

Long-term (1781-2010) Eel Fishery in the Coastal Lagoon of Comacchio (Northern Italy) and use of a new Index for Fish Evaluation.

Federico Brunelli, Elena Fabbri

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University of Bologna – Interdepartmental Research Centre in Environmental Sciences
163 via Sant'Alberto – 48123 Ravenna (Italy), ph. +39 0544 937311 fax +39 0544 937411
Federico Brunelli, e-mail: federico.brunelli2@unibo.it
Elena Fabbri, e-mail: elena.fabbri@unibo.it

The European eel (*Anguilla anguilla* L.) is an endangered species with an important role in local economies of coastal lagoons and its health evaluation is of crucial interest both for fishery's managers and for conservationists.

In the Comacchio lagoon the eel fishery trend is known since 1781. A sharp decline has been registered since 1920s and the habitat loss seems the most important factor of stock collapse. Furthermore, the reduced importance of fishery's economy has lead to the lack of funds for restocking, which is a further threat for conservation of eel in this region.

The eel fishery in Comacchio is made in Autumn by the *lavoriero*, a V-shaped permanent trapping weir located into the canal connecting the lagoon to the sea, that captures the fish during the reproductive migration. In our experiments we report a large dominance of females.

A Sustainable Eel Fishery Index (SEELF) for the evaluation of fish condition has been designed using body indexes, internal indexes and blood parameters; SEELF Index has been calculated in a 5-year sample and, as a synthetic parameter for analysis of the historical trend, it proofs whether lagoon fishery's good practices are respected.

Furthermore, mature female eel migrating towards the open sea from the Comacchio lagoon are less then 10years old, are not affected by *Anguillicola crassus* and, according to biomarker analyses, are not affected by impacts of pollution. Thus, we argue that this lagoon is a suitable environment for restocking and for application of an efficient Eel Management Plan.

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Introduction

The European eel (*Anguilla anguilla*, L.) is a catadromous fish species with its spawning grounds in the Sargasso Sea, that in the last forty years has suffered a rapid decline in all Europe (Feunteun 2002; ICES 2010) as well as in Comacchio. This species is included in the Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since March 2009 (CITES, 2007, 2008) and thus it has been classified as “endangered species”. The European Union imposes the definition and application of an Eel Management Plan (EMP, Council of the European Union, 2007), for monitoring and restocking.

The Comacchio lagoon (fig.1), a brackish coastal lagoon of 100km², hosts an extensive farm of European eel (Tesch, 2003) and is included in a NATURA2000 site, in a regional protected area called Po Delta Park Emilia-Romagna and in the UNESCO World's Heritage site of “Ferrara, city of Renaissance and its Po Delta”.

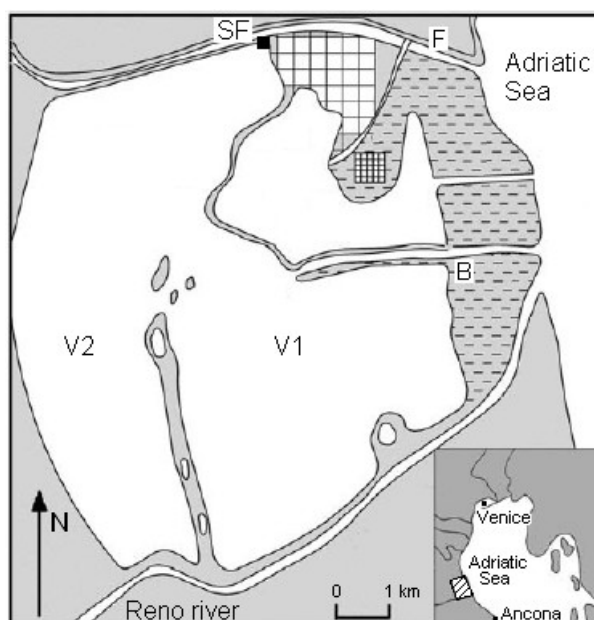


Fig. 1: The Comacchio lagoon (Northern Italy), with the Stazione Foce hatchery (SF) and the two marine channels, Foce (F) and Bellocchio (B).

Long-term evaluation of eel fishery

In the past the eel fishery had an important role in local economies of coastal lagoons and its evaluation is important both for fishery's managers and for conservationists. In the Comacchio lagoon the eel fishery trend is known since 1781 and annual captures are officially recorded (fig. 2). The historical trend shows some rapid variations, occurred in years when large areas of the lagoon were reclaimed or when severe meteorological events produced a high mortality of fish. During the XX century, huge effects were caused by land reclamations and by World War II.

