I-BASS

Immature Bass Acoustic Stock Surveillance

Tracking immature European bass (*Dicentrarchus labrax*) to assess the effectiveness of Bass Nursery Areas

Contents

Project Brief

From 2013-2016 ICES reported a dramatic decline in North Atlantic European Bass (*Dicentrarchus labrax*) stocks, and recommended corresponding severe reductions in landings. Due to continuing declines ICES is recommending a complete ban for both commercial and recreational North Atlantic fisheries in 2017. The reason for declining North Atlantic seabass stocks is unclear, however has been linked to cold weather causing high juvenile mortality and increased commercial fishing pressure on mature stocks.

Juvenile bass are highly dependent on defined coastal nursery habitats throughout infancy. In 1990, 34 Bass Nursery Areas (BNA) - estuaries, power plants and shallow embayments where designated. Within BNAs targeted commercial bass fishing is prohibited for all or part of the year. From approximately year 2 adolescent bass may begin feeding in coastal areas outside BNA boundaries where they are vulnerable to capture within either targeted fisheries or as by-catch in non-targeted fisheries. Furthermore very little information is known on juvenile bass movement patterns or habitat preferences. Growing human demand and threats to coastal habitats means there is an increasing need to understand the mechanisms that support juvenile bass development in BNA and surrounding coastal habitats.

The Dart Estuary, Salcombe Harbour and Taw/Torridge Estuaries are four designated BNA within Devon, UK. Within the following project we propose to use acoustic telemetry to track fine scale movement patterns of resident juvenile bass. The project may therefore provide valuable data which could aid the conservation of North Atlantic bass stocks. In particular; data could be provided which highlights the efficiency of BNA legislation at protecting immature/undersized bass, as well as provide advice on BNA boundaries or netting practices within close proximity to designated BNAs.

Introduction

Background information

European Bass (*Dicentrarchus labrax*) is a commercially and recreationally exploited fin fish native to the North East Atlantic (Pickett & Pawson, 1994). Recorded as far north as Tromsø, Norway (Pickett & Pawson, 1994), and to its southerly limit Morocco (Naciri et al., 1999) and throughout the Mediterranean (Israel: Galil *et al.,* 2011, Greece: Koukouras,2010). A recent decline in North Atlantic bass stocks has caused the International Council for Exploration of the Seas (ICES) to suggest an 80% reduction of commercial landings between 2013-2015, and a complete moratorium for both commercial and recreational North Atlantic fisheries in 2017 (ICES, 2016). In response to ICES advice the European Union (EU) implemented a number of strict emergency measures in 2015 and 2016 such as; banning targeted commercial pelagic bass trawling from 1st January-30th June in the English Channel and North sea, imposing a catch and release recreational fishery over the same time period, and increasing the minimum conservation reference size to 42cm (Ares, 2016). Even if fisheries managers are compliant with current recommendations, ICES predicts north Atlantic bass stocks will only marginally increase above a defined "red area" in 2018. Below this defined red area (termed Blim – Cochrane & Garcia, 2002) "continuation of resource production is in danger and immediate management action is required" (Caddy & Mahon, 1995).

The decline in north Atlantic bass stocks is not fully understood, however it has been suggested the combined impacts of cold winter temperatures leading to high juvenile mortality, and increasing fishing pressure on mature stocks are largely responsible (Pickett & Pawson, 1994; Ares, 2016). These factors are amplified by various life history traits which increase the vulnerability of North Atlantic bass stocks, e.g. slow growth rate and high site fidelity (Pickett & Pawson, 1994). In particular, Juvenile and immature individuals (<42cm) are thought to remain in close proximity to Bass Nursery Areas (BNAs) e.g. estuaries, power plants and shallow embayment's, and be heavily dependent on intertidal habitats such as saltmarsh (Laffaille *et al.,* 2000 & 2001; Colclough, 2005; Fonseca *et al.,* 2011; Green *et al,*. 2012 Nelson, 2015).

Life history and spatial management

The timing of bass spawning can be regionally and annually variable; however, within the western English Channel and Celtic sea spawning can occur offshore from as early as February (Pickett & Pawson, 1994). Fry (approximately 10-15mm length) will then actively migrate to BNAs from May-June. In 1990, the Ministry of Agriculture, Fisheries and Food (MAFF) introduced legislation in England and Wales to protect juvenile bass from commercial fishing. The measures included: an increase in minimum landing size from 32-36cm, complimentary mesh size regulations for enmeshing nets and designation of 34 BNAs (Figure 1), largely within estuaries, where targeted commercial fishing for bass would be prohibited for all or part of each year (MAFF, 1990). From 2-3 years old adolescent bass may make migrations from BNAs into deeper water from autumn-late November but return to inshore coastal habitat in late April-early May (Holden & Williams, 1974; Pickett & Pawson, 1994). Mature bass are thought to make large migrations between winter spawning and summer feeding grounds (Kelley, 1988; Pickett & Pawson, 1994).

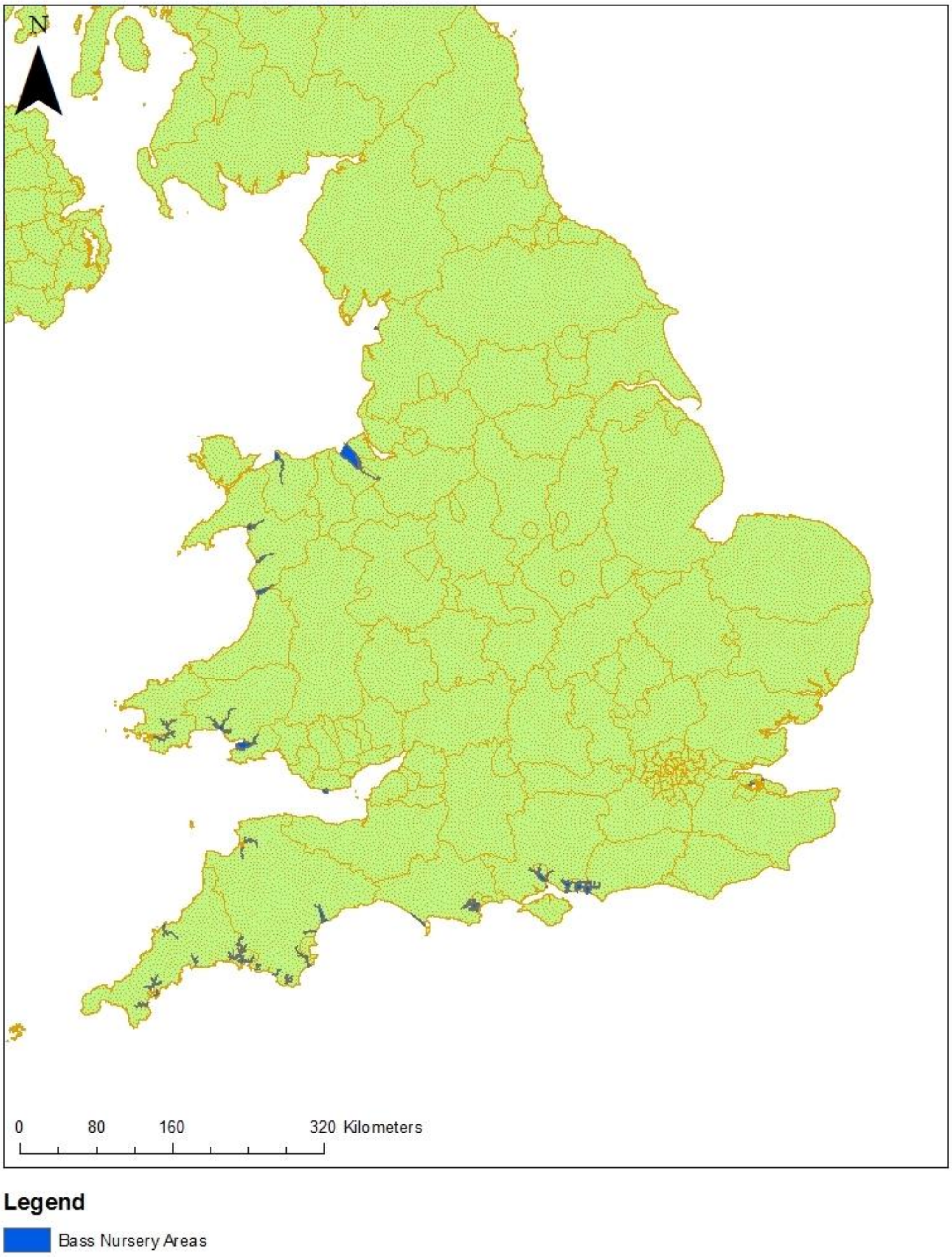

Figure 1 - Designated Bass Nursery Areas under-The bass (Specified Areas) (Prohibition of Fishing) Order 1990

