Solent State of Nature Report

FEBRUARY 2025

Volume 1 – Main report

Non-Technical Summary (NTS)

Introduction

The State of Nature Solent report presents an overview of the current status of coastal and marine wildlife in the region, including consideration of trends and pressures that are currently affecting these features. Most of the Solent's habitats and species are struggling, with many having suffered dramatic declines. While more work is undoubtedly needed to help the Solent's nature, a lot of important effort has already been put in to help it recover.

The report has been compiled on behalf of the Solent Seascape Project. This project aims to be the first of its kind in the UK to initiate recovery of the marine and coastal environment at a seascape scale. The long-term vision for the project is to protect and restore the Solent's seascape, tipping the balance from a degraded state to a naturally expanding, connected and productive ecosystem.

There are ten partners on the project: Blue Marine Foundation, RSPB, Hampshire and Isle of Wight Wildlife Trust (HIWWT), Project Seagrass, Natural England, Environment Agency, Coastal Partners, Isle of Wight Estuaries Project, Chichester Harbour Protection and Recovery of Nature (CHaPRoN) and University of Portsmouth.

The Solent

For the purpose of this report, the Solent region extends from Hurst Beach and the Needles (Isle of Wight) in the west to a line between Black Rock (Isle of Wight) and Selsey Bill in the east; incorporating Pagham Harbour. The Solent measures approximately 510 km^2, or 51,000 hectares (ha). The catchments which feed into the Solent region cumulatively measure 3,360 km^2 (or 336,000 ha) and extend 60 km inland.

The Solent itself is a large channel between the Isle of Wight and mainland Great Britain which is 32 km long and varies in width between 4 and 8 km. The major ports of Southampton and Portsmouth are situated in the Solent, and it is a major shipping lane for military, freight and passenger vessels as well as a popular location for recreational activities and water sports, including sailing, walking, angling, swimming and paddle sports.

The Solent is a system with unique tidal characteristics. Near Calshot (at the entrance to Southampton Water), the tidal conditions and depth and shape of the seabed result in a double high tide. Further to the east, around Spithead / Portsmouth, there is an extended (rather than double) high tide. In addition, the tidal range (the difference between low and high tide) varies substantially across the region; it increases from west to east. For example, on springs, it is 2.2 m in the west (e.g. Yarmouth / Isle of Wight) and 5.1 m in the east (at Pagham Harbour entrance).

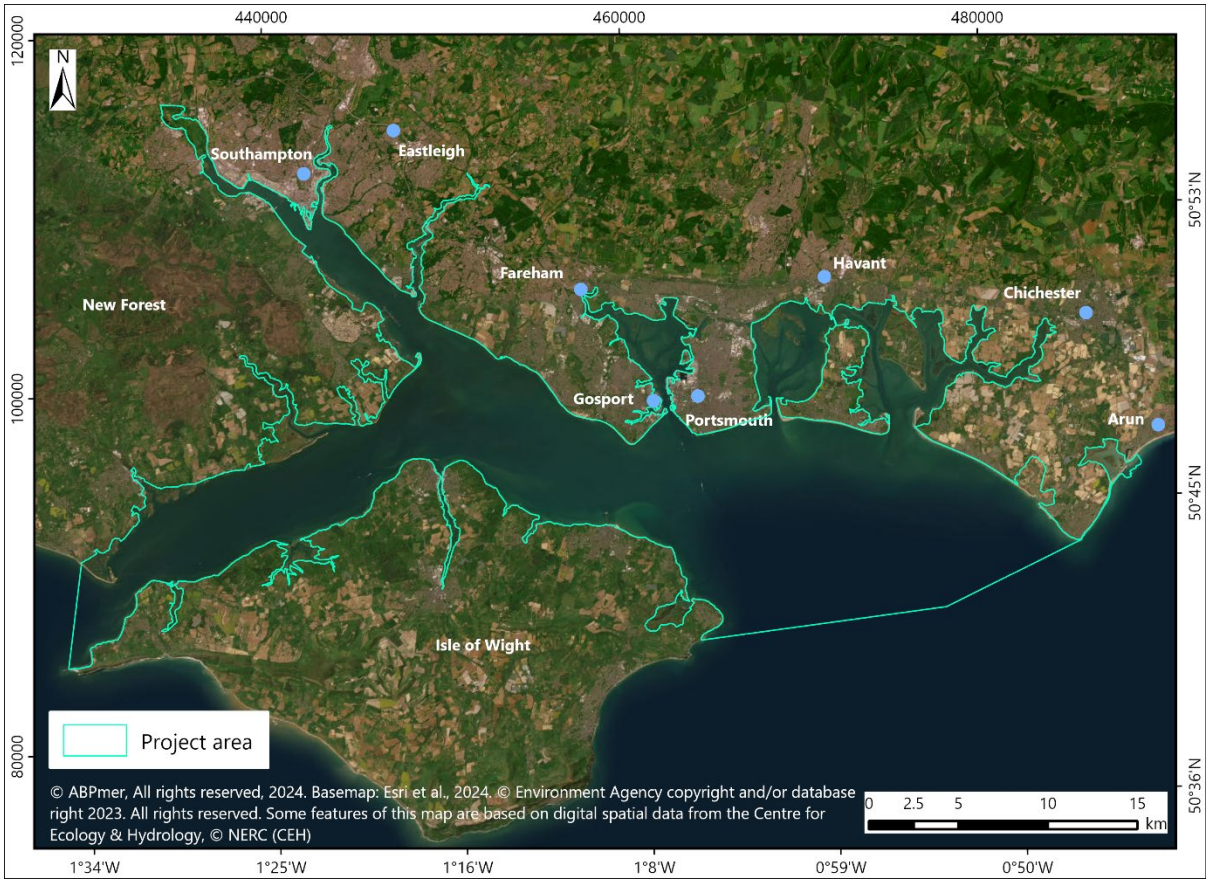

Figure NTS1. The Solent Seascape project area

Marine Protected Areas and Protected, Rare or Threatened Species and Habitats

The Solent's nature is considered to be very important internationally, nationally and locally. This is reflected in the many 'designated' sites which can be found here. In total, there are 72 designated sites within the region, which often overlap with each other.

Many of the species and habitats in the Solent region are considered important, rare or particularly threatened.

- There are 117 marine species in the Solent which are of particular importance, threatened and/or endangered.
    - Important species include birds such as the curlew and dark-bellied brent goose; fish such as bass, mackerel and whiting; and mammals such as the harbour seal.
    - Particularly endangered or rare species include the birds roseate tern and ruff; fish such as Atlantic salmon, European eel and thornback ray; and mammals such as harbour porpoise.

- There are 18 marine habitats in the Solent which are of particular importance, threatened and/or endangered.
    - Important existing habitats include coastal saltmarsh, vegetated shingle, seagrass beds and saline lagoons.
    - Threatened habitats include saltmarshes, seagrass beds, intertidal chalk and subtidal kelp beds.
    - Lost habitats include native oyster reefs.

Habitats

Overview

The Solent is of great ecological importance and contains more than 51,000 hectares (ha) of coastal and marine habitats.

There are just over 11,000 ha of intertidal habitats, which are areas that are underwater at high tide, but exposed to air during low tide. These include:

- Over 8,300 ha of intertidal mudflats which are rich in invertebrates and are internationally important feeding grounds for waterfowl and wading birds;
- Over 2,100 ha of declining and threatened saltmarshes and seagrass beds; and
- 95 ha of rare intertidal chalk.

Above the intertidal zone, in the splash or spray zone, there are around 250 ha of vegetated shingle, dunes, cliffs (and their slopes) and beaches.

The subtidal, always submerged, areas measure just under 40,000 ha altogether, and include:

- Almost 24,000 ha of sands and gravels;
- Around 12,000 ha of mixed or muddy seabed; and
- Rarer habitats, such as just under 150 ha of kelp beds (mostly off Hayling Island) and rocky habitats (almost 1,500 ha).

Many of the adjacent terrestrial rivers and habitats are also often important to birds and other animals which use these coastal and marine areas. For example, wading birds and waterfowl such as brent geese also forage and rest in adjacent fields, coastal lagoon and grazing marshes. A Solent wide project identifying such important terrestrial areas has mapped 3,600 ha of such fields and grassland next to the Solent's marine and coastal habitats. In addition, there are several species of fish such as Atlantic Salmon which migrate between the sea and the Solent's rivers.

Key habitats of the Solent – focus on saltmarshes, mudflats, seagrass beds and oyster beds

Most of the Solent's habitats are under a lot of pressure from human activities, particularly those in the intertidal and splash zones. Notably, many of the habitats created by shellfish or plants ('biogenic' habitats) which can be found in the Solent have seen dramatic declines and degradation, primarily due to destructive fishing activities, water pollution, land claim and diseases.

The status and trends of the four key marine biogenic habitats of the Solent (saltmarshes, mudflats, seagrasses and oyster beds) are summarised in the table below, and further explained thereafter.

Table NTS1. Extent, trends and condition for the four key marine habitats of the Solent

Key habitat	Current mapped extent (ha)	Historic trend	Future trend (without restoration / further action)	Current condition of majority of Solent
Saltmarsh	1,386	↓	↓	Unfavourable
Mudflat	8,362	↔	↓	Unfavourable
Seagrass	715	↓	↓	Unfavourable
Oyster reefs	0	↓		Lost

Saltmarsh

Importance

Saltmarsh is a critical coastal habitat in the UK which provides many benefits to the surrounding seascape. Saltmarsh habitats support local biodiversity, including many fish species, particularly during their younger life stages. Saltmarsh is critically important for the Solent's internationally renowned bird populations, especially as resting and breeding areas. The few remaining isolated saltmarsh islands in the Western Solent and Langstone Harbour are hugely important for breeding seabirds and other marine birds. For example, in 2023, more than 85% of all the seabirds that breed in the Solent did so using these saltmarsh islands (especially sandwich tern, black-headed gull and mediterranean gull). Saltmarshes also fulfil many important services for humans - saltmarsh habitats act as a natural flood and coastal defence and are very efficient at storing carbon, mitigating the impacts of climate change. Because of this, they are often referred to as a 'blue carbon' habitat. Saltmarshes also improve water quality and are important for nature tourism, as they provide habitat for an incredible breadth of species.

Extent and trends

There are just under 1,400 ha of saltmarshes remaining in the Solent, and most of these are quite low lying, with 57% being either *Spartina* (cordgrass) or pioneer marshes. The fact that such a high percentage of the Solent's saltmarshes is very low lying makes them very vulnerable to climate change and other pressures. It is of note that many of the saltmarsh areas within the Solent are of relatively recent origin, resulting from the spread of the (then new) hybrid *Spartina anglica (*which originated in the Solent) from 1870s onward. Since around the 1940s, there has been a rapid and ongoing decline of saltmarshes, and extent has more than halved, with estimates that there used to be over 3,000 ha of this habitat before the 1940s.

In the Solent, it is evident from current best available evidence, that saltmarsh extent continues to reduce, mostly due to relatively low sediment availability and ongoing sea level rise. Almost everywhere, saltmarsh cannot move inland due to the presence of flood embankments, and other human infrastructure (this is termed 'coastal squeeze'). Other human factors are also believed to play a key role in saltmarsh decline, with poor water quality, algal mats and small wash waves created by boats being other damaging pressures. Estimates have been made that, without intervention, saltmarsh habitat will all but disappear from the Solent over the next 100 to 200 years.

Condition

Whilst there are some saltmarshes that are faring relatively well in the Solent, the vast majority of them are struggling and are considered to be in 'unfavourable' condition. This is due to a combination of

factors, but mainly sea level rise, insufficient sediment supply and poor water quality (including the problematic algal mats which often form as a result).

Mudflats

Importance
Mudflats are very important habitats which can be found at the lower end of the intertidal zone. Mudflats provide a vital food source for most of the coastal and marine birds which either visit the Solent or consider it their home. Many fish and shellfish species also rely on them for feeding and shelter, and many worms such as lugworm and ragworm live in burrows in the mud. Mudflats also provide various benefits to people, including the burial / storage of nutrients, pollutants and carbon.

Extent and trends
There are over 8,300 ha of intertidal mudflats in the Solent region, and while some of these are being lost to sea level rise (and erosion) and are becoming subtidal, more is being gained as saltmarshes erode or are submerged, die and shift to mudflat. On balance, mudflats are expected to increase in extent over the coming century, though this is at the expense of saltmarsh habitats. Beyond the 100 year timeframe, there is however expected to be an ongoing net loss of mudflats.

Condition
The majority of the mudflats in the Solent are considered to be in unfavourable condition. This is largely due to sea level rise and poor water quality. In the Solent's estuaries and harbours, harmful blooms of macroalgae often occur due to too many nutrients in the water. Too much macroalgae can smother mudflats and negatively affect the species living on and within them, along with the species that rely on their resources. Furthermore, excessive nutrient, bacteria and contaminant loads in the water and sediments are also affecting the organisms that reside in and on muds. Heavy metal contamination is a particular issue in the Solent, with large quantities still being added every year (e.g. copper, which is used in antifouling paint on boats and ships). Invasive species have also been highlighted as a reason for mudflats in the Solent being in unfavourable condition, as too many of them have been, and continue to be, introduced, mainly via the many boats and ships which frequent the region.

