Seasonal patterns on isotopic niches and diet of Bigeye and Southern Spotted Opah (Lamprididae) in Southwestern Atlantic Ocean

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Abstract

Opahs (Lampsis spp.) are large deep-water epi-mesopelagic predator fishes captured worldwide as bycatch of longline fisheries targeting large pelagic fishes. Despite the growing culinary interest leading to increasing commercial interest, several basic biological information about the species is still poorly known. This study uses stable isotope and stomach content analysis to access the diet and seasonality on the isotopic niche of the Big-eye Opah, Lampris megalopsis, and the Southern Spotted Opah Lampris australensis in the Southwest Atlantic Ocean (SWAO). Generalized Linear Models were applied to investigate the influence of the species, sex, seasons, and furcal length on 13C and 15N isotopic compositions. Significant differences were observed only for Autumn and for L. megalopsis. The isotopic niches resulted in overlapped 40% ellipses between the species. Seasonal differences for 15N in hot and cold seasons for both species related to the dynamic of the Brazilian and the Malvinas (Falkland) currents and the shift on the baseline source of nitrogen. Differences in 13C, with enriched values in the warmer season, were observed only for L. megalopsis and suggested movements to areas with depleted 15C values. Diet for both species was composed predominantly by Cephalopods and Teleost's, followed by Crustacea, in smaller quantities. An alarming high plastic frequency of occurrence was observed in 40% of the stomachs of L. megalopsis and 31% of L. australensis. This study advances in understanding the Opah fishes feeding ecology in SWAO and provides information on community dynamics and the functional role that these species play in the structure of all marine ecosystems where they occur. Given the growing global commercial importance of Lampris spp., it is also increasingly important to know their inter and intraspecific relationships and the anthropological impacts they are suffering.

Keywords: Lampris, 13C and 15N, plastic pollution

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1. Bibliography styles

Here are two sample references: Feynman and Vernon Jr. (1963; Dirac, 1953).

By default, natbib will be used with the `authoryear` style, set in `classoption` variable in YAML and with `elsearticle-harv.bst` which is among provided style by `elsarticle` documentclass. Other available style

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are `elsarticle-num.bst` and `elsarticle-num-names.bst` — the first one can be used for the numbered scheme, second one for numbered with new options of natbib.sty.

You can sets extra options with `natbiboptions` variable in YAML header. Example

```
natbiboptions: longnamesfirst,angle,semicolon
```

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1.1. Using CSL

If `citation_package` is set to `default` in `elsevier_article()`, then pandoc is used for citations instead of `natbib`. In this case, the `csl` option is used to format the references. Alternative `csl` files are available from `https://www.zotero.org/styles?q=elsevier`. These can be downloaded and stored locally, or the url can be used as in the example header.

2. Equations

Here is an equation:

$$f_X(x) = \left(\frac{\alpha}{\beta}\right)\left(\frac{x}{\beta}\right)^{\alpha-1} e^{-\left(\frac{x}{\beta}\right)^{\alpha}}; \alpha, \beta, x > 0.$$

Here is another:

$$a^2 + b^2 = c^2. \tag{1}$$

Inline equations: $\sum_{i=2}^{\infty}\{\alpha_i^{\beta}\}$

3. Figures and tables

Figure 1 is generated using an R chunk.

4. Tables coming from R

Tables can also be generated using R chunks, as shown in Table 1 for example.

```
knitr::kable(head(mtcars)[,1:4],
    caption = "\\label{tab1}Caption centered above table"
)
```

Table 1: Caption centered above table

	mpg	cyl	disp	hp
Mazda RX4	21.0	6	160	110
Mazda RX4 Wag	21.0	6	160	110
Datsun 710	22.8	4	108	93
Hornet 4 Drive	21.4	6	258	110
Hornet Sportabout	18.7	8	360	175
Valiant	18.1	6	225	105

References

Dirac, P.A.M., 1953. The Lorentz transformation and absolute time. Physica 19, 888–896. doi:10.1016/S0031-8914(53)80099-6.

Feynman, R.P., Vernon Jr., F.L., 1963. The theory of a general quantum system interacting with a linear dissipative system. Annals of Physics 24, 118–173. doi:10.1016/0003-4916(63)90068-X.

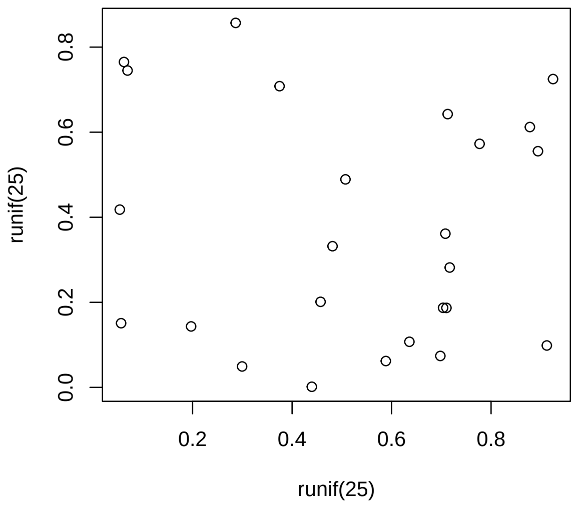

Figure 1: A meaningless scatterplot.