto Rico DNER
Will Patterson, University of Florida
Julien Magras, St. Thomas/St. John Fishermen's Association

Contact Virginia at:
shervette@gmail.com

Assessment-Management Paradigm under MSRA (2006)



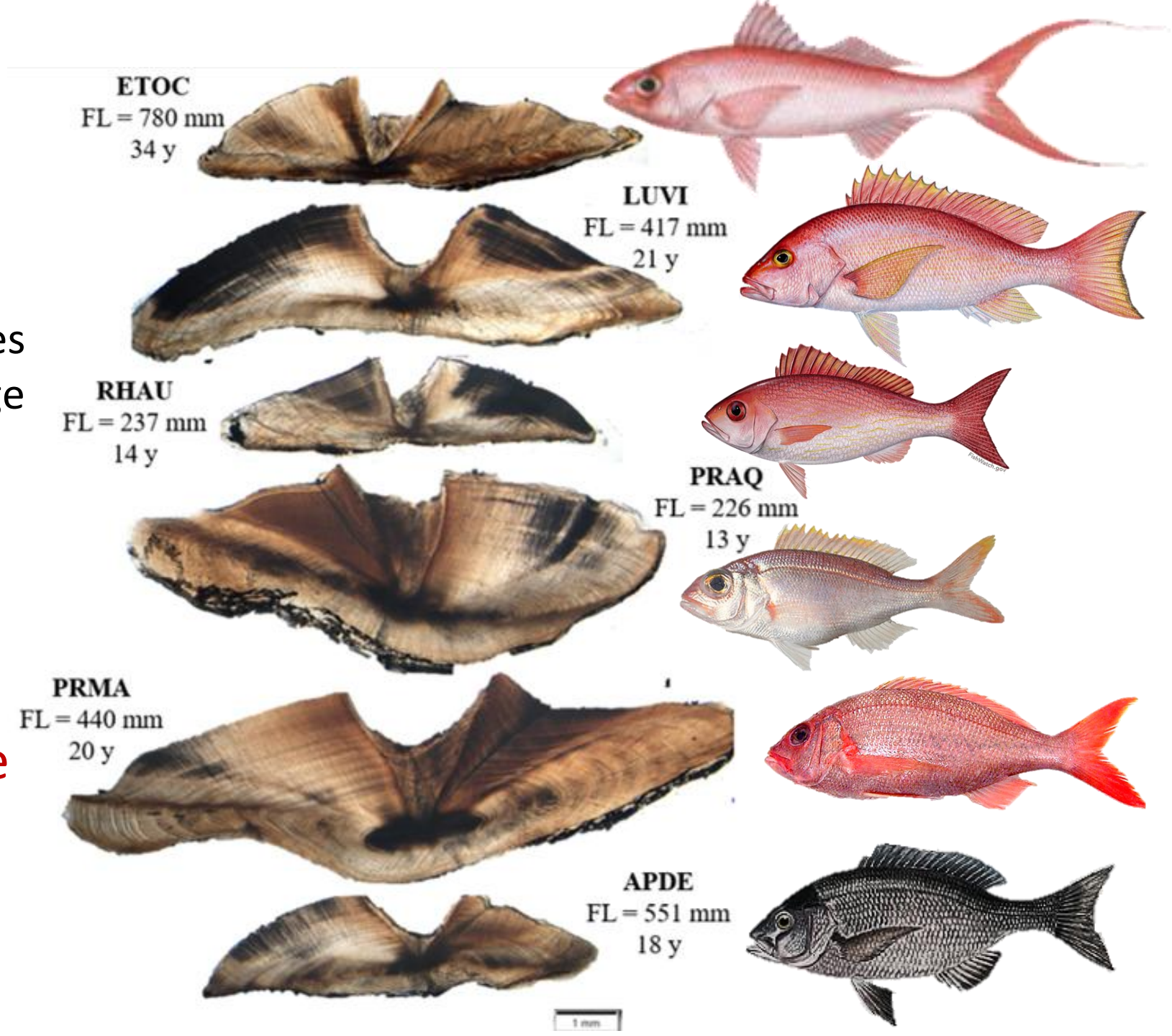
- No true management target; goal = avoid overfishing (i.e., landings < OFL)
- Overfishing avoided via buffers between OFL and ABC and between ACL and ACT
- Result: realized F often < F_{OY} for Caribbean reef fishes

- **Increasing life history information, minimizing aging error, and expediting age estimation = means to minimize scientific uncertainty**

Estimating ages/documenting longevity for fisheries species is a fundamental step in our ability to sustainably manage fisheries

- Rocket science
- Sagittal otolith sections, count opaque zones
- Temperate versus tropical
- Many U.S. Caribbean species inaccurately aged in past studies or have different population age structure than reported for SEUS

"Takes a meticulous effort and large amount of work to ensure that age data are accurate for our U.S. Caribbean fish species!"