Seagrass beds

Importance
Seagrasses are the only flowering plants that can live in seawater but are restricted to shallow and protected coastal areas. Seagrass beds are very important for marine life, being a critical fish habitat and they are thought to support the productivity of a fifth of the world's biggest fisheries. Furthermore, the meadows seagrasses form also help to store carbon and stabilise the sediment on our sea floors. This can help combat climate change and prevent coastal erosion. Seagrass beds are a blue carbon habitat because they can capture carbon and move it to the underlying sediment.

Extent and trends
At least 715 ha of seagrass beds have been mapped in the Solent, though overall extent is believed to be bigger. This uncertainty is related to seagrass being difficult to map and monitor. Efforts are underway across the Solent to better understand and map seagrass extent.

Historically, there used to be much more seagrass in the Solent, though numbers on historic extent do not exist. In the UK, estimates suggest that 92% of the seagrass meadows were lost over the last century, largely due to a catastrophic wasting disease which occurred across the North Atlantic in the 1930s, and also poor water quality, as well as bottom-towed and other destructive fishing practices and the spread of *Spartina*. In the future, seagrass beds will continue to be impacted by many of these pressures, and also by sea level rise and climate change. For example, intertidal seagrass, which resides on mudflats,

would be lost wherever mudflat is lost, and subtidal seagrass would also eventually not receive enough light as water depths increase.

Condition
The majority of the remaining seagrass beds in the Solent are considered to be in unfavourable condition. This is due to nutrient enrichment resulting from water pollution, as well as seabed disturbance caused by recreational activities including boat anchors. Heavy metal and other contamination and invasive species are also reasons for the unfavourable condition of some of the Solent's seagrass meadows.

Native oysters

Importance
Native oysters provide numerous ecosystem and social benefits. They filter large amounts of water; for example, just one adult native oyster can filter over 140 litres of water per day. Oysters contribute to improvements in water quality, as well as the removal of excess nutrients and contaminants, and they form a commercially important food source (although the Solent native oyster fishery is closed, see below). They stabilise sediments, reduce wave energy and provide shelter to many marine species; for example, they are an important nursery and feeding habitat for fish.

Extent and trends
Naturally occurring native oyster reefs have all been lost from the Solent, leaving fragmented remnant populations of oysters and historic beds which are not generally home to enough oysters to be officially classed as 'beds' (at least five oysters per square metre are required for this). Comprehensive efforts are underway to restore these back into the seascape.

Similar to other regions in Northern Europe, the effective extinction of native oyster reefs in the Solent was likely mostly due to overfishing of the native oyster, which is an issue which goes back many centuries (industrial-scale fishing is believed to have started in the late 18th Century in the Solent). It is also important to understand that not only did the Solent used to have large areas of native oyster reefs, but these used to be substantial three-dimensional structures, and would have often likely reached several metres in height, possibly as high as houses in some deeper locations (pre industrial fishing). In the more recent past, severe winters and diseases and parasites further contributed to the decline of the remaining oysters. Until the early 2000s, the Solent oyster fishery was one of the last remaining (and largest) native oyster fisheries in Europe. In 1978, 450 vessels harvested 15 million oysters, however, in 2007, populations collapsed and have not recovered since and the fishery has been closed since 2013.

Condition
As noted above, native oyster reefs/beds in the Solent are absent. The invasive Pacific oysters are however widespread in the Solent, and they (and other invasive species) often occupy areas where native oysters could historically be found.

Animals

Overview

The Solent is home to a large variety of animals which depend on the marine and coastal habitats which are found here. The Solent is very important for overwintering marine and coastal birds, feeding mainly on the invertebrates found in the mud. Many birds also stay the region during other seasons, and

important seabird breeding colonies can be found here. A small common/harbour seal colony is present within the Solent, and several other marine mammals pass through the region. A wide variety of fish can be found, with the harbours and estuaries being of particular importance to juvenile fish, and also as corridors for migratory fish.

Key animal groups of the Solent – focus on birds, mammals and fish

The status and trends of key marine and coastal animal groups found in the Solent are summarised in the table below, and further explained thereafter.

Table NTS2. Numbers, trends and condition for the key animal groups of the Solent

Key habitat	Current numbers	Historic trend	Future trend (without restoration/ further action)	Current condition of majority of Solent population
Non-breeding marine and coastal birds	163,000 (5-year mean peaks, summed)	↓	↓	Mixed
Breeding seabirds (gulls and terns)	11,700 (observed occupied nests, 2023)	↓	↓	Mixed
Fish	Unknown	↓	Unknown	Unknown
Seals	80 (harbour seals, Solent colony); grey seals (visiting) unknown	Recent (30 years): ↑ Further back: ↓	Unknown	Unknown

Birds

Numbers and species

The Solent is of international, national and regional significance for birds; its estuaries and harbours attract over 150,000 birds of 160 species.

The birds which frequent the Solent can be split into three groups:

1. Waterfowl (ducks, geese and swans);
2. Waders (birds which wade along shorelines and mudflats to forage for food); and
3. Seabirds (birds that live most of their life on or near the sea; in the Solent, this mainly applies to tern and gull species).

Many of these birds are present in the Solent year round, and some breed here. However, the highest numbers are seen in the winter, when thousands of birds migrate here to feed on the rich mudflats and other habitats in relatively mild weather (when compared to their Arctic summer grounds). These 'non-breeding' birds have long been monitored by British bird enthusiasts and organisations, as part of the Wetlands Bird Survey (WeBS) counts. For these monthly surveys, numbers observed are logged, and the averages of the highest numbers seen ('mean peaks') are published.

Further detail on each of the three groups is provided below, and a graph showing summed peak numbers for non-breeding birds across the Solent is also shown (expressed as an average (mean) of numbers observed over the past five years of counts, and derived from WeBS counts). These birds are found throughout the Solent, though Chichester and Langstone Harbours are particularly important, with around 45% of the non-breeding marine and coastal birds found here during recent count periods.

Waterfowl: Waterfowl numbers in the Solent typically peak at between 65,000 and 70,000 birds every year, with numbers being particularly high in the winter, though many species are also present during other seasons. Just over 70 coastal and marine waterfowl species are regularly observed; examples include:

- Dark-bellied brent geese; the Solent region supports one of the largest wintering populations of these birds in the UK and is of international importance for this species. By January each year, around 28,000 individuals, or 6 per cent of the world's population, can be found in the Solent. Dark-bellied brent geese are widespread in the region and feed in the intertidal (on seagrass and green algae), as well as on nearby grazing marsh, grassland, and arable fields.
- Dabbling ducks such as wigeon, teal, pintail and mallard; these duck species are often seen in sheltered locations such as upper sections of estuaries, lagoons, creeks, and sheltered channels, as well as freshwater pools and ponds near the coast. Species with peaks in excess of 1,000 birds include:
    - Wigeon, whose numbers round up to around 13,000 birds in the region; this species is mainly present in winter, feeding on coastal grassland habitat;
    - Shelduck, whose numbers typically peak at just under 2,000; this species is particularly reliant on mudflat habitat, and feeds on mud snails, cockles and ragworms; and
    - Pintail, which typically have peak numbers of around 1,300, and are found in sheltered estuary and harbour locations.

Some of these marine and coastal waterfowl species also breed in the Solent; this includes shelduck, shoveler, gadwall and teal.

Wading birds: These now peak at around 80,000 birds every winter in the Solent, with the intertidal mudflats of the region being particularly important feeding habitats. A wide variety of waders can be found, with most of them visiting the region in particularly high numbers over the winter. However, some species, such as lapwing, redshank and bar-tailed godwit, can be found year-round. Around 60 species are regularly observed; notably:

- There are nationally important populations of dunlin (peaking at around 33,000 per annum recently), redshank (4,300), black-tailed godwit (3,300), curlew (3,800), grey plover (3,100), and sanderling (600); most of these are observed throughout the Solent; and
- There are also large numbers of other species such as ringed plover (1,500), knot (1,900), bar-tailed godwit (500) and turnstone (1,400).

Some of these waders are also known to breed in the region; this includes avocet, lapwing, redshank, ringed plover and oystercatchers. For example, in 2022, at least 55 breeding territories of ringed plover were found across 24 sites in the region, often in precarious shingle beach locations. Efforts are underway to protect the nests of ringed plover (and other vulnerable breeding coastal birds).

Seabirds: Count data is available for both breeding and non-breeding seabirds.

The Solent is also an important location for breeding seabirds. Over 11,700 seabird pairs bred in the Solent region in 2023, with varying productivity / breeding success.

- Gull species accounted for the largest percentage of this, with 8,645 black-headed gull apparently occupied nests in 2023, followed by mediterranean gulls (2,218). Whilst exact annual breeding abundance trends are not known, it has been estimated that the Solent breeding mediterranean gull population represents the overwhelming majority of the UK and Ireland population, likely well over 90% in any given year.
- 484 sandwich tern pairs were seen nesting in 2023, followed by 317 common tern pairs and 57 little tern pairs. In addition, in 2024, two roseate tern adults successfully raised two chicks in the Solent; this was the first roseate tern breeding success in the Solent in over 15 years, and was the result of concerted efforts by conservation bodies.

Breeding locations are often precarious for most of the Solent's breeding seabirds (and indeed waders breeding in similar habitats); for example:

- Herring gull and lesser black-backed gulls mostly breed in urban areas in the region. They prefer to nest on non-smooth corrugated iron-type flat roofs. Deterrents are frequently used to prevent them from nesting at such sites;
- Black-backed and mediterranean gulls, as well as sandwich terns mostly breed on saltmarsh and lagoon islands in the region. These can be subject to disturbance and are generally threated by erosion and/or sea level rise; and
- A lot of common terns in the Solent rely on tern rafts for breeding, but also lagoon islands and offshore islands. Tern rafts need to be regularly maintained and reconstructed, and many of the Solent's shingle islands are relatively low lying and could benefit from raising to stop nests from being washed out (some have been raised already, see 'restoration and management' section below).

Trends

Numbers of many of these Solent's bird species are declining, some rapidly, and often declines are due to reasons which originate elsewhere. Most notably, the numbers of non-breeding waders in the Solent have seen a large decline over the last 30 years (almost 60%), especially ringed plover, bar-tailed godwit, sanderling and ruff. Numbers of other species such as black-tailed godwit, redshank and oystercatcher have generally been more stable. Trends for breeding waders are not known due to a lack of longer term monitoring data for this category of birds.

Waterfowl numbers have been relatively stable over the past 30 years, though some species have seen declines across the region, especially shelduck and red-breasted merganser.

Historic data in the Solent is often inconsistent or incomplete, especially for breeding seabirds; however, it is believed that the Solent is broadly following national trends. Across the UK, since the late 1990s, breeding seabird numbers have declined by 28%, on average. In the Solent, seabird breeding success is frequently quite low, and not generally high enough to sustain, or even grow, populations.

Condition

Condition information on birds is not consistent across the Solent, and where condition assessments are available, the conclusions are mixed, i.e. both favourable and unfavourable. Efforts are underway, or planned, to provide assessments for more sites and their bird features.

Where unfavourable conditions have been identified, then coastal squeeze and erosion, recreational disturbance and nutrient enrichment / water pollution were the reasons most commonly cited for causing such a state.

Predation by foxes and predatory birds is furthermore known to often devastate breeding bird colonies in the Solent. In the last few years, bird flu (Highly Pathogenic Avian Influenza) has also emerged as a

major threat to all marine birds, but breeding seabirds in particular. In Hampshire, black-headed gulls and common and sandwich terns all appear to have been severely impacted.

Marine, estuarine and migratory fish and shellfish

Numbers and species

Many fish are found in the Solent's estuaries and harbours, and some of these migrate through to the rivers of the region; including Atlantic salmon, sea trout and European eel. Atlantic Salmon are only found on the Rivers Test and Itchen. All the eastern harbours of the Solent, as well as Southampton Water, are designated bass nursery areas.

Over 50 species of fish are observed in the estuaries and harbours of the Solent, with clupeidae (herrings, shads, sardines, menhadens) being the most abundant family group, followed by Atherinidae (silver sides / sand smelt) (30%) and moronidae (bass).

Away from the estuaries and harbours, other fish species will be observed, although reporting on this can be quite sparse. The South Coast region is, however, known to support a diverse array of bottom-dwelling and pelagic fish and shellfish. Among the most characteristic are black sea bream, plaice, smoothhound, mackerel and sprat (also known as whitebait).

The Solent supports a wide range of shellfish species, including important commercial species typical to the UK such as whelk, king scallop, lobsters, crabs, and cuttlefish. Cockles and clams (particularly manila clam) are common along the region's sandy beaches and muddy estuaries.

The Solent and Isle of Wight area have also been highlighted as a shark and ray hotspot, and provides a pupping ground for smoothhound, tope and possibly thresher shark.

Many other fish also spawn here (i.e. produce offspring); including Dover and lemon sole, cod and plaice.

The Solent, and particularly its harbours and estuaries, is also a vitally important nursery ground (i.e. sheltered habitat for juveniles) for many fish, shark and ray species. For example, most of the easterly harbours, and Southampton Water, are protected bass nursery areas. Nursery grounds for many other fish species have been identified in the area, including mackerel, plaice, lemon and dover sole. Juvenile thornback and undulate ray and tope shark are also found in the Solent.

Many fish also migrate through to (and from) the rivers of the region; including Atlantic salmon, sea trout and European eel. Atlantic salmon are only found on the Rivers Test and Itchen in the Solent. Sea trout and European eel are observed in many rivers of the Solent, essentially all those rivers where there are no significant obstructions to the sea to stop them from migrating in and out. Rare migrants, which probably used to be present in larger numbers, include River and Sea Lamprey and Twaite Shad.

