Northern European Wrasse – Summary of commercial use, fisheries and implications for management

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Executive summary

- The use of 'cleaner fish' (fish species that feed on ectoparasites) is of increasing focus to the salmon farming industry as an alternative to chemical (organophosphate) treatments. The preferred species of cleaner fish are various species of wrasse (Labridae), and there is also increasing interest in lumpfish *Cyclopterus lumpus*.

- As the use of wrasse (and lumpfish) as cleaner fish has increased, there is growing concern regarding the potential localised over-exploitation of wrasse populations around parts of the UK, and in relation to the potential impacts of transporting wrasse from one part of the country to another.

- There are very limited data on wrasse populations from existing survey programmes, as trawl surveys tend to avoid rocky inshore grounds where wrasses are usually most abundant. Therefore, there are insufficient data to examine 'stock trends'.

- Wrasse have biological characteristics (e.g. site fidelity, hermaphroditism in some species, nest guarding) that would make them susceptible to localised over-exploitation and potentially localised depletion.

- The scale of the wrasse fishery around the coasts of the UK is uncertain, and there are limited data on the species composition as well as the size range and sex ratio of landed fish.

- Whilst there is the potential for localised depletion, wrasse fisheries can be an important economic element of the diversification of inshore fisheries. Hence, options for precautionary management measures could usefully be developed with IFCAs and the fishing industry to ensure the sustainability of these fisheries.

- Precautionary management measures could include quota management (which could be applied over zonal areas of coastline), spatial management (especially if aligned with the current MCZ network) and seasonal restrictions (to minimise fishing impacts during the spawning season). Size restrictions would need more careful consideration, in order to balance market demands with the need to ensure an appropriate size range and sex ratio of fish in the wild.

- Further studies on wrasse could usefully consider the population dynamics of wild populations (life history, movements, population structure and status, parasites and genetic structure), wild

capture fisheries, transportation and husbandry, and captive breeding. Such work would require close cooperation of the various sectors involved in this fishery.

Introduction

1. Sea lice *Lepeophtheirus salmonis* infestation is a major problem in sea cage rearing of Atlantic salmon *Salmo salar*, as sea lice infestations result in fin damage, skin erosion and wounding, which affects market value and acts as a pathway for other pathogens (Morton and Routledge, 2005). Sea lice were previously controlled by regular exposure to organophosphate pesticides. However, such treatment is expensive, due to continual use, difficult to apply, can cause stress to the fish and reduce growth rates, may impact on the wider marine environment, and sea lice may exhibit reduced sensitivity over time.

2. An alternative to chemicals is the use of 'cleaner fish', such as wrasse (Family Labridae). After experimental trials confirmed that some wrasse species helped control sea lice in aquaculture (Bjordal, 1988), the financial and environmental benefits of using cleaner wrasse led to increased commercial exploitation of wild populations in Norway and the British Isles (Darwall *et al.*, 1992; Treasurer, 1994b). It is not known if the main exploited species can sustain intensive fisheries.

3. The first observations of cleaning behaviour by European wrasse was in aquaria (Potts, 1973) and underwater observations (Potts, 1973; Hilldén, 1983). That locally-caught wrasse would act as cleaner fish to control sea lice on salmon was noted by Bjordal (1988) and Costello (1996). Subsequent trials in experimental cages saw significant reductions of sea lice on salmon. From 1990, the use of wrasse for biological control became an established part of lice control measures in Norway (Costello, 1996). Trials of cleaner wrasse in salmon cages then occurred in Scotland (1989) and Ireland (1990). The trials successfully showed cleaner fish as a viable and cheaper alternative to chemical treatment in the control of sea lice in salmon farms (Costello, 1996).

4. In the 1990s, scientific studies and industry-led funding led to ecological, behavioural, physiological and parasitological investigations of the population dynamics and distributions of wrasse. This work aimed to (i) improve the cleaning efficiency and wrasse survival in salmon cages, (ii) assess potential disease threats from wild-caught fish, and (iii) investigate the potential for captive breeding of wrasse. Field and experimental data examined wrasse behaviour, movements, interactions with other fish, reproduction, fishing methods, use in farming and rearing in aquaculture.

5. Most of the studies in the 1990's focused on goldsinny, rockcook and corkwing wrasse, due to their small size, inshore habitats and distribution[1]. The utility of ballan wrasse was thought to be restricted by their larger size (up to 60 cm). Cuckoo wrasse tends to occur in deeper water and may not be suitable for the shallower waters associated with salmon farms.

6. Whilst smaller wrasse (e.g. goldsinny) were used originally, ballan wrasse is currently regarded as a preferred species, although some farms use a mixture of wrasse species and sometime also use lumpfish (lumpsucker; *Cyclopterus lumpus*). Ballan wrasse and lumpfish are proving more successful to breed and rear, although there is not yet commercial-scale production of farmed individuals to adequately supply farmed 'cleaner fish'. It has been suggested that salmon farms would use a ratio of one wrasse to 25 salmon (i.e. 4% of the salmon stocked), highlighting the potential demand for wrasse.