Validation of Age Estimation via $\Delta^{14}C$ Chronometer

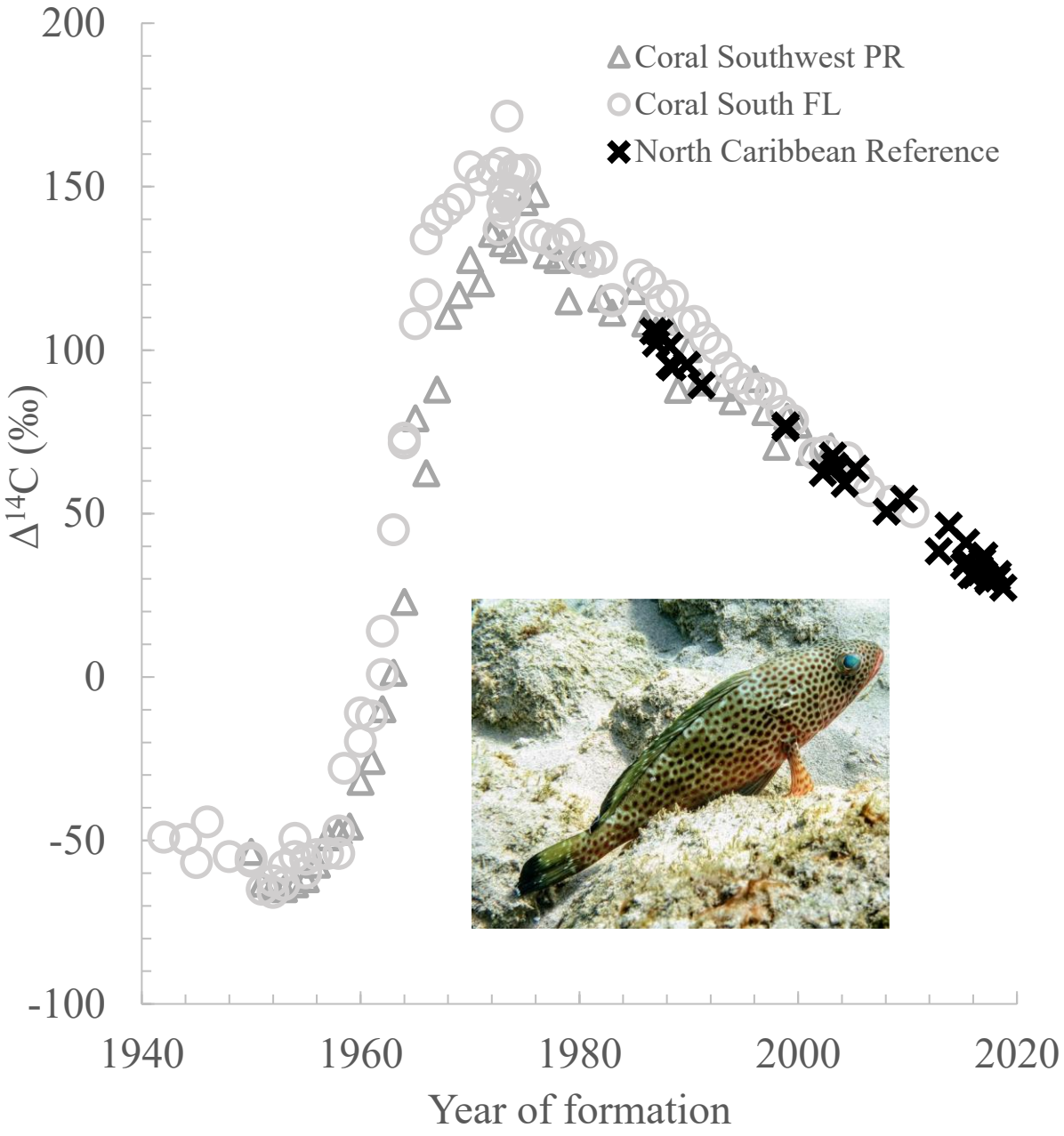
Bomb radiocarbon is a useful tool applied to the validation of age estimates in fishes

^{14}C was introduced into the atmosphere - nuclear bomb testing 1950s until 1970

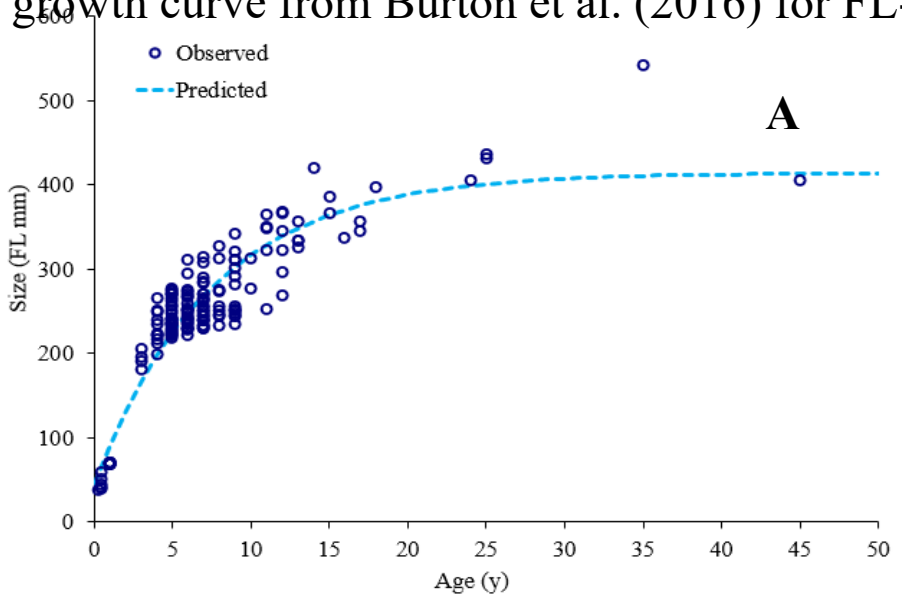
^{14}C dissolved into ocean CO_2 and incorporated into aragonite (biogenic $CaCO_3$) skeletons of hermatypic corals, carbonate-based shells of mollusks, and the aragonite structures of fishes

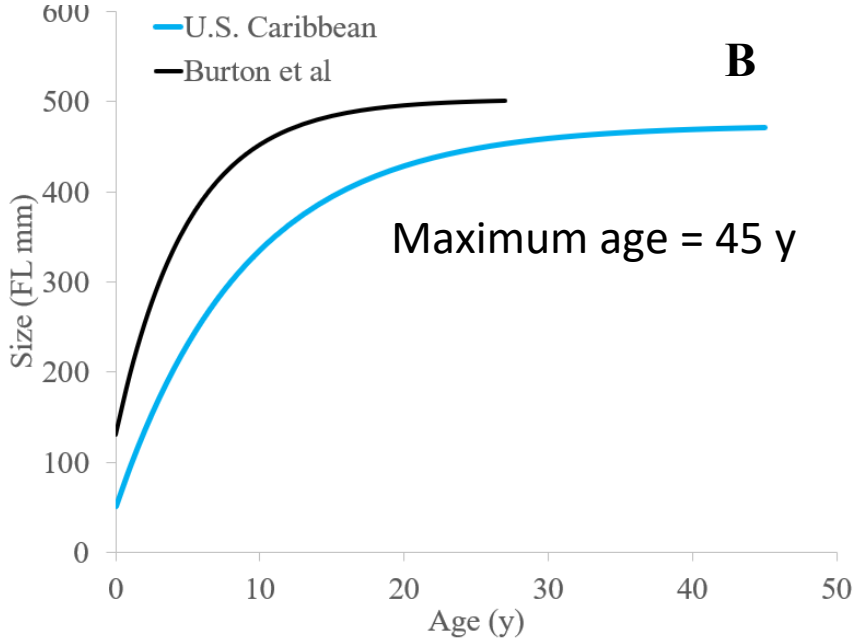
The time-specific $\Delta^{14}C$ aragonite records provide regional reference chronologies used to evaluate fish age estimates through comparison of fish $\Delta^{14}C$ measured in otolith core or eye lens core material that formed during early life