Trends

There have not been many studies on fish trends in the Solent, although it is not disputed that there would have been many more fish species and much higher numbers in the distant past, before industrial fishing commenced and water quality drastically deteriorated in the late 19th Century.

A recent study led by the University of Portsmouth (Morrall *et al.,* 2024) shows that, in the region's estuaries and harbours, there has also been a significant recent decline in fish abundance over the past two decades, with most of the (14) study sites having seen decreased total fish numbers.

Detailed monitoring data is available from the region's two salmon rivers, the Test and the Itchen. This reveals that Atlantic salmon numbers are far below the conservation limits in both the Test and the

Itchen, which means numbers are well below the abundance levels which the rivers should support. The Solent's Atlantic salmon stock is considered to be at risk. Reasons for this are believed to include low river flows, high water temperatures and water pollution (with continuous outflow from a sewage plant at Portswood/Southampton having been highlighted as problematic, amongst others).

European eel numbers have also collapsed in the Solent, and those of middle aged and older eels are particularly low. In addition, eels are not found as high up the rivers as they used to be. There are many reasons for the collapse and continuing decline of European eel numbers; including obstructions on rivers, pollution, parasites and diseases, and overfishing elsewhere (European eels migrate a long way to and from their spawning ground in the western Atlantic near Bermuda (an area known as the Sargasso Sea)).

Sea trout go against a declining migratory fish trend in the Solent, for reasons which are not entirely understood. The trend here also contravenes other regions in the UK, where numbers are falling markedly. In the Solent, numbers are increasing, and indications for 2024 are for a boom in numbers; this is likely related to above average river flows in combination with a cool spring.

Marine mammals

Numbers and species

The Solent is home to a small colony of harbour seals; apart from that, other marine mammals pass through but are not residents. Bottlenose dolphin and grey seals are the most commonly spotted other mammals in the region, with sightings generally increasing over recent years. Less common, but occasionally spotted visitors include harbour porpoise and common dolphins.

Harbour seals were first reported to have recolonised the Solent in 1994. The population has continued to increase ever since, and there are now estimated to be around 80 individuals in this colony (main haul outs are in Chichester Harbour). Harbour seals give birth from late June to late July. Over the past nine years, the number of pups born has varied between six and 14, with 2022 seeing the highest number of births to date. In 2023, one harbour seal pup was counted in Langstone Harbour for the first time. These seals are not only seen in Chichester and Langstone Harbours, but also elsewhere across the Solent as they roam and forage for food. Over the past decade, Newtown Harbour on the Isle of Wight has become established as another site where harbour seals frequently 'haul out' in the Solent, i.e. where they rest and sleep.

Grey seals normally only visit the Solent (rather than living here permanently), although they do so quite frequently, and they haul out at similar locations to the resident harbour seals. In March 2024, in what is believed to be the first of its kind in the Solent, a grey seal pup was born on the Beaulieu Estuary.

Trends

Seal numbers are increasing in the Solent, with the resident harbour seal numbers having gone from 0 in the early 1990s to around 80 today, and numbers having more than tripled in the last decade. Grey seals also visit the area more.

Other animals and species

In addition to the key animal species discussed above, the Solent is of course home to many further animals from other groups.

There are for example many species of 'invertebrates' (animals without a backbone) which live on and in the marine sediments of the Solent. For example, many worms live in the mudflats of the region, and provide food for fish and birds; this includes bristleworms, ragworms and catworms. Marine invertebrate

communities are generally judged to be in good or moderate condition in the Solent, where condition has been assessed (invertebrate condition has not been formally assessed for nine of the smaller waterbodies in the region).
The waters of the Solent also hold a rich planktonic life. Plankton comprise a wide range of organisms (not just animals) which live at least part of their lives drifting in the water column. Their size ranges from that of a single bacterium to big jelly fish. In the Solent, plankton includes millions of larvae of crustaceans which, as adults, live on the sea floor as crabs and prawns. A recent quality status report for the North Atlantic region, which includes the UK, reveals that trends vary amongst the different groups of plankton. Small copepods, a category of zooplankton that serve as vital prey for larval fish, have exhibited long-term increases in abundance in many coastal regions, but not the Solent. Additionally, the population of planktonic larvae, such as sea urchins and crustaceans, has risen in most regions, correlating with increasing sea temperatures. This includes the Solent, and another plankton category, large copepods appear to also have seen modest increases in this region. Weak decreases are mapped for the Solent for the four other plankton categories, dinoflagellates (phytoplankton), diatoms (phytoplankton), small copepods and holoplankton (zooplankton).

Biological invasions by non-native species also represent a key threat to biodiversity in the Solent. The Solent is known as a key entry point for such species into the UK due to its high volumes of international shipping and recreational boating. Many non-native species are found in the Solent, including Slipper Limpet, Pacific Oyster and several species of sea squirt. Trends are still increasing in both the number of species observed (though at slower rates than in the past), and likely also the area these species cover.

Human activities and pressures

Human activities

Population

The Solent is home to a large number of people, it has a population of just under 1.3 million (population of the nine unitary/local authority areas which are next to the Solent). This population is growing. Over the past decade, increases have been seen in all the counties which share a boundary with the Solent, with the population of West Sussex growing the most, by almost 9% between 2011 and 2021, and the Isle of Wight seeing more modest increases of just under 2%.

Shipping and navigational dredging

Ports are vital to the UK economy, with 95% (by volume) of all imports and exports transported by sea. In the Solent, activity centres on the ports of Southampton and Portsmouth. Cowes Harbour is the main port for the Isle of Wight, and the only location on the Island with deep-water channels capable of handling bulk-cargo carrying ships. For example, over the past two decades, movements to and from the Port of Southampton terminals have averaged between 43,000 and 70,000 per year. Southampton is also the main cruise ship calling point in the UK, with over 80 % of the nation's cruise traffic typically passing through Southampton. For example, in 2023, 87% of the cruise traffic passed through Southampton, with record passenger numbers of 2.6 million observed.

Shipping intensity to and from these ports is high, with most of the traffic exiting and entering the Solent to the east, via the Nab Channel, though substantial traffic also navigates through the Needles Channel which lies between the western tip of the Isle of Wight and the mainland.

Dredging for navigation occurs over substantial proportions of the marine environment in the Solent, with around a quarter of the marine area subject to active dredging licences. Large amounts of sediments are dredged every year, and deposited at offshore disposal sites; mostly the Nab Tower site east of the Isle of Wight. Between 2012 and 2022, just over 15,500,000 wet tonnes were deposited here. Dredged sediments can be used beneficially to reshape shorelines and to protect and restore coastal and estuarine habitats such as mudflat and salt marsh. However, only a very small percentage of the dredged sediment is used that way, although the Solent is home to a relatively high number of such projects.

Industry and military

There are many marine industries in the Solent, often related to the shipping and navigational activities in the region, as well as the fact that the Solent is an internationally renowned location for sailing and other water sports.

The petrochemical industry is of particular importance to the region, with the largest refinery in the UK being located at Fawley on Southampton Water. This facility processes around 270,000 barrels of crude oil a day and provides 20 per cent of UK refinery capacity. Over 2,000 ship movements are handled by Fawley refinery every year.

Military use of the Solent is of substantial economic importance to the region, and centres primarily on the naval base at Portsmouth Harbour and Marchwood Military Port. Portsmouth Harbour is the traditional home of the Royal Navy, is the base port for the majority of the Navy's surface warships, including aircraft carriers, and is also the major naval stores distribution centre in the UK.

Flood risk management

The construction of hard defences around parts of England's coast has provided coastal communities, farmland, and infrastructure with valuable protection from flooding and erosion. Around 45% of the Solent's shoreline is defended with hard defence structures. Coastal defence techniques frequently involve groynes and breakwaters, often backed by concrete seawalls, with less exposed frontages in the estuaries and harbours generally protected by earth embankments. Numerous flood and erosion risk management programmes are underway or in development in the region, including for example the Hurst Spit to Lymington Flood and Coastal Risk Management Strategy, the Southsea Coastal Scheme, and the North Portsea Coastal scheme.

Where there are hard defences such as embankments and seawalls in place, this can cause 'coastal squeeze' which happens where the landward movement of saltmarshes and other intertidal habitats is prevented by human structures. In England, some of those losses are already being compensated for in line with the requirements of the 2017 Habitats Regulations. For example, the 300 ha Medmerry managed realignment west of Selsey was implemented as such a compensation scheme in 2011.

Fisheries

Commercial fishing

There is a relatively small commercial fishing fleet in the Solent, with 49 boats registered at harbours in the region; 31 of those in Portsmouth. Numbers are much reduced these days, for example, fishing vessel numbers effectively halved over the past decade (Defra, 2024a). The boats based in the Solent mainly target shellfish, with whelk, clam and crab being the top three most caught commercial species in the region. Most of the fish tend to be caught outside of the Solent itself, although some low intensity fishing takes place in the region, where this is permitted. There are many byelaws (local laws) in place

to support sustainable fishing throughout much of the Solent, both to protect stocks and sensitive habitats and species. For example, net fishing, trawling and oyster dredging are heavily restricted in many locations.

Hand gathering

Hand gathering encompasses both bait digging (for fishing), mainly by recreational anglers (for ragworm, for example), and the collection of clams, cockles or other bivalves for consumption. These activities are theoretically only allowed for personal use/consumption in most locations, but illegal collection is believed to take place in several locations; this can, however, be difficult to prove. Bait diggers typically use a garden fork to turn over the sediment to then pick worms out by hand.

Bait digging is widespread throughout the Solent, with hotspots found in Chichester Harbour (Fishbourne Channel especially), Portsmouth Harbour (Fareham Creek) and the Hamble. The collection of bivalves for consumption is particularly pronounced in Chichester Harbour, where it is of concern in the Bosham and Prinstead areas.

Recreational fishing

The South Coast region has a well-established and popular recreational fishery due to its population density, as well as good accessibility and numerous sheltered areas. It attracts recreational shore and boat anglers all year round, the vast majority of which are line anglers. Many marinas, ports and harbours support numerous smaller boats which are used by casual hobby fisherman.

Marinas, harbours, breakwaters, piers and beaches also offer easily accessible shoreline fishing areas, and this takes place throughout the Solent.

Recreation

Recreation can be counted as the Solent's most significant activity in terms of the number of people which take part. At least twenty different activities take place, each with its own characteristic distribution and pattern of use. Tourism is also significant, particularly for the Isle of Wight. On the Hampshire coast, there are fewer long stay visitors, but the number of day and short stay visitors is significant.

In addition, many people enjoy the coast for the region's beaches and harbour and estuary shorelines, with over 200 car parks being at or near the coast, and the vast majority of the shoreline being accessible to walkers. Only very few quiet and inaccessible shorelines remain, most of these are found along the northwest Solent and on the Isle of Wight.

The Solent is one of the most densely populated sailing areas in the world and enjoys an international reputation. There are approximately 24,000 moorings and marina berths in the area, with at least 69 marinas located in the Solent study area.

Paddle sports and wind sports have also been practiced for many years, but have grown in popularity recently, with the introduction of paddle boards and new wind sports such as wind foiling. Paddle sports, mostly rowing, kayaking and paddle boarding, are popular in most estuaries and harbours, as well as along many of the beaches, with Langstone Harbour and parts of the New Forest coast being notable exceptions. Particular paddle sports hot spots include the Hamble and Beaulieu estuaries, as well as Calshot and the upper reaches of the Emsworth Channel in Chichester Harbour. Wind and kite surfing is mostly practiced along the popular beaches of the region, notably Bracklesham, Stubbington to Gosport, around Calshot and at Hurst Spit. Some within estuary and harbour activity also takes place, for example at Netley in Southampton Water and in the Emsworth Channel in Chichester Harbour.

Potential impacts on nature

These activities lead to a lot of pressures on the coastal and marine environment. For example, shipping causes air, water, noise and light pollution which can all affect the marine environment. Southampton Water and the eastern Solent are particularly noisy underwater areas. Some bottom towed fishing practices such as trawling can destroy seabed habitats such as kelp and seagrasses, and fishing can also deplete some species. Bait digging and hand gathering of shellfish is also considered to be problematic for nature in many areas of the Solent as these activities can cause trampling of habitats and disturbance to birds.

Recreational activities have many effects on the marine environment, with disturbance of wintering and breeding birds, but also seals, being key areas of concern. Dog walkers, and particularly those which let their dogs off leads near sensitive locations, are a key issue in the Solent. Boat anchorage and mooring is also of concern, as this can cause damage to seabed habitats such as seagrass beds.

Pollution

Pollutants originating from various sources lead to significant pressures on the Solent's coastal and marine ecosystems. It is estimated that approximately 80% of marine pollution is derived from land-based sources. Contaminants entering rivers and streams (from agricultural activities, stormwater overflows, wastewater treatment facilities, urban area runoff, and industrial facilities) are carried downstream into estuaries and coastal waters, leading to a large variety of adverse effects on ecosystems and wildlife.