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[1] It has been suggested that some species may damage the salmon (e.g. their eyes), which may depend on the size of the wrasse in relation to the size of the salmon.

7. As yet, there is no commercial-scale production of wrasse capable of supplying industry demand. Investigations are being carried out in Scotland to breed wrasse (particularly ballan wrasse) in aquaculture in order to supply the salmon farming industry. However, adequate supplies of farmed cleaner fish are unlikely to become available in the short term, and so there is a need to ensure that current levels of exploitation of wild populations are sustainable, in order to protect wild stocks. Improvements to live transportation, disease control and husbandry practice in farms may increase the longer-term survival of wrasse and reduce the quantity of replacement fish needed.

Wrasse fisheries

8. Most UK salmon farms are in Scottish waters, and farms used locally-caught wrasse initially. However, due to supply not meeting demand (which may be related to increased demand, shorter fishing seasons in cooler waters, and potential depletion in local populations), the supply of wrasse moved further afield. Wrasse fishing elsewhere around the coast increased, including along the south coast of England, where the wrasse fishing season is longer due to warmer sea temperatures.

9. Fishing in the south-west has increased so much that is thought up to a million wrasse (mixed species, but thought to be primarily ballan wrasse) are caught for live transfer to Scottish salmon farms annually. Wrasse have been suggested to make £1–17 per fish, making them valuable fishery species in Europe, and providing inshore fishing fleets an opportunity to diversify, although an accurate economic assessment of wrasse fisheries is required.

10. Targeted wrasse fisheries mainly use traps (creels, pots), but they are also taken in a variety of other gears (e.g. gillnets). There has not been a thorough description of the target fisheries in English waters.

11. In Scottish waters, fishing for wrasse is thought to have commenced in 1990. The fishery is seasonal, as few fish are caught when sea temperature is <7°C (Darwall *et al.*, 1992; Sayer *et al.*, 1993) and salmon farms generally request wrasse for stocking from June–August, when salmon smolts are small and when wrasse can clean fish effectively before sea temperatures decrease. Initially, prawn creels baited with shellfish were used to catch wrasse in Scotland. At first, they were deployed close inshore (3–10 m depth; 30–60 min soak time on a rising tide), but later were deployed unbaited and overnight. Fyke nets are increasing as one of the main fishing gears in the Scottish wrasse fishery.

12. The south coast of England is seeing increased wrasse fisheries, due to an opportunity for inshore fleets to diversify from traditional fisheries, because the numbers of wrasse are comparatively high, and the warmer water temperature provides a longer fishing season.

UK landings of wrasse

13. Most fishing vessels targeting wrasse are small <12 m vessels operating inshore. Hence, available landings data are likely to underestimate catches. It must also be noted that most wrasse are landed live and comparatively few fish (e.g. larger ballan wrasse and cuckoo wrasse) are sold for consumption. Most reported UK landings are recorded under the generic wrasse species code, and accurate data on the species composition is lacking in FAD/iFISH data (Table 1).

14. The relevant FAO codes that may be used for wrasse in UK waters are given below, but it is noted that wrasse might also be reported under the more generic codes for 'other demersal fish', and some landings might not have been reported.

FAO code	Scientific name	Common name
USB	*Labrus bergylta*	Ballan wrasse
USI	*Labrus bimaculatus*	Cuckoo wrasse
TBR	*Ctenolabrus rupestris*	Goldsinny wrasse
YFM	*Symphodus melops*	Corkwing wrasse
WRA	Labridae	Wrasses, hogfishes, etc. nei

15. Data from iFISH (2000 to November 2016) were examined, indicating that annual landings of 43–69 t were reported in the last three years. Over the entire time series examined, the main ICES Divisions where wrasse were taken from (Table 2; Figure 1) were the west coast of Scotland (Division 6.a; 138 t; 33% of landings, but landings likely underestimated), western English Channel (Division 7.e; 175 t; 42%) and eastern English Channel (Division 7.d; 76 t; 18%).

16. Scottish landings were reported across *ca.* 40 ports within Division 6.a, the main two ports being Shieldaig (18% of 6.a landings) and Ulva Ferry (Isle of Mull, 15.5%). The main reported gear of capture was pots (98.5%).

17. On the south coast of England, wrasse caught in Divisions 7.d–e were landed into some 70 ports, with the main landing ports being Brixham (16% of Channel landings), followed by Lyme Regis (~12%) and Eastbourne (~12%). The main gears for these landings were gillnets (40%) and otter trawl (30%), whilst potting only accounted for 4% of recorded landings.

18. Landings in Scotland increased in April and continued until December, whilst landings in England continued throughout the year (Table 3). The main landings period in Division 6.a was June–October, peaking in August/September, although landings increased again in December. For Divisions 7.d–e, landings increased in April and continued through to January, peaking from September-November. This highlights the differences in the timing and peaks of the fishing seasons between the two areas, which likely relates to the differences in sea temperature and the seasonality of wrasse.