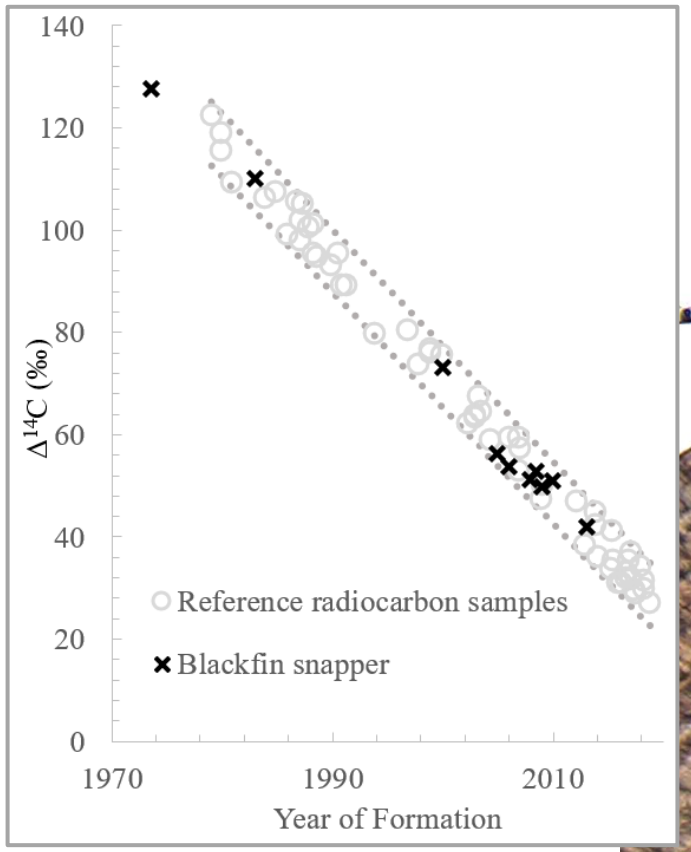
We recently developed a region-specific northern Caribbean $\Delta^{14}C$ chronometer for reef fish age validation work



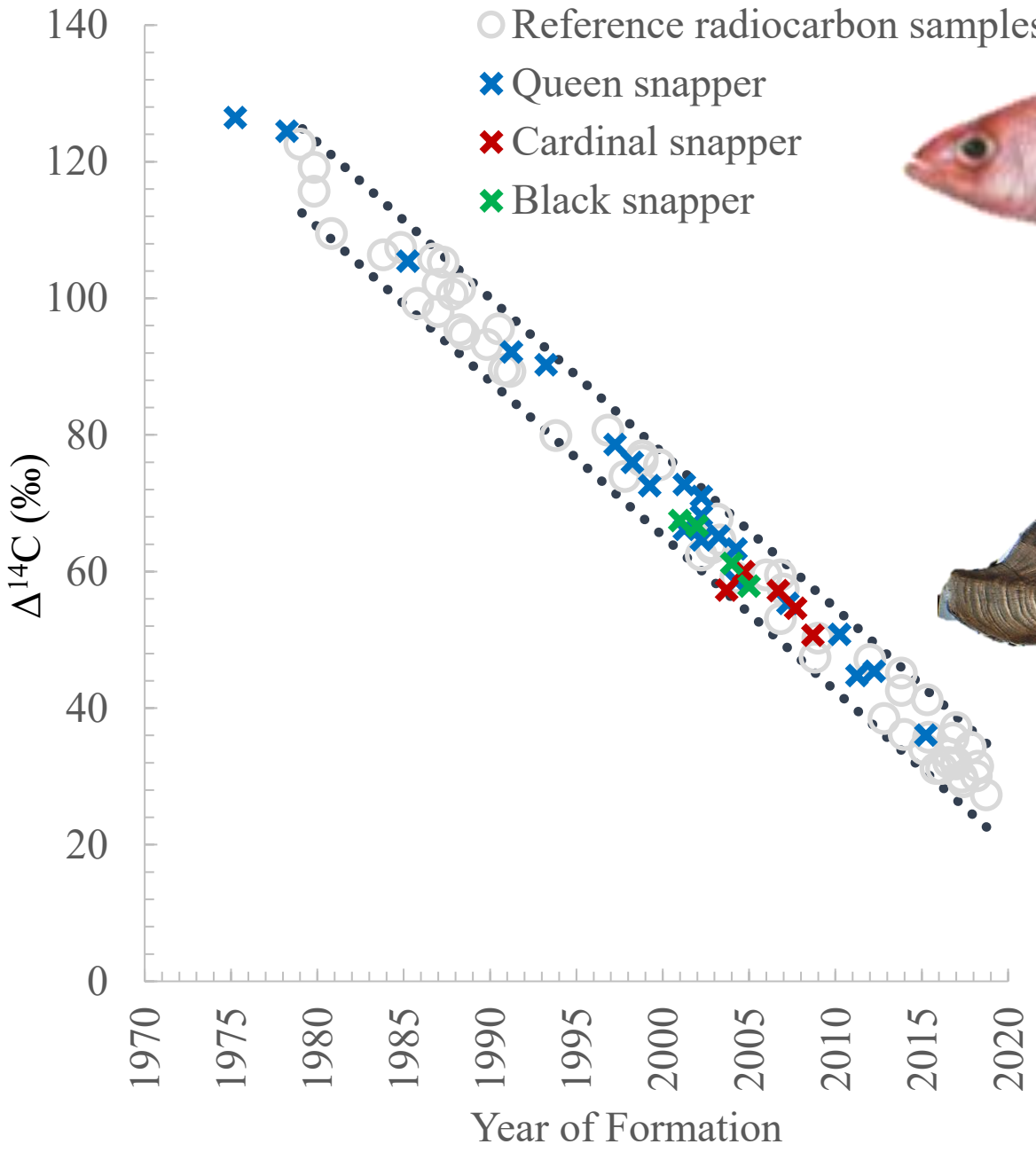
(A) Growth function fit to observed size at age data for our U.S. Caribbean blackfin snapper samples. (B) von Bertalanffy growth curves for our U.S. Caribbean samples compared to the growth curve from Burton et al. (2016) for FL-Caribbean blackfin samples.