Knowledge Gaps and Project Requirement

To date, studies have suggested bass are faithful to well defined feeding and spawning grounds (see: Pawson *et al.,* 1987; Pickett *et al.,* 2004; Fritsch *et al.,* 2007; Pawson *et al.,* 2007; Cambiè *et al.,* 2016). However, little information is known on juvenile bass movement within coastal areas or in association to Bass Nursery Areas (BNA). Pickett *et al.* (2004) tagged 6438 Bass across 11 BNAs in England and Wales. Of the undersized (defined as <32cm total length by Pickett *et al.* (2004)) bass that were re-captured 88.2% were within 50km of where they were originally tagged. Indicating that undersize/immature Bass are likely to stay regionally faithful to their BNA and/or feeding ground.

The majority of information available concerning bass movement patterns has relied upon mark recapture methods e.g. Floy tagging. Mark recapture techniques provide information on (re)capture sites, and movement between these locations is inferred. While effective at understanding broad scale patterns, these methods are likely to grossly underestimate regional and fine scale movement, which may have important management implications (Ng *et al.,* 2007). Furthermore, data from published mark-recapture studies are generally limited to “larger” size categories. For example, Fritsch *et al.,* (2007) exclusively targeted >32cm bass and within Pawson *et al.* (1987) 70% of the recapture observations were from bass >32cm. 66% of the recapture data within Pickett *et al.,* (2004) was accounted for by bass >36cm. 82% of the recapture observations within Holden & Williams (1974) was from bass >26cm. The studies mentioned above represent some of the largest bass tagging studies within the UK, however the results indicate there is a scarcity of data concerning bass <32cm.

Despite legislative protection from targeted commercial fishing within BNAs, for all or part of the year, recreational angling as well as commercial netting for other species e.g. sand eels (D&S IFCA, 2016) is permitted within BNAs (MAFF, 1990). There is also evidence to suggest that juvenile bass, 2-3 years, may exploit coastal habitats outside the boundaries of BNAs (Pickett & Pawson, 1994) where they may be captured in commercial fisheries. Due to the tendency of bass to maintain localised or regional feeding aggregations (Cambiè *et al.,* 2016) the Devon and Severn Inshore Fisheries and Conservation Authority are interested in potential regional management practices which could help improve the sustainability of the commercial and recreational fishery. As highlighted above very little information is known regarding juvenile bass movement and habitat use within and in close proximity to BNAs. Given the dramatic decline in north Atlantic stocks combined with increasing human demand/threats on estuarine and coastal habitats (Mossman et al., 2012), it is of critical importance to conduct research which highlights the effectiveness of BNA legislation at protecting immature/undersized bass (<42cm). As well as identifying priority estuarine features which may help conserve local juvenile bass stocks.

The proposed project will be able to provide valuable evidence which highlights the efficiency of BNA legislation at protecting immature/undersize bass stocks, as well as provide advice on BNA boundaries or netting practices within close proximity to BNAs. The project may also increase the sustainability of regional bass fisheries within the North Atlantic, as well as help inform estuarine management from a bass conservation perspective. The proposed method has been developed in collaboration and is fully supported by the Devon and Severn IFCA.

Project Aims and Research Questions

The primary project aims are to use acoustic telemetry to record the frequency and duration of immature/undersize European Bass (*Dicentrarchus labrax*) (<42cm) habitat use within, and in coastal areas adjacent to, Bass Nursery Areas (BNA) of Devon, UK.

Research Questions

1) What is the frequency and duration of undersized (<42cm total length) European Bass (*Dicentrarchus labrax*) use of coastal habitats outside the boundaries of Bass Nursery Areas?
2) Do undersized (<42cm total length) European Bass (*Dicentrarchus labrax*) preferentially exploit specific habitats?
3) Is undersized (<42cm total length) European Bass (*Dicentrarchus labrax*) movement significantly different with season, or affected by temperature and/or salinity?

Methods

Acoustic Telemetry

Unlike mark recapture studies acoustic telemetry provides continues fine scale monitoring of marked individuals. Furthermore movement patterns can be correlated to environmental variables (e.g. salinity and temperature) as well as with specific habitats (Ng *et al.,* 2007). Acoustic telemetry has been successfully used to identify site fidelity and habitat use for a variety of species, including: Sockeye salmon (Welch, 2009), Bonefish (Humston, 2005) and striped bass (Ng *et al.,* 2007).

Acoustic telemetry primarily relies on two parts of equipment; an acoustic tag and receiver (Table 1). Acoustic tags can be produced to various specifications and sizes (Table 2). An appropriately sized tag is surgically inserted within the body cavity of a test organism e.g. European Bass, and coded to emit a unique “ping”. Tag pings can then be received and recorded by receivers that are within range.

Table 1 - Example images of acoustic telemetry equipment

Equipment Name	Example Image
Acoustic tag	
Acoustic receiver (static or mobile)	

Sampling Sites

Acoustic telemetry will be used to track the movement patterns of undersized bass residing within 2 estuaries and 1 ria system of Devon (Figure 2 & Annex 1). The sampling sites are as follows:

- Taw/Torridge (Estuary),
- Salcombe Harbour (Ria),
- Dart (Estuary)