Management issues

19. To understand the impacts of this fishery it is important to know the species' vulnerability to exploitation by obtaining quantitative information on the productivity, abundance, and distribution of the various species of wrasse. There is relatively limited information on wrasse in UK seas (see Annex). In addition, information regarding the impacts of fishing, transportation and husbandry practice, wrasse interactions with salmon, wrasse parasites and diseases, and opportunities for captive breeding of wrasse are all important elements to enable effective management, regulation and sustainable exploitation.

20. Wrasse may be considered biologically vulnerable to over-exploitation and possibly localised depletion (Munoz, 1991; Varian *et al.*, 1996), due to various aspects of their life history:
    - Limited home range: Field observations of wrasse in European seas have indicated high site fidelity (Villegas-Ríos *et al.*, 2013), suggesting that over-exploitation could lead to localised depletion.

- Longevity: Whilst some wrasse species may not live for periods of >10 years, ballan wrasse may attain ages of >20 years.
- Reproduction/sex ratio: The reproductive biology of wrasse is quite varied. Several species are nest-guarding, with territorial males protecting the eggs as they develop. Loss of large males from a population may therefore impact on recruitment success. Some wrasse are protogynous hermaphrodites (i.e. smaller individuals are female that become male when at a sufficiently large size). In such circumstances, there is the capacity for size-based exploitation to impact on the sex ratio and reproductive success. Consequently, both the size-based and sex-based exploitation patterns of wrasse should be considered.
- Behaviour in relation to temperature: Some wrasse exhibit reduced activity in the winter, and in some species (e.g. goldsinny and rock cook), the reduced metabolic activity and reduced feeding allows the fish to enter a hypometabolic state (analogous to a form of hibernation).

21. There are no stock assessments for any species of wrasse in British waters, with biological data limited, and the quantities of wrasse being taken (as well as the species composition, size composition and sex ratio) largely unrecorded.

22. There are no robust indicators of stock size. Existing trawl surveys tend to catch wrasse only infrequently, as most surveys do not operate on rocky, inshore grounds where wrasse would be most abundant. Localised studies on wrasse have generally used SCUBA surveys or baited pots and traps to examine wrasse populations (Treasurer, 2000; Gjøsaeter, 2002b). It has been suggested that recreational divers are observing fewer wrasse, but there are no published data to verify this. It is unlikely that existing trawl surveys could be used to inform on stock trends of most wrasse species. There may be sources of historical data for some sections of the English coastline (e.g. Solent bass survey), but data are lacking for most areas.

23. The scale of the fisheries is uncertain. There is likely to have been some under-reporting (as highlighted in Table 2), and it is unclear as to whether all live trade of wrasse is included in landings statistics. Data on the species composition of landings is also highly uncertain, with the majority of reported landings recorded at the family level (Table 1). Further studies to better document the fisheries and scale of landings are required.

24. Transportation of live fish should also be examined in greater detail. The salmon farming industry has highlighted the importance of farms following a set code of practice in transportation, handling, husbandry, holding fish over winter, training of and use of wrasse following their capture. Practice and control of transportation, holding and care of live wrasse (and lumpfish) may require improvements and, potentially, regulation.

25. In relation to aquaculture and market demand for wrasse, further understanding about husbandry conditions (including overwintering), diseases and interactions with salmon may be needed to develop effective regulation. This might also reduce demand for wild-caught fish. Other aquaculture-related issues that may need to be considered include consideration of potential impacts from any escaped wrasse on local populations, in terms of mixing of genetic structure and potential transfer of disease and parasites.

26. Whilst there are no assessments for wrasse, there could be consideration of precautionary management measures. Such measures could usefully be developed with the IFCAs and fishing industry. Size restrictions may require careful thought, as the market demand for fish over a

particular size may need to be balanced with the need to ensure an appropriate sex/size composition for the wild stock. Options for precautionary management include:

- Quota management, which could be applied over zonal areas of coastline
- Spatial management, which could be considered within the current MCZ network
- Seasonal restrictions, which could reduce the impact of the fishery during the spawning season

Figure 1. Wrasse landings weight (kg) by ICES rectangle from 2000–2016. (MMO Fisheries Statistics, 2016).