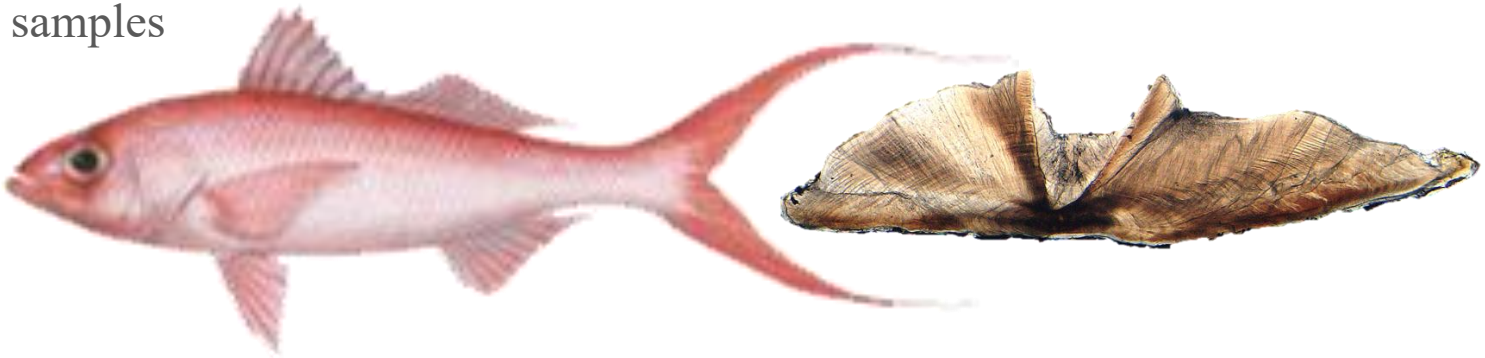




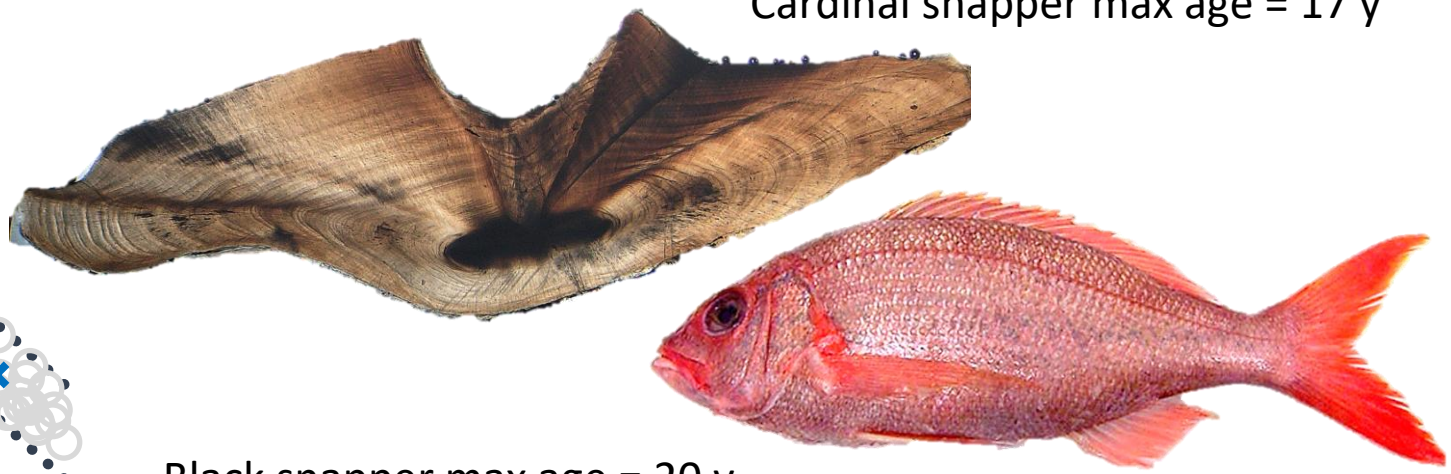
Caught 2016
south of St. Thomas
FL 405 mm
Female



