2021 Annual Virtual Meeting
Florida Chapter of the American Fisheries Society

Trophic Transfer of Mercury in Coastal Pelagic Fishes of Southeast Florida

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Introduction

High levels of mercury in fish populations is an ongoing public concern, in part because mercury can build up over time and pose human health risks[1]. While bioaccumulation is the process by which mercury simply accumulates over time in individual organisms, the associated term of biomagnification refers to the process by which mercury is passed from one trophic level to the next (and thereby increase in concentration) within a food web[2, 3].

The targeted study fishes are not only crucial to Florida's recreational and commercial fisheries, but also important predators in the coastal pelagic ecotone, spending large portions of their lifespans in both coastal and pelagic ecosystems. Many of these species have habitat and prey item overlaps, and stable isotope ratios of nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) can be used to trace trophic level and carbon source, respectively[4, 5]. As mercury increases with the trophic level from sources at the base of the ecosystem, using these stable isotopes as tracers can further aid in exploring how mercury travels through the ecosystem. Based on this study, a new replicate project was started in 2020 to add a temporal component to mercury analysis.

Species	N	FL Mean(cm) (±SD)	δ15N(±SD)	δ13C(±SD)	T Hg(mg/kg) (±SD)
Albacore	4	352(±65)	7.74(±1.15)	-16.65(±0.15)	0.06(±0.04)
Blue Runner	1	308	10.86	-16.98	0.49
Bluefin Tuna	4	417.5(±11.0)	11.07(±0.41)	-17.15(±0.15)	0.07(±0.001)
Cero	1	326	13.46	-18.38	0.16
Cobia	8	900.4(±326)	12.90(±0.58)	-15.89(±0.39)	0.62(±0.29)
Crevalle Jack	3	444.3(±76.0)	12.89(±0.01)	-16.76(±0.88)	0.52(±0.14)
Dolphinfish	50	758.7(±159.1)	9.33(±1.12)	-16.80(±1.23)	0.10(±0.08)
Frigate Mackerel	1	340	8.63	-18.17	0.24
King Mackerel	65	1008.7(±146.0)	13.54(±0.99)	-18.50(±0.91)	1.14(±0.65)
Little Tunny	62	620.4(±126.3)	12.28(±1.21)	-17.54(±0.74)	0.94(±0.64)
Skipjack Tuna	26	570.2(±102.9)	8.70(±1.50)	-16.89(±0.41)	0.41(±0.34)
Spanish Mackerel	37	391.7(±59.2)	13.37(±0.69)	-19.72(±1.13)	0.19(±0.07)
Wahoo	19	928.5(±272.6)	8.20(±1.15)	-16.98(±1.04)	0.17(±0.19)
Yellowfin Tuna	7	843.3(±128.5)	8.36(±0.47)	-17.11(±0.42)	0.18(±0.74)

Table 1. Number of species sampled in 2010-2013 with corresponding Fork Length (FL), $\delta^{15}N$, $\delta^{13}C$, and total mercury (T Hg), all plus or minus the standard deviation.

Methods

- 14 species of coastal pelagic fishes were sampled from March 2010-2013 in Broward, Miami-Dade, and Monroe county locations, including public docks, angler-provided catches, and recreational tournaments (Table 1)
- ~30 g of white muscle tissue sampled using clean techniques, with 5 g subsampled and analyzed for for $\delta^{13}C$ and $\delta^{15}N$, and 10 g subsampled and analyzed with Direct Mercury Analyzer (DMA-80) for total mercury

Results

Spearman's rank identified:
- Positive correlation for $\delta^{15}N$ and mercury (rho= 0.56, $p=2.2\times10^{-16}$, Figure 1)
- Positive correlation for fork length and mercury (rho= 0.50, $p=2.2\times10^{-16}$)
- Negative correlation for $\delta^{13}C$ and mercury (rho= -0.34, $p=2.4\times10^{-8}$)

A hierarchical cluster analysis identified two distinct clusters among 8 of 14 species based on $\delta^{15}N$, $\delta^{13}C$, and mercury (Figure 2):
- Group A: Dolphinfish, Skipjack Tuna, Wahoo, and Yellowfin Tuna
- Group B: King Mackerel, Spanish Mackerel, Cobia, and Little Tunny

