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Short communication

Will philopatry in sea bass, *Dicentrarchus labrax*, facilitate the use of catch-restricted areas for management of recreational fisheries?

M.G. Pawson[a,*], M. Brown[b], J. Leballeur[c], G.D. Pickett[d]

[a] 3 Dickens Court, Blundeston, Lowestoft, Suffolk NR32 5BA, UK
[b] The Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK
[c] 69 Langstone Drive, Exmouth, Devon EX8 4HZ, UK
[d] Virginia Cottage, Marsh Lane, North Cove, Suffolk NR34 7PP, UK

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ABSTRACT

Many adult sea bass (>40 cm total length) tagged between May and October around the coasts of England and Wales have been recaptured close to their respective tagging locations in successive years. Analysis of mark and recapture data sets, for the late 1970s and early 1980s and in 2000–2006, show that some 55% of all recaptures were within 16 km of their original release position. This suggests that mortality rates of adult bass in local populations could be reduced by around 50% if a number of carefully selected areas were designated as catch and release only for bass, thus providing a management option with which more and bigger sea bass will be available to recreational sea anglers.

1. Introduction

Recreational sea anglers in England have been pressing for a management regime in which more and bigger sea bass (*Dicentrarchus labrax*) will be available to anglers, and this has recently been the subject of a Government consultation exercise (Defra: http://www.defra.gov.uk/corporate/consult/bass-mls/index.htm). The overall strategy has been to reduce fishing mortality, thus allowing more fish to survive for longer. One emerging tactic is to restrict commercial fishing for bass in areas where recreational anglers have priority of access, and where survivorship of bass would be maximized through catch and release.

Mark-recapture studies around England and Wales have shown a tendency of adult bass to migrate to the south and west during the autumn prior to spawning, with a return in spring north and eastwards to geographically discrete feeding areas (Pawson et al., 1987, 2007a). The migration patterns inferred from these studies in the late 1970s and early 1980s remained largely unchanged in the early 2000s, and the results include a number of tagged bass that have been recaptured at or close to their respective tagging locations in successive years.

The purpose of this paper is to evaluate whether this precision of homing is high enough that protection of adult bass in particular areas would result in more large individuals being available for capture there by the recreational fishery. We also contrast the results from bass tagged in summer feeding areas with those from bass tagged in winter pre-spawning aggregations.

2. Materials and methods

This study used mark and recapture data for sea bass >40 cm total length (used throughout) caught and tagged around the coasts of England and Wales between May and October ("summer") in the late 1970s and early 1980s (1490 fish, see Pawson et al., 1987) and in 2000–2006 (1342 fish, Pawson et al., 2007a, plus some post-publication recaptures). The two data sets have been reanalysed to compare the spatial and temporal distributions of the distance of recaptures from release positions.

We have also investigated whether there were seasonal differences in this behaviour, using the same analysis on data for 190 bass tagged at the Runnelstone in late October 1982 (Pawson et al., 1987) and new data on 502 fish caught, tagged (using Hallmark tags, see Pawson et al., 2007a) and released in February and March 2006 and between December 2006 and February 2007 in the commercial line fishery on the Boue Blondell reef off the northwest coast of Guernsey.

* Corresponding author. Tel.: +44 1502 730108.
E-mail address: m-pawson@sky.com (M.G. Pawson).

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In all cases, Cefas provided tags and associated tagging equipment and paid a standard reward for any returned tags (Pawson et al., 2007a). Posters encouraging reporting of tagged bass recaptured were displayed in ports along the coast of the UK, and also translated into French and distributed in the Channel Islands and along the Channel coast of France.