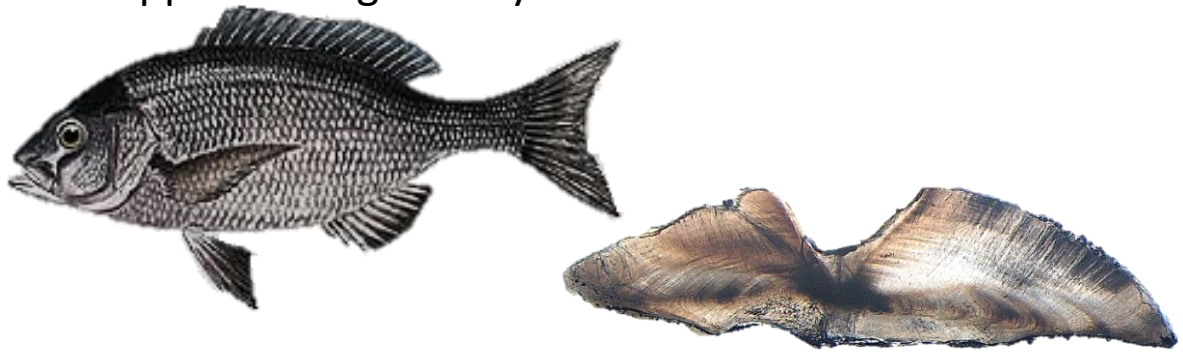
Queen snapper max age = 45+ y

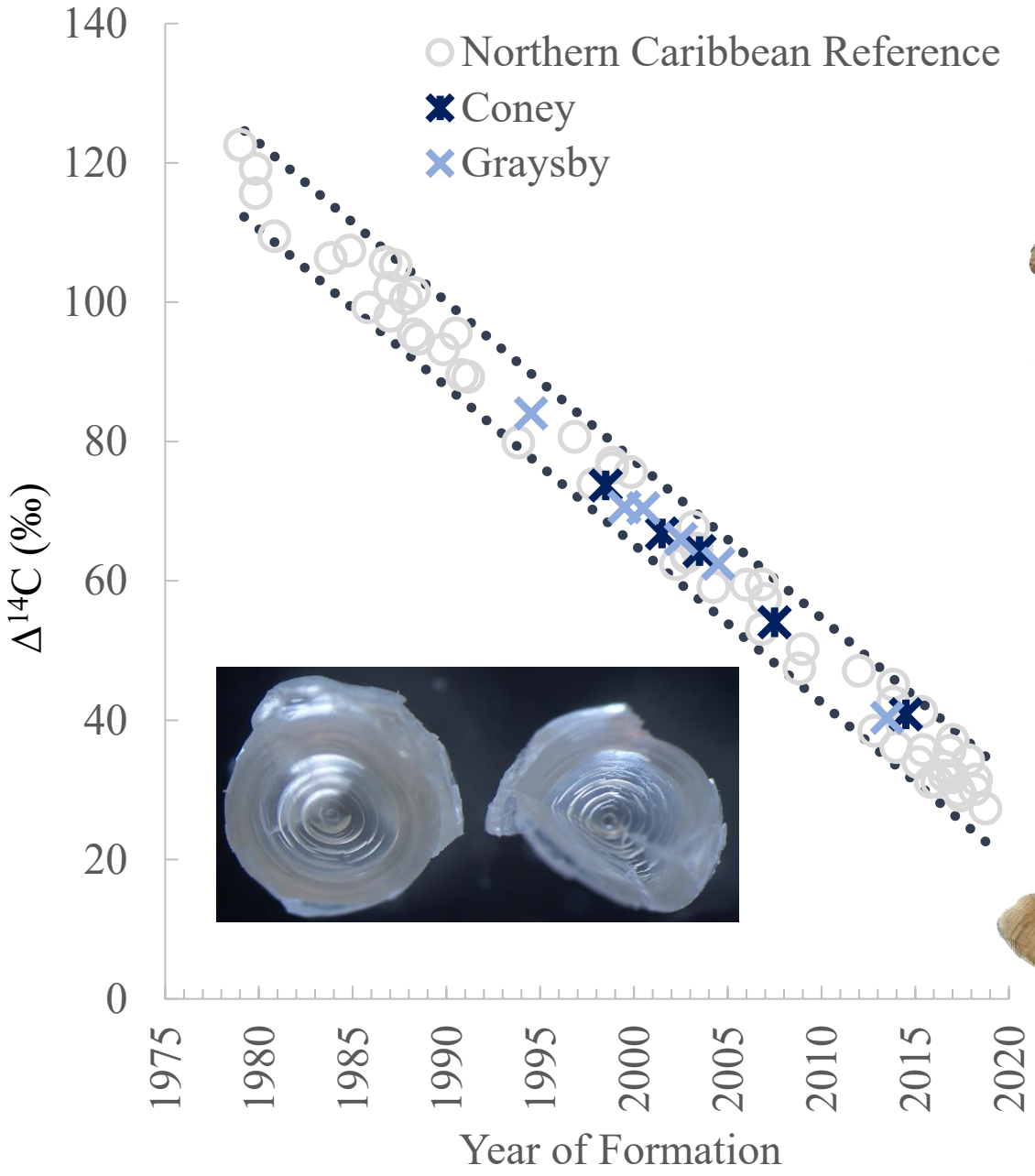


Cardinal snapper max age = 17 y



Black snapper max age = 20 y




Northern Caribbean Reference
Coney
Graysby
140
120
100
80
60
40
20
0
Δ14C (‰)
