



ESF - Short Visit Grant - Final Report

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SHORT VISIT GRANT

Reference Number : 1643
Report submitted : 22/03/2007 11:14:54

ESF ACTIVITY

Unit(s) : LESC
Activity Title : Integrating population genetics and conservation biology: Merging theoretical, experimental and applied approaches
Activity Acronym : CONGEN

PROJECT

Title of the proposed research project : Fishery induced evolution in Spanish salmon populations
Date of visit (starting date) : 11/03/2007
Duration : 12 day(s)
Travel Granted : 450 €
Applicant's Name : Dr. Anna Kristiina Kuparinen, Helsinki, Finland

MAXIMUM AMOUNT GRANTED

TOTAL ESF Grant FUNDING : 1470 €

HOST INSTITUTE(s)

Dr. Carlos Garcia De Leaniz, Swansea, United Kingdom

ACTUAL EXPENDITURE

Travel Cost : 450 €

Fishery Induced Evolution in Spanish Salmon Populations

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1. Project Background

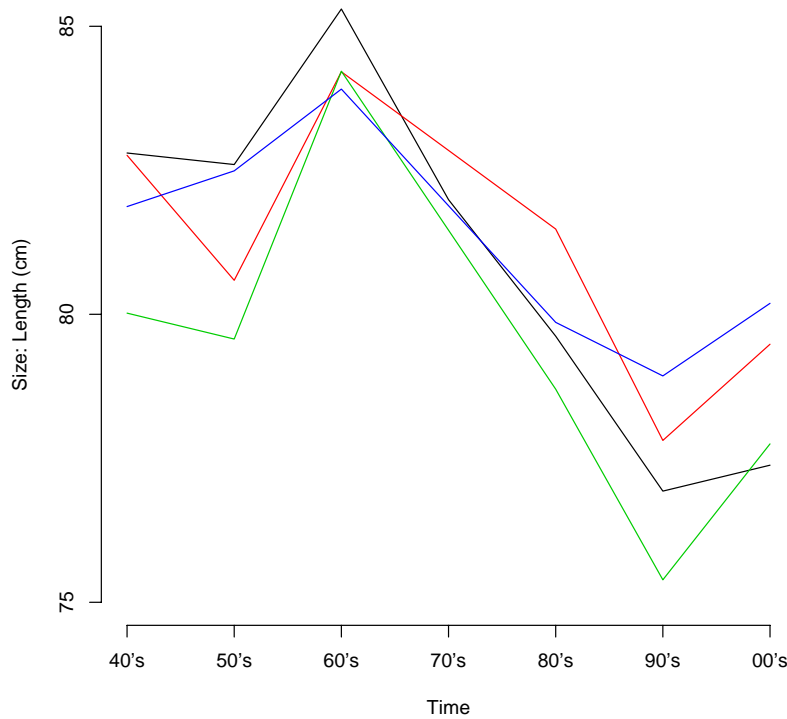
Increasing exploitation of natural fish populations may not only affect the population sizes but also cause evolutionary changes in the populations. In particular, harvesting of large fishes may induce evolution of the populations, by selectively favouring those fishes that mature at smaller sizes and at younger age (Olsen et al. 2004). This may lead to the adaptive shifts in the probabilistic reaction norm of the populations which defines the probability of maturing at each size and age (Morita et al. 2006).

Here, we will focus on investigating the possible evolutionary changes in Atlantic salmon (*Salmo Salar*) due to increased exploitation of the populations during the latter half of the 20th century. To this end, we will analyse data collected on Atlantic salmon populations in northern Spain (e.g. Consuegra et al. 2005). This data provides measurements on the ages, sizes, past growth trajectories and back-calculated smolt sizes of the salmons that return to the river for spawning. The measurements have been collected in four Iberian rivers: Nansa, Ason, Pas and Deva. The earliest measurements are collected in late 40's and the latest ones are obtained early 00's. Thus, the data set is ideal for detecting long-term impacts of fishery on the ages and sizes of mature individuals.

2. Aim of the visit

The purpose of the visit to the University of Wales Swansea was to establish collaboration with Dr. Carlos Garcia De Leaniz, who has been investigating Spanish Atlantic salmon populations for years, and who is an expert on the field of fisheries induced evolution. The main aim of the visit was to extract and combine all the information required for the statistical analyses of the data and to identify the main processes and interactions on which the analyses should focus.

Fig. 1 Observed average lengths of mature fishes in each decade. Different rivers are denoted with different colours.



3. Work carried out during the visit

During the course of the visit (11.-17.3.07), Dr. Garcia De Leaniz and I worked intensively with the salmon data. We combined several data sets on back-calculated growth trajectories, scale erosion, life-history characteristics, fishery records and prevailing environmental conditions. The combined data set will provide all the basic information required for the analyses, and it will shortly be complemented with information on additional back-calculated growth trajectories. Also, information on annual fishing effort and sea fishery catches during the observation period is currently being searched for.

