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Assessment of sea bass (*Dicentrarchus labrax*, L.) stock delimitation in the Bay of Biscay and the English Channel based on mark-recapture and genetic data

M. Fritsch [a,*], Y. Morizur [a], E. Lambert [b], F. Bonhomme [b], B. Guinand [b]

[a] *IFREMER, Centre de Brest, Département Sciences et Technologies Halieutiques, Laboratoire Unité des Populations et des Peuplements, BP 70, 29280 Plouzané, France*

[b] *Université Montpellier II, IFREMER, CNRS UMR 5171, Laboratoire Génome, Populations, Interactions, Adaptation, Station Méditerranéenne de l'Environnement Littoral, 1 Quai de la Daurade, 34200 Sète, France*

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Abstract

Sea bass (*Dicentrarchus labrax*) fisheries are becoming increasingly abundant along eastern Atlantic coastlines, especially in the ICES sub-areas IV, VII and VIII, but they are still not being managed by the European Union TAC (Total Allowed Catches) system. Scientific information about these sea bass stocks is limited, but the fishery is currently managed or modelled based upon these data, separated into the ICES divisions. Clearly, failure to manage satisfactorily the fishery may lead to a decline in stocks. We therefore investigated the structure of Atlantic sea bass populations at eight microsatellite loci in the Bay of Biscay and the English Channel and, additionally, at five selected loci in Ireland and Scotland. Genetic data showed no significant population differentiation between the Bay of Biscay and the English Channel samples, either for juvenile or adult individuals, indicating substantial gene flow. These results contrast with tag-recapture data that indicated restricted movements of individuals within the Bay of Biscay or the English Channel, and little exchange between them. These apparently contradictory genetic and tag-recapture results can be reconciled by various aspects of sea bass biology, factors that should be considered in stock management. Furthermore, the results indicate some local genetic differentiation in the Irish sample when compared to other samples, possibly indicating a complex population structure of sea bass around the British Isles. This point should be further investigated, but results clearly indicate that sea bass stock management should not be based only upon the currently recognized ICES divisions.

Keywords: *Dicentrarchus labrax*; Mark-recapture; Tagging; Microsatellite loci; Population structure

1. Introduction

The sea bass, *Dicentrarchus labrax* (L., 1758), is a demersal species found throughout the Mediterranean Sea and the Eastern Atlantic, ranging approximately from Southern Morocco to the Norwegian coastlines. Currently, natural populations of sea bass are not managed with the European Union TAC (Total Allowed Catches) system, although they are exploited by several fisheries in the European countries, principally France, UK, and Spain. For example, the largest bass fishery is in France, where the species is targeted throughout the year by professional liners, and seasonally by trawlers, gillnetters and recreational anglers. It is the fifth species in landed value in spite of a relatively low total catch of about 4000 tonnes per year. A lack of quota management partly explains the relatively low scientific contribution to sea bass stock assessment. Management of the fisheries is, however, now required because of the increasing interest in this species by both recreational and commercial fishermen. The main fishing areas in European waters are the Mediterranean Sea and, in the Eastern Atlantic, the ICES (International Council for the Exploitation of the Sea) sub-areas IV, VII and VIII. Indeed, the bulk of the catch comes from the area between the Bay of Biscay, the Irish Sea and the North Sea. In this region, the wide dispersion of "adolescent" sea bass as they migrate from nursery areas to join spawning stocks, and of adults between summer and winter areas provide little evidence for the existence of independent biological populations. Nevertheless, tagging studies carried out around the British Isles (Kennedy and Fitzmaurice,

* Corresponding author. Tel.: +33 2 98 22 43 68; fax: +33 2 98 22 46 53.
E-mail address: manonfritsch@yahoo.fr (M. Fritsch).

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1972; Holden and Williams, 1974; Kelley, 1979; Pawson et al., 1987) and the seasonal distribution of the fisheries suggest that separate populations may exist.

