# The use of otolith microchemistry to determine sources of Lutjanid recruits to the Dry Tortugas Ecological Reserve

**A.Wright [1]**, T. Gerard [2], E. Malca [1], J. Lamkin [2]

[1]University of Miami, Cooperative Institute for Marine and Atmospheric Studies, Miami, FL 33149

[2]NOAA, Southeast Fisheries Science Center, Early Life History Unit, Miami, FL 33149

## Introduction

An understanding of the connectivity among local fish populations through larval dispersal is essential for defining the geographic scale of resource management. In this study, we collected newly settled recruits (12-17 mm) of two Lutjanid species (*Lutjanus griseus* and *Ocyurus chrysurus*) from the Dry Tortugas National Park, an enclave of islands located 112 km west of Key West. We performed isotopic analysis of otoliths to assess the potential for determining whether recruits originated from single or multiple sources. Reconstruction of source history of Dry Tortugas *L. griseus* and *O. chrysurus* recruits was facilitated by establishing a gradient of environmental variability.

## Objective

Analyze $\delta^{13}C$ and $\delta^{18}O$ signatures of O. chrysurus and L. griseus otoliths to assess the potential for determining sources of newly settled recruits.

1. Compare the $\delta^{13}C$ and $\delta^{18}O$ signatures of L. griseus and O. chrysurus recruits collected in the Dry Tortugas
2. Compare the $\delta^{13}C$ and $\delta^{18}O$ signatures of L. griseus and O. chrysurus recruits with the $\delta^{13}C$ and $\delta^{18}O$ signatures of L. griseus and O. chrysurus recruits collected in Xcalak, Mexico and Brewer's Bay, US Virgin Islands.
3. Compare the $\delta^{13}C$ and $\delta^{18}O$ signatures of newly recruited L. griseus and O. chrysurus with the $\delta^{13}C$ and $\delta^{18}O$ signatures of L. griseus juveniles collected in the Dry Tortugas.

## Target Species

Yellowtail snapper (*Ocyurus chrysurus*) and gray snapper (*Lutjanus griseus*) are reef-associated members of the family Lutjanidae. *O. chrysurus* and *L. griseus* are valuable commercial species in Florida Bay yet their pre-settlement life history is relatively unknown. Isotopic analysis of newly recruited *O. chrysurus* and *L. griseus* otoliths may reveal whether these fishes originate from single or multiple sources.

**Figure 1.** Juvenile *Lutjanus griseus* and *Ocyurus chrysurus*. Bar = 1mm

## Otoliths

Otoliths are aragonitic accretions located within the inner ear of teleost fish (Thorrold et al., 1997). Various elements and isotopes are deposited onto growing otoliths from ambient physical and chemical environments. Since deposition is unaltered by metabolic processes, environmental signatures of particular habitats are captured permanently within the otolith (Campana et al., 2000).

**Figure 2.** Fish otoliths of O. chrysurus. Bar = 1 µm

## Methodology

Specimens were collected from Dry Tortugas National Park in August 2002 using settlement collectors during a South Florida larval recruit cruise aboard the NOAA ship Gordon Gunter. Samples were frozen and then preserved in 95% reagent grade ethanol. Sagittal otolith pairs were extracted from 16 *O. chrysurus* and 23 *L. griseus* recruits (12-17 mm) and 10 *L. griseus* juveniles (167-187 mm). Otoliths were submerged in 11% sodium hypochlorite, rinsed in $ddH_2O$ and dried in a Class 100 clean hood. Analyses of $\delta^{13}C$ and $\delta^{18}O$ were performed by a ThermoQuest Finnigan Delta Plus Mass Spectrometer with a Kiel III device. Standard mass spectrometric techniques were applied after the carbonate was decomposed to $CO_2$ with 100% phosphoric acid. ISODAT software calculated all isotopic values which are reported using the international standard delta notation for carbonates relative to the PDB-1 standard (Gerard, 2009). Nonparametric multivariate statistical analysis was performed with Primer software. The difference between species and collection sites was tested using nonparametric multivariate ANOVA (Permanova). Ordination of normalized isotope signatures using principal components analysis (PCA) was used to explore the data and compare signatures between species and collection sites.

**Figure 4.** Collection sites in Mexico, Dry Tortugas National Park and USVI.

## Results

- $\delta^{18}O$ signatures between Dry Tortugas *O. chrysurus* and *L. griseus* recruits are not significantly different (nonparametric MANOVA, $p = 0.21$).
- There was a significant difference in $\delta^{18}O$ signatures between the Dry Tortugas, Mexico and USVI sampling sites (nonparametric MANOVA, $p < 0.001$).
- $\delta^{18}O$ and $\delta^{13}C$ signatures between *O. chrysurus* and *L. griseus* recruits and *L. griseus* juveniles are significantly different (nonparametric MANOVA, $p < 0.001$).
- Average lengths of *O. chrysurus* and *L. griseus* are significantly different (t-test, $p < 0.001$ ). The average length of newly recruited *O. chrysurus* (14.9 mm) was larger than the average length of newly recruited *L. griseus* (13 mm).
- Length (SL mm) significantly influences $\delta^{13}C$ signatures (nonparametric MANOVA, $p < 0.001$) with $\delta^{13}C$ signatures increasing with increasing length.
- $\delta^{13}C$ signatures between *O. chrysurus* and *L. griseus* recruits are significantly different (nonparametric MANOVA, $p < 0.001$).

