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# Sustainability of by-catch of sharks and finfish in the Norway lobster fishery

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# GOAL

- assessment of the sustainability of by-catch species in the Norway lobster fishery
- (A quantitative stock assessment is not feasible in this case because there is a general shortage on the historical and biological information on those species)

Use of the software PSA (Productivity and Susceptibility Analysis) aimed at examining the impact of the Norway lobster fishery on the fishery's by-catch

The species are assessed as regards their level of susceptibility to be captured with the consequent mortality impact and on their capacity to recover after depletion based on considerations on productivity.

The analysis was done for the 15 species that represent about the 85% of the total landings of the fishery in weight

Article 6 comma 2 of the FAO Code of Conduct for Responsible Fisheries state that "….Fisheries management should promote the maintenance of the quality, diversity and availability of fishery resources in sufficient quantities for present and future generations in the context of food security, poverty alleviation and sustainable development."

Management measures should not only ensure the conservation of target species but also of other species belonging to the same ecosystem or associated with or dependent upon the target species

The impact on target species may be quite different from those exerted on non-target species

For instance, certain exploitation rate can be suitable for some target species but excessive for other species within the community that constitute part of the by-catch

# DATA

- Data of landings and effort for the period 1990-2010 of the Viareggio fleet targeting Norway lobster
- catch assessment survey made through regular samplings in the port during the landing procedures
- Trawl surveys biological information
- Literature

# PSA

- PSA (Productivity and Susceptibility Analysis) developed by Stobutzki et al (2001)
- a semi-quantitative approach considered very useful for examining the vulnerability of stocks
- Used by several organizations and working groups as an approach for determining **vulnerability and risk** of driving stocks to unsustainable levels.

## The two elements fundamental for determining vulnerability

- stock **productivity** mainly dependent on life-history characteristics. Related with the capacity of the stock to fast recover when is at low values of abundance
- stock **susceptibility**, that is the potential of a stock to be negatively impacted by a fishery

PSA assumes that the species in a fishery will be at risk if they are characterised by a **low productivity**, that implies long recovery times and/or if they are **very susceptible** (they are highly exposed) to the fishing activity

Several units of analysis, that include indicators linked to productivity and susceptibility are used

# The Productivity attributes

- **The intrinsic rate of population growth r** is the maximum population growth that would occur in the absence of fishing.
- **Maximum age** is linked to the natural mortality rate M, because M is negatively correlated with maximum age.
- **Maximum size** is correlated with productivity, because large fish have in general lower levels of productivity.
- **von Bertalanffy growth coefficient K** measures the time a fish needs to reach its maximum size. In general, long-lived species have low K and also are characterised by a lower productivity
- **Natural mortality M.** Natural mortality rate defines the population productivity because the stocks with high M need of higher levels of production for maintain adequate levels of abundance.
- **Fecundity** is the number of eggs that a female produce in certain period. Musik (1999) suggested fecundity be always measured at the age of first maturity.

# The Productivity attributes(2)

- **Breeding strategy** indicates the level of mortality during the first life phases than is related to the way eggs and larvae are placed in the water column, the time (if any) of parental protection of eggs or larvae, the time of gestation.
- **Recruitment pattern** is related to the frequency of recruitment success.
- **Age at maturity** is in general related with the maximum age and long-lived low-productive species in general show a older age of maturity.
- **Mean trophic level** can be a useful information for inferring stock productivity. Major productivity is in general observed for the species that are at lower trophic levels in the community.

# The Susceptibility attributes

- **Management strategy.** The susceptibility of a stock to be hardly fished will depend on the existence of control rules. Stocks managed by using some effort or catch limitation is expected will have a low susceptibility to overfishing.
- **Area overlapping** measures the level of spatial overlap between the distribution of the stock and the distribution of the fishing effort. A major overlap makes the stock more susceptible to be impacted by fishing activity.
- **Spatial concentration** supplies information on the geographic distribution pattern of a stock. A highly aggregated stock is more susceptible than other with a very scattered spatial distribution.
- **Vertical overlapping** measures the degree of overlapping by comparing the vertical distribution of the stock along the water column with the depth in which the fishing gear operates.
- **Fishing mortality rate** (in relation to M ). When estimates of fishing and natural mortality rates are available, it is possible to define which portion of the production is removed by each one of them. Here a threshold value for F/M=1 is used as a conservative reference value.