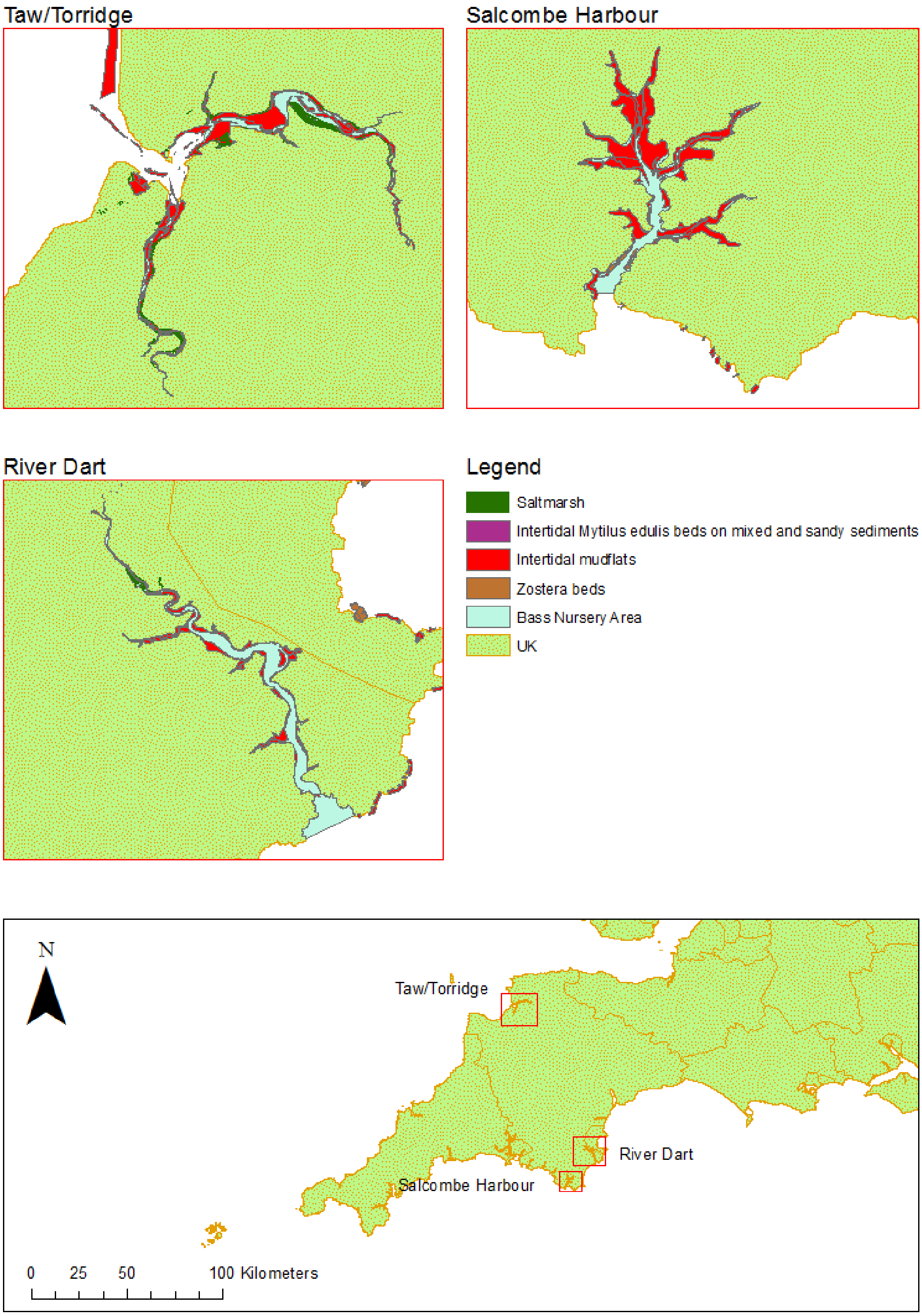

Figure 2 - Proposed Sampling Locations for Juvenile Bass Tagging Project

Acoustic Tags

In order to gain a robust assessment of undersized bass movement within each estuary and ria a minimum of 30 tagged fish are necessary, however, due to concerns of significant variability in fish behaviour when sampling at an estuary level the sampling size has been increased to 60 fish per sampling site (Kar & Ramalingam, 2013). Pickett & Pawson (1994) suggested from March of the 2nd year juvenile bass begin to use coastal habitats outside of BNAs. At this age it is anticipated juvenile bass will be approximately 12-16cm total length (Kennedy & Fitzmaurice, 1972; Holden & Williams, 1974; Pickett & Pawson, 1994). Chittenden *et al.,* (2009) investigated suitable tag to body size ratios for Coho salmon (*Oncorhynchus kisutch*), and suggested 16cm individuals (total length) where capable of receiving a tag with following dimensions without causing significant distress or tag rejection: 9*21mm tag. It is therefore envisaged that 60 Bass which have a minimum total length of 16cm, will be tagged within each sampling site. In order to minimise mortality of acoustically tagged bass via recreational angling or commercial fishing activity, each tagged fish will also be externally marked e.g. Floy tag (Floytag, 2004).

The experiment's duration is dependent on the acoustic tag battery life. Vemco V9 acoustic tags have an estimated battery life of 912 days (2.5 years – Table 2). Home office licensing is required to surgically insert acoustic tags within the body cavity of experimental bass. To ensure animal welfare standards are high, and mortality associated with this project is kept low, approved consultants will be contracted to perform any surgical procedures.

Table 2: Comparative details of the size and battery life of various acoustic tags produced by Vemco Ltd

<table>
<tr><th rowspan="2">Tag Family</th><th rowspan="2">Diameter (mm)</th><th>Minimum Tag Size:</th><th>Maximum Tag Size:</th><th colspan="2" rowspan="2">Power output (d)
Estimated Range (m)</th><th rowspan="2">Battery Life</th><th rowspan="2">Minimum fish total length (mm)</th><th rowspan="2">References</th></tr>
<tr><th>Length (mm)
Weight (g)</th><th>Length (mm)
Weight (g)</th></tr>
<tr><td rowspan="2">V7</td><td rowspan="2">7</td><td>18</td><td>22.5</td><td colspan="2">136</td><td rowspan="2">220 days</td><td rowspan="2">125</td><td rowspan="2">Coho Salmon - Chittenden et al., 2009</td></tr>
<tr><td>0.7</td><td>1</td><td colspan="2">112-292</td></tr>
<tr><td rowspan="2">V8</td><td rowspan="2">8</td><td>20.5</td><td>20.5</td><td>144</td><td>147</td><td rowspan="2">165 days</td><td rowspan="2">137</td><td rowspan="2">Coho Salmon - Chittenden et al., 2009</td></tr>
<tr><td>0.9</td><td>0.9</td><td>230-464</td><td>282-539</td></tr>
<tr><td rowspan="2">V9 (150s Ping Delay)</td><td rowspan="2">9</td><td>21</td><td>45</td><td>145</td><td>151</td><td rowspan="2">912 days</td><td rowspan="2">140-300</td><td rowspan="2">Salmon Smolt & Coho Salmon - Chittenden et al., 2009</td></tr>
<tr><td>1.6</td><td>3.3</td><td>27-489</td><td>362-645</td></tr>
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Acoustic Receivers

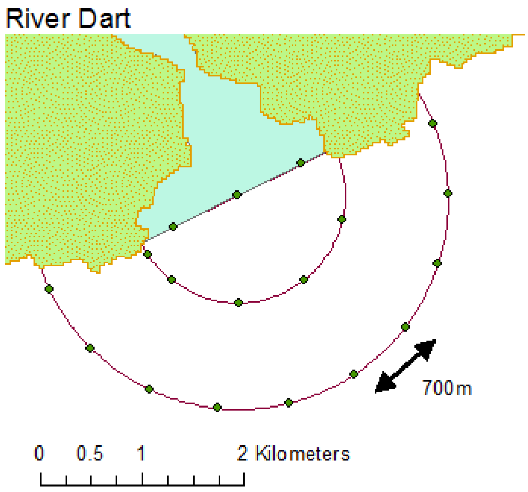

Figure 3 - Proposed Static Receiver "Arc Array" to track European Bass Movement in Coastal Areas Adjacent to Bass Nursery Areas. River Dart Bass Nursery Area used as example.

Within each sampling site a static receiver array will be deployed in an arc formation with progressive distance from the mouth of the estuary or ria (Figure3). Each arc acts like a gate which records the presence of tagged fish when within range. Placement of arcs at progressive distances from the estuary or ria entrance will provide detailed spatial data of undersized bass movement in coastal areas within close proximity to BNA. V9 tags have a potential maximum detection range of 489m (Table 2). Tag detection can however be significantly affected by local environmental conditions and background noise. At each of the study sites local water chemistry and salinity is likely to vary on a seasonal and potentially daily basis. Due to the anticipated variability of conditions and local background noise caused by local ship movement static receivers will ideally be placed at 700m intervals within each arc formation (Figure 3) to ensure 100% coverage. When receivers are deployed a range testing exercise will be conducted to assess the actual tag detection range at each sampling site.

To track bass movement within BNAs, static receivers will be placed at narrows or major confluence points (Figure4). Ng *et al.* (2007) suggested that static receiver arrays which are complimented with mobile transducers can provide fine scale fish movement and habitat preference patterns. Therefore, the static receiver array highlighted within this proposal will be complimented with a mobile transducer. A mobile transducer can be deployed from a moving vessel, and used to actively track tagged fish in areas of interest, e.g. saltmarsh habitats or deep sections of the estuary of ria.

As with other fish species, e.g. striped bass (*Morone saxatilis*), European Bass habitat use and movement patterns are likely to be highly affected by; temperature and salinity (Pickett & Pawson, 1994). The static array within each BNA will be complimented with salinity and temperature loggers deployed at high, mid and low estuary and ria locations. The data from these loggers will be correlated with undersized bass movement patterns.