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year of Formation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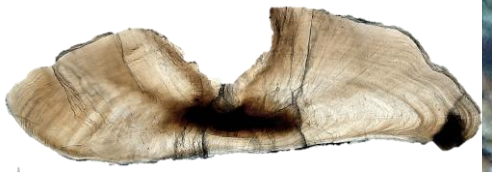
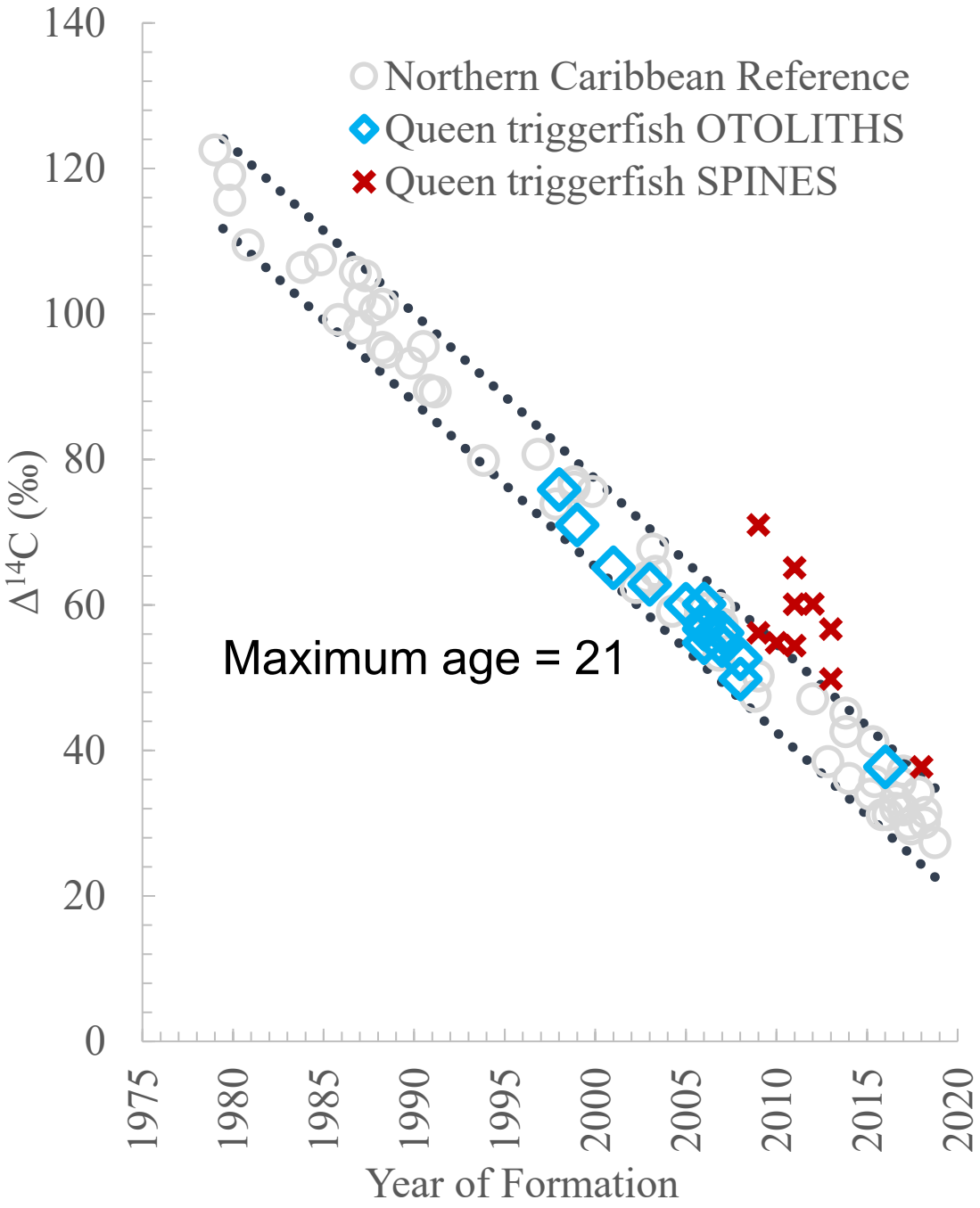
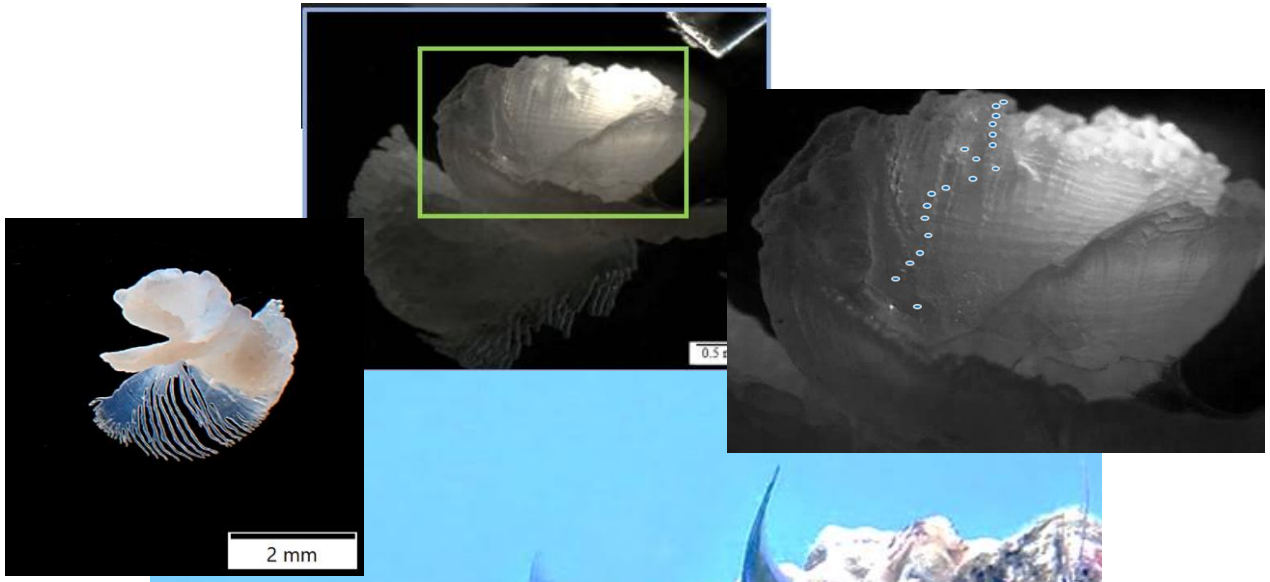
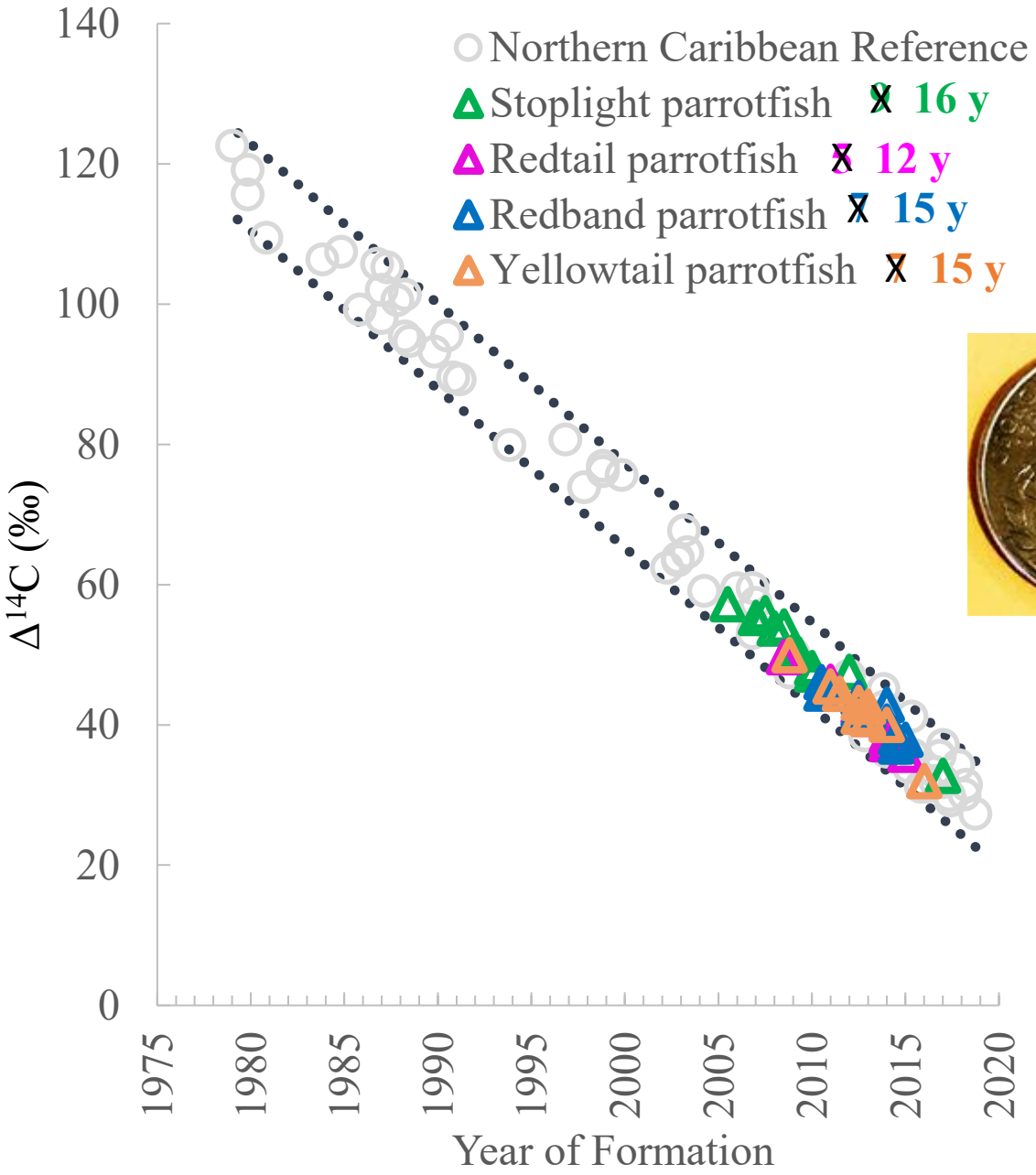