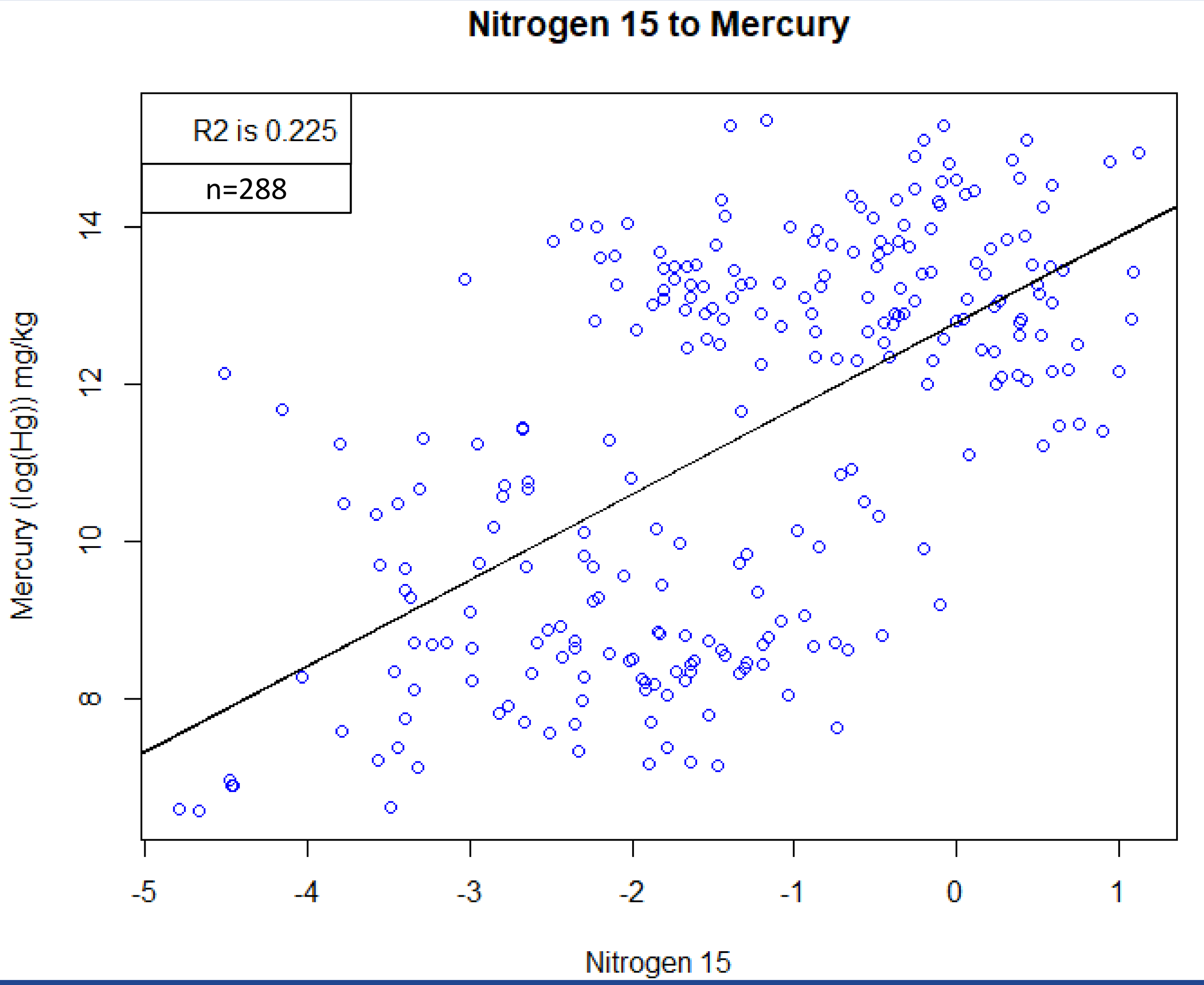

Figure 1. The relationship between mercury and $\delta^{15}N$ is positively correlated in a combined analysis of all 288 coastal pelagic fishes sampled.