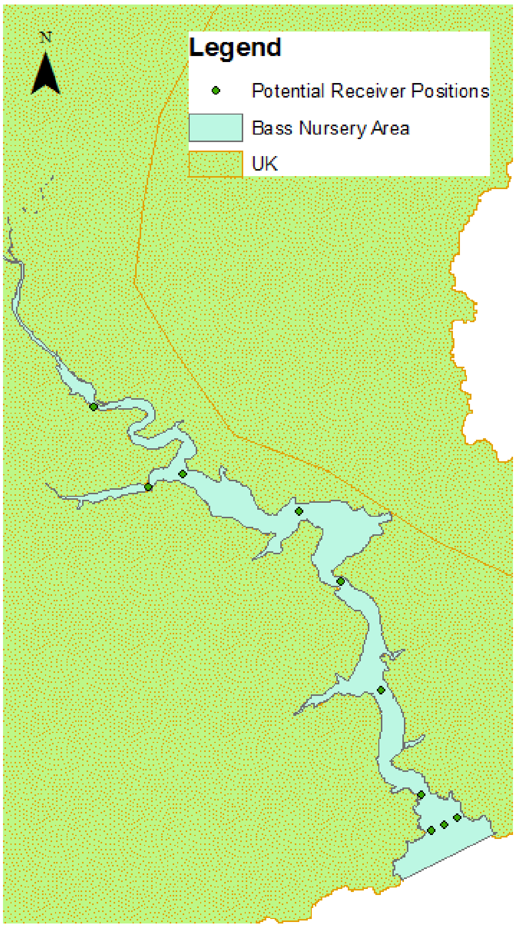

Figure 4 - Proposed Static Receiver Positions to track European Bass Movement within Bass Nursery Areas. River Dart Bass Nursery Area used as example.

Where possible both static receivers plus salinity and salinity loggers will be attached to existing structures, however were no structure is available receivers and loggers will be attached to custom made moorings. Figure 5, details the design of each custom made mooring for the I-BASS project. Moorings will be deployed using "large" vessels, however receiver maintenance and data download will be completed by smaller vessels e.g. RIB. Active tracking surveys will also be completed by smaller vessels e.g. RIBS.

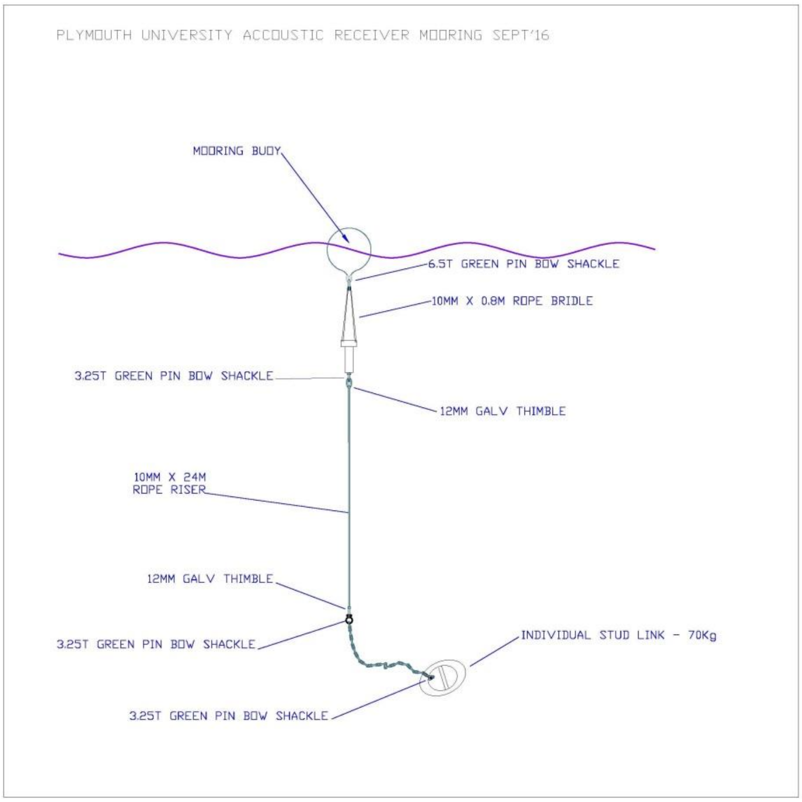

Figure 5 – Custom made mooring design to deploy acoustic receiver

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Annex 1: Proposed Acoustic Receiver Positions

River Dart (Estuary)

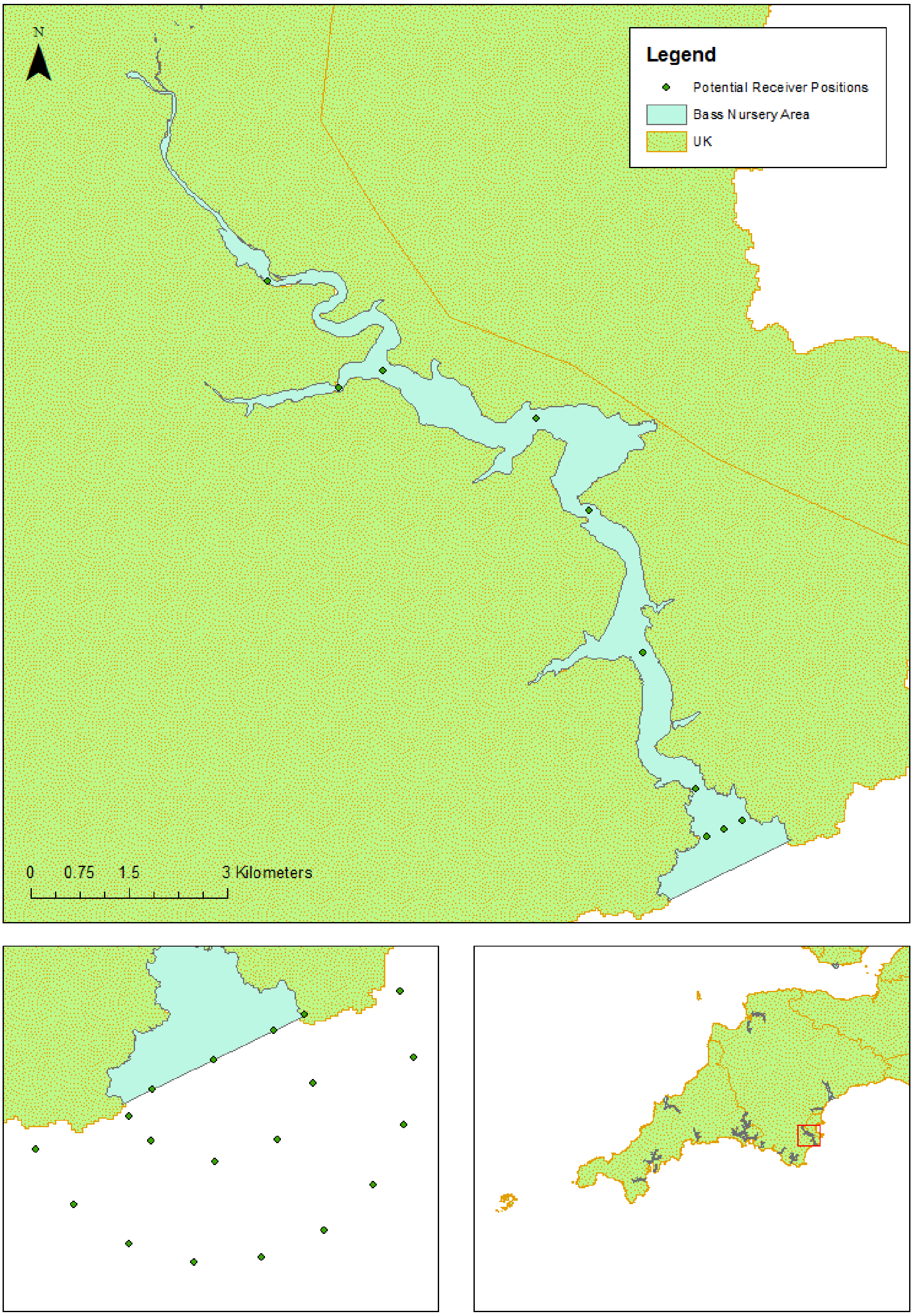

Figure 6 - Proposed Static Receiver Positions within River Dart Bass Nursery Area and Adjacent Coastal Areas