Sewage overflows and sewage plant discharges

Storm overflows from the sewage system very frequently discharge into the Solent or its catchment rivers. Over the past two years, there have been almost 100,000 hours of storm overflow discharge into the Solent or its catchment rivers**.**

The day to day discharges from the region's sewage treatment plants is also substantial. For example, a recent (2024) report by the Friends of the Itchen estimated that the Portswood plant in Southampton has an annual discharge volume of 7 million m^3, and that the E. Coli bacterial load from this was 34 times greater that the bacterial load from stormwater spills. There are 36 sewage treatment plants along the rivers and shores which are attributed to the Solent region and its catchments. Many of the plants on the Solent are likely to be relatively high emitters of bacteria and nutrients, as indicated by the Itchen report above, and also the fact that 32 of the region's water treatment plants are considered to require urgent improvements (including Portswood). This is in relation to nutrients; all 32 require improvements for nitrogen, but four plants also require works to reduce phosphorus emissions.

Eutrophication and nutrient monitoring

Eutrophication occurs where increased nutrients, especially nitrogen, in the water result in too much plant growth, seen in the Solent as harmful green macroalgal mats which often cover intertidal mudflats and other habitats.

The main sources of nitrogen to Solent estuaries are agriculture (about 50% of nitrogen is estimated to be from agriculture, often via rivers), followed by point sources from sewage discharges (about 10% of nitrogen is estimated to be from sewage).

A 2023 eutrophication report by the Environment Agency (2023b) concluded that there had been a reduction in the amount of macroalgae within the estuaries of the Solent, compared to the previous two decades, and that recovery from eutrophication, in parts of the Solent, was well underway. This was attributed to schemes which encourage changes in farming practices and also improvements to water treatment plants. It was acknowledged that further work was needed however.

A 2023 study by the University of Portsmouth (Watson *et al.,* 2023) which analysed data from hundreds of water quality monitoring stations has however claimed that the Solent's water quality had not improved in 25 years, which it stated does '*not support current [Environment Agency] eutrophication assessments'*.

Sediment contamination

The Solent's sediments are often contaminated with harmful substances which can have a long 'shelf life'. This includes heavy metals, pesticides, and other chemical products.

A 2021 study by the University of Portsmouth (Richir *et al.,* 2021) which analysed available government sediment contamination monitoring data, found that trace element contamination markedly declined up to the 1980s. This was mostly due to improved waste treatment and increased recycling. However, improvements have slowed in the past three decades, and in fact a distinct increase in some elements can be seen after 2010. Increasing levels of pollution were found for nickel and iron (but still at low pollution levels). Copper pollution is considered to be at moderate levels, and copper pollution has steadily worsened since the mid-1990s. Ship antifouling paints, ship scrubbers and sacrificial anodes were considered to be substantial causes for increases in some trace elements, notably copper, zinc and nickel. It was estimated that the following quantities are being added to the Solent every year:

- 94 tonnes of copper (mainly due to antifouling paint, but also ship scrubbers (exhaust gas cleaning system));
- 377 tonnes of zinc (mainly from anodes (metal blocks mounted to ship hulls to help protect against erosion), but also scrubbing and anti-fouling); and
- 0.2 tonnes of nickel (scrubbers).

Other pollution issues

In addition to the above, there are many other causes of pollution in the Solent. For example, over 140 existing and historic landfills are found along the Solent's shores; these are often releasing waste into the system, or are at high risk of doing so due to deterioration of defences.

There is also a lot of abandoned debris in the Solent, including from abandoned structures such as pipes or jetties, abandoned boats and fly tipping. In addition, litter is a substantial issue, with most of the input of marine plastic litter (80%) being from land-based sources (including littering on beaches or from sewage systems or rivers). About 20% is from marine sources; predominantly from the fishing industry (e.g. nets and buoys).

Potential impacts on nature

Poor water and sediment quality negatively affect many species and habitats, and results from a wide variety of factors, as set out above. These can cause many issues for the Solent's nature.

High nutrient inputs to estuaries and coastal waters can lead to problem levels of growth of macroalgae in some locations. These can smother habitats and animals and also stop birds and fish from feeding

effectively. There can also be wider ecological effects because of impacts from excess nutrients on plankton and other animal communities.

There is also growing recognition and understanding of the threats posed by chemical and heavy metal pollution to coastal and marine environments. Many of the substances which are still being added to the marine environment, or are still present due to historic build up, have been identified as potentially dangerous to marine life. However, there is not enough evidence on what levels of the many different pollutants can cause damage to biodiversity.

Climate change

Climate change is already impacting the Solent, and this will only get worse in the future. The intensity of these effects will vary both in time and space, but key physical changes will include changes in water temperature, sea level rise, and variations in salinity. These can have many potential impacts on the Solent's nature, including changes in the distribution of animals and plants.

Sea level rise in particular is already impacting the Solent's nature, and is projected to get worse. In Southampton for example, sea level rise is now on average almost 4 mm per year, and forecasts for the region are for a rise of 1.2 to 1.6 m by 2125. Larger rises than this are considered possible.

Sea level rise can:

- Lead to more widespread loss of coastal habitats, such as seagrass and saltmarsh; with saltmarsh in particular already known to struggle in the Solent due to coastal squeeze;
- Lead to increased risk to marine environments from erosion and exposing old landfill sites; and there are many such sites in the Solent, as noted above; and
- Cause salt water intrusion to brackish and freshwater habitats.

Management and Restoration of the Solent's Nature

Management and regulation

Using site management to remove or reduce damaging activities or pressures is crucial, and numerous such management measures are already in place in the Solent. These include regulation and byelaws, guidance/best practice, monitoring, as well as voluntary measures and awareness raising. Many of these are Solent specific and some of them are considered pioneering. For example, Bird Aware Solent was initiated here in 2017; this is a strategic partnership which aims to reduce potential recreational impacts on protected birds from increased local housing development.

The measures in place in the Solent fall into the following categories:

- **Designated site management** (e.g. the dedicated management scheme for the Solent's marine sites; Natural England's lists of operations for Sites of Special Scientific Interest, and also site improvement plans for most of the Solent's international sites);
- **Wildlife disturbance management** (e.g. rangers and signage to reduce disturbance, for example by Bird Aware; also nest protection enclosures and wardening to protect breeding seabirds and their nests);

- **Byelaws, codes of conduct, best practice guidance**; selected examples include:
    - Many fishing byelaws exist to facilitate sustainable fishing and protect sensitive habitats and species;
    - Most harbours and estuaries have guides for their users, e.g. for those taking part in paddle sports;
    - Bird Aware Solent has produced a Coastal Code to minimise disturbance to birds; and
- A **voluntary no anchor zone** has been introduced in Osbourne Bay on the Isle of Wight to protect seagrass beds); and
- **Pollution management and reduction** e.g. litter picking and avoidance campaigns by various bodies; the Green Blue's anti-fouling best practice guide; the Environment Agency and others encouraging sewage treatment plant improvements; the Partnership for South Hampshire, and their efforts to achieve nutrient neutrality for new houses.

Active restoration

Overview

Active restoration measures have been implemented in the Solent, with many more under way. A wide variety of techniques have been employed and are being considered; these broadly fall into the following categories:

- **Seawall realignment (also referred to as managed realignment**): This involves relocating or removing often vulnerable coastal defences and extending areas of tidal inundation to create intertidal habitats across low-lying land (often in coastal areas that have been historically claimed from the sea);
- **Coastal intervention**: Influencing or adjusting existing coastal processes to change environmental conditions to protect habitats or promote their recovery (e.g. installation of brushwood or coir fences);
- **Sediment recharge (or beneficial use)**: Replenishing deteriorating habitats, islands, and barriers with sediment, including silt, sand, shell and/or shingle, as appropriate to the habitat in question (e.g. seabird breeding habitat creation)
- **Habitat recreation**: Adopting a technique to restore and create specific habitat types either by (re)introducing keystone species (e.g. seagrass, kelp or native oyster) and/or altering seabed substrata to promote species recruitment and habitat change.

In addition, there are smaller-scale, complementary measures which can be adopted for newly created or existing habitats. These include clearing vegetation to facilitate bird nesting, the installation of bird nesting platforms on infrastructure or adding native oyster brood stock cages.

Solent examples

Many active restoration schemes have either been implemented or are underway in the Solent.

At least 13 existing managed realignment and sediment recharge schemes have been undertaken in the Solent to date, which have together led to the creation of just under 250 ha of mudflat and saltmarsh habitats. These schemes include the large Medmerry realignment west of Selsey Bill and several beneficial use schemes at Lymington. Around eight of the region's important bird islands have also been (partially) topped up with soft and shingle sediment.

Active restoration to restore native oyster habitat and populations started in the Solent in 2017 with the pioneering Solent Oyster Restoration Project. This work is being continued and scaled up as part of the

Solent Seascape Project. The initial oyster restoration approach was to increase larval supply by installation of broodstock nurseries in marinas across the Solent to increase breeding and the output of larvae to the wider Solent (estimated to be over 1 billion larvae in 2017). Subsequently, an oyster hatchery was installed at the Institute of Marine Sciences at the University of Portsmouth which successfully trialled the breeding of Solent stock to produce larvae for spat on shell. Following the introduction of fishery closure areas and legal protection from bottom towed fishing gear, two seabed oyster reefs have been created to improve the quality of the seabed habitat through the addition of gravel and shell material that oyster larvae will be able to settle on. This also created a suitable reef habitat for the laying of live oysters. To date, over 56,000 live oysters have been added to the two reef areas to kick start the creation of a self-sustaining oyster habitat.

Several seagrass seeding and planting schemes have also been initiated over the past two years, with many more being planned, drawing in large numbers of volunteers (e.g. HIWWT's Solent Seagrass Champions). There have been several schemes on the Isle Wight, as well as in Langstone Harbour, and at the entrance to the Beaulieu estuary. Advanced mooring systems have also been installed in some locations in the Solent, to reduce seagrass damage that can occur from the anchoring and mooring of recreational boats.

Active restoration efforts to support breeding marine and coastal birds have mostly focussed on ensuring the height of the existing breeding islands is high enough (by raising with sediment including shingle), but also creating new islands and installing tern rafts and fencing.

Planned measures

Many more schemes are being planned as part of the various initiatives and projects which are taking place across the Solent, including the Solent Seascape Project, which is coordinating many of these efforts. Planned schemes by various organisations include further managed realignment and beneficial use schemes (often to support flood risk management activities / compensate for coastal squeeze), as well as more oyster and seagrass restoration sites.

National and regional 'opportunity' maps have been produced to help identify areas which might be suitable for habitat creation, including for managed realignment potential areas, as well as seagrass, kelp and oyster habitats.

Gaps in understanding and evidence

There are many evidence gaps which mean that the understanding of the state of the Solent's nature is not complete.

There is frequently insufficient information on existing numbers and extents of the habitats and species. This is particularly the case for habitats which are always under water, and animals which are difficult to spot; making monitoring difficult and costly. Seagrass and kelp for example are likely to be underreported for these reasons. Several programmes are underway or planned to try and improve this situation. Historic information and mapping is generally not available to help gauge trends, and where it is, it can be inconsistent and difficult to interpret (e.g. for saltmarshes).

Often, monitoring data is collected, but data is either not analysed at all, or only partially; and where analysis is undertaken then this is frequently not made public. These issues apply to a lot of data, including most of the water and sediment quality monitoring undertaken by government organisations, some of the fish monitoring undertaken by the government and authorities/centres, and some of the

bird monitoring undertaken by various reserve managers. Valuable insights have been gained from recent studies carried out by the University of Portsmouth, but more detailed and consistent studies would be beneficial for all of these categories. Efforts are also underway to improve the collation and reporting of seabird breeding data across the Solent, led by the RSPB as part of the Solent Seascape Project.

Condition assessments are also not available for many animals and habitats, and where they have been done, the information is often not consistent and does not tend to be mapped. Again, efforts are underway to improve this; with Natural England planning on publishing condition reports for more designated sites in the near future, and also the development of a more standardised assessment approach. Condition assessments are also undertaken by other bodies. For example, as part of the 'Sea the Value' project, Portsmouth University has been undertaking habitat quality assessments for seagrass beds, oyster beds and saltmarshes in Langstone and Chichester Harbours recently (results are not yet available).

Locations where human activities cause particular issues to nature are also often not properly identified, although there is a relatively good level of understanding of this in the Solent. Efforts have been made in relation to this State of Nature work to collate the knowledge of the different Solent Seascape partner organisations for example. However, more detailed mapping would still be beneficial for most pressures.

With regard to management and restoration, there is frequently not enough information on the individual measures, and in particular lessons learned from them, or consistent approaches for defining success. Again, both within the Solent, and nationally, there are various endeavours to improve this, though more can still be done by all the organisations involved in such measures, to facilitate consistent and efficient exchange of knowledge and evidence.

Purpose of this report

This Solent State of Nature report has been produced to present a baseline description of the Solent region using best available evidence. This is needed so that relevant stakeholders can see and understand key aspects, such as habitat extent and condition, anthropogenic pressures and existing management measures. There is also a supporting Solent State of Nature data viewer, where relevant maps can be interrogated. These information sources will be used to engage with stakeholders to ultimately inform a Recovery Plan for the Solent as part of the Solent Seascape Project.

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1 Introduction

1.1 Project background

The Solent Seascape Project aims to be the first of its kind in the UK to initiate recovery of the marine and coastal environment at a regional/seascape scale. The long-term vision for the project is to protect and restore the Solent's seascape, tipping the balance from a degraded state to a naturally expanding, connected and productive ecosystem. By restoring and connecting the Solent's habitats and its seascape as a whole; nature-based solutions will be provided to address many of the issues currently affecting it and the people who depend on it, as well as helping to fight the impacts of climate change.

To support these goals, Blue Marine Foundation has commissioned ABPmer to develop (and maintain until early 2027) new digital products on the State of Nature of the Solent, as well as write a State of Nature report. The latter is contained in this report, which has been split into two volumes; Volume 1 – main report (this report), and Volume 2 – technical appendices.