3. Results

3.1. Releases in summer feeding areas

There were only three examples of an adult bass tagged inshore in the summer in the late 1970s and early 1980s that was recaptured in the same or any subsequent summer outside the area in which it was tagged (defined as the local fishing sites where bass were caught for tagging, see Pawson et al., 1987). In the more recent study, 42 out of 73 bass recaptured between May and October in 2000–2006 were reported from the original release sites. In both studies, most sea bass >40 cm tagged inshore and subsequently recaptured between May and October inclusive were reported from within 16 km of their tagging position (Table 1), though the overall proportion decreased from 76% in the 1970s and 1980s to 55% in 2000–2006. This has been accompanied by an increase in the proportion of adult bass recaptured between November and April within the UK's 3-mile zone, some 30% in 2000–2006 compared to 10% in the 1970s and 1980s, which Pawson et al. (2007a) suggest is related to a lengthening of the duration of residence of adult sea bass in summer feeding areas, according to the hypothesis that the movement to pre-spawning areas will be delayed (and probably take place over a shorter distance) during warmer winters (Pawson and Pickett, 1996).

Fig. 1 suggests that the incidence of bass being caught in the same feeding area (i.e. within 16 km of the original release position) has not diminished over the last 25 years in most areas where data are available for comparison (between the eastern English Channel and west Wales), at some 60–80% of recaptures. More northern areas (southern North Sea and north-west Wales) in which fisheries have developed as the sea bass population has expanded (Pawson et al., 2007b) tend to show a lower "local" recapture rate.

The size of bass tagged does not appear to have influenced "homing" rates. Comparison of the proportions released at 40–50 cm, 50–60 cm, and over 60 cm at individual sites showed that proportionately more bigger fish were tagged in the 1970s and early 1980s than in the early 2000s only in north Devon and at Portland, where the proportions recaptured locally were lower in 2000–2006, whereas proportionately more bigger bass were released in 2000/2001 only in the Solent and Thames, where local recapture rates were lower in 2000-2006.

The probability of an adult sea bass being recaptured more than 80 km from its summer release site tends to be highest in the winter (Table 1), usually after they have moved several 100 km to the south and west (Pawson et al., 1987; Pawson et al., 2007a). This is despite the ubiquity of both recreational and commercial fisheries for sea bass around much of the coast of England and Wales (Pawson et al., 2007a).

The precision of homing to summer feeding areas is illustrated by the repeat recaptures of bass by members of tagging teams at the original tagging sites in years subsequent to tagging. Out of 29 adult bass reported from within 33 km of the release site in the Cefni Estuary, Anglesey, between 1971 and 1984, 14 were recaptured at the tagging position. Since 2000, 17 fish were recaptured at the original tagging positions in Devon, Cornwall, Dorset, the Isle of Wight, Channel Islands and south Wales, six in the year of tagging or the winter immediately following, and 11 in subsequent years and within three calendar months of the release date. Among these fish were 4 – out of 40 tagged and released at a station permanently

Table 1
Numbers of bass >40 cm TL tagged and released in (a) summer (May–mid-October) and (b) winter (late October–April) and recaptured between May and October and between November and April in relation to distance from release position, and the proportion of tagged fish recaptured

(a) Summer release site	Number tagged (May–October)	Number recaptured (May–October/ November–April) (% of total tagged)	Recaptured within 16 km of release position May-October	Recaptured >80 km from release position May–October	Recaptured within 16 km of release position November–April	Recaptured >80 km from release position November–April
South Yorkshire (2000–2006)	111	6/6 (10.8)	1	2	2	2
Thames Estuary (1970s and 1980s)	531	33/17 (9.4)	29	1	3	13
Thames Estuary (2000–2006)	42	2/0 (4.8)	0	2	0	0
Solent (1970s and 1980s)	195	11/2 (6.7)	7	0	1	1
Solent/IOW (2000–2006)	218	14/11(11.5)	7	1	1	6
Poole Bay (2000–2006)	81	13/1 (17.3)	11	1	0	0
Portland (1970s and 1980s)	139	14/1 (10.8)	10	2	0	1
Portland (2000–2006)	161	9/6 (9.3)	7	0	2	3
South Devon (1970s and 1980s)	236	13/6 (8.1)	11		3	2
South Devon (2000–2006)	98	6/0 (6.1)	5	0	0	0
South Cornwall (2000–2006)	107	1/1 (1.9)	0	1	0	1
North Cornwall (1970s and 1980s)	45	5/1 (13.3)	5			1
North Cornwall (2000–2006)	113	5/3 (7.1)	2	2	0	2
South Wales (2000–2006)	120	9/2 (9.2)	6	0	1	1
Cardigan Bay (1970s and 1980s)	37	8/4 (32.4)	8			4
Anglesey (1970s and 1980s)	307	29/10(12.7)	29		2	8
Anglesey (2000–2006)	144	4/5 (6.3)	0	0	0	5
Cumbria (2000–2006)	147	4/3 (4.8)	1	0	1	2