Although numerous population genetics studies have been carried out with sea bass, they have focussed upon Mediterranean populations (e.g. Patarnello et al., 1993; Allegrucci et al., 1997; Caccone et al., 1997; Bahri-Sfar et al., 2000), with less attention paid to Atlantic populations (Castilho and Mcandrew, 1998; Naciri et al., 1999; Bonhomme et al., 2002). As for numerous other marine species, the most striking feature in the genetic structure of sea bass populations is the division between Atlantic and Mediterranean populations (Naciri et al., 1999). While the Mediterranean Sea appears to be genetically structured into several sub-basins (Patarnello et al., 1993; Bahri-Sfar et al., 2000; see also Garcia De Leon et al., 1997), Atlantic populations were genetically homogeneous over wide areas, indicating high levels of gene flow (e.g. Bonhomme et al., 2002). Despite such knowledge, further data about the genetic structure of sea bass in the Atlantic is important for several reasons. Firstly, few Atlantic populations have been screened for both allozymes (Castilho and Mcandrew, 1998) and microsatellites (Naciri et al., 1999; Bonhomme et al., 2002), but these report slightly contrasting results (i.e. no genetic differentiation when using microsatellite loci versus low but significant differentiation with allozymes). Such previous studies were also mainly restricted to Moroccan and Portuguese populations, together with one English Channel and one North Sea population. As a major objective of fisheries genetics is the identification of discrete populations or groups with more or less restricted gene flow (reviewed in, e.g. Carvalho and Hauser, 1995; Hauser and Ward, 1998), stock delimitation – if any – among Atlantic sea bass populations should be investigated more closely using genetic tools. Furthermore, the previous studies were restricted to analysis of population or stock differentiation and they did not consider other biological aspects that can structure genetic data. In particular, studies have considered either juveniles (Castilho and Mcandrew, 1998) or adults (Naciri et al., 1999), but not different life-stages concomitantly. As many so-called populations of marine fish may consist of amalgamations of geographic subpopulations or spawning components with a variable degree of segregation (e.g. McQuinn, 1997; Smedbol and Stephenson, 2001), this can lead to processes that may partly bias the picture of genetic structure in Atlantic sea bass (for instance, are juveniles representative of the local adult population?). Failure by fishery managers to account for stock complexity and composition may lead to depletion of particular components, with unknown ecological consequences (e.g. Stephenson, 1999). This can critically affect the long-term stability and sustainability of the entire stock. Finally, and most importantly, insights from genetic data in sea bass have not been compared to quantitative methods that also provide pictures of the dispersal of individuals, such as mark-recapture methods. Hence, a sustainable management scheme for sea bass cannot be implemented without accurate stock identification, for which genetic and tagging studies provide essential and complementary information (Slatkin, 1985; Rousset, 2001; Adams and Hutchings, 2003; Vandewoestijne and Baguette, 2004; Palumbi, 2004).

In this study we investigated genetic variation at microsatellite loci for a set of Atlantic populations of adult and juvenile sea bass, with a primary focus on Bay of Biscay and English Channel populations, but also on Irish and Scottish populations. We contrasted results obtained from this genetic analysis with those from a 3-year mark-recapture study on adult populations in the Bay of Biscay and English Channel.

2. Materials and methods

2.1. ICES divisions for sea bass management

Recognized divisions (A–F) for sea bass management are given in Fig. 1, together with positions of samples that were used in genetic analysis.

2.2. Mark-recapture/tagging studies

From December 2001 until March 2004, around 6100 sea bass were tagged in the Bay of Biscay and the English Channel. Tagging campaigns, organised by the Département Sciences et Technologies Halieutiques of IFREMER (Institut Français pour la Recherche et l'Exploration de la Mer Brest Centre, France) with the collaboration of the Oceanic Development company, were conducted on commercial pelagic trawlers. These fishing boats target concentrations of adult sea bass in winter, during

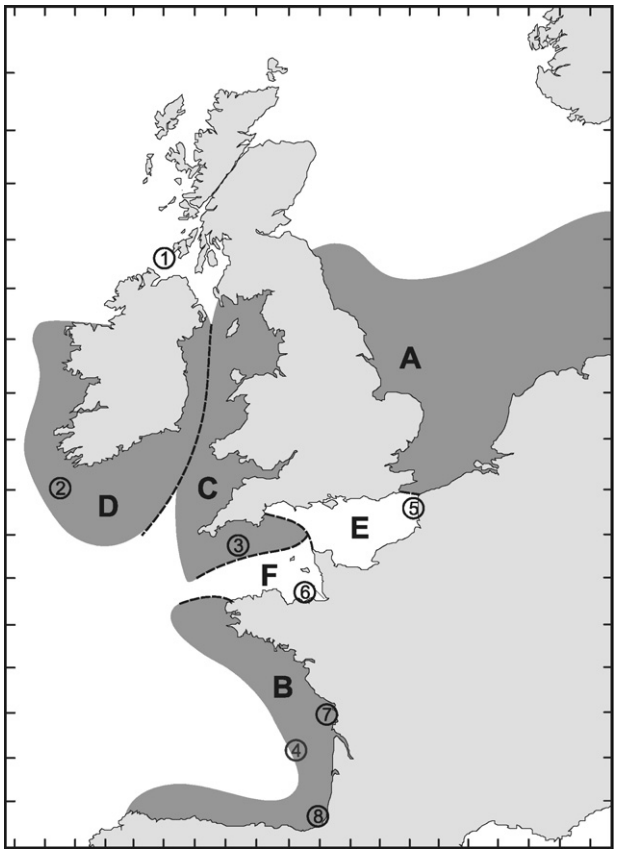

Fig. 1. Recognized "stocks" for sea bass management along Western European Atlantic coastlines (A–F; ICES, 2003). Locations of samples used for genetic analyses are indicated by circled numbers (see Table 2 for details).