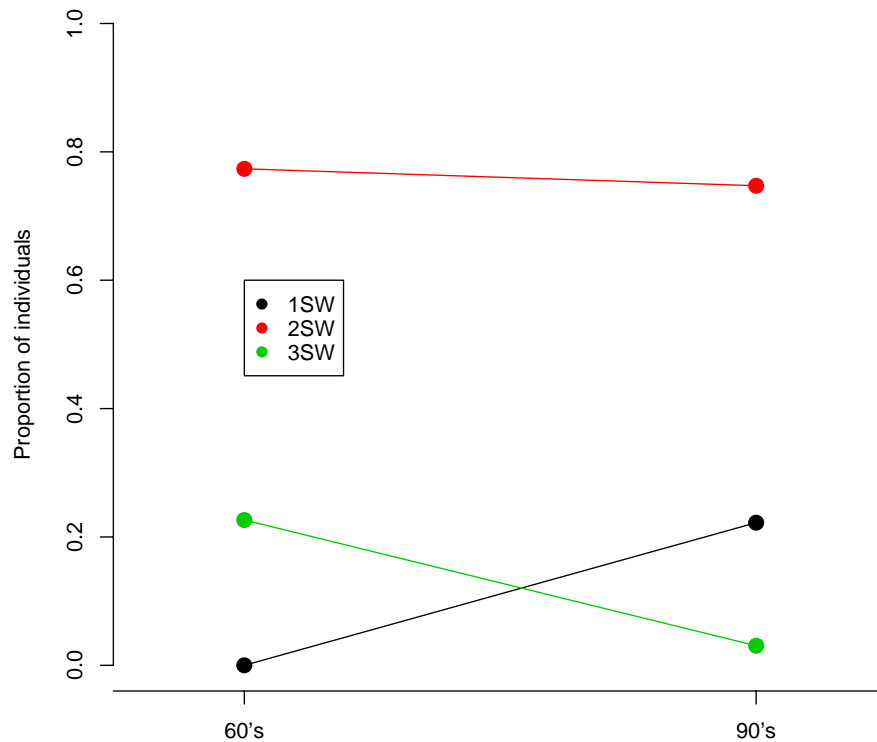
The data set shows clear trend of both weights and sizes of the mature fishes reducing in all rivers from late 40's to nowadays (Fig. 1). In addition, also the ages of the mature fishes reduce during this period. In particular, the proportion of mature one sea-winter old individuals can be seen to have considerably increased while the proportion of mature three sea-winter old individuals has reduced (Fig. 2).

In order to plan the analyses to be carried out, we focused on identifying different factors and processes through which the age and size distributions of mature individuals

may have changed. In addition to purely evolutionary changes in the populations, also climate change induced changes in juvenile growth were considered.

During my visit I also gave a speech “Detecting fisheries induced selection” in the seminar “Sustainable Aquaculture and Fisheries”.

Fig. 2 Observed proportions of one, two and three sea-winter (SW) old fishes in 60’s and 90’s.



4. Main results obtained

Our main result obtained during my visit was the following plan for the analyses through which the reasons behind the observed changes in mature salmon will be investigated.

1) *Changes in the reaction norms.* Changes in the reaction norms for age and size at maturity will be investigated by using the back-calculated sizes of the mature fishes at their earlier ages. Logistic regression will be fitted to the data, in order to assess how the probability of maturing at each age is affected by the size of the individual (Fig. 3). Possible changes in the reaction norms will be investigated by comparing the model parameters estimated by using the data available from late 40’s, 60’s, 80’s and 90’s. (Of the lacking decades, there are no observations available on growth trajectories.)

2) *Changes in the growth of juveniles.* In order to investigate the impacts of climate changes (i.e. higher water temperatures in rivers) on age and size at maturity, we will focus our analyses on the changes in the sizes of the smolts between late 40's and early 00's and on post-smolt growth in sea. In particular, we will try to identify possible effects of the smolt size and growth during first sea-summer on the maturing age.

3) *Changes in the sizes of individuals due to rod fishing.* Preliminary analyses of the data clearly indicate that the size distribution of the fishes caught by anglers differ from that of the spawning fishes (Fig. 4). Rod fishing seems to truncate the distribution of mature individuals by removing large individuals from the rivers before they spawn. Also the timing of the fishing season supports the survival of mature one sea-winter fishes, since they start to arrive to the rivers at the end of the fishing season. These fishes are typically smaller than fishes that have spent more that one winter in sea. To study the long-term effects of the fishing by anglers, we will try to build the link between size-selection and maturing age and size. This will be done by both statistical analyses and the simulation of life-histories.

Fig. 3 Modelled probabilistic reaction norm for one sea-winter old fishes.