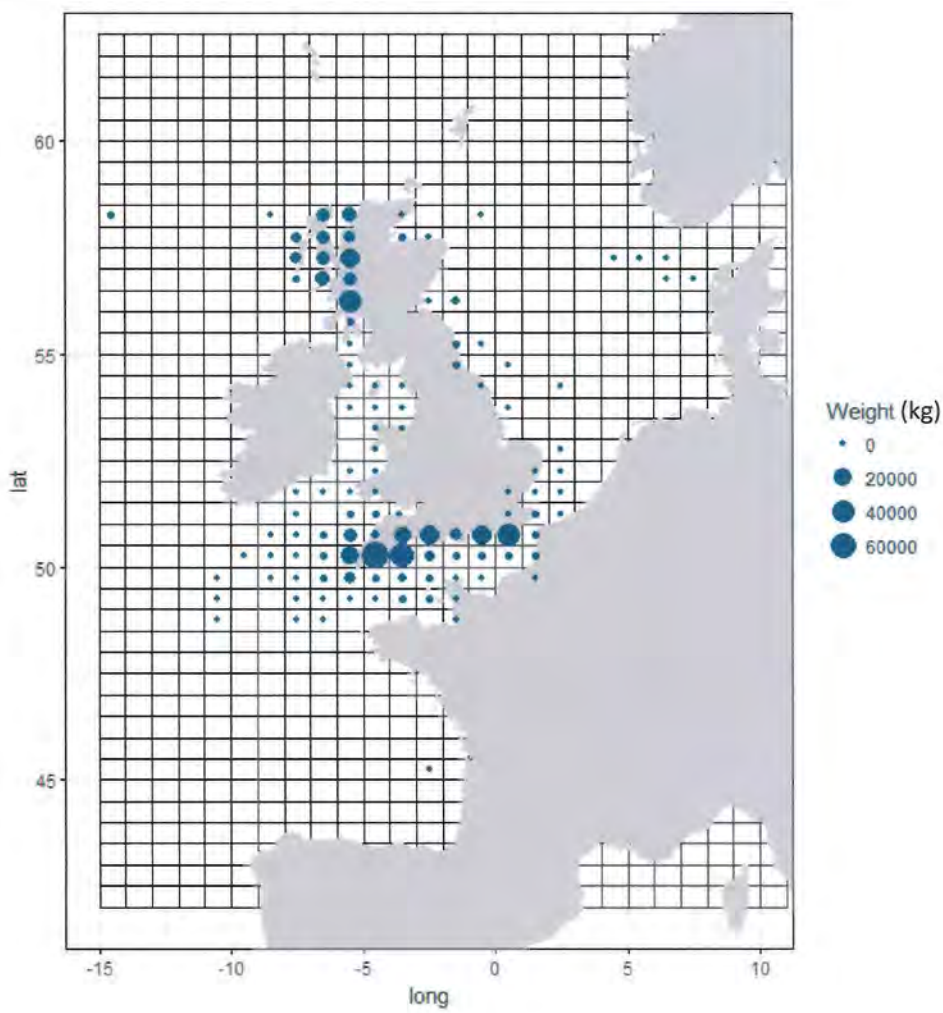

Table 1. Wrasse landings (kg) by reporting category 2000–November 2016 (Source: MMO). Most wrasse are not identified to species-level. (N.B. Data are compiled from recorded landings from UK vessels into UK ports and foreign vessels into UK ports).

Year	Ballan Wrasse	Wrasses*	Total
2000	1849	20665	22514
2001	387	25179	25566
2002		21145	21145
2003		16421	16421
2004		15749	15749
2005		10155	10155
2006		14166	14166
2007		18753	18753
2008	8	13677	13685
2009	34	18123	18157
2010	89	14493	14582
2011	54	11912	11966
2012	291	18013	18304
2013	1	17449	17450
2014		69009	69009
2015	27	42573	42600
2016	128	68683	68811
Total	2868	416165	419033

Table 2. Wrasse landings (kg) by ICES Division 2000–November 2016 (Source: MMO). The rapid increase in landings in 6.a suggests that landings have not been reported consistently over time, and so these values may be underestimates.

Year	4.a	4.b	4.c	6.a	6.b	7.a	7.d	7.e	7.f	7.g	7.h	8.b	7.j	Total
2000		60	18			18	4901	16192	1303	9	4	9		**22514**
2001		264	5		206	23	7728	14679	2657	2	2			**25566**
2002			62	102		2	6868	12558	1477	9	67			**21145**
2003		1000	47			8	5549	9653	137	24	3			**16421**
2004			13				5559	9525	640	8	4			**15749**
2005		12	7	0		39	5492	4198	323	84				**10155**
2006		89	1			18	3608	9885	562	1	2		0	**14166**
2007		16	115			11	4954	11679	1960	0	18			**18753**
2008		20	55			5	4771	7491	1299	44	0			**13685**
2009		30	27			72	5978	10904	1095	51	0			**18157**
2010	2	114	96			29	3357	9661	1316	5	2			**14582**
2011		243	60			34	1859	9029	720	12	9			**11966**
2012	32	24	5			89	3498	13291	1230	135				**18304**
2013	160	54	54			9	3365	12530	1178	100	0			**17450**
2014		25	7	51111		13	2719	11557	3471	102	2		2	**69009**
2015	737	37	14	30288		16	2649	6514	2202	127	16			**42600**
2016	116	29	6	56508		91	3377	6032	2504	88	60			**68811**
Total	**1047**	**2017**	**592**	**138009**	**206**	**477**	**76232**	**175378**	**24074**	**801**	**189**	**9**	**2**	**419033**

Table 3. Monthly landings (kg) of wrasse in 6.a and 7.d–e (Source: MMO).