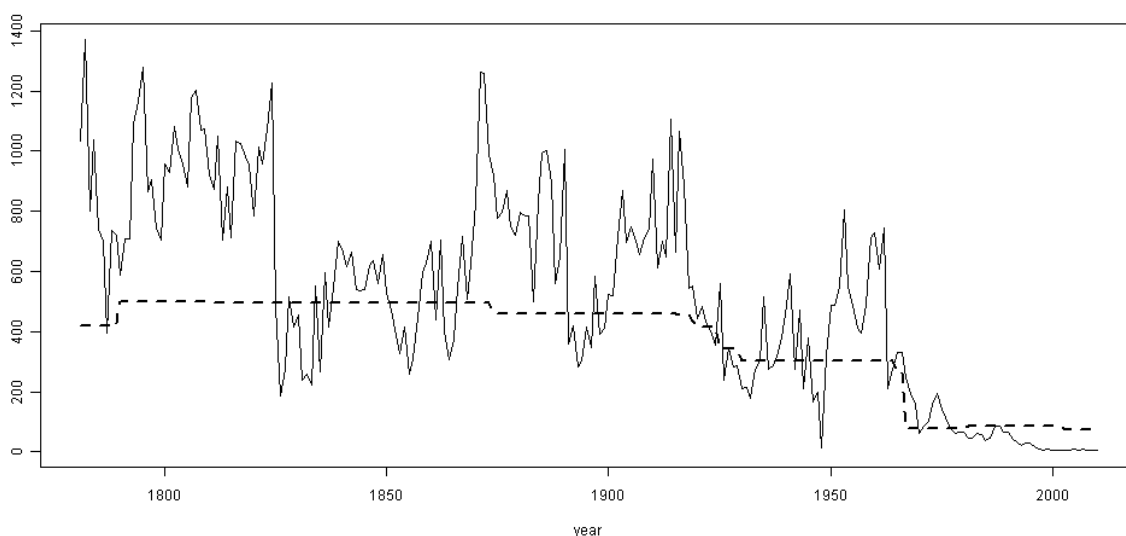


Fig. 2: Long-term (1781-2010) European eel captures in the Comacchio lagoon (t – continue line) and surface area of the lagoon (km² – dashed line).

In 1950s and 1960s several actions, such as introduction of juveniles, were devoted to improve the production, without long lasting effects. In this period the production of Marinated Eel was boosted and now it is a typical product listed in the Atlas of typical products of Parks (SlowFood, 2002) and in the Decree of Ministry 16/06/2010 (Italian Ministry of Agricultural Policies, 2010). Subsequently, the last attempt for the management of an intensive plant was done during 1970s by a public-private company. This facility, closed in the late 1980s, caused severe ecological impacts (Sorokin et al., 1996, Sorokin and Zakuskina, 2010), that only recently were recovered, although not completely (Munari and Mistri, 2010). Regardless the improvement in productivity showed in 1950s, after the main reclamations in 1920s and, definitely in 1960s, the reduction of surface of the lagoon determined the reduction of its potential for fishery and a long-term decrease in productivity. Although the technical capabilities have evolved over the decades, the *valliculture* (a particular aquaculture performed in coastal lagoons close to the sea) became less and less economically sustainable, until a definitive decline documented in the 1980s.

Moreover, the increase of pollution in internal and marine waters was a further factor of pressure that was recently solved by an efficient application of the EU's directives on water quality.

The sharp decline of eel fishery in the Comacchio lagoon was studied in the past (Carrieri, 1992) for the dynamic of population, however no suitable tool for evaluation of fish was provided.

An Index for evaluation of fish condition

In recent years, the research for conservation of the European eel was devoted to develop indexes and methods for evaluation of fish condition and maturation (Silver Index; Durif, 2009) at large scale.

The Comacchio lagoon is a very peculiar environment, where (a) the water inlet is managed handling the sluice-gates on two marine channels and (b) the eel are captured only by *lavoriero*, a tool located in the marine channels, that captures mature eel at the onset of reproductive migration; therefore it was possible to develop an index on a homogeneous population of eel.

The SEELF Index (Sustainable Eel Fishery Index) for the evaluation of eel fishery, describes mature female specimens (harvested during the migration from the lagoon to the open sea, in Autumn) using parametric measurements of body indexes, internal indexes and blood.

The Index was developed in two versions: SEELF A, to be employed for a rapid evaluation of fish condition, usable in the field and by non-expert personnel (such as fishermen or conservationists involved in monitoring) and SEELF B, to be used in research, quality control and laboratories by skilled personnel.

SEELF A includes external indexes such as Condition Factor, Eye Index and Silver Index, while SEELF B consists of the indexes included into the A version and, in addition, LSI (hepato-somatic index), RBC (red blood cell count), hematocrit and an evaluation of the fish skin.

SEELF Index evaluates the fish in a range from 0 (minimum) to 10 (maximum) and was developed, respectively, on a 5-year (SEELF A) and on a 2-year (SEELF B) database.

Both versions of the Index were able to identify the respect of good practices in sustainable eel fishery in the Comacchio lagoon.

A proposal for a reliable application of the Eel Management Plan

The EU's Regulation 1100/2007 states that one of the objectives of each Eel Management Plan shall be to permit, with high probability, the escapement to the sea of at least 40 % of the silver eel biomass. Although no details on evaluation of fish are provided in EMP, we argue that the SEELF Index is an appropriated tool for discrimination of fish with the highest hypothetical potential to complete the reproductive migration. The fish evaluated with the highest score by SEELF should

be released. Fish with lower score, or with an high score exceeding the EMP's target, should be sold and the money earned could be used for financing the restocking.

Conclusions

We argue that the reduction of habitats in the Comacchio lagoon was one of the most important factor for the reduction of eel stock and for the decline of economical importance of fishery with huge consequences for the conservation of the species. Furthermore, the reduced importance of fishery's economy is leading to the lack of funds for restocking, which is a further threat for conservation of eel.

The Eel Management Plan contains guidelines for conservation of the species, however it should include reliable tools for fish evaluation; the SEELF Index proved to be a reliable tool for the eel evaluation in the Comacchio lagoon and we believe it can be used, or adapted, for other environments.

Acknowledgment

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