# The Susceptibility attributes(2)

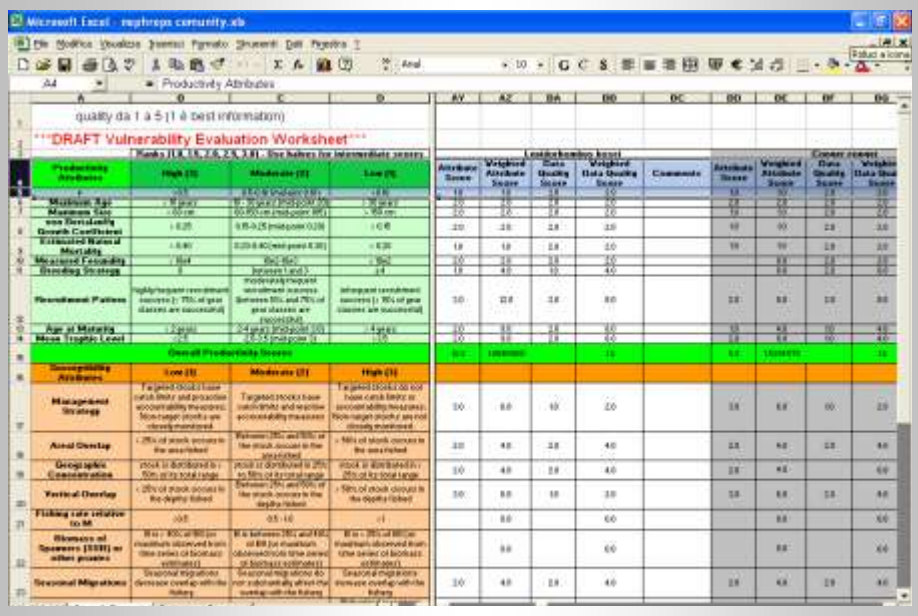
- **Surviving fraction of spawners biomass.** The rate between the current stock biomass and the expected level for the unfished stock is used as an indicator of susceptibility to fishing activity. It is expected that the value of this rate will decrease as fishing effort increase.
- **Seasonal migrations**. Movements of exit or entry from the fishery area affect the level of overlapping between the stock and the operational area of the fishery and the "encounterability".
- **Schooling aggregation** addresses behavioural features that may affect catchability, but also changes in the area of distribution due to changes in the population size.
- **Morphology affecting capture.** The efficiency of capture of a gear may be conditioned by the morphological characteristics of a species and the individual size. The inclusion of this attribute considers the portion of the demographic composition of the population that is vulnerable to the fishing gear in use.
- **Survival after release.** The survival of released individuals may vary by species, utilised fishing gear, depth, affecting the susceptibility of the stock.

## PRODUCTIVITY ATTRIBUTES

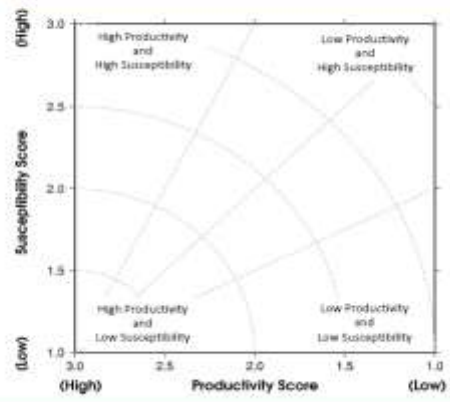
| Productivity Attributes | High (3) | Moderate (2) | Low (1) |
|---|---|---|---|
| r | >0.5 | 0.5-0.16 (mid-pint 0.10) | <0.16 |
| Maximum Age | < 10 years | 10 - 30 years (mid-point 20) | > 30 years |
| Maximum Size | < 60 cm | 60-150 cm (mid-point 105) | > 150 cm |
| von Bertalanffy Growth Coefficient (k) | > 0.25 | 0.15-0.25 (mid-point 0.20) | < 0.15 |
| Estimated Natural Mortality | > 0.40 | 0.20-0.40 (mid-point 0.30) | < 0.20 |
| Measured Fecundity | > 10e4 | 10e2-10e3 | < 10e2 |
| Breeding Strategy | 0 | between 1 and 3 | ?4 |
| Recruitment Pattern | highly frequent recruitment success (> 75% of year classes are successful) | moderately frequent recruitment success (between 10% and 75% of year classes are successful) | infrequent recruitment success (< 10% of year classes are successful) |
| Age at Maturity | < 2 years | 2-4 years (mid-point 3.0) | > 4 years |
| Mean Trophic Level | <2.5 | 2.5-3.5 (mid-point 3) | >3.5 |