(b) Winter release site	Number tagged (October–March)	Number recaptured (May–October/ Nov–April) (% of total tagged)	Recaptured within 16 km of release position May–October	Recaptured >80 km from release position May–October	Recaptured within 16 km of release position November–April	Recaptured >80 km from release position November–April
Runnelstone (1982)	190	9/3 (6.3)	0	9	2	0
Boue Blondell (2006–2007)	502	14/10(4.8)	0	13	4	6

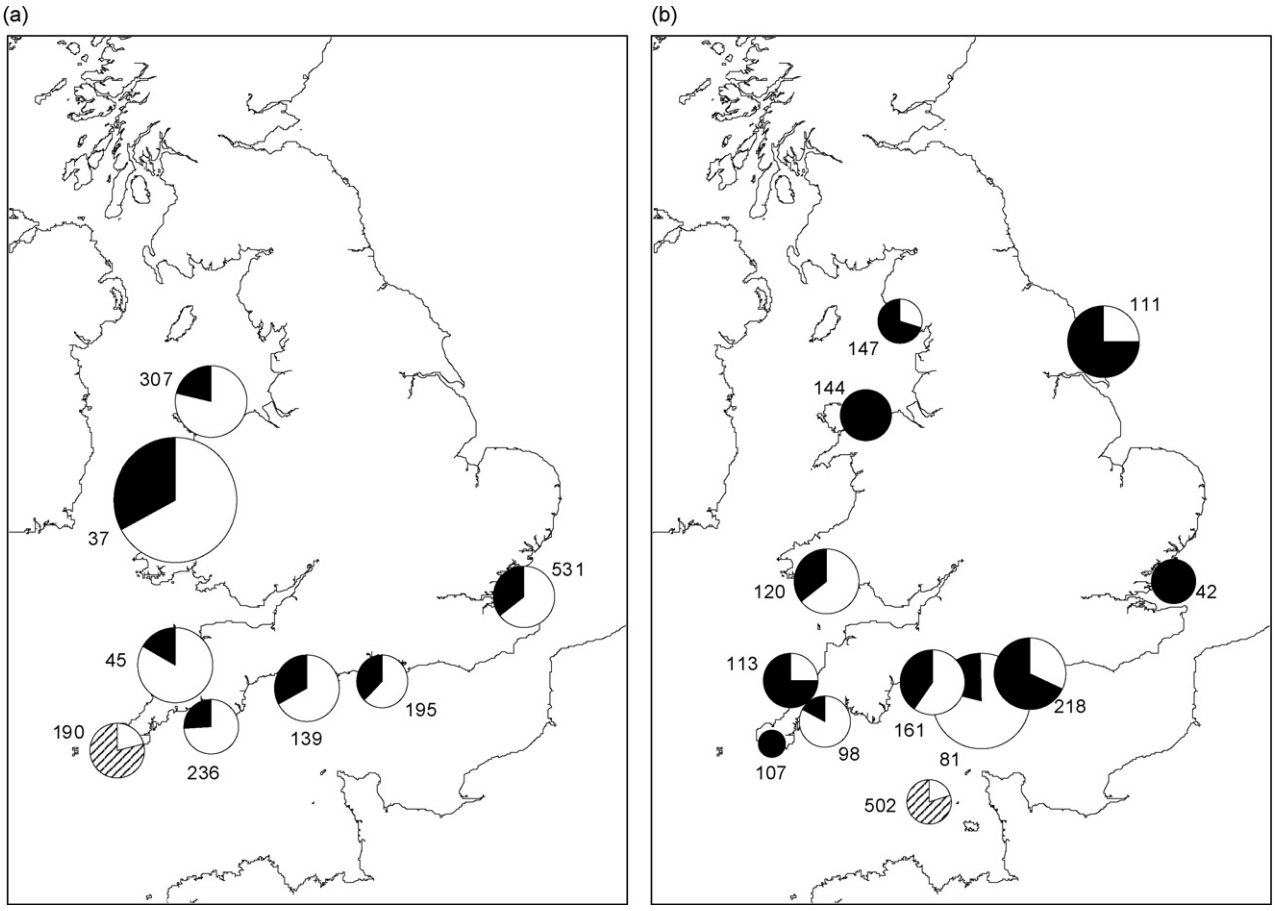

Fig. 1. The numbers of sea bass tagged and released around England and Wales between May and October and the proportions reported recaptured within 16 km of the tagging position (open sector of rondal, size of rondal proportional to recapture rate of fish released at each site), (a) in the late 1970 s and early 1980s, and (b) in the early 2000s (see Table 1 for details). Bass tagged in "winter" fisheries at the Runnelstone and Boue Blondell shown as hatched rondals in (a) and (b), respectively.

marked by a buoy on Christchurch Ledges on 27th and 28th July 2001 – that were all recaptured at the same position between 8th May and 4th June 2002.

3.2. Releases in winter pre-spawning aggregations

Two of the 190 bass tagged in late October 1982 at the Runnelstone, where a traditional line fishery has existed since the 1970s, were reported from within 16 km of the tagging position in the same winter, but the majority (9) were reported in summer between Newquay (75 km north east of the Runnelstone) and the Duddon Estuary, Cumbria, on the west coast of England and Wales (Pawson et al., 1987).

To date, 24 tagged bass have been recaptured and reported from the 502 fish released at the Boue in winter 2006 and 2007. Eight of fourteen fish recaptured during the summer months (May–October) had moved northeast to the English coast of the eastern English Channel and the southern North Sea as far north as Lowestoft. Five other fish were recaptured along