For the purpose of this project, the Solent region extends from Hurst Beach and the Needles (Isle of Wight) in the west to a line between Black Rock (Isle of Wight) and Selsey Bill in the east; incorporating Pagham Harbour (see Figure 1). Whilst the latter is not located in the Solent, it has been included in the study area, as it is functionally tightly linked to the adjacent Solent system.

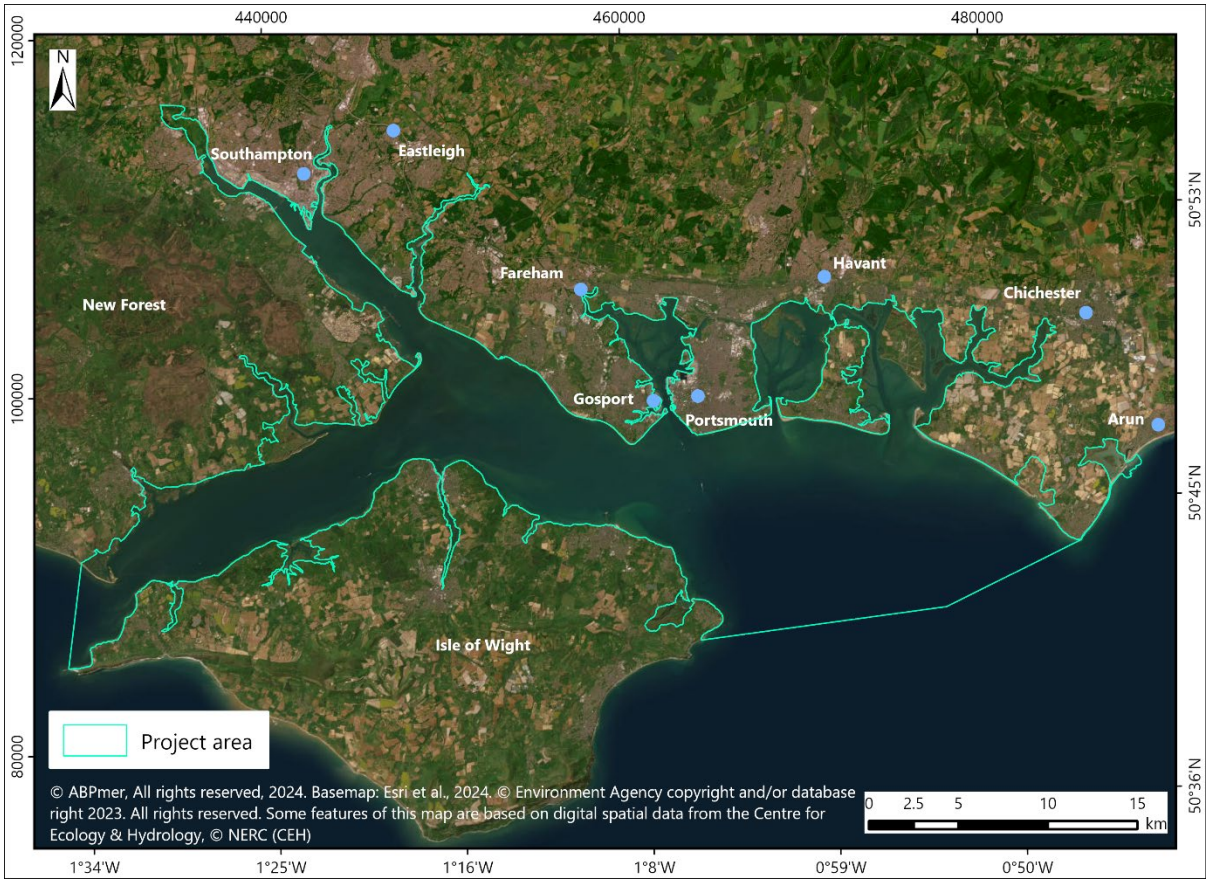


Figure 1. The Solent Seascape project area

1.2 Aims for Solent State of Nature report

The Solent Seascape project has five aims/workstreams:

- To better protect habitats (this State of Nature project falls under this workstream);
- To deliver active restoration;
- To implement monitoring;
- To provide policy advocacy and financial stability mechanisms; and
- To facilitate community engagement (as led by the Wildlife Trust).

The project is underpinned by consultation and engagement that has been collaboratively designed with stakeholders and partners. There are ten organisational partners on the project, these are: Blue Marine Foundation, Royal Society for the Protection of Birds (RSPB), Hampshire and Isle of Wight Wildlife Trust (HIWWT), Project Seagrass, Natural England, Environment Agency, Coastal Partners, Isle of Wight Estuaries Project, Chichester Harbour Protection and Recovery of Nature (CHaPRoN) and University of Portsmouth.

The main aim of the Solent State of Nature element of the Solent Seascape project is to present a baseline description of the region, using best available evidence. This is needed so that relevant stakeholders can access and understand key aspects such as habitat extent and condition, anthropogenic pressures, and existing management measures. As part of this work, a report and an accessible and interactive online data viewer have been produced. These will help achieve, amongst other objectives, the identification of gaps in management, or areas where pressure removal may be desirable. These deliverables will be used to engage stakeholders to ultimately inform a Recovery Plan for the Solent.

1.3 Report structure

This Solent State of Nature report (Volume 1) is structured as follows:

- **Section 1: Introduction** (this section) - providing background on the project and its objectives;
- **Section 2**: **The Solent's Nature** – a review of the latter, with the following sub-sections on:
    - Section 2.1 – Solent system overview;
    - Section 2.2 - Marine protected areas, habitats and species;
    - Section 2.3 – Habitats (providing detail on extent, trends and condition; plus future predictions and a summary on ecosystem service provision);
    - Section 2.4 – Species (providing detail on numbers, trends and condition; also information on invasive species);
- **Section 3**: **Activities and Pressures on the Solent's Nature** – summarising the many activities taking place in the Solent region and how they may exert pressure on the Solent's nature; also discussing pollution and climate change;
- **Section 4: Restoration and recovery of the Solent's Nature** – outlining the myriad of potential and ongoing actions to facilitate recovery, and also providing summaries on the ongoing initiatives;
- **Section 5: Focus on key areas of the Solent** - providing summary overviews for six key areas in the region; and
- **Section 6: Next steps / the future** – discussing how this report, and the accompanying data viewer, will be used to inform the Solent Seascape Recovery Plan process, and other next steps.

Volume 2, the technical appendices to this main report, is supplied as a separate document.

2 The Solent's Nature

The Solent region is a busy, densely populated coastal region in southern England which is home to many marine and coastal habitats and species, many of which are threatened and / or considered to be of high national or international importance. Section 2.2 provides detail on the marine protected areas and species found in this system, followed by Section 2.3 and 2.4 that provide more detail on habitats and species respectively. Prior to this, a brief overview on the Solent system is provided in Section 2.1.

2.1 Solent system overview

As noted in Section 1, for the purpose of this report, the Solent region is understood to extend from Hurst Beach and the Needles (Isle of Wight) in the west to a line between Black Rock (Isle of Wight) and Selsey Bill in the east; incorporating Pagham Harbour (see Figure 1).

This study area measures 530 km^2, although the purely marine area (excluding some coastal land and lagoons which have been included in the study area boundary) measures slightly less at around 510 km^2. The catchments which empty into the Solent region, as defined for this report (inclusive of Pagham Harbour), cumulatively measure 3,360 km^2. These catchments extend a substantial distance from the coast; the furthest catchment boundary for the study area is located near Walbury Hill in Berkshire, 60 km from the Solent. More than 85 % of the land area of the Isle of Wight drains into the Solent.

The Solent itself is the strait that separates the Isle of Wight from the mainland of England. It is approximately 32 kilometres (km) long[1] and varies in width between 2.6 km and 8 km, although the Hurst Spit, which projects 1.3 km into the Solent, narrows the sea crossing between Hurst Castle and Colwell Bay to just 1.3 km. The Solent is considered to be the drowned valley of a river which once flowed east between the Isle of Wight and the mainland of Hampshire and West Sussex.

The Solent region encompasses a major estuarine system with many estuaries and harbours, with most of the estuaries being classed as 'spit enclosed'[2] estuaries, and all the main harbours as 'tidal inlets' (ABPmer and HR Wallingford, 2024). The coastline measures around 540 km in length[3].

The spring tidal ranges differ significantly across the Solent region, from 2.2 m in the west (e.g. Yarmouth / Isle of Wight) to 5.1 m in the east (at Pagham, next to the entrance to the Harbour); see Table 1 for tidal values for a selection of tidal stations in the Solent study region. Near Calshot (at the entrance to Southampton Water), the tidal regime and bathymetry result in a double high water. Further to the east, around Spithead / Portsmouth, changes in the relationship between the tides and bathymetry result in an extended (rather than double) high tide. In Southampton Water, the tidal characteristics are exaggerated by internal resonance within the estuary; this results in a 'young flood stand' and a double high-water period with little change in water level. The largest waves in the Solent are principally generated by waves blowing along the East and West Solent; these are the two directions with the longest fetch. Protection from Hurst Spit and the Bramble Bank means that swell waves within the Solent itself tend to be minimal (Solent Forum, 2024a).

[1] From Hurst Spit to a line drawn between Ryde on the Isle of Wight and Gilkicker Point/Gosport.

[2] There are many ways in which estuaries have been defined; for the updated Estuaries Database (ABPmer and HR Wallingford, 2024), the 'EstSim' (Estuary Simulations) classification system has been applied. This classes the Solent estuaries into three classifications: (1) spit enclosed (drowned river valley in origin, with one or more spits and not an embayment), (2) tidal inlet (drowned coastal plain in origin, with barrier beaches or spits) and (3) funnel-shaped (drowned river valley in origin, with linear banks or no ebb/flood delta and not an embayment). Only the Medina is classed as funnel shapes, all other estuaries or rivers are considered to be spit enclosed (this includes Bembridge Harbour), and the four big harbours (Portsmouth, Langstone, Chichester, Pagham) are considered to be tidal inlets.

[3] As measured using the Environment Agency's 'Spatial Flood Defences' data layer.

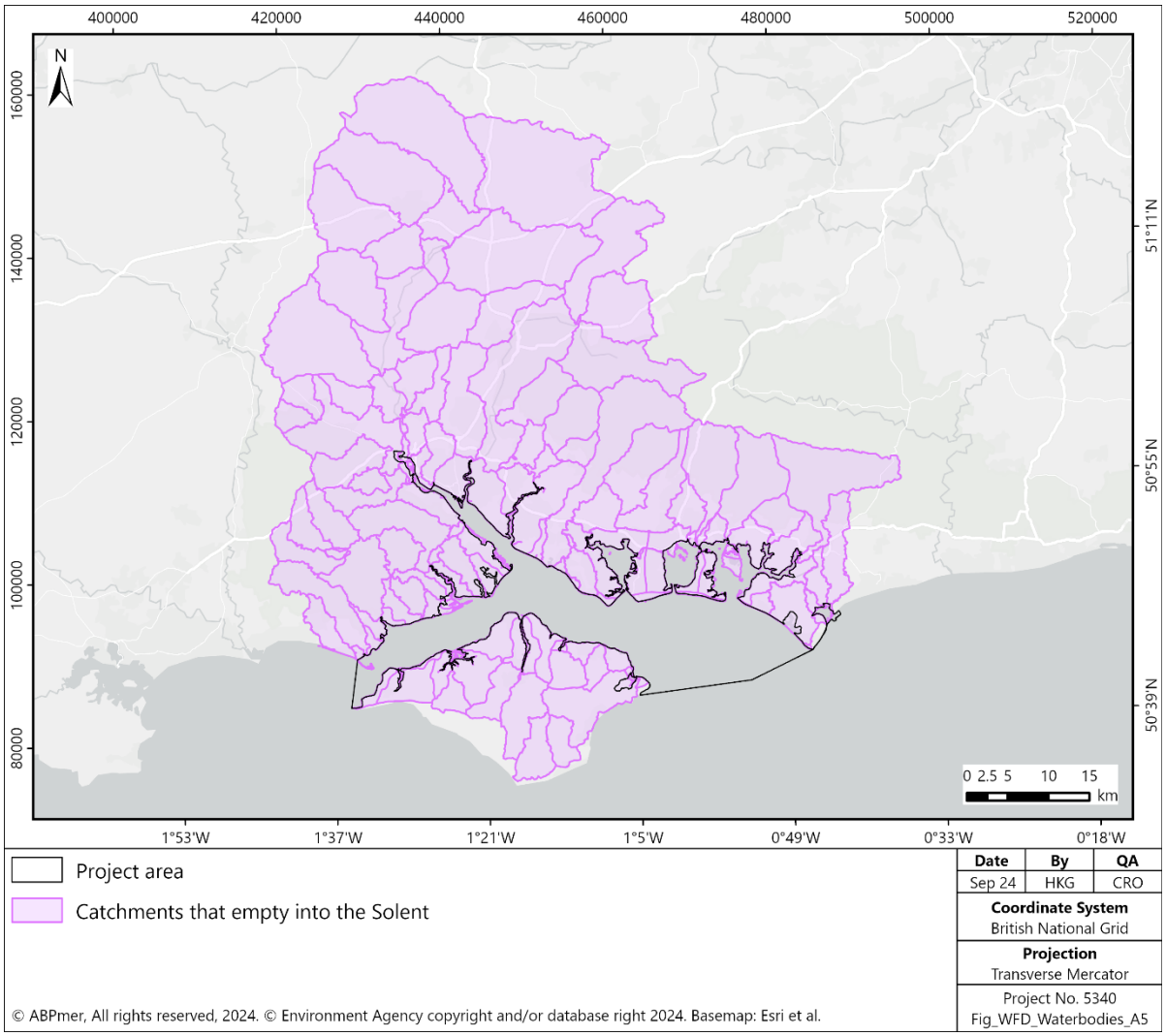


Figure 2. **Solent region catchments**

Table 1. **Tidal values for a selection of Solent region stations (west to east)**