# SUSCEPTIBILITY ATTRIBUTES

| Susceptibility Attributes | Low (1) | Moderate (2) | High (3) |
|---|---|---|---|
| Management Strategy | Targeted stocks have catch limits and proactive accountability measures; Non-target stocks are closely monitored. | Targeted stocks have catch limits and reactive accountability measures | Targeted stocks do not have catch limits or accountability measures; Non-target stocks are not closely monitored. |
| Areal Overlap | < 25% of stock occurs in the area fished | Between 25% and 50% of the stock occurs in the area fished | > 50% of stock occurs in the area fished |
| Geographic Concentration | stock is distributed in > 50% of its total range | stock is distributed in 25% to 50% of its total range | stock is distributed in < 25% of its total range |
| Vertical Overlap | < 25% of stock occurs in the depths fished | Between 25% and 50% of the stock occurs in the depths fished | > 50% of stock occurs in the depths fished |
| Fishing rate relative to M | <0.5 | 0.5 - 1.0 | >1 |
| Biomass of Spawners (SSB) or other proxies | B is > 40% of B0 (or maximum observed from time series of biomass estimates) | B is between 25% and 40% of B0 (or maximum observed from time series of biomass estimates) | B is < 25% of B0 (or maximum observed from time series of biomass estimates) |
| Seasonal Migrations | Seasonal migrations decrease overlap with the fishery | Seasonal migrations do not substantially affect the overlap with the fishery | Seasonal migrations increase overlap with the fishery |
| Schooling/Aggregation and Other Behavioral Responses | Behavioral responses decrease the catchability of the gear | Behavioral responses do not substantially affect the catchability of the gear | Behavioral responses increase the catchability of the gear [i.e., hyperstability of CPUE with schooling behavior] |
| Morphology Affecting Capture | Species shows low selectivity to the fishing gear. | Species shows moderate selectivity to the fishing gear. | Species shows high selectivity to the fishing gear. |
| Survival After Capture and Release | Probability of survival > 67% | 33% < probability of survival < 67% | Probability of survival < 33% |
| Desirability/Value of the Fishery | stock is not highly valued or desired by the fishery | stock is moderately valued or desired by the fishery | stock is highly valued or desired by the fishery |
| Fishery Impact to EFH or Habitat in General for Non-targets | Adverse effects absent, minimal or temporary | Adverse effects more than minimal or temporary but are mitigated | Adverse effects more than minimal or temporary and are not mitigated |