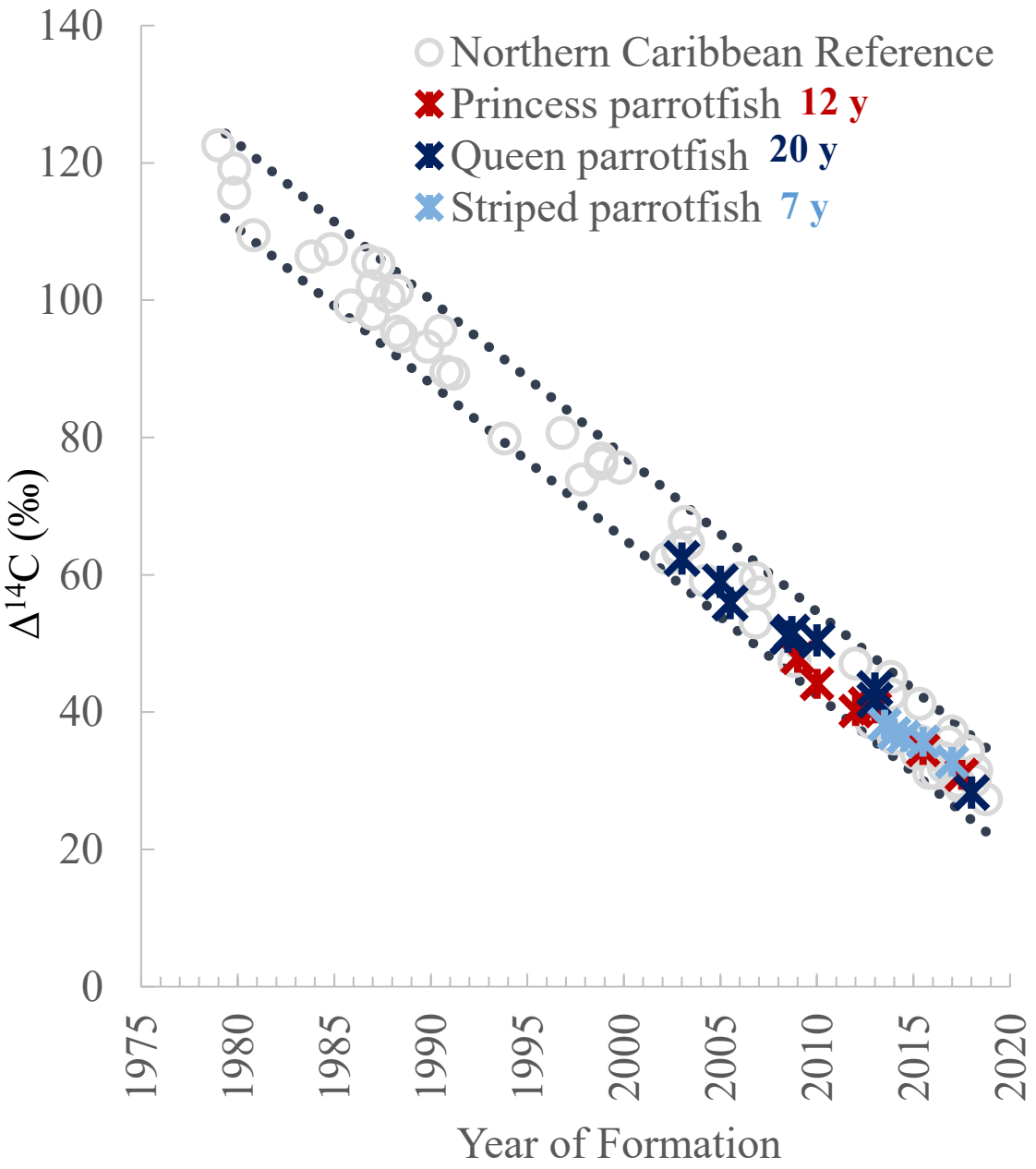


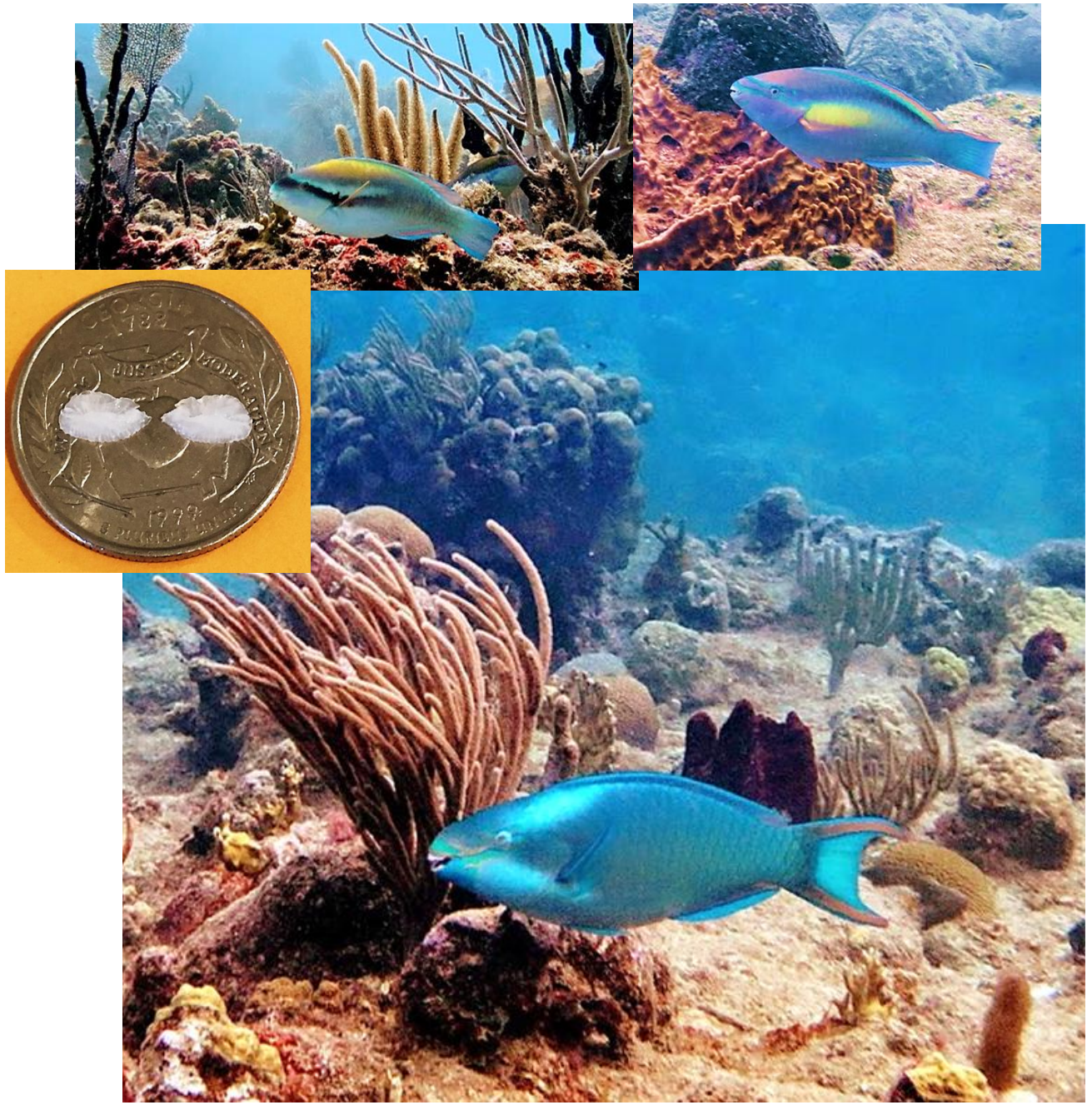


Previously published age data from Caribbean: Max age = 7 y



Previous T_{max} estimatesfrom Choat and Robertson 2002. Age based studies on coral reef fishes.