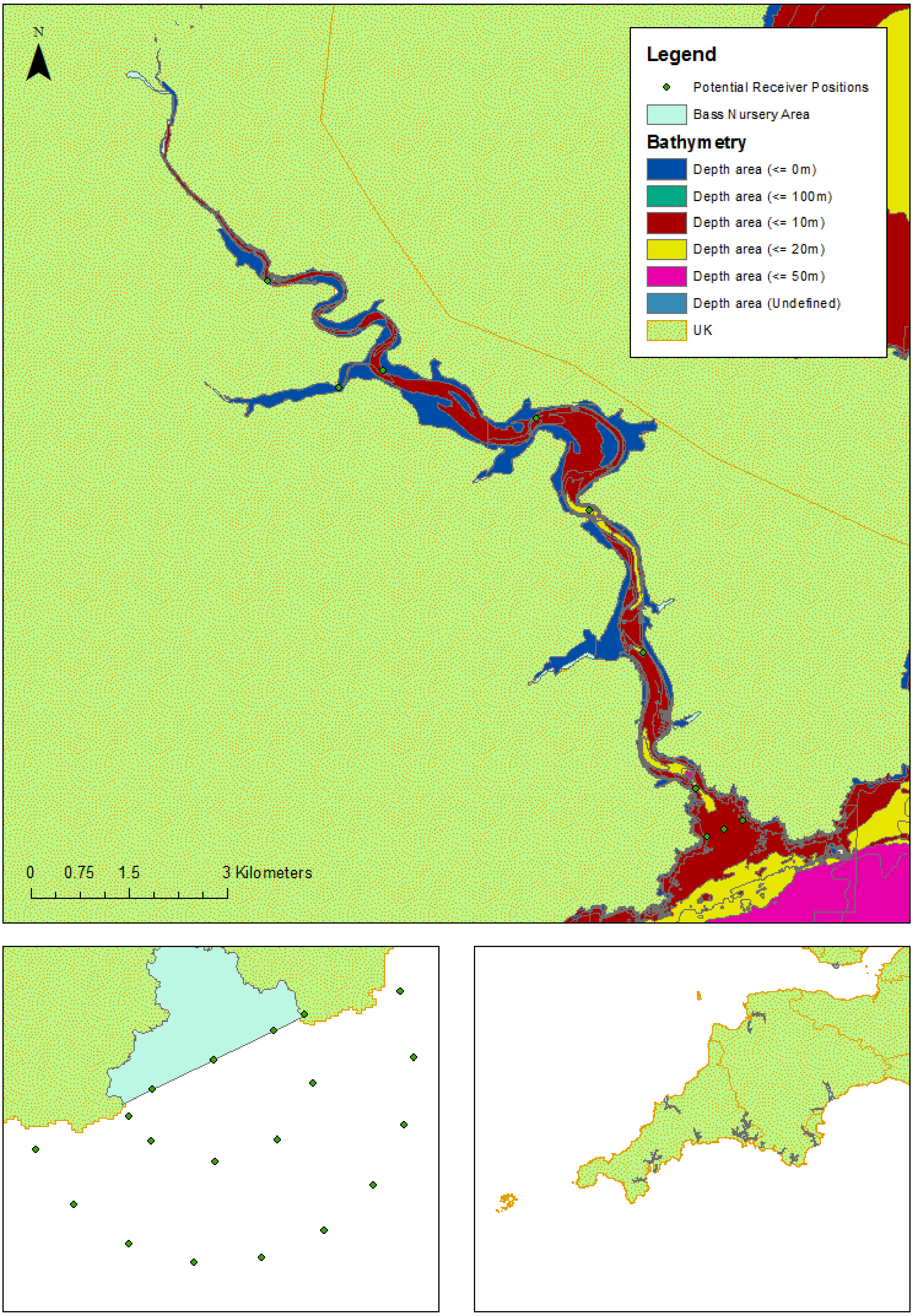

Figure 7 - Proposed Static Receiver Positions within River Dart Bass Nursery Area and Adjacent Coastal Areas (Including Bathymetry)

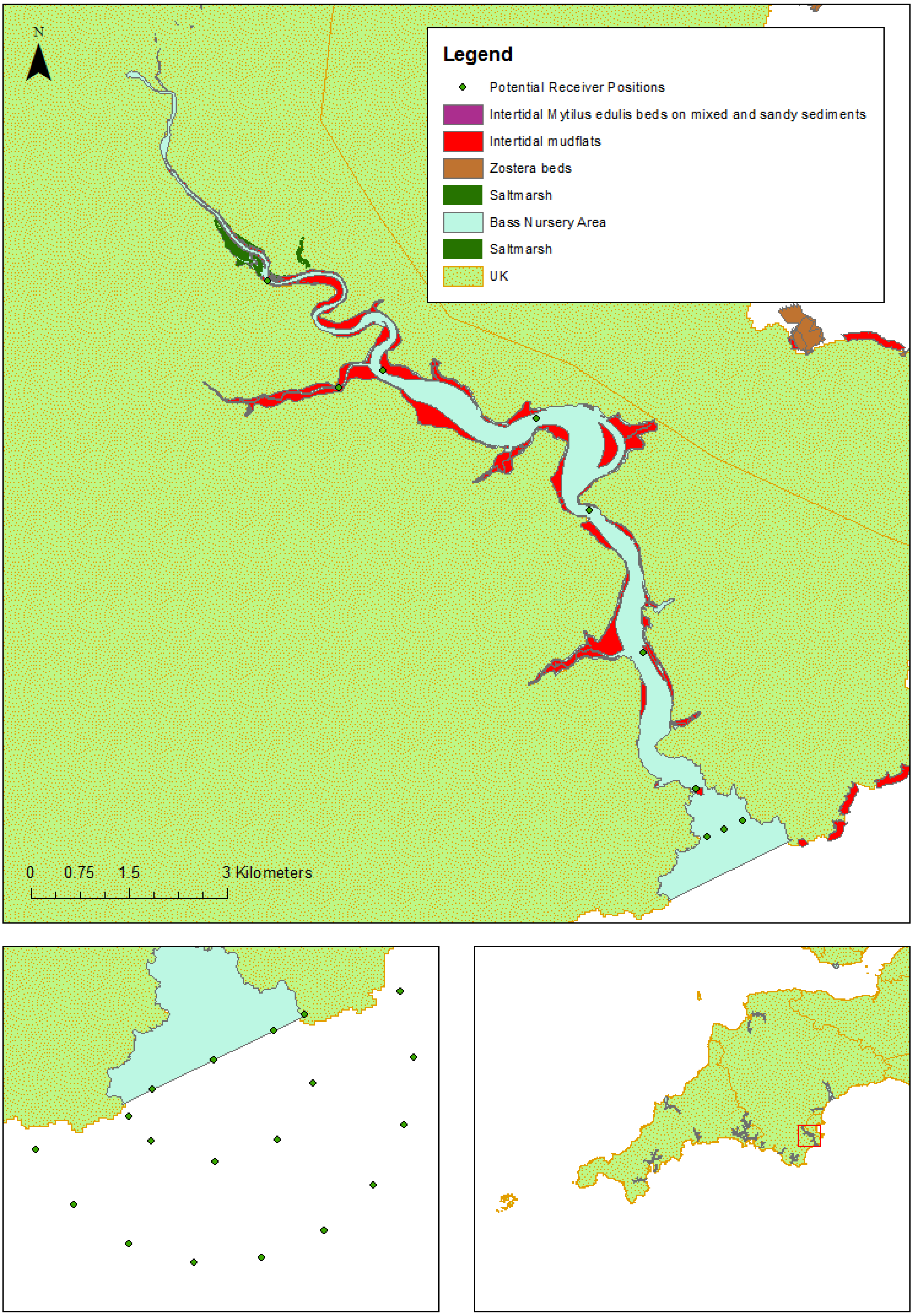

Figure 8 - Proposed Static Receiver Positions within River Dart Bass Nursery Area and Adjacent Coastal Areas (Including OSPAR Habitats and Saltmarsh extent)