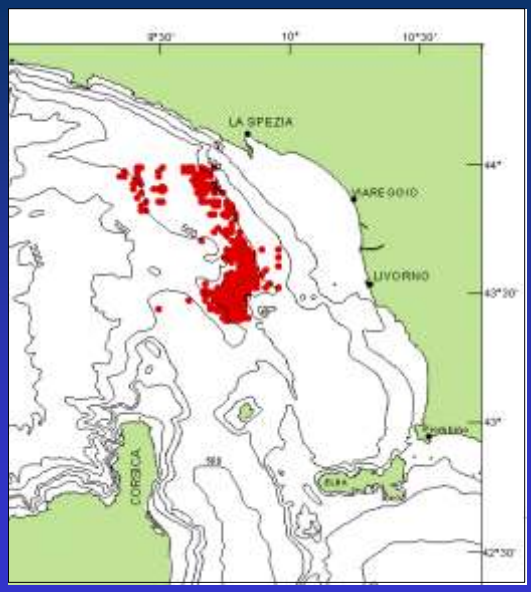
## PSA scatter plot




Vulnerability is measured as Euclidian distance from plot origin

$$v = \sqrt{(p-3)^2 + (s-1)^2}$$

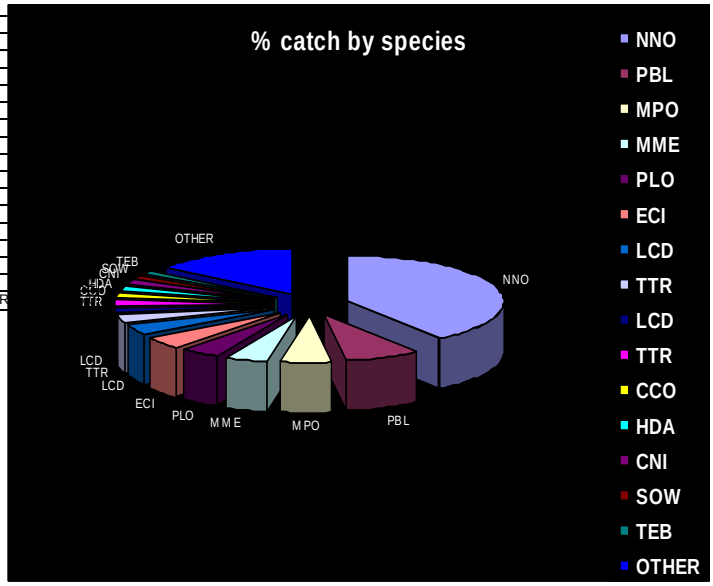
## Nephrops fishery



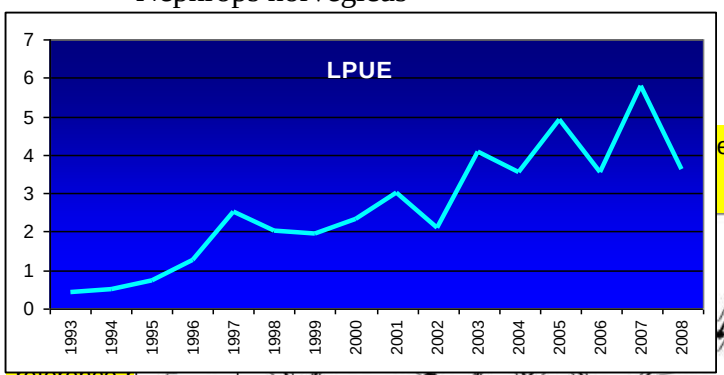

Effort increased from 2000 to 2009 as a result of the progressive increase of the abundance of *Nephrops* observed in the area

# Norway lobster fishery:Landings composition

| | CODE |
|---|---|
| N.norvegicus | NNO |
| Phycis blennoides | PBL |
| Micromesistius potassou | MPO |
| Merluccius merluccius | MME |
| Papapenaeus longirostris | PLO |
| Eledone cirrhosa | ECI |
| Lepidopus caudatus | LCD |
| Trachurus trachurus | TTR |
| Lepidorhombus bosci | LBO |
| Galeus melastomus | GME |
| Conger conger | CCO |
| Helicolenus dactylopterus | HDA |
| Centrolophus niger | CNI |
| Sepietta oweniana | SOW |
| Todaropsis eblanae | TEB |
| Other species | OTHER |




# Nephrops norvegicus

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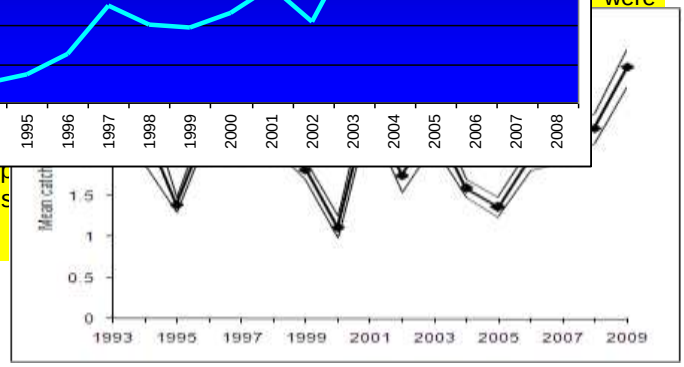
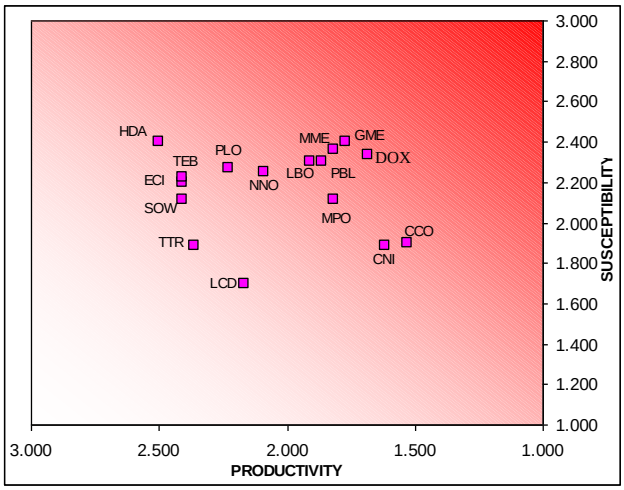
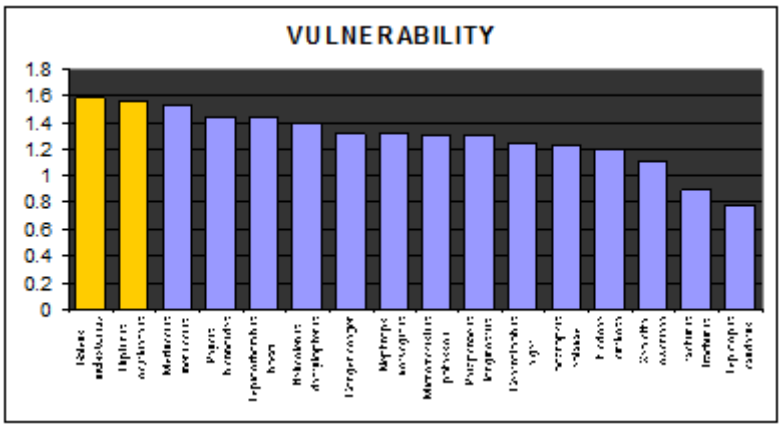