Month	Weight landed in 6.a	% by month	Weight landed in 7.d	Weight landed in 7.e	Total landed in 7.d–e	% by month
Jan	0	0.00	2470	12789	15259	6.06
Feb	0	0.00	2111	7237	9348	3.72
Mar	0	0.00	2860	7697	10557	4.20
Apr	48	0.03	9297	5983	15280	6.07
May	1628	1.18	11635	9071	20706	8.23
Jun	14292	10.36	6498	10908	17406	6.92
Jul	22622	16.39	2834	13780	16614	6.60
Aug	28107	20.37	5333	17872	23205	9.22
Sep	37410	27.11	10841	21129	31970	12.71
Oct	19849	14.38	10196	25501	35697	14.19
Nov	3400	2.46	8304	27812	36116	14.35
Dec	10653	7.72	3853	15599	19452	7.73
Total	138009		76232	175378	251610	

Landings above 5%

Peak landing period

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Annex 1: Wrasse around the British Isles

Wrasse (Labridae) are widely distributed and commonly found in tropical to temperate seas (Wheeler, 1969; Wernerus, 1989). They are an important component of the demersal fish assemblage in shallow water rocky habitats (Magill and Sayer, 2002; Gjøsaeter, 2002a) and are often abundant in and near to kelp forests and other macroalgal habitats (Norderhaug *et al.*, 2005). Wrasse are often territorial and are likely to have limited movements.

There are eight species in northern European waters, of which the following six are common in English waters:

- Goldsinny *Ctenolabrus rupestris*
- Rock cook *Centrolabrus exoletus*
- Baillon's wrasse *Symphodus bailloni* C
- Corkwing wrasse *Symphodus melops*
- Ballan wrasse *Labrus bergylta*
- Cuckoo wrasse *Labrus mixtus*

Two other species, scale-rayed wrasse *Acantholabrus palloni* and rainbow wrasse *Coris julis* are much less common and therefore are less likely to be used as cleaner fish. Neither of these species, or the little-studied Baillon's wrasse is considered further here. Four species (goldsinny, corkwing, rockcook and ballan wrasse) are commonly used in the salmon farming industry, to control sea lice. Prior to their use in salmon farms, wrasse were of negligible economic importance. Consequently, knowledge of their biology, population status and the effects of over-exploitation are generally little known (Sayer and Treasurer, 1996).

Goldsinny *Ctenolabrus rupestris*

Goldsinny wrasse is distributed widely around Britain and Ireland, occurring from the shallow sub-littoral to depths of ca. 50–90 m (Heessen *et al.*, 2015). It occurs on rocky grounds where there are numerous crevices in which to hide. In addition to predating on small invertebrates, this species is known to eat the ectoparasites of fish.

Survey data presented in Heessen *et al.* (2015) reported goldsinny to be caught most frequently along the southern and western coasts of the British Isles, over a depth range of 6–175 m. Larger sized individuals occur in deeper waters than juveniles (Quignard and Pras, 1986; Sayer *et al.*, 1993).

Goldsinny is a relatively small wrasse, usually 10–12 cm long, sometimes growing to 18 cm (Smitt, 1892; Quignard and Pras, 1986; Sayer and Treasurer, 1996). Survey data from Heessen *et al.* (2015) reported a length range of 3–19 cm.

Goldsinny are common to about 8 years of age, with maximum reported ages of 14 years for males and 20 years for females (Sayer and Treasurer, 1996). They reach maturity at about two years (Sayer and Treasurer, 1996).

Spawning occurs from April to August, peaking in June, (Golani *et al.* 2006). Males are highly territorial (Hilldén, 1981) and defend their territory during the spawning season (Muus and Nielsen, 1999). Spawning takes place in mid-water; they are batch spawners and the pelagic eggs hatch to become planktonic larvae (Golani *et al.* 2006; Dipper and Pullin, 1979; Darwall *et al.*, 1992). Based on a study carried out off the south west Irish coast (Varian *et al.*, 1996), females produce on average 12,808 eggs/gonad weight(g) per batch, further estimates of fecundity of individual females in one season ranged from 2700-81000 eggs (Stone, 1996). However, the number of batches per female per season and survival rate of eggs and larvae is unknown. The eggs of goldsinny can be abundant in the ichthyoplankton in the Irish Sea and can drift up to 2-6 miles (Varian *et al.*, 1996), although other studies have found abundance to be more sporadic, (Varian *et al.*, 1996). Newly settled young have been reported from coastal waters from late August and September (Sayer *et al.*, 1993).