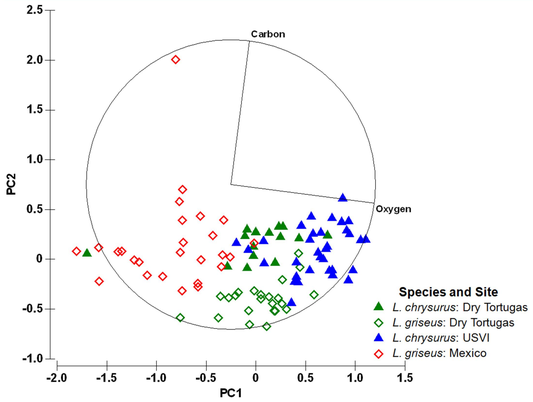


**Figure 5.** Otolith isotopic signatures for newly recruited *O. chrysurus* and *L. griseus* are displayed across three different sampling sites (Dry Tortugas National Park, Brewer's Bay, US Virgin Islands and Xcalak, Mexico).

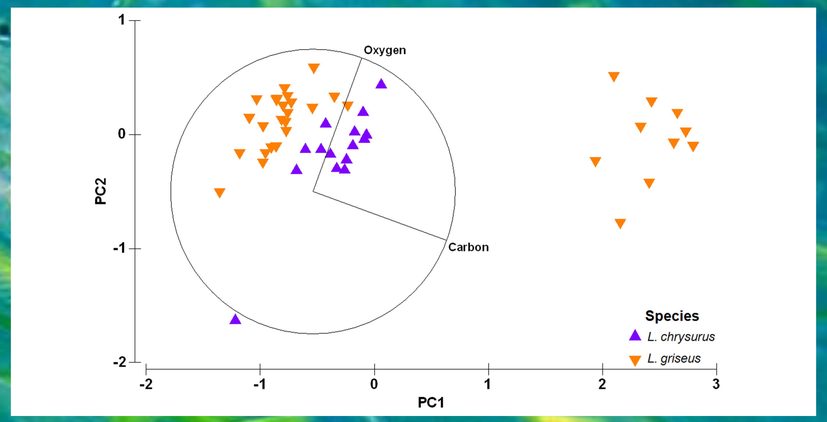


**Figure 6.** Otolith signatures from newly recruited *O. chrysurus* and *L. griseus* and juvenile *L. griseus* caught in Dry Tortugas National Park showed a clear separation between the two age groups.

## Conclusions

- $\delta^{18}O$ signatures of newly settled *O. chrysurus* and *L. griseus* recruits indicate that these species may originate from the same source.
  - An unusual *O. chrysurus* recruit showed a $\delta^{18}O$ signature more characteristic of ambient temperature and salinity in Xcalak, Mexico.
    - This deviation calls for further sampling in Dry Tortugas National Park to potentially reconstruct a comprehensive source history.
- The distinct $\delta^{18}O$ signatures between the Dry Tortugas, Mexico and USVI sampling sites may reflect ambient temperature and salinity conditions that characterize these sites.
  - Further sampling of *O. chrysurus* and *L. griseus* throughout the Gulf of Mexico and the Caribbean would facilitate the construction of a more refined gradient of environmental variability.
- $\delta^{18}O$ signatures between newly settled *O. chrysurus* and *L. griseus* recruits and *L. griseus* juveniles had a small but significant difference ($p<0.001$) which suggests that recruits had not been subject to environmental conditions that deviated greatly from environmental conditions experienced by juveniles.
  - This may indicate that newly settled *O. chrysurus* and *L. griseus* recruits were spawned in the vicinity of Dry Tortugas National Park.
- $\delta^{13}C$ signatures between newly settled *O. chrysurus* and *L. griseus* recruits and *L. griseus* juveniles had a pronounced difference which indicates a change of diet with age.
- The separation of $\delta^{13}C$ signatures and significantly different ($p < 0.001$) average length between newly settled *O. chrysurus* and *L. griseus* recruits suggests a change of diet with size and/or age.

## References

Campana, S.E., Chouinard, G.A., Hanson, J.M., Fréchet, A., Brattey, J., 2000. Otolith elemental fingerprints as biological tracers of fish stocks. Fisheries Research 46, 343-357.

Gerard, T. 2009. Spatial and temporal variation of juvenile gray snapper (*Lutjanus griseus*) habitats in southern Florida using otolith microchemistry. Fishery Bulletin. *In review*.

Thorrold, S.R., Campana, S.E., Jones, C.M., Swart, P.K., 1997. Factors determining d13C and d18O fractionation in aragonitic otoliths of marine fish. Geochim. Cosmochim. Acta 61, 2909-2919.