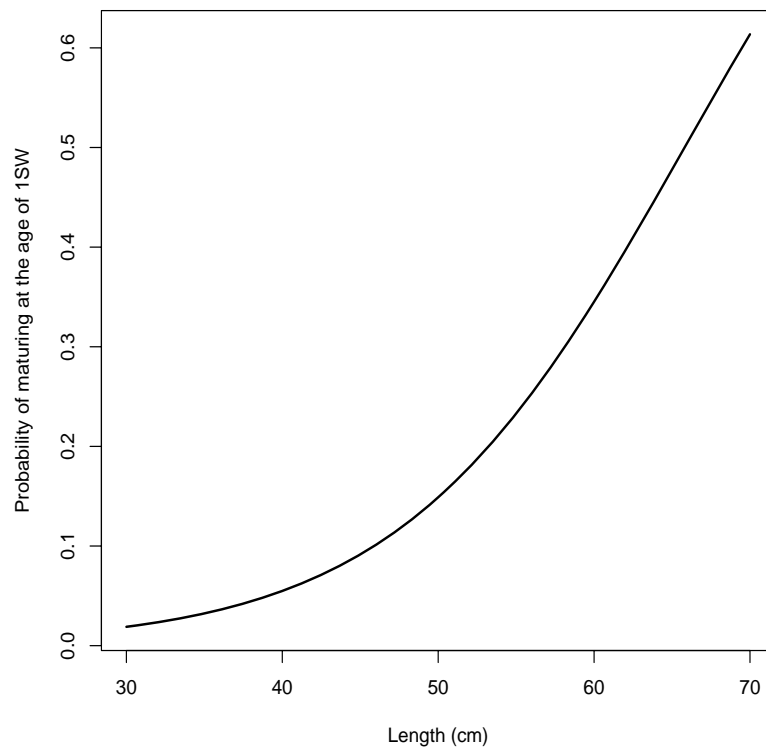
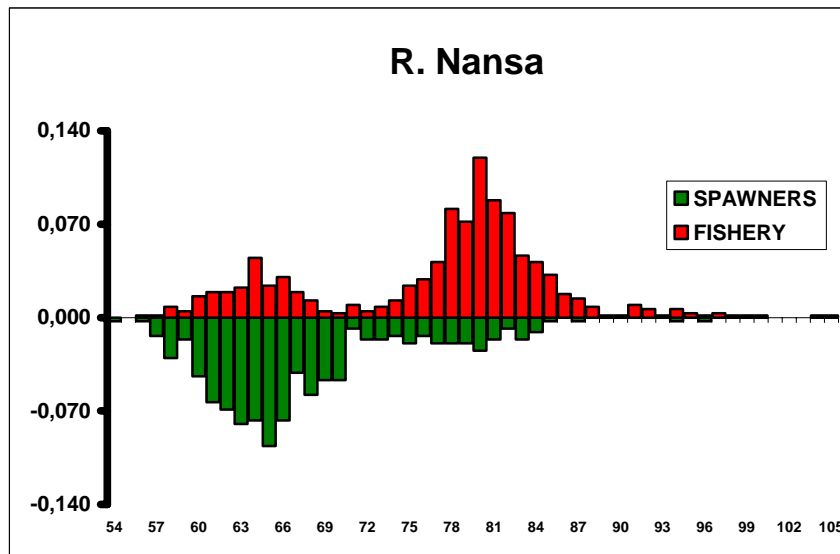


Fig. 4 Frequency distributions of the sizes of fishes caught by anglers and the sizes of the spawning fishes in river Nansa.



5. Future collaboration with host institution

Future collaborations are planned with Dr. Garcia De Leaniz to obtain the lacking parts of the data and to carry out the analyses described above. After finishing the analyses I am planning to visit the University of Wales Swansea again, in order to interpret and discuss the results together with Dr. Garcia De Leaniz. During this visit, also a manuscript about the analyses will be outlined.

6. Projected articles to result from the grant

I am preparing a research paper about the concept of probabilistic reaction norms and the use of them in detecting fishery induced evolutionary changes in natural populations. This will be followed by a paper about the analyses of the data on Spanish salmon population (see 4.).

References

- Conover, D.O., Munch, S.B. (2002). Sustaining fisheries yields over evolutionary time scales. *Science* **297**: 94-96.
- Consuegra S., Garcia De Leaniz C., Serdio A. and Verspoor E. (2005) Selective exploitation of early running fish may induce genetic and phenotypic changes in Atlantic salmon. *Journal of Fish Biology* **67**:129-145.
- Morita, K., Fukuwaka, M.A. (2006). Does size matter most? The effect of growth history on probabilistic reaction norm for salmon maturation. *Evolution* **60**: 1516-1521.
- Olsen E.M., Heino M., Lilly G.R., Morgan M.J., Brattey J., Ernande B., Dieckmann U. (2004) Maturation trends indicative of rapid evolution preceded the collapse of northern cod. *Nature* **428**: 932-935.