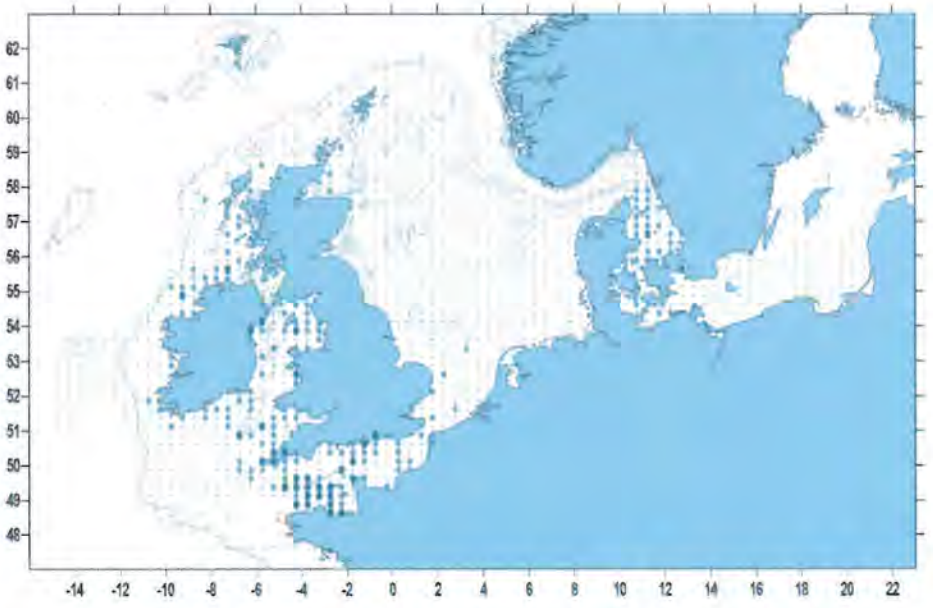

Figure 2. Distribution of goldsinny recorded in trawl surveys around the British Isles (Source: Heessen *et al.* (2015)).

Rock cook *Centrolabrus exoletus*

Rock cook, or small-mouth wrasse, is widespread around Ireland and western coasts of Britain, but is more sporadic along the south-east coast of England (Heessen *et al.*, 2015). It usually occurs in shallow inshore areas (<20m) near seaweed covered rocks and seagrass beds (Quignard and Pras, 1986). It is occasionally caught over sand and reported down to depths of 35 m (Picton and Morrow, 2016). There may be a tendency for rock cook to move into deeper water during the winter (Sayer and Treasurer, 1996).

Rock cook is a small-bodied species, generally 10–16.5 cm long (Darwall *et al.*, 1992). Survey data from Heessen *et al.* (2015) reported a length range of 4–13 cm, with these specimens caught at depths of 14–91 m.

The maximum age of rock cook in Scottish waters has been reported as 9 years (Treasurer, 1994a). They spawn from May to July (Sayer *et al.*, 1996), with females maturing at about age 2 (Darwall *et al.*, 1992; Sayer *et al.*, 1996). They form a distinct pairing during breeding (Breder and Rosen, 1966), and females lay their sticky, demersal eggs in 'nests' constructed of algae in rock crevices (Muus and Nielsen, 1999). Estimated von Bertalanffy growth parameters are $L\infty$ = 135.2 mm, K = 0.807 and t_0 = –1.128 (males) and $L\infty$ = 131.5 mm, K = 0.689 and t_0 = –0.435 (females), (Sayer *et al.*, 1996).

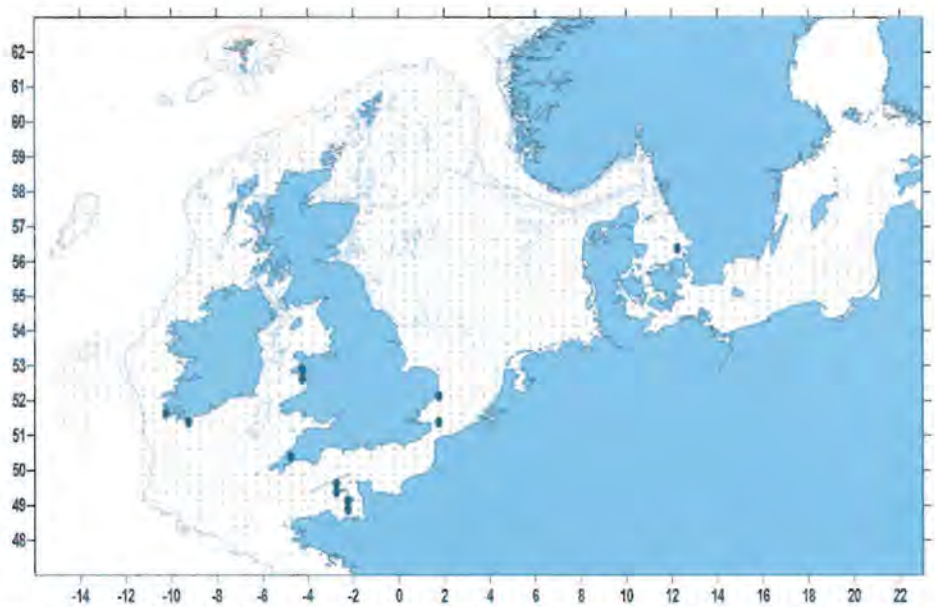

Figure 3. Distribution of rock cook wrasse recorded in trawl surveys around the British Isles (Source: Heessen *et al.* (2015)).