Northern Caribbean Reference
Princess parrotfish 12 y
Queen parrotfish 20 y
Striped parrotfish 7 y
Δ14C (‰)
140
120
100
80
60
40
20
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year of Formation



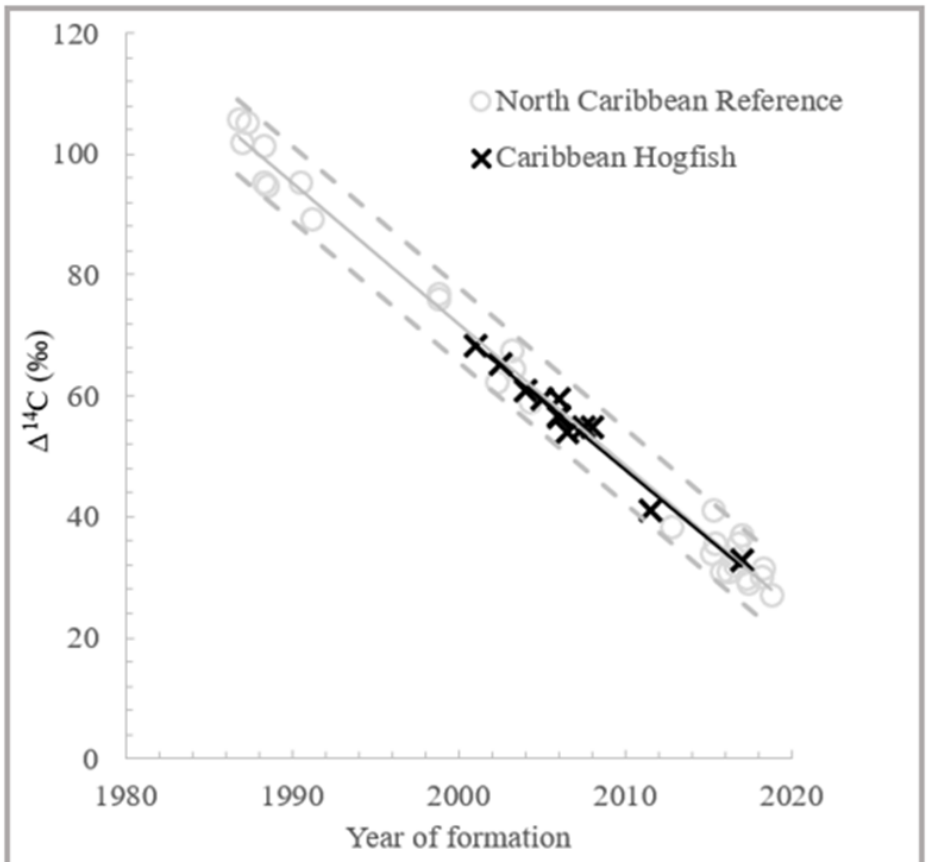


Figure 9. Bomb radiocarbon relationship for the north Caribbean reference series. Hogfish lens core estimated birth years, based on sagittal otolith increment counts and corresponding $\Delta^{14}C$ results were overlaid on the reference decline for the region. Also illustrated are fitted linear trends for the reference decline (solid gray line) and for hogfish (black line).

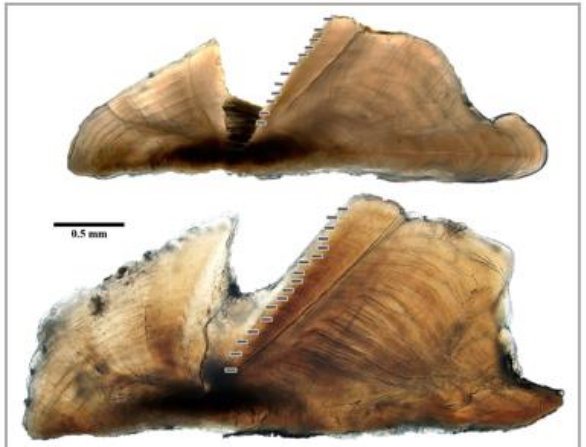


Figure 3. Sectioned sagittal otoliths of hogfish selected for $\Delta^{14}C$ analysis. The top section is from a hogfish caught May 2019 in PR; FL = 601 mm. The bottom section is from a hogfish caught October 2018 in PR; FL = 578 mm.

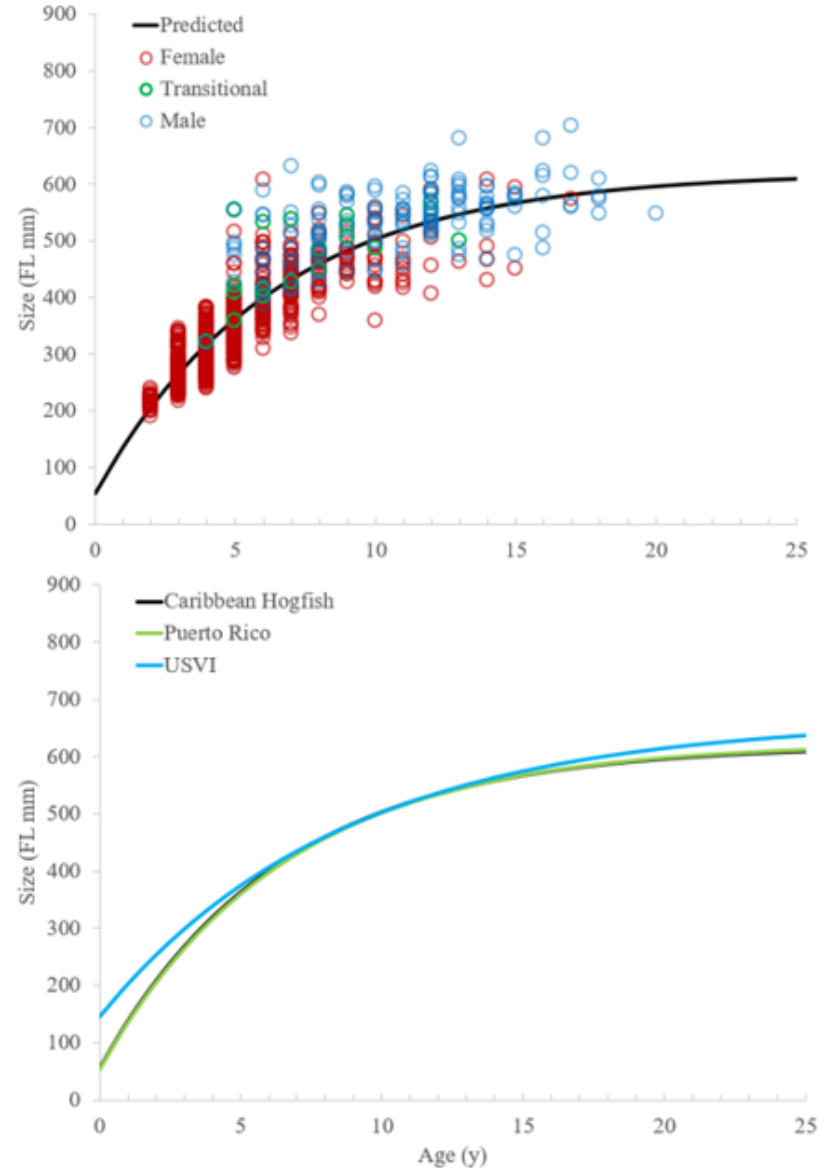


Figure 11. Von Bertalanffy growth function fit to observed size at age data for fisheries-dependent Caribbean hogfish samples from 2015-2020 (top) and a comparison of the three von Bertalanffy growth functions determined for the combined Caribbean samples, PR samples, and USVI samples (bottom).

Maximum age from current study = 20 y

Similar maximum age reported from Florida = 23 y (McBride and Richardson 2007)

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