Station	Tide level (m Ordnance Datum (OD))*						Tidal range (m)	
	HAT	MHWS	MHWN	MLWN	MLWS	LAT	Spring	Neap
Yarmouth (Isle of Wight)	1.22	1.02	0.62	-0.38	-1.18	-1.68	2.2	1.0
Calshot Castle	2.16	1.76	0.96	-0.74	-1.94	-2.64	3.7	1.7
Southampton	2.26	1.76	0.96	-0.94	-2.24	-2.84	4.0	1.9
Warsash	2.26	1.76	1.06	-0.84	-1.94	-2.44	3.7	1.9
Bembridge	2.26	1.86	1.06	-0.74	-1.54	-2.04	3.4	1.8
Langstone	2.66	2.06	1.16	-0.84	-1.94	-2.64	4.0	2.0
Chichester Harbour Entrance	2.56	2.16	1.26	-0.84	-1.84	-2.54	4.0	2.1
Pagham	3.05	2.55	1.25	-1.25	-2.55	-3.15	5.1	2.5

* HAT = Highest Astronomical Tide; MHWS = Mean High Water Spring; MHWN = Mean High Water Neap; MLWN = Mean Low Water Neap; MLWS = Mean Low Water Spring; LAT = Lowest Astronomical Tide

(Source: Admiralty Total Tide)

2.2 Marine protected areas, habitats and species

2.2.1 Designated sites – overview and features

Overview

Seventy-two designated sites, including several dedicated Marine Protected Areas (MPAs), can be found across the Solent. These encompass Special Areas of Conservation (SACs), Ramsar sites, Special Protected Areas (SPAs), Sites of Special Scientific Interest (SSSIs), Marine Conservation Zones (MCZs), National Nature Reserves (NNRs), and Local Nature Reserves (LNRs). They cover over 91 % of the study area, and also apply to much of the adjacent terrestrial areas. Figure 3 shows those sites which overlap with the Solent Seascape project area. As can be seen, many of the designated sites overlap, such that in some locations, up to six local, national and international designations can apply to a given area.

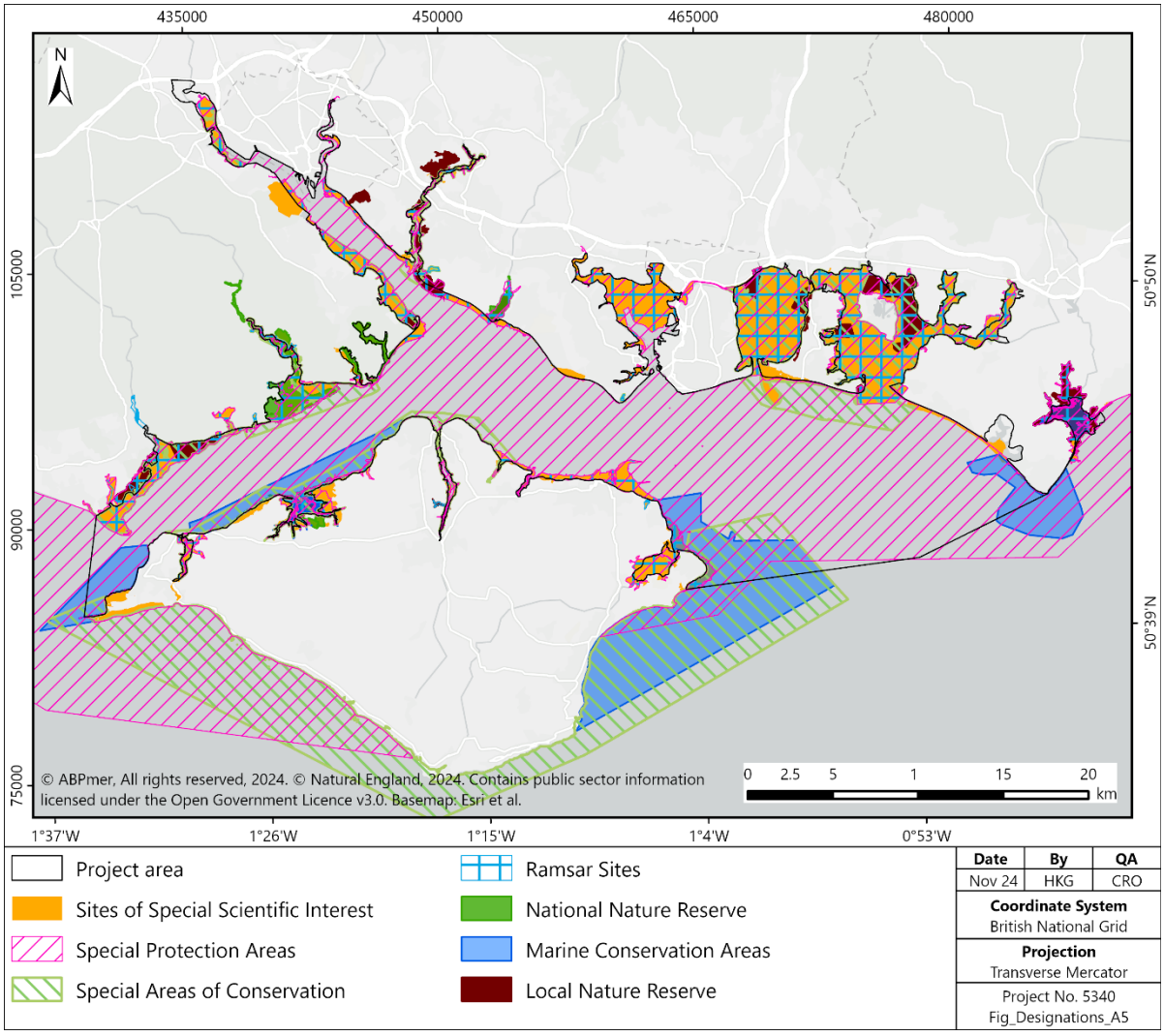


Figure 3. Designations which have an overlap with the Solent Seascape area

The names of the sites which overlap with the study area are provided in Table 2 below. The other designations are too numerous to list here, but in total consist of four Ramsar sites (which overlap with all the SPAs listed, except for the Solent and Dorset Coast SPA), 33 SSSIs, two NNRs and 20 LNRs. Details on the designated features for each of the 72 sites, as well as conservation objectives and hectarage (where available) are provided in Appendix A (see Volume 2 to this report).

Table 2. SPAs, SACs and MCZs in the Solent region

SPAs	SACs	MCZs
Solent and Dorset Coast SPA	Solent Maritime SAC	Bembridge MCZ
Chichester and Langstone Harbours SPA	Solent and Isle of Wight Lagoons SAC	Pagham Harbour MCZ
Pagham Harbour SPA	South Wight Maritime SAC	Selsey Bill and the Hounds MCZ
Portsmouth Harbour SPA		The Needles MCZ
Solent and Southampton Water SPA		Yarmouth to Cowes MCZ

Designated features

A detailed review of the information provided on each of the 72 designated sites on the Natural England Designated Sites Website (Natural England, 2024a) revealed that, across these sites, 51 marine/coastal species and 97 marine/coastal habitat communities are listed as reasons for, or features of, these sites. Many of these species and habitats are listed for more than one of the sites. Most of the birds are, for example, observed across all the SPAs (and Ramsar sites), but also a lot of the SSSIs. Saltmarshes (and their various sub-communities) are listed more often than any of the other habitat types; almost 50 times across the many designated sites.

The 97 habitat communities were classified into 19 broad habitat categories (see Table 3).

Table 3. Marine/coastal habitats listed in documentation of designated sites in the Solent region

Habitat category	Habitat category
Coastal and floodplain grazing marsh	Mud habitats in deep water / subtidal mud
Coastal saltmarsh	Peat and clay exposures
Coastal sand dunes	Saline lagoons
Coastal vegetated shingle	Seagrass beds (intertidal and subtidal)
Estuarine rocky habitats	Sea-pens and burrowing megafauna
Intertidal (mud)flats	Sheltered muddy gravels
Intertidal underboulder communities	Subtidal chalk
Intertidal chalk	Subtidal sandbanks (and component sub-features)
Maritime cliff and slopes	Subtidal sands and gravels
Subtidal rock	

Of the 51 marine species listed as part of the designated sites (i.e. either listed as a feature or mentioned in the citation), there are 38 bird species (including six breeding seabird species), four fish species, one plant species (excluding those listed under habitat communities), three cnidaria and five invertebrate species. Lists of these are provided in Table 4 to Table 6. Full lists, including Latin names and relevant designations, are provided in Appendix A.

Table 4. Marine fish listed in documentation of designated sites in the Solent region

Common name	Common name
European sea bass	Gobies
Flounder	Short-snouted seahorse

Table 5. Marine/coastal birds listed in documentation of designated sites in the Solent region

Common name	Specified category	Common name	Specified category
Gadwall	Non-breeding	Great crested grebe	Non-breeding
Bar-tailed godwit	Non-breeding	Grey plover	Non-breeding
Black-headed gull	Breeding	Little grebe	Non-breeding
Black-tailed godwit	Non-breeding, passage	Little ringed plover	Not specified
Common greenshank	Non-breeding	Little stint	Not specified
Common redshank	Non-breeding, passage	Little tern	Breeding
Common ringed plover	Non-breeding, passage	Mediterranean gull	Breeding
Common sandpiper	Not specified	Northern lapwing	Not specified
Common shelduck	Non-breeding	Northern pintail	Non-breeding
Common tern	Breeding	Northern shoveler	Non-breeding
Curlew sandpiper	Not specified	Red-breasted merganser	Non-breeding, wintering
Dark-bellied brent goose	Non-breeding	Roseate tern	Breeding
Dunlin	Non-breeding	Ruddy turnstone	Non-breeding
Eurasian curlew	Non-breeding or not specified	Ruff	Non-breeding
Eurasian golden plover	Not specified	Sanderling	Non-breeding
Eurasian teal	Non-breeding	Sandwich tern	Breeding
Eurasian oystercatcher	Non-breeding	Spotted redshank	Non-breeding
Eurasian wigeon	Non-breeding	Whimbrel	Not specified
Great cormorant	Non-breeding	Wood sandpiper	Not specified

Table 6. Marine cnidaria, plants and invertebrates listed in documentation of designated sites in the Solent region

Common name	Species category	Common name	Species category
Peacock's tail	Plant	Lagoon sand shrimp	Invertebrates
Stalked jellyfish *Calvadosia campanulata*	Cnidaria	Native oyster	Invertebrates
Stalked jellyfish *Haliclystus spp*	Cnidaria	Defolin's lagoon snail	Invertebrates
Starlet sea anemone	Cnidaria	Ragworm / nereididae	Invertebrates
Desmoulin`s whorl snail	Invertebrates		

2.2.2 Designated site condition

The condition of some of the designated sites listed above is regularly assessed. This has historically been the case for SSSIs only, and recently, Natural England has also started undertaking assessments for SPAs, SACs and MCZs. To date, the only SPA for which condition information is available is Portsmouth Harbour, please see below.

SSSI condition – littoral (shore and marine) units only

All SSSIs which fall within the study area have been regularly assessed on a unit by unit basis, although some of the assessments are now quite old. More recently, the condition of some SSSI features has also started to be assessed, including bird aggregations and habitats. However, these have not been undertaken consistently across the SSSIs of the Solent, and not yet for the majority of SSSIs. Furthermore, a narrative on condition reasons is not provided. Thus, unit condition only has been assessed here. A table summarising feature condition has however been included in Appendix A.

SSSI 'units' do not necessarily correspond to habitat types,. For example, within the Solent SSSIs, there are five unit categories for littoral sediments; these are: inshore Sublittoral Sediment; Littoral Rock; Littoral Sediment; Supralittoral Rock; and Supralittoral Sediment. These are upper shore, intertidal and shallow subtidal areas which encompass a variety of habitats, including vegetated shingle, maritime cliffs and slopes, intertidal sand and mudflats, saltmarshes and seagrass beds.

The SSSI condition narrative was extracted from Natural England's designated site website, and data for all the coastal / marine units (understood to encompass the five unit categories listed in the previous paragraph) extracted. Please note that purely terrestrial units, including those potentially containing coastal grazing marsh, were excluded. The data was then analysed and a relevant datalayer created (as at present, SSSI unit condition is not available as a national spatial dataset). It was found that, currently (August 2024), the majority of the marine and coastal SSSI units in the Solent (56%) are in unfavourable condition, as illustrated in Image 1. Figure 4 shows how this applies to various areas of the Solent region. Compensatory habitat creation is often the reason for units being classed as 'recovering', and this can be a substantial distance from the unit. For example, the Medmerry compensatory managed realignment west of Selsey is mentioned as the reason for Unit 17 / Seagrove Bay of the Ryde Sands and Wootton Creek SSSI (Isle of Wight) being in a recovering state.