Corkwing *Symphodus melops*

Corkwing wrasse is widespread around the Britain Isles, especially along western and southern coasts (Heessen *et al.*, 2015). It is associated mainly with coastal lagoons, eel-grass beds, rocky reefs and amongst seaweed covered rocks down to a depth of 30 m, although survey data indicate that smaller numbers can occur down to depths of 165 m (Heessen *et al.*, 2015). Whilst occurring in small aggregations, it is also territorial.

It is a relatively small-bodied wrasse, usually up to about 15–20 cm in length, but sometimes to 28 cm. Estimates longevity ranges from about 6 (Wheeler, 1969; Quignard and Pras, 1986) to 9 years of age (Darwall *et al.*, 1992). They mature at about 2–3 years and spawn from May to July. The males are aggressively territorial (Potts, 1974) and construct a nest of seaweed amongst rocks or in rock crevices, in which the adhesive eggs are laid (Golani *et al.* 2006). Males are observed to grow faster than females (Quignard and Pras, 1986). The von Bertalanffy growth parameters have been estimated as $L\infty$ = 245.5 mm, K = 0.294 and t_0 = –0.76 (males) and $L\infty$ = 244.0 mm, K = 0.214 and t_0 = –1.355 (females) (Sayer *et al.*, 1996).

In addition to predating on small invertebrates (Quignard and Pras, 1986; Deady and Fives, 1995a; Sayer *et al.*, 1996; Wennhage and Pihl, 2002), this species is known to eat the ectoparasites of fish (Potts, 1973).

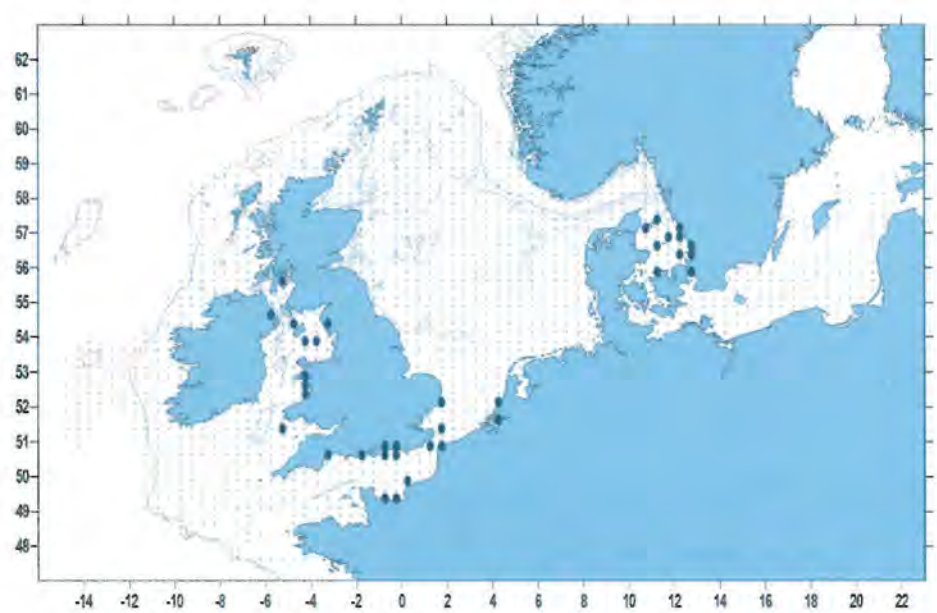

Figure 4. Distribution of corkwing wrasse recorded in trawl surveys around the British Isles (Source: Heessen *et al.* (2015)).

Ballan wrasse *Labrus bergylta*

Ballan wrasse is widespread around the coasts of Britain and Ireland. It is usually found on rocky habitats, including rocky reefs and boulder habitats, from the shallow sub-littoral to depths down to 50 m, and occasionally deeper (Heessen *et al.*, 2015).

Ballan wrasse is the largest of the north European wrasse species and can grow up to 60 cm (Quignard and Pras, 1986; Darwall *et al.*, 1992), although they are usually found at lengths of 12–30 cm. A maximum age of 24 years was reported by Darwall *et al.*, (1992), although it may live up to 29 years.

Ballan wrasse is a protogynous hermaphrodite; all individuals are born females and change sex at some point between 4–14 years (Muus and Nielsen 1999). The largest ballan wrasse are almost certainly male. One (or more) females spawn in a nest built of algae by the male in a rocky crevice or depression in sediment. Spawning occurs from April to August, peaking in May (Muncaster *et al.*, 2010) and the male guards the nest for one to two weeks until the eggs hatch (Muus and Nielsen 1999). The development of *L. bergylta* eggs is described by D'Arcy *et al.* (2012), and several accounts provide descriptions of the larval and post-larval stages (Ford, 1922; Fives, 1976; Russell, 1976). The larvae are generally pelagic, although larger larvae occur nearer the bottom (Borges *et al.*, 2007).

The diet consists mainly of molluscs, sea urchins and crustaceans (Dipper *et al.*, 1977; Deady and Fives, 1995b; Wennhage and Pihl, 2002; Figueiredo *et al.*, 2005).