the French Coast around Normandy and in the Gulf de St Malo, and one fish in the Bristol Channel. Ten fish were recaptured between November and April: four in the release area, three offshore in the Western English Channel, two off the south coast of England, and one in the southern North Sea.

A direct comparison, in terms of proportion of recaptures, between summer- and winter-tagged bass indicates that the latter had a much higher probability to be recaught more than 16 km from the respective release position (Fig. 1).

4. Discussion

There is strong evidence, then, that contingents of adult bass, which may share common migration routes during spring and autumn and frequent the same spawning grounds, segregate to specific summer feeding areas. It is possible that these contingents retain their biological integrity at all times, but an extended larval drift phase (Jennings and Pawson, 1992) and the wide dispersion of pre-adults (Pickett et al., 2004) militates against any genetic separation (Fritsch et al., 2006). Thus, whilst there is little evidence of distinct self-sustaining "biological stocks" of sea bass in North west Europe, the observation that adult sea bass show a strong propensity to return again and again to particular feeding areas has implications for management of their fisheries.

In many cases, rather than kill tagged fish, the captors noted tag details and released the fish with the original tag attached. One bass in particular was first caught, tagged and released from a mark in South Wales on 24th May 2001, weighing 2.84 kg. This fish was subsequently recaptured at the same location on 21st August 2002, weighing 3.18 kg, and again on 17th September 2003, when it weighed 4.2 kg. Clearly, repeated recapture had not inhibited the growth of this fish nor its propensity to feed in that particular locality, suggesting that catch and release may have real conservation benefits for sea bass.