Salcombe Harbour (Ria)

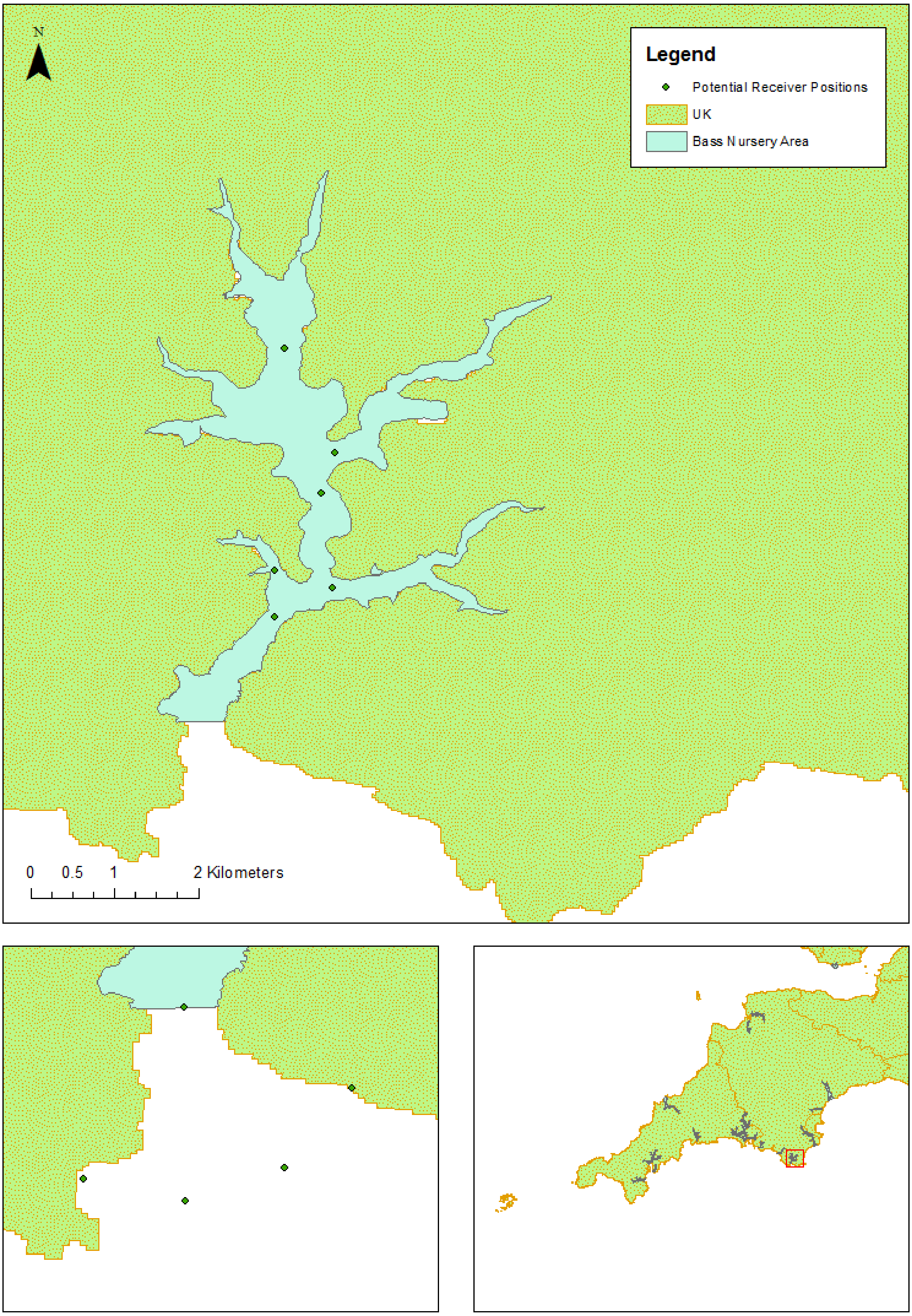

Figure 9 - Proposed Static Receiver Positions within Salcombe Harbour Bass Nursery Area and Adjacent Coastal Areas

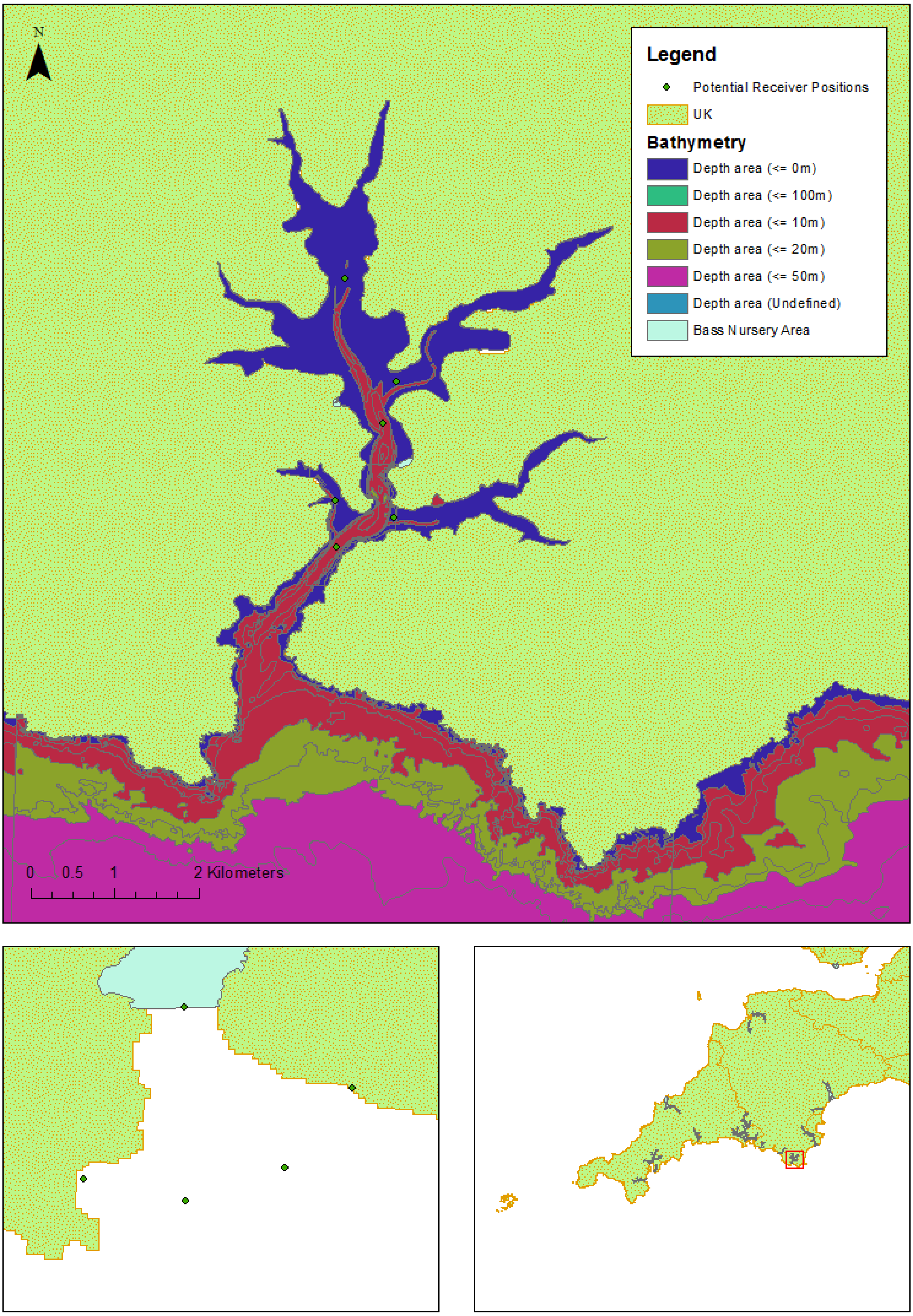

Figure 10 - Proposed Static Receiver Positions within Salcombe Harbour Bass Nursery Area and Adjacent Coastal Areas (Including Bathymetry)