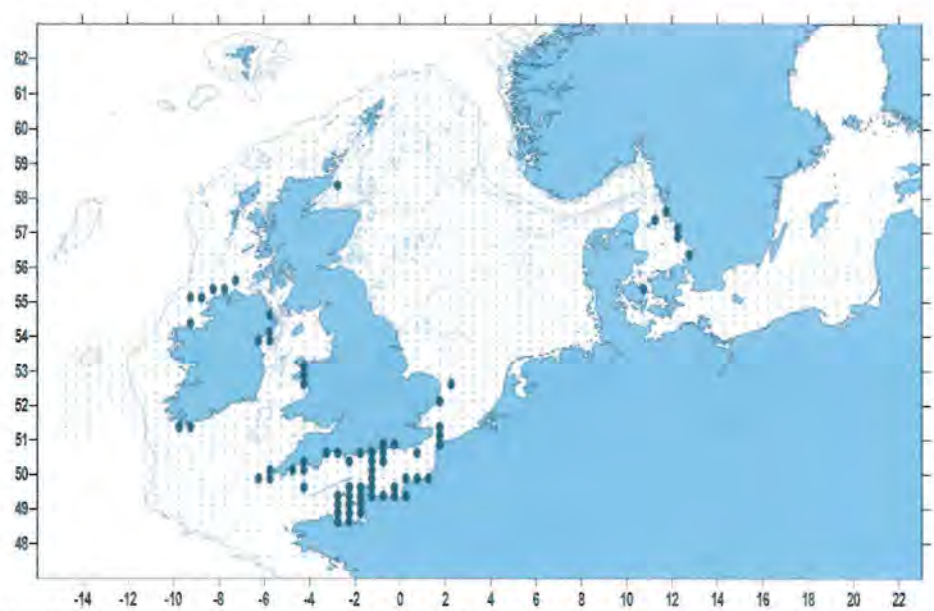

Figure 5. Distribution of ballan wrasse recorded in trawl surveys around the British Isles (Source: Heessen *et al.* (2015)).

Cuckoo wrasse *Labrus mixtus*

Cuckoo wrasse is widespread around the coasts of the Britain Isles, with trawl surveys suggesting they are widespread along the western and southern seaboards (Heessen *et al.*, 2015). They tend to prefer rocky habitats with algal cover, and are often found at depths of 30–90 m (Quignard and Pras, 1986; Heessen *et al.*, 2015), and are not as abundant in very shallow water (Wheeler, 1969; Lythgoe and Lythgoe, 1991).

Cuckoo wrasse has a maximum length of 35 cm and can lives to 17 years (Darwall *et al.*, 1997). It is a protogynous hermaphrodite (i.e. fish start as female, with females becoming male later in life), and sex reversal is completed in seven months (Sadovy and Shapiro 1987, Lönnberg and Gustafson, 1937). Cuckoo wrasse spawn from May to July, and the males build nests (depressions in the sediment). Females lay about 1,000 eggs in a nest of algae (Golani *et al.* 2006), and the male guards the nest.

It mainly feeds on crustaceans, worms, molluscs and fish (Quignard and Pras 1986; Wennhage and Pihl, 2002).

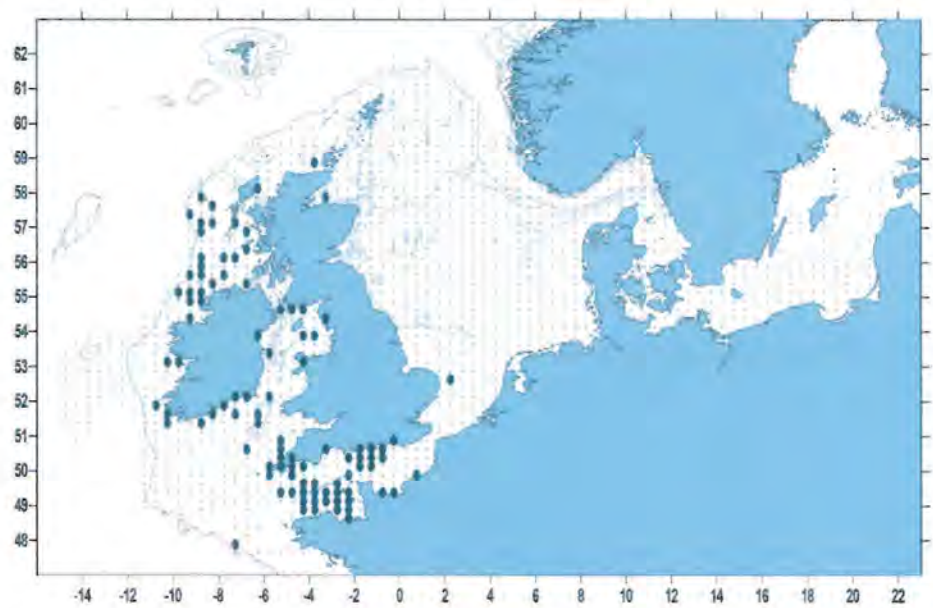

Figure 6. Distribution of cuckoo recorded in trawl surveys around the British Isles (Source: Heessen *et al.* (2015)).