In the condition assessments, rationale narratives are given for why units are considered to be in a given condition; those for marine units which are in unfavourable condition were investigated. Of the 154 units which are in unfavourable condition, a narrative was provided for 147. For 80% of these, more than one reason was given (up to four); resulting in 319 reasons given across the 147 units. Reasons for unfavourable condition were categorised into 14 categories by ABPmer (as these are not standardised), with results summarised in Image 2. The most frequently highlighted reasons were related to high nutrient loads and opportunistic macroalgae cover. This was followed by coastal squeeze[4] and erosion. Activities in, and pressures on the Solent's nature are further discussed in Section 3 of this report.

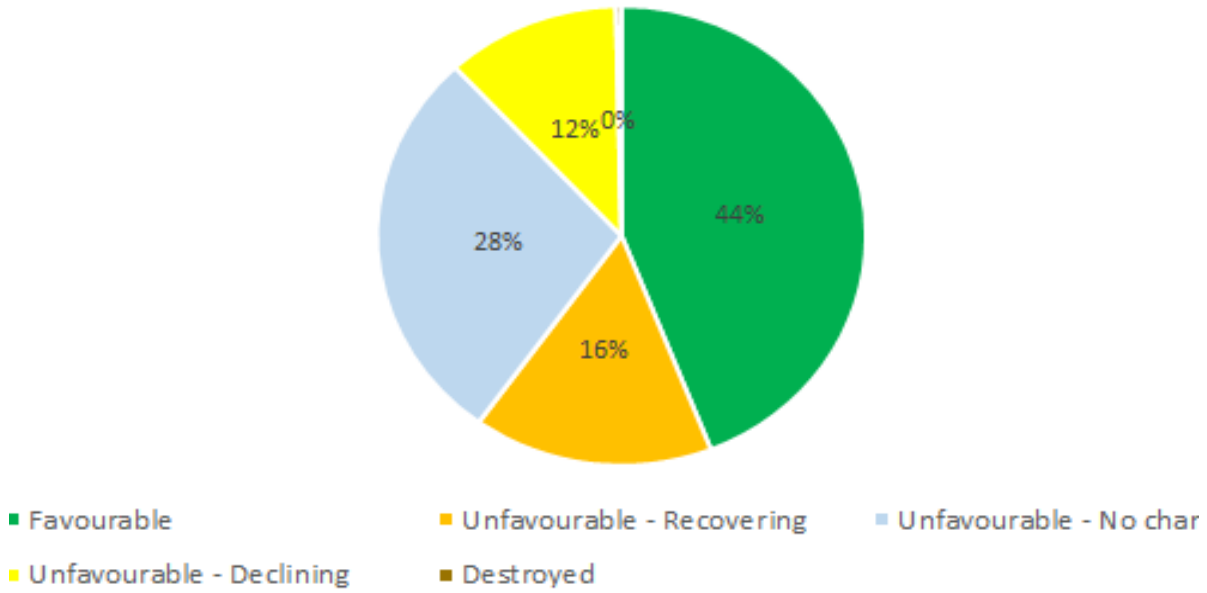


Image 1. Condition percentages for Solent sublittoral, littoral and supralittoral SSSI units

[4] Coastal squeeze occurs where hard defences, or rising land, prevent intertidal habitats from migrating inland in the face of sea level rise.

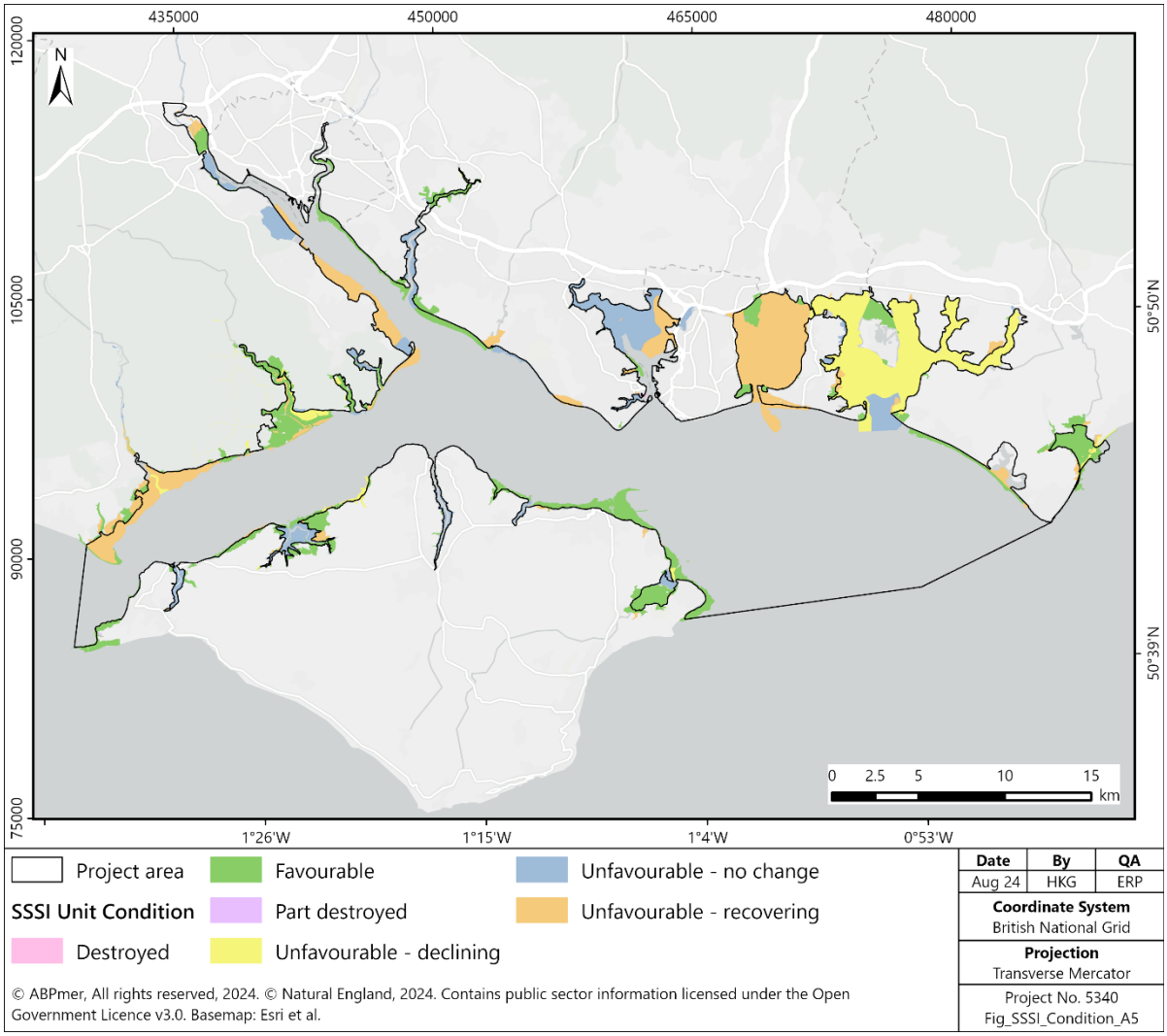


Figure 4. **SSSI unit condition for sublittoral, littoral and supralittoral units only**

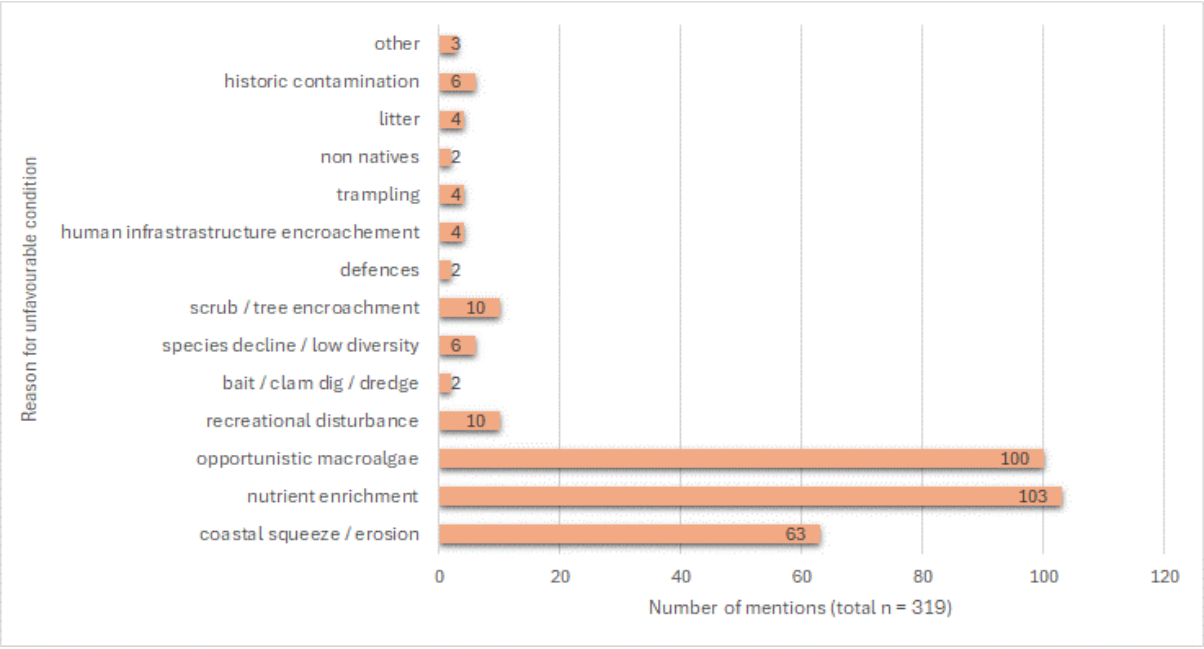


Image 2. **Reasons given for unfavourable condition of Solent sublittoral, littoral and supralittoral SSSI units**

Condition of SACs, SPAs and MCZs

Condition assessments for sites other than SSSIs are a relatively new development, and have to date only been undertaken for five of the 16 MPA sites in the region (i.e. marine SACs, SPAs, MCZs). These are listed in Table 7 below, together with the features for which condition has been assessed (noting that this will often not apply to all features of a given site).

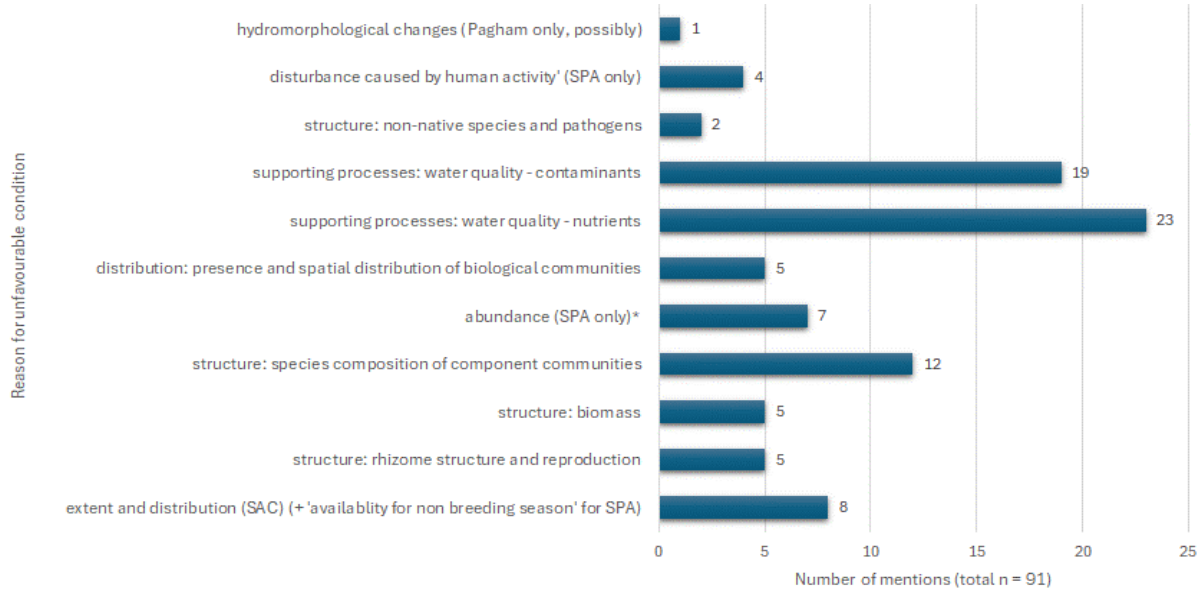
Table 7. Condition information for assessed features of relevant European / MPA sites

Site	Assessed feature	Sub-feature (if applicable)	Condition of assessed feature*
Pagham Harbour SPA	Common Tern	Not applicable	100% Unfav Decl
	Little Tern	Not applicable	100% Unfav Decl
	Dark-bellied Brent Goose	Not applicable	100% Fav
	Ruff	Not applicable	100% Unfav Decl
Pagham Harbour MCZ	Seagrass beds	Not applicable	100% Unfav Decl
Portsmouth Harbour SPA	Black-tailed Godwit	Not applicable	100% Unfav Rec
	Red-breasted Merganser	Not applicable	100% Unfav Decl
	Dunlin	Not applicable	100% Unfav Decl
	Dark-bellied Brent goose	Not applicable	100% Unfav NC
Solent and Isle of Wight Lagoons SAC	Coastal lagoons	Not applicable	100% Fav
Solent Maritime SAC	Sandbanks which are slightly covered by sea water all the time	Overall feature (see below for elements)	100% Unfav NC
		Subtidal coarse sediment	100% Unfav NC
		Subtidal mixed sediments	100% Unfav NC
		Subtidal sand	100% Unfav NC
		Subtidal seagrass beds	100% Unfav DK
	Mudflats and sandflats not covered by seawater at low tide	SEE BELOW	70% Unfav NC, 30% Unfav Decl
		Intertidal coarse sediment	100% Unfav NC
		Intertidal mixed sediments	100% Unfav NC
		Intertidal mud	100% Unfav NC
		Intertidal sand and muddy sand	100% Unfav NC
		Intertidal seagrass beds	100% Unfav DK
	Coastal lagoons	Not applicable	100% favourable
	Estuaries	SEE BELOW	70% Unfav NC, 30% Unfav Decl
		Intertidal coarse sediment	100% Unfav NC
		Intertidal mixed sediments	100% Unfav NC
		Intertidal mud	100% Unfav NC
		Intertidal sand and muddy sand	100% Unfav NC
		Intertidal seagrass beds	100% Unfav DK
		Subtidal coarse sediment	100% Unfav NC
		Subtidal mixed sediments	100% Unfav NC
		Subtidal sand	100% Unfav NC
		Subtidal seagrass beds	100% Unfav DK

* Fav = Favourable; Unfav Rec = Unfavourable Recovering; Unfav NC = Unfavourable No Change; Unfav Decl = Unfavourable Declining; Unfav DK = Unfavourable Unknown

This shows that most features for which condition has been assessed are considered to be in unfavourable condition, with only two features assessed as being in favourable condition across these sites, namely coastal lagoons in the Solent and Isle of Wight Lagoons SAC, and Dark-bellied Brent Goose in the Pagham Harbour SPA.