Because adult bass appear to be less susceptible to capture when they move outside their "home" summer feeding areas, protection of the populations in such areas should enhanced survivorship and lead to more, bigger bass being available to recreational anglers.

It can be assumed that the recaptures of fish tagged at all release sites were derived from the same fishing effort within the various fisheries around the coasts of England and Wales, and that the distribution of returns can be used to indicate relative exploitation levels (see Dunn and Pawson, 2002; or Pawson et al., 2007a,b, for a comprehensive discussion of this concept). Taking the two published UK tagged-bass data sets together, 55% of recaptures of bass >40 cm released between May and mid-October were reported recaptured within 16 km of their original release position, whilst a further 23% were caught at least 80 km away, chiefly in winter. Even allowing for higher reporting levels by members of the tagging teams, this suggests that mortality rates of adult bass in local populations could be reduced by around 50% if a number of carefully selected areas were designated as catch and release only for bass. This would build on the successful protection of juvenile bass in "nursery areas" established around the coasts of England and Wales in 1990, which have significantly reduced mortality on fish below 36 cm (Pawson et al., 2005) and boosted recruitment of larger fish to the adult stock and fishery, often well away from the "home" range (Pickett et al., 2004).

The results of tagging bass at the Boue Blondell (Guernsey) winter fishery show that most fish disperse in summer along the nearby French Normandy coast or the south east English coast. No tagged fish were reported from the Channel Islands between May and October, and only 4 of 24 recaptures where reported from within 16 km of the Boue between November and April. The pre-spawning aggregation of sea bass around the Boue is similar to that on the Runnelstone reef off south Cornwall, where adult bass were tagged in late autumn 1982. In both cases, bass appear more likely to be recaptured in quite distant summer feeding areas than at the tagging site in following winters, in contrast to fish tagged in summer feeding areas, which are far more likely to be recaptured nearby.

Whilst multi-year homing of adult fish to particular locations in freshwater is well known in migratory salmonids, repeat-spawning sea trout *Salmo trutta* (Sambrook, 1987; Walker, 1987) for example, the nature of conventional mark and recapture programmes militates against such evidence being collected for marine fish species. Usually, the fish has to be killed for the tag to be returned, or the details of tagging and recapture positions are insufficiently precise to demonstrate whether a fish has returned to a specific location. Data storage tags (Hunter et al., 2003a) may be used to construct time series geolocations of a fish's track whilst at liberty, and this has provided evidence of philopatry (the tendency of an individual to return to, or stay in its home area, natal site or other adopted locality, Mayr, 1963) to spawning and feeding areas in a number of plaice *Pleuronected platessa* sub-populations in the North Sea (Hunter et al., 2003b, 2004). However, the technique's spatial resolution (±35 km) is insufficient to demonstrate the accuracy of homing required to evaluate the benefits of designating areas for the purpose of segregating recreational and commercial fisheries for bass.

Robichaud and Rose (2001) used sonar transmitting tags to demonstrate repeat homing of cod *Gadus morhua* to within 10 km of their release position in a spawning area in Placentia Bay, Newfoundland. These cod, like European sea bass, may move several 100 s of km to feeding areas. Whilst an insight to the spatial and temporal susceptibility of fish to fisheries throughout the movement range of particular contingents may only be feasible through the scale of recaptures attained by conventional tagging studies, recent work using DSTs on thornback rays *Raja clavata* in the Thames Estuary (Hunter et al., 2003a, 2005) has shown much more extensive movements than were indicated by mark-recapture. It may, therefore, take a combination of both approaches to determine whether fish that appear to be "homing" are using landmarks to navigate accurately, or if they are only susceptible to being caught in particular locations despite ranging widely.

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