**2. Material and Methods**

**Part 1 –Mean Temperature of the Catch [MTC Index]:**

**Trawl Catch Time Series Data**

Data on trawl fishing catches from the Mediterranean Israeli cost were extracted from log books of over 13,000 fishing hauls. These hauls were conducted by the same fishing vessel, the trawler 'Moti', using the same gear. This vessel used beam trawl gear with 70~m horizontal distance between beams, and net of 40 mm diamond-shaped cod-end. The data covered the period 1991-2013, with nearly daily reports on trawling location and catch composition (Van Rijn 2017).

I restricted the catch data to fish only, removing records of invertebrates. Catch quantities are expressed in standard box units. A standard box holds approximately 10 Kg of fish, and the catch is reported in half box resolution (~5 Kg). Description of catch composition is given using common names for the local fish species. By interviewing fishers, we translated these common names to their corresponding taxonomic groups. In most instances, a single common name corresponds to a single taxonomic species. In other cases, a single common name includes few species [table 2.1].

**Calculating Catch Temperature Index**

Evaluation of the changes in the species composition as a result of the sea warming examine through the Mean Temperature of the Catch index (MTC), proposed by Cheung et al., 2013. Define as:

While Ci,yr is the catch of species i in a given region in year (yr); *n* is the total number of species; and Ti is the mean temperature preference of each species. This calculated based on the temperature range across a species geographic al distribution. For most of the species, I took the mean temperature preference (Ti) from the Supplementary online Material of Cheung (Cheung et al. 2013). Within Cheung et al. (2013) Ti was calculated as…. Give more detail here. Some species doesn't have Ti value with Cheung et al. (2013) (see Table X), and for those I calculate Ti independently. First, the geographical distribution of each species was assessed using occurrence records of each species from the Global Biodiversity Information Facility (GBIF http://www.gbif.org/) database. Did you clean the data? Check that the records make sense? Measures of the yearly mean sea surface temperature for each location was extracted from Bio Oracle ( http://www.bio-oracle.org/). I used the mean value of the temperatures for each species acorns all locations is a measure of Ti. When I re-run the analyses calculating Ti for all species (i.e., without using Cheung et al. (2013) the results were qualitatively the same (see appendix X).

As mentioned, some of the common names used by the fishers included more than a single species. For those species, I calculated Ti as the mean temperature preference weighted by relative frequency of species in the catch based on other sources. I used three trawl surveys conducted in 1990-1994, 2008-2011 (Edelist et al., 2012) and 2013-2015 (ref) where the relative abundance of each species in each haul is recorded including XXX hauls. Not clear if you used a single ration across all data, the average of all hauls, how did you treat the different periods etc.

I also used data derived from a trawl survey conducted from 2013-2015. In this survey, hauls were conducted in 15, 40, 70 and 100 m depth, in both spring (April-May) and autumn (October-November). Overall, 49 fishing hauls were recorded (24 during spring and 25 during autumn).

The above procedure for calculating a single mean temperature preference for multiple species, was done for the groups: Saragus, Bori, Barbunia / Soltan Mix, and Rofus Fake [table 2.1]. For two species from genus *Epinephelus (Epinephelus marginatus and the Epinephelus aeneus)*, I used the mean temperature preference of Epinephelud aeneus, because this species is much more abundant in the local trawl fisheries. Species from the family Batoidea were recorded under single common name. The most common Batoidea in the trawl catch are Raja clavata, Raja miraletus, Torpedo torpedo and Dasyatis pastinaca.. I used the mean temperature preference of them as the Batoidea temperature preference.

The MTC index was calculated for three species groups: invasive species only, indigenous species only, and for the entire community together. Catches under common names which included both indigenous and Lessepsian species, were removed from the data [table 2.2].

**Hauls Temperature:**

The temperature of each haul was calculated for the date, depth and location it was deployed. Temperature data was extracted form Copernicus Model, a model of the temperatures in the Mediterranean Sea in spatial and temporal resolution of XXXX provided by the Euro-Mediterranean Center on Climate Change.

I calculated the mean haul temperatures by seasons [table 2.3] and by years, and correlate it to MTC index. Mean haul depth by seasons and by years attached to the correlation.