In the condition assessments of the SPAs and SACs, reasons for unfavourable condition are provided according to structured primary and secondary 'attributes' (though this was not done for the Pagham Harbour MCZ). Of the 27 features/sub-features which were in unfavourable condition, between one and six reasons were given, resulting in 91 reasons given across the 27 features/sub-features. Reasons for unfavourable condition were analysed and found to effectively belong to 11 categories, with results summarised in Image 3. The most frequently highlighted reasons were related to water quality – with high nutrient loads and contaminants both quoted as reasons. This was followed by species composition and extent and distribution (for main habitat features for SACs, or supporting habitat features for SPAs). Please note, as there have been more habitat condition assessments undertaken than species ones to date, the image is considered to mask some of the key drivers for unfavourable status in the Solent. For example disturbance is only mentioned four times, but there have only been eight bird features assessed to date.



* for Pagham Harbour SPA features, there was no structured rationale, the narrative given as interpreted as 'abundance'

Image 3. Reasons given for unfavourable condition of Solent SPA, SAC and MCZ features

2.2.3 Important, rare and threatened species and habitats

A review was also undertaken to find out what species and habitats in the Solent region are considered important, rare or particularly threatened; irrespective of whether or not they are features of designated sites. The results for species are first discussed, before those for habitats are presented.

Species

In order to determine what marine species are important, rare or threatened in the Solent region, six lists were consulted; as follows:

- Species of principal importance in England under the Natural Environment and Rural Communities (NERC) Act 2006 (NERC / Section 41 species)[5];
- Species listed in Section 9(4) and / or Schedule 5 of the Wildlife and Countryside Act 1981 (WACA) (as amended)[6];
- Species listed as threatened and / or declining by the Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention');
- Species listed as European Protected Species (EPS) under Part 3 of the Conservation of Habitats and Species Regulations 2017;
- Species listed as 'critically endangered' or 'endangered' on the International Union for Conservation of Nature (IUCN) Red List[7]; and
- Birds listed as 'Birds of Conservation Concern', commonly referred to as being on the UK Red List for birds (birds considered as of both red and amber concern were identified)[8].

Species presence against these lists was determined by consulting several resources, including designated site information, Wetland Bird Survey (WeBS) data as administered by the British Trust for Ornithology (BTO) (BTO, 2024a), the National Biodiversity Network (NBN) Atlas (if several recent records noted; NBN, 2024), as well as various sources accessed for other chapters of this report. For more detail on individual species groups, please see Section 2.4. Results are presented in Table 8 for the first five lists, and in Table 9 for the Birds of Conservation Concern. In total, across both tables, 93 species which are present in the Solent are considered particularly important, threatened or endangered. The majority of these are birds, specifically 61 species, which represents around 70 % of all the marine and coastal bird species observed in the Solent region.

Table 8. Threatened or important species known to be present in Solent region

Species category	Common name	Legislation / list indicating conservation concern*				
		NERC S. 41	WACA	OSPAR	EPS	IUCN endangered?
Birds	Black-tailed godwit	Yes				
	Curlew	Yes				
	Dark-bellied brent goose	Yes				
	Herring gull	Yes				
	Lapwing	Yes				
	Roseate tern	Yes				
Cnidaria	Stalked jellyfish	Yes				
	Starlet sea anemone	Yes	Yes			
Fish	Atlantic salmon	Yes	Yes		Yes	
	Blue skate					Yes
	Cod	Yes		Yes		
	Common sole	Yes				
	Dover sole	Yes				
	European eel	Yes		Yes		Yes

5 The Section 41 lists are used to guide decision-makers in implementing their duty under Section 40 of the NERC Act, to have regard to the conservation of biodiversity in England, when carrying out their normal functions. There are approximately 105 marine species on the S41 list.

6 Various species of marine animals are protected from being killed, injured or disturbed under provisions in Section 9(4) and Schedule 5 of the WACA (as amended by the Countryside and Rights of Way Act 2000)., as well as Part 3 of the Conservation of Habitats and Species Regulations 2017 (EPS).

7 The IUCN classify species at high risk of global extinction into nine categories: Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild. There were no 'extinct in the wild' species on the UK list; in total, 864 marine species are on the English IUCN red list, as extracted in July 2024.

8 This list is arrived at through a collaboration between experts from a range of bird Non-Governmental Organisations (NGOs), including the BTO, with regular reviews undertaken (2021 being the latest).

Species category	Common name	Legislation / list indicating conservation concern*				
		NERC S. 41	WACA	OSPAR	EPS	IUCN endangered?
	Lesser sandeel	Yes				
	Horse mackerel	Yes				
	Long snouted seahorse	Yes	Yes	Yes		Yes
	Mackerel	Yes				
	Herring	Yes				
	Plaice	Yes				
	Sea lamprey	Yes		Yes		
	Sea trout	Yes				
	Short-snouted seahorse	Yes	Yes	Yes		
	Smelt	Yes				Yes
	Spotted ray			Yes		
	Thornback ray			Yes		
	Tope	Yes				Yes
	Twaite Shad	Yes				
	Undulate ray					Yes
	Whiting	Yes				
Invertebrates	Dog whelk			Yes		
	Lagoon sand shrimp	Yes				
	Native oyster	Yes		Yes (beds)		
Mammals	Bottlenose dolphin	Yes	Yes		Yes	
	Common seal	Yes			Yes	
	Grey seal				Yes	
	Harbour porpoise	Yes	Yes	Yes	Yes	
Plants	Peacock's tail	Yes				
* See bullets in text above table for explanation						

(Copyright: Luke Helmer, Blue Marine Foundation)

Image 4. **Photo of 'winking' harbour seals in the Solent**

Table 9. **Birds of UK Conservation Concern (UK Red List for birds) known to be present in Solent region**

Common name	List colour	Common name	List colour	Common name	List colour
Avocet	Amber	Greenshank	Amber	Ruddy Turnstone	Amber
Barnacle Goose	Amber	Grey Plover	Amber	Ruff	Red
Bar-tailed Godwit	Amber	Greylag Goose	Amber	Sanderling	Amber
Black-headed Gull	Amber	Herring Gull	Red	Sandwich Tern	Amber
Black-tailed Godwit	Red	Knot	Amber	Scaup	Red

Common name	List colour	Common name	List colour	Common name	List colour
Black-throated Diver	Amber	Lapwing	Red	Shag	Amber
Cattle Egret	Amber	Lesser Black-backed Gull	Amber	Shelduck	Amber
Common Gull	Red	Little Tern	Amber	Shoveler	Amber
Common Sandpiper	Amber	Mallard	Amber	Slavonian Grebe	Red
Common Scoter	Red	Mediterranean Gull	Amber	Smew	Red
Common Tern	Amber	Moorhen	Amber	Snipe	Amber
Curlew	Red	Oystercatcher	Amber	Spotted Crake	Amber
Curlew Sandpiper	Amber	Pintail	Amber	Spotted Redshank	Amber
Dark-bellied Brent Goose	Amber	Pochard	Red	Teal	Amber
Dunlin	Red	Purple Sandpiper	Red	Turnstone	Amber
Eider	Amber	Red-Breasted Merganser	Amber	Whimbrel	Red
Gadwall	Amber	Red-necked Grebe	Red	Wigeon	Amber
Goldeneye	Red	Redshank	Amber	Wood Sandpiper	Amber
Great Black-backed Gull	Red	Ringed Plover	Red	Woodcock	Red
Great Northern Diver	Amber	Roseate Tern	Red	Yellow-legged Gull	Amber
Green Sandpiper	Amber				

Habitats

In order to determine what marine habitats are important, rare or threatened in the Solent region, six lists were drawn upon; as follows:

- Habitats of principal importance in England under the 2006 NERC (NERC / Section 41 habitats);
- Habitats listed as either high sensitivity habitats in relation to the Water Environment (Water Framework Directive (WFD)) (England and Wales) Regulations 2017;
- Habitats listed as threatened and / or declining by the OSPAR Convention; and
- Habitats listed as 'Annex I' habitat types - natural habitat types considered to be of community interest ('core areas' of these would have been designated as SACs).

Habitat presence against these lists was determined by consulting relevant mapping as well as the designated site information. For more detail on the individual habitats (and their mapping), please see Section 2.3.

Results are presented in Table 10. Please note that this is restricted to littoral (shore and marine) habitats only. Coastal floodplain grazing marsh (a habitat of principal importance) has been excluded from this list, as this habitat is mostly located outside of the study area boundary, and is by its very nature generally found behind sea defences or embankments. A brief paragraph on this habitat has been included in Section 2.3.1 below, given its importance to marine features, notably birds. Reedbeds (a habitat of principal importance) have also not been included, despite tidal reedbeds conceivably belonging to this habitat. However, they are routinely classed as a type of saltmarsh by marine practitioners, and this approach has also been taken for the purpose of this report; please see Section 2.3.1 for a discussion on tidal reedbeds in the Solent.

In total, 18 habitats which are present in the Solent are considered particularly important, threatened or endangered. Please note that seagrass beds are often split into two separate habitats, intertidal and subtidal beds. Oyster beds, which have disappeared from the Solent (noting substantial restoration

efforts), are of principal importance, WFD high sensitivity and OSPAR threatened. In addition, some habitats may be present, but have not been identified or mapped. For example, blue mussels are found throughout the Solent region, but no beds are mapped (blue mussel beds are of similar importance/status as oyster beds). Similarly, a *Sabellaria spinulosa* reef at the entrance to Chichester Harbour is mentioned by Joint Nature Conservation Committee (JNCC) (2024), but this has not been mapped, nor could any further reference be found. *S. spinulosa* reefs are found on all four lists bulleted above.

Table 10. Marine habitats known to be present in Solent region which are listed as important or threatened

Habitat name	NERC Section 41	WFD high?	OSPAR	Annex I
Coastal saltmarsh	Yes	Yes		Yes*
Coastal sand dunes	Yes			Yes*
Coastal vegetated shingle	Yes			Yes*
Intertidal mudflats	Yes		Yes	Yes*
Maritime cliff and slopes	Yes			Yes*
Saline lagoons	Yes			Yes*
Estuarine rocky habitats	Yes			
Intertidal boulder communities	Yes			
Intertidal chalk	Yes		Yes*	
Mud habitats in deep water	Yes			
Peat and clay exposures	Yes			
Seagrass beds (intertidal and subtidal)	Yes	Yes*	Yes	
Sheltered muddy gravels	Yes			
Subtidal chalk	Yes	Yes*		Yes*
Subtidal sands and gravels	Yes			Yes*
Sea-pens and burrowing megafauna			Yes	
Subtidal kelp beds		Yes	Yes*	

* The actual name on a given list may differ; this is particularly the case for Annex I 'habitats'; see for example Table 7 for list of Solent Maritime SAC features and sub-features.

Not listed in the above table, but worth highlighting are irreplaceable habitats which have been identified in relation to Biodiversity Net Gain (BNG)[9], noting that BNG only applies to intertidal areas. The BNG definition of irreplaceable habitats is: 'habitats which are very difficult (or take a very significant time) to restore, recreate or replace once destroyed, due to their age, uniqueness, species diversity, or rarity.' Of the eight irreplaceable habitats defined by the Biodiversity Gain Requirements (Irreplaceable Habitat) Regulations 2024, three are coastal habitats: coastal sand dunes, *Spartina* saltmarsh swards, and Mediterranean saltmarsh scrub. Coastal sand dunes and Spartina swards *(Spartinion maritimae*) occur in the Solent region; both are designated features of the Solent Maritime SAC.

Comparison with designated site features lists / summary

The habitats and species lists presented in this sub-section were compared with the lists of features of designated sites in Section 2.2.1 above.

[9] This became a new requirement in February 2024, for developments subject to planning; this extends into the