# RESULTS

| | Productivity | | Susceptibility | | |
|---|---|---|---|---|---|
| Stock Name | Weighted Attribute Score | Weighted Data Quality Score | Weighted Attribute Score | Weighted Data Quality Score | vulnerability |
| Merluccius merluccius | 1.818 | 1.045 | 2.364 | 1.250 | 1.52 |
| Galeus melastomus | 1.773 | 1.864 | 2.400 | 1.500 | 1.58 |
| Phycis blennoides | 1.864 | 1.409 | 2.300 | 1.500 | 1.45 |
| Micromesistius potassou | 1.818 | 1.727 | 2.111 | 0.833 | 1.30 |
| Nephrops norvegicus | 2.091 | 0.909 | 2.250 | 1.333 | 1.32 |
| Parapenaeus longirostris | 2.227 | 1.636 | 2.273 | 1.333 | 1.30 |
| Eledone cirrhosa | 2.409 | 1.364 | 2.200 | 0.917 | 1.20 |
| Lepidopus caudatus | 2.167 | 1.045 | 1.700 | 1.167 | 0.78 |
| Trachurus trachurus | 2.364 | 1.682 | 1.889 | 0.917 | 0.90 |
| Lepidorhombus bosci | 1.909 | 1.818 | 2.300 | 1.167 | 1.43 |
| Conger conger | 1.529 | 1.636 | 1.900 | 1.083 | 1.32 |
| Helicolenus dactylopterus | 2.500 | 1.727 | 2.400 | 0.917 | 1.40 |
| Centrolophus niger | 1.615 | 1.182 | 1.889 | 1.333 | 1.25 |
| Sepietta oweniana | 2.409 | 1.409 | 2.111 | 1.000 | 1.11 |
| Todaropsis eblanae | 2.409 | 1.409 | 2.222 | 1.083 | 1.23 |
| Dipturus oxyrhinchus | 1.682 | 1.864 | 2.333 | 1.417 | 1.56 |




| | |
|---|---|
| GME | Galeus melastomus |
| DOX | Dipturus oxyrhinchus |
| MME | Merluccius merluccius |
| PBL | Phycis blennoides |
| LBO | Lepidorhombus bosci |
| HDL | Helicolenus dactylopterus |
| CCO | Conger conger |
| NNO | Nephrops norvegicus |
| MPO | Micromesistius potassou |
| PLO | Parapenaeus longirostris |
| CNI | Centrolophus niger |
| TEB | Todaropsis eblanae |
| ECI | Eledone cirrhosa |
| SOW | Sepietta oweniana |
| TTR | Trachurus trachurus |
| LCD | Lepidopus caudatus |




*Dipturus oxyrhinchus* and *Galeus melastomus*, considered the most vulnerable stocks in the fishery.

Why it appears sustainable?

Even though effort increased in the area, probably is still relatively low

Part of the distribution area of the stocks not involved in the fishery

Selection of only the big-sized individuals, but…

need to confirm probabilities of survival after release of discarded individuals.

## Less vulnerable species

3 cephalopods (*S.oweniana*, *T.eblanae* and *E.cirrhosa*) share the group with two finfish (*Lepidopus caudatus* and *Trachurus trachurus*).

Most of these less vulnerable species show a semi-pelagic behaviour, and/or are characterized by a short life span, fast growth

The results obtained are consistent with the limited knowledge of the involved stocks and allowed an assessment of vulnerability and risk of overexploitation of several not well known stocks of the Norway lobster fishery by-catch.

The defined vulnerability ranking is particularly useful for giving **priority for research and management** for those species considered more exposed to the fishery and less resilient. **(also in this case two chondrichtyans!)**