**Table 2.1: Species and species groups recorded in the data. Make all scientific names italic. On the left put only scientific names (not Upeneus sp.). You do not describe what you do when the same species have several categorizations (eg. Diplodus). I am missing here data on Ti, whether it is from Cheung or from GBIF, and what proportions were used when a few species were combined.**

|  |  |
| --- | --- |
| **Common Name** | **Scientific Name** |
| Anshubi | Engraulis encrasicolus/Stolephorus insularis |
| Bakala / Bakala Masmerim | Merluccius merluccius |
| Barbon | Nemipterus randalli |
| Barbunia / Soltan Mix | Mullus/Upeneus sp. (Mullus barbatus/Mullus surmuletus/Upeneus pori/Upeneus moluccensis) |
| Ben Gurion | Alectis alexandrinus |
| Bori | Mugil cephalus/Liza sp. (Liza aurata/Liza ramada) |
| Daba | Epinephelus haifensis |
| Farida | Pagrus caeruleostictus |
| Gerbida | Pagellus erythrinus |
| Hazir | Balistes carolinensis |
| Intias | Seriola dumerili |
| Lavan | Lithognathus mormyrus, Diplodus saragus, Diplodus vulgaris, Diplodus cervinus, Diplodus puntazoo. |
| Lokus / Lokus Bibi / Lokus Manot | Epinephelus marginatus, Epinephelus aeneus) |
| Makarunim / Hulim | Saurida undosquamis, Synodus saurus |
| Malitta | Sphyraena sphyraena, Sphyraena chrysotaenia, Sphyraena viridensis) |
| Marmir | Lithognathus mormyrus |
| Musar | Argyrosomus regius |
| Muslach / Sol | Solea solea |
| Palamud | Scomberomorus commerson |
| Pas Tzahov | Upeneus moluccensis |
| Rofus | Boops boops |
| Rofus Fake | Spicara manena, Spicara smaris |
| Saragus | Diplodus saragus, Diplodus vulgaris, Diplodus cervinus, Diplodus puntazoo |
| Sardin / Sardin Round | Sardinella sp. (Sardinella aurita/Sardinella maderensis/Etrumeus golanii/Dussumieria elopsoides/Spratelloides delicatulus/Sardinella gibbosa ) |
| Scombri | Scomber japonicas |
| Shalpohim / Alafuchim / Gitara | Rhinobatos rhinobatos |
| Shed Yam | Lophius budegassa |
| Soltan | Mullus sp. (Mullus barbatus/Mullus surmuletus) |
| Soltan Fake | Upeneus pori |
| Tarachun | Trachurus sp. (Trachurus trachurus/Trachurus mediterraneus/ Decapterus russelli) |
| Taref | Batoidea (Superorder) |
| Televisia | Sillago sihama |
| Trulus | Caranx crysos/Alepes djedaba |
| Tziporot / Denis | Sparus aurata |

**Table 2.2: Species removed from the data for the MTC calculation because the invasive and the indigenous species are similar and the fisher do not differentiate them. We need to add the proportion of the species that were removed. In any case, I suggest you look at them as well to examine potential trends.**

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| --- | --- |
| **Common name** | **Scientific name** |
| Trulus | Caranx crysos/Alepes djedaba |
| Barbunia | Mullus/Upeneus sp. (Mullus barbatus/Mullus surmuletus/Upeneus pori/Upeneus moluccensis) |
| Soltan Mix | Mullus/Upeneus sp. (Mullus barbatus/Mullus surmuletus/Upeneus pori/Upeneus moluccensis) |
| Kaptzonim | Squilla mantis/Erugosquilla massavensis |
| Sardinella | Sardinella aurita/Sardinella aurita/ Etrumeus golanii / Dussumieria elopsoides/ Spratelloides delicatulus / Sardinella gibbosa |
| Anshubi | Engraulis encrasicolus/Stolephorus insularis |
| Makarunim | Saurida undosquamis/Synodus saurus |
| Malitta | Sphyraena sphyraena/Sphyraena chrysotaenia/Sphyraena viridensis |
| Tarachun | Trachurus trachurus/Decapterus russelli/Trachurus mediterraneus |

**Table 2.3: Definition of seasons' duration**

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| --- | --- |
| **Season Name** | **Period** |
| Winter | December-February |
| Spring | March-May |
| Summer | June-August |
| autumn | September-November |