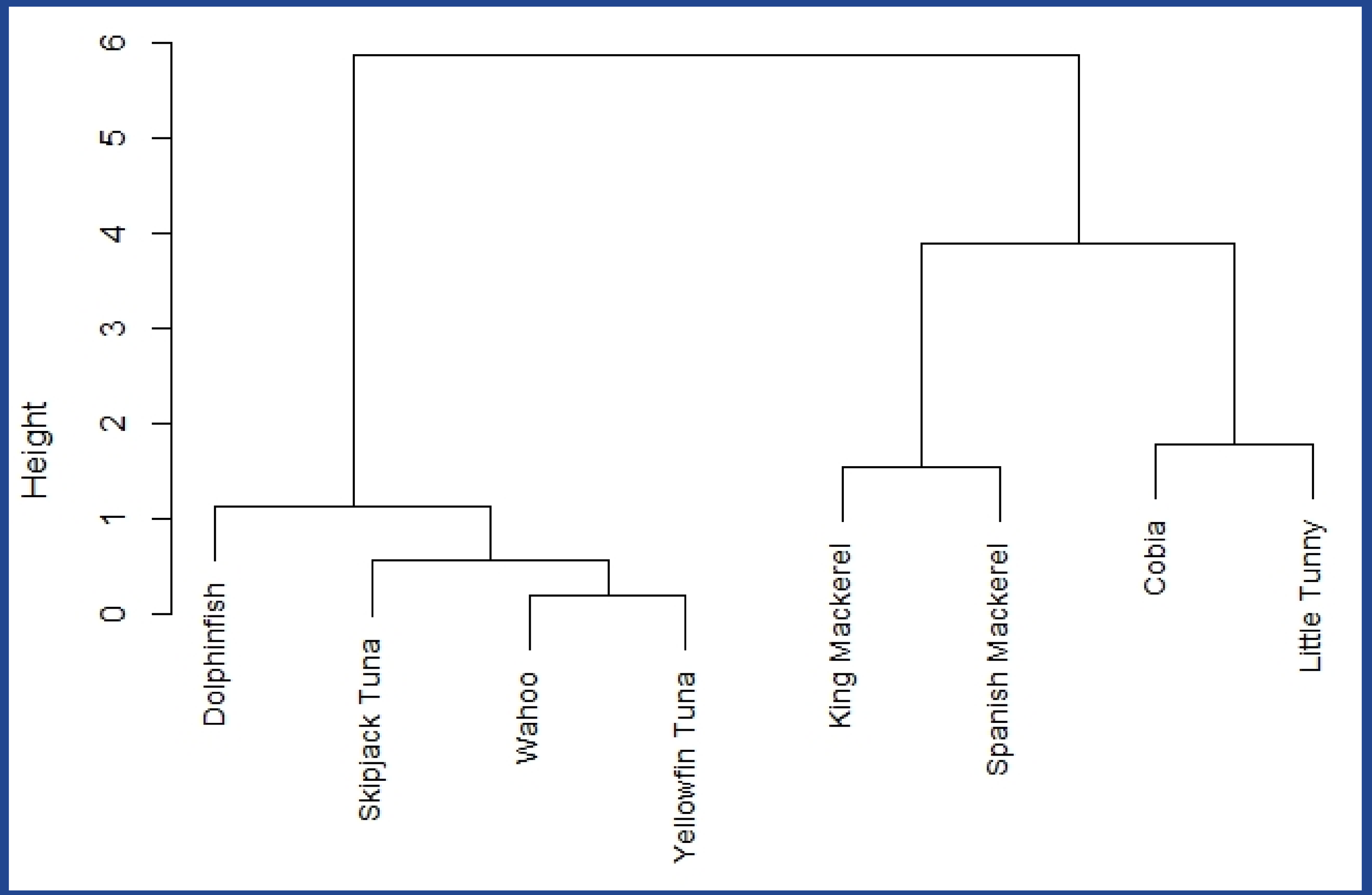

Figure 2. Cluster dendrogram of 2010 data identifying two distinct clusters based on $\delta^{15}N$, $\delta^{13}C$, and mercury.

Discussion

Based on the results, there were significant relationships between $\delta^{15}N$, $\delta^{13}C$, fork length, and mercury. It is not surprising that mercury levels increase with $\delta^{15}N$ and fork length, given that mercury builds up over an organism's lifetime and increases with the trophic level in an established trend [6, 7, 8].

Past studies have given mixed results when it comes to the relationship between $\delta^{13}C$ and mercury, indicating that the relationship between these two values and mercury in the environment is a complex one [9, 10]. The groups created in the cluster analysis reveal that in addition to trophic level affecting mercury concentrations, the level of movement and migration may be influential. Species thought to be more migratory (i.e., Yellowfin Tuna) are clustered together and tend to have lower mercury concentrations, indicating that those species that have more diverse diets may have lower mercury concentrations.

Next Steps

The 2010-2013 data provide crucial baselines for studies to explore mercury concentrations on a temporal scale. This project began during a dynamic time for mercury emissions, with the EPA's "Mercury and Air Toxics Standards" being implemented in 2011, aiming to reduce mercury emissions in the United States. We have begun a study that replicates this project's sampling methods and species to not only bolster the information available for these target species, but also to begin the temporal component of mercury analysis.

(1) Beckers, F., and J. Rinklebe. 2017. Env. Sci. and Tech. 47: 693-794.
(2) Sunderland, E. 2007. Env. Hlth. Persp. 115: 235-243.
(3) Dijkstra, J., K. Buckman, D. Ward, D. Evans, M. Dionne, and C. Chen. 2013. PLOS one 47:1-9.
(4) Peterson, B., and B. Fry. 1987. 18:293-320.
(5) Post, D. 2002. Ecological Society of America 83: 703-718.
(6) Al-Reasi, H. et al., 2007. Env. Toxic. and Chem. 26: 1572-1581.
(7) Atwell, L. et al., . 1996. Canadian Journal of Fisheries and Aquatic Sciences 55: 1114-1121.
(8) Jarman, W., et al.,. 1996. Env. Sci. & Tech. 30: 654-659.
(9) Le Croizier et al., 2019. Science of the Total Environment 650: 2129-2140.
(10) Power, M. et al., 2002. Journal of Applied Ecology 39 (5): 819-830.
(11) Moore, T. 2014. Trophic Dynamics and Feeding Ecology of the Southeast Florida Coastal Pelagic Fish Community.Master's thesis. Nova Southeastern University. Retrieved from NSUWorks, Oceanographic Center. (3)

Acknowledgments: We would like to thank Travis Moore and those who assisted him for their efforts in starting this project[11].

Charles Cichra is inviting you to a scheduled Zoom meeting.

Topic: Trophic Transfer of Mercury

Time: Apr 20, 2021 02:30 PM Eastern Time (US and Canada)

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