Searching forward a conceptual framework for the statistical analysis of occurrence data for large elasmobranch species: the case study of the porbeagle shark *Lamna nasus*.

By

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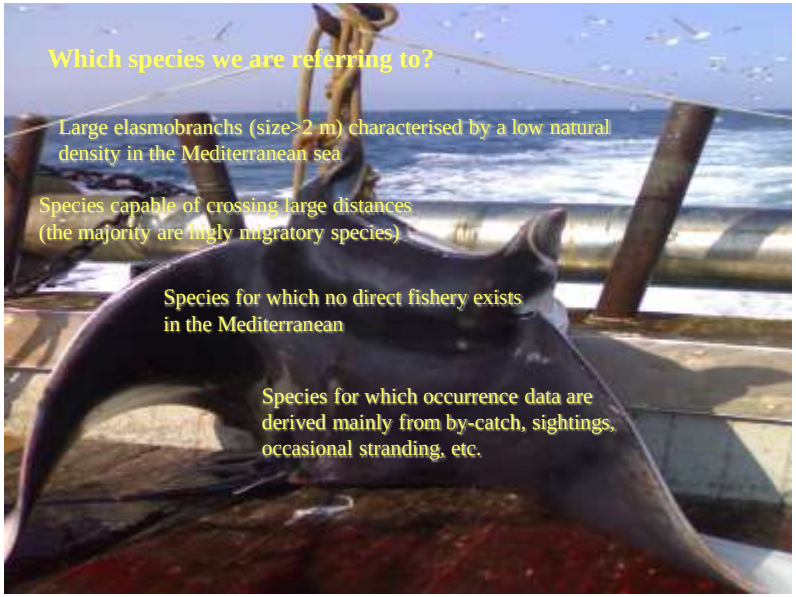


Lamnidae
Lamna nasus
Isurus oxyrhincus
Alopidae
Alopias vulpinus
Mobulidae
Mobula mobular
Cetorhinidae
Cetorhinus maximus
Carcharhinidae
Prionace glauca
Carcharhinus plumbeus
Rare or increasingly rare native species


Alopidae
Alopias superciliosus
Lamnidae
Charcarodon charcarias
Isurus paucus ?
Galeocerdo cuvieri
Carcharhinidae
Carcharhinus altimus
Carcharhinus falciformis
Carcharhinus brachyurus
Odontaspididae
Carcharias taurus
Odontaspis ferox
Pristidae
Pristis pristis
Pristis pectinata
Sphyrnidae
Sphyrna zigaena
Sphyrna lewini
Sphyrna mokarran
Sphyrna tudes
Native or introduced species very rare and/or nearly extirpated.

Problem → A large amount of information for Mediterranean large elasmobranch species is often represented by single ocurrences and sightings, either as peer reviewed published papers or personal communications .

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the validation of a species' presence in a given area often depends on the quality and accuracy of data reported in occurrence descriptions.

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Proposal → A methodological framework to get a quantitative evaluation of the quality of occurrence information.

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Availability of "weighted" data as prerequisite to further analyses.

The case study of porbeagle shark *Lamna nasus*

Bio-ecological features

circumglobally distributed in subtropical and temperate pelagic ed epipelagic waters (Last & Stevens, 1994)

Migratory species (Riede, 2004)

aplacental viviparous (Dulvy & Reynolds, 1997)

long living (Natanson *et al.*, 2002; Campana et al., 2002)

apex predator feeding on intermediate to higher levels of the food web (Bowman *et al.*, 2000)

Threats

The porbeagle shark populations are suffering from overexploitation, either as incidental or target catch, of their stocks worldwide (Stevens *et al.*, 2006).

As other Mediterranean large sharks, the porbeagle has dramatically declined throughout the basin, and therefore faces an imminent local extinction (Ferretti *et al.*, 2008).

The reduction or even extinction of some large shark populations, as apex predators within the marine food webs, could consequently lead to a strong imbalance of the biomass and energy flows throughout marine trophic levels (Ferretti *et al.*, 2010)

Pprotection and conservation status of the species

Vulnerable (A2bd + 3d + 4bd) on the IUCN red list.

Included in annex 1 of UNCLOS

Decision 13.42 of CITES

Included in appendix III of Bern Convention

Included in annex III of Barcelona Convention and proposed for upgrading in annex II

Latest (and very good) news (beginning of November): EU waters: all fishing for porbeagles illegal and any sharks caught accidentally to be released immediately

Available fishery data for the porbeagle shark in the Mediterranean

0 catches from a study on swordfish longline bycatch in the western Mediterranean (De La Serna *et al*. 2002).

15 specimens from a study evaluating by catches and discards of sharks in the large pelagic fisheries in the southern Adriatic and Ionian Sea (Megalofonou *et al*., 2000)

1ton of landings declared in 1996 by Malta according to the Mediterranean official statistics (FAO, 2002, 2003)

Available occurrence data for the porbeagle shark in the Italian seas

Latest record of two males (2010 and 2011) in the central Adriatic sea (Scacco *et al*, accepted pending revision to MBR)

Recent records: two newborn specimens in the central Adriatic sea (Marconi & De Maddalena, 2001; Orsi Relini & Garibaldi, 2002); two newborn specimens in the western Ligurian sea (Orsi Relini & Garibaldi, 2002); three adult specimens in the central Adriatic sea (Cugini & De Maddalena, 2003)

Historical records: 9 records throughout the Adriatic sea in about 100 year period (Soldo & Jardas, 2002); 15 specimens in the North Tyrrhenian and Ligurian Sea during a few decades of observation (Serena & Vacchi, 1997); historical survey (1871-2004) of the porbeagle shark occurrences in Italian waters (Storai *et al*., 2005)

The latest two occurrences in the central Adriatic sea (from Scacco *et al.*, 2011)

Analysing occurrence data…

From Soldo and Jardas (2002): 6 records from central Adriatic,1 from northern part, 2 from southern one;

Figure 3: Distribution of records of porbeagle (•), smooth hammerhead (▲) and basking shark (■) in the Eastern Adriatic. From Soldo and Jardas (2002).

From Storai et al., (2005): 7 records from central Adriatic, 5 from northern part, 1 from southern part.

Scacco *et al.*, (2011): 2 males from central Adriatic in 2010 and 2011.

Records appear to be somehow concentrated in the central part of the basin

Is the central Adriatic an ecologically important area for *Lamna nasus*?

Need to develop a statistical method to "weight" available information

Choice of evaluation criteria and scoring

Each single published* occurrence (each single specimen in papers reporting more than one individual) to be analysed according to the following criteria and their associated scores:

*In case of occurrence referred as personal communication allotted scores have to be halved

Meristic description: 5 if available, 0 if not

Photo or movie: 5 if available, 0 if not

Museum preservation: 5 if present, 0 if not

3 criteria are to evaluate reliability and verifiability of information. The maximum score value is the highest among maximum score values of criteria.

Date or period: 1 if given, 0 if not

Geolocation:
3 if exact (coordinates)
2 if area
1 if harbour
0 if absent

2 criteria to evaluate the strenght of the temporal and georeference precision. 4 different scores for the latter criterion according to accuracy of the information provided. The maximum score value is intermediate between the highest and the lowest score values of criteria.

Length: 2 if reported, 0 if not

Weight: 2 if reported, 0 if not

Sex: 2 if reported, 0 if not

3 criteria to evaluate raw biometric information. Maximum score value is the lowest among score values of criteria.

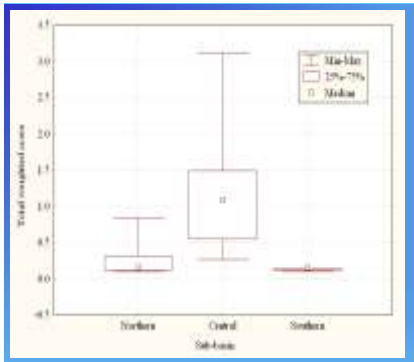
Each single occurrence can be characterised by the sum of criterion scores obtaining a correspondent total score.

Each sum has to be weighted according to a factor-space weighting frequency of occurrences and a factor time weighting time span elapsed between the oldest and the latest finding.

Factor space: number of occurrence in an area/total number of occurrences in all compared areas.
Relation with total score: inverse.
Math. operator: ratio

Factor time: Ln (time span).
Relation with total score: inverse.
Math. operator: ratio

Weighted total score: total score/(factor space*factor time)



The weighted total scores, derived from each single occurrence, represent the replicates within each group (sub-basin) so that sub-basins can be compared each other by mean of a statistical analysis.

Considering the nature of data (discrete, ordinal and heteroscedastic values), a non-parametric comparison is suggested due to its suitability to such a kind of data. The null hypotesis H_0 is: there is no difference among median locations of groups; the alternative H_1 is: there is a significant difference among median locations of groups.

Box-plot of Kruskal-Wallis ANOVA results ($H_{2,24}$= 13.32, p=0.0013<0.01). H_0 is rejected, H_1 is true. Hence, which groups are different from each other?

Use of Mann-Whitney U test with Bonferroni's correction for multiple comparison (3) as a post-hoc: p-level for acceptance of H_1 <0.05/3= 0.01666.

p-level for acceptance <0.05/3= 0.01666.

Northern vs. Central: U=8, P=0.003

Central vs. Southern : U=4, P=0.006

Northern vs. Southern : U=0, P=0.19

How have the results been interpreted?

The quality and accuracy of space-time standardised data on presence of the porbeagle shark in the central Adriatic resulted to be the highest among the compared sub-basins. Post-hoc comparisons detected significant differences between Central vs. Southern basins and Central vs. Northern.

As a matter of fact, the central Adriatic sea encompasses a peculiar pit zone, namely the Jabuka-Pomo pit.

The Jabuka- Pomo pit is an area of 2100 Km2 located outside the national boundaries.

High productivity resulting from one of the most important geo-oceanographic and hydrological peculiarities in the Adriatic sea (CIESM, 2011)

A very important nursery area for M. merluccius and Nephrops norvegicus (Arneri & Morales Nin, 2000).

Jointly declared a BPZ (Bioloical Protection Zone) by Italy and Croatia in 1998 (CIESM, 2011)

Actually considered a vulnerable habitat, mainly due to unregulated trawl fishing activity (AdriaMed, 2000), in the Mediterranean high seas (de Juan & Lleonart, 2010).

Probably an area of great biological value for larger shark species also, that urgently needs conservation and management measures at a cross-border and international scale.

Which use can be made of such a method?

- A preliminary data set for identification of marine areas potentially important for large elasmobranch species.

- Availability of "weighted" data for a GIS species distribution mapping in a multi-layers framework

-Availability of "weighted" data for further analyses

Limits of the method

- Scarce bio-ecological significance: the method assesses the quality and accuracy of bio-geographic information but it does not estimate the bio-ecological relevance of a given occurrence.

Perspesctives

- Implementing the method by refining criteria's scores, adding further weighting algorithms and factors.

Any suggestions and comments is most welcome

Thank you for your attention!