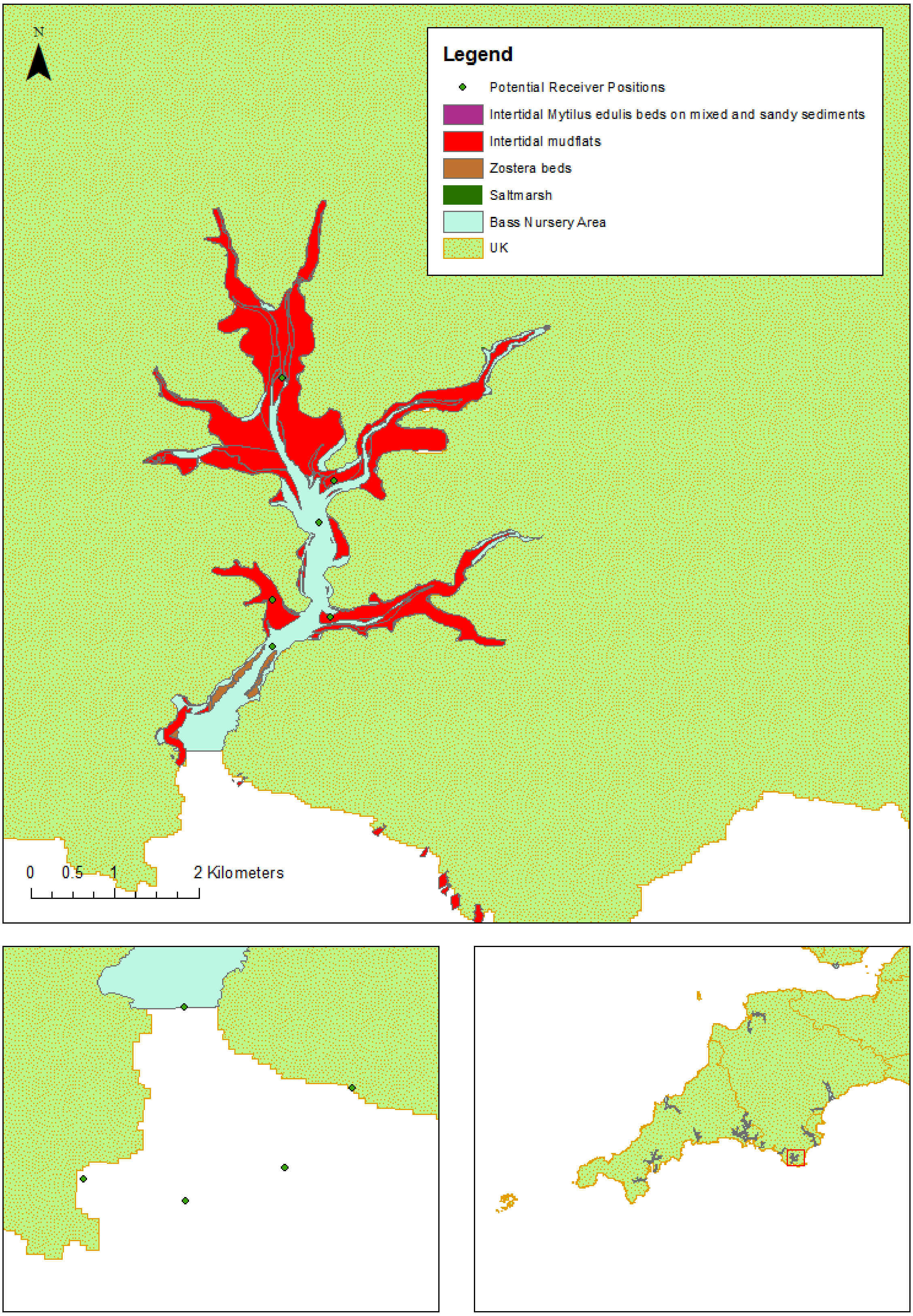

Figure 11 - Proposed Static Receiver Positions within Salcombe Harbour Bass Nursery Area and Adjacent Coastal Areas (Including OSPAR Habitats and Saltmarsh extent)

Taw/Torridge (Estuary)

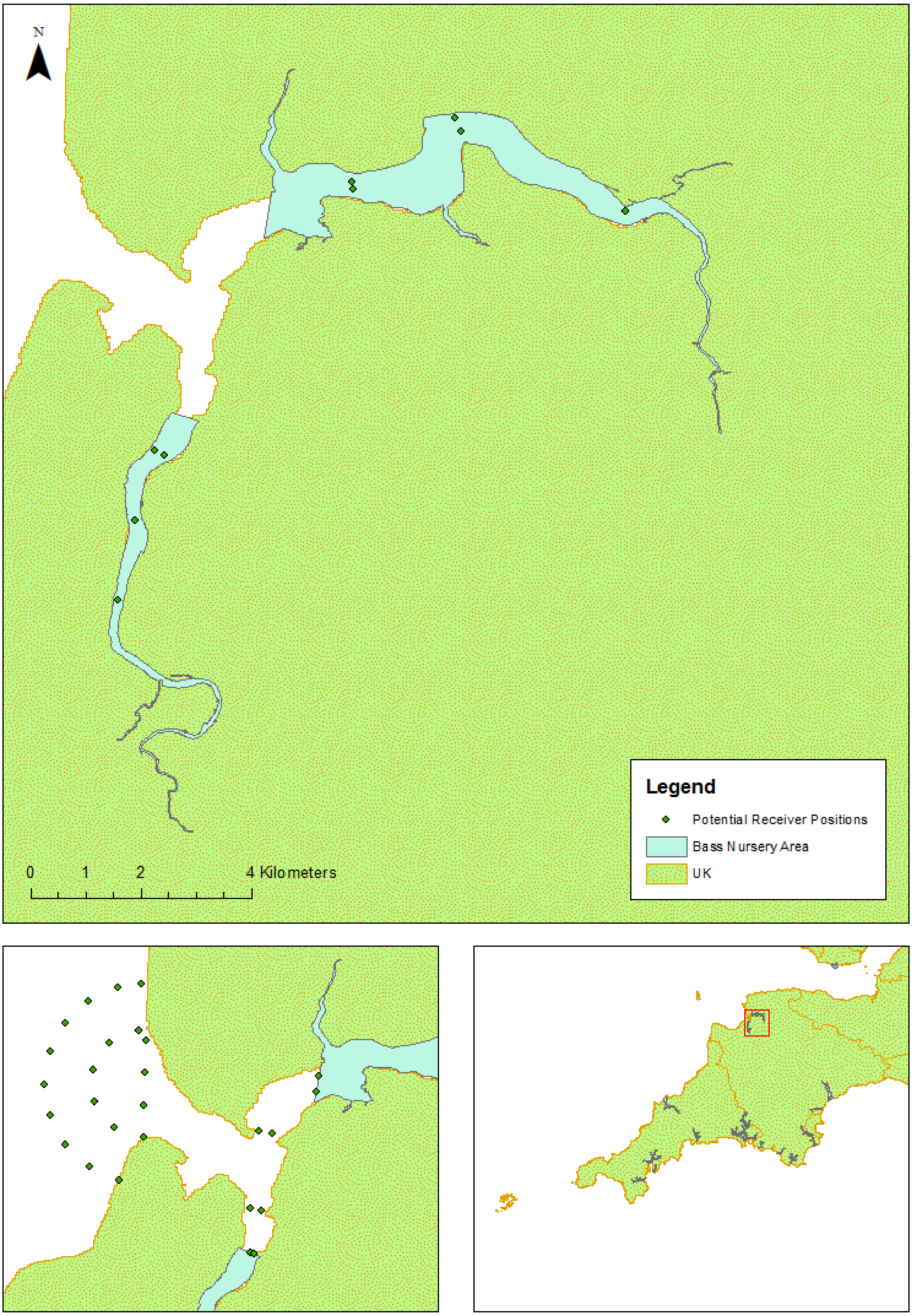

Figure 12 - Proposed Static Receiver Positions within River Taw & Torridge Bass Nursery Areas and Adjacent Coastal Areas

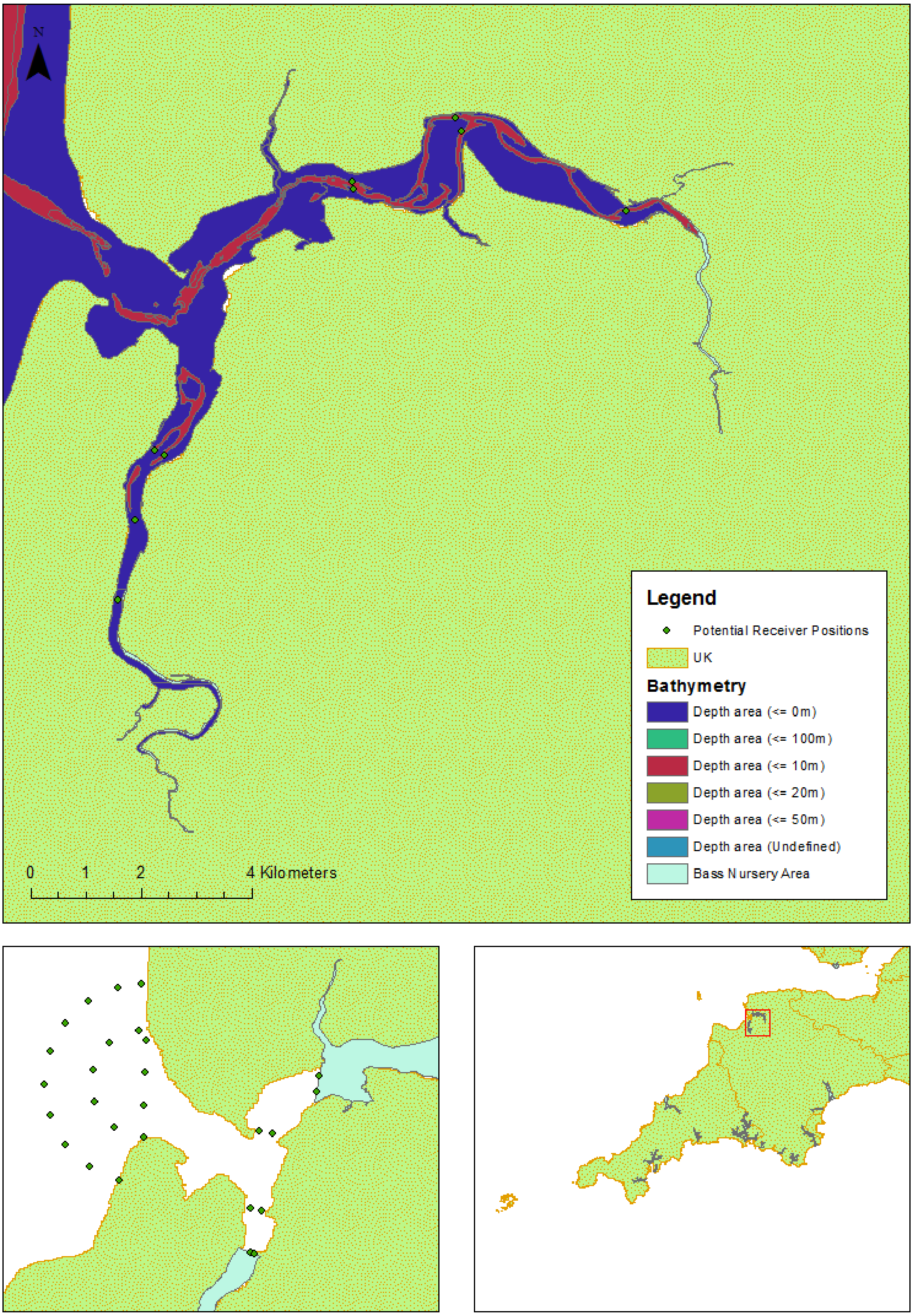

Figure 13 - Proposed Static Receiver Positions within River Taw & Torridge Bass Nursery Areas and Adjacent Coastal Areas (Including Bathymetry)

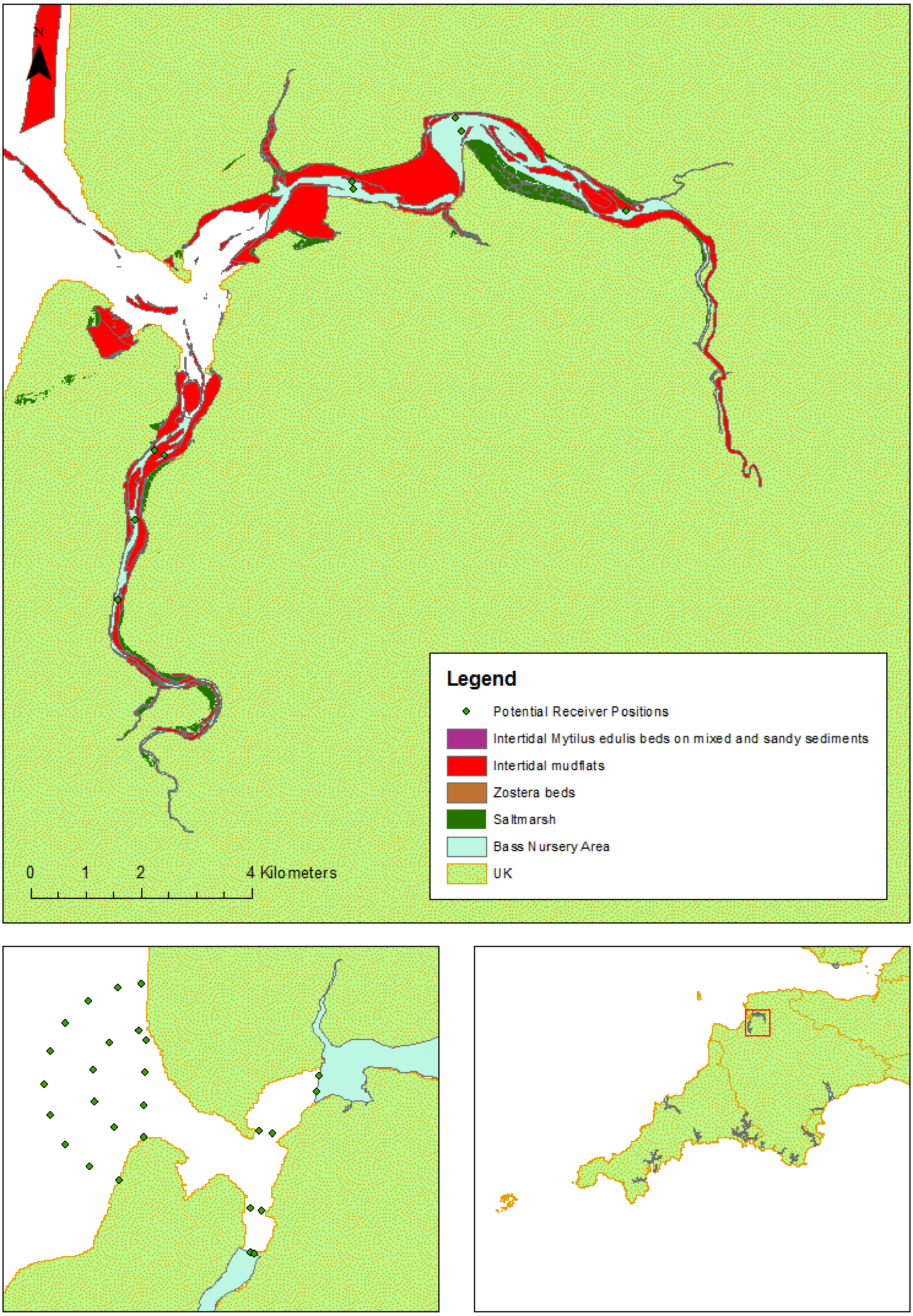

Figure 14 - Proposed Static Receiver Positions within River Taw & Torridge Bass Nursery Areas and Adjacent Coastal Areas (Including OSPAR Habitats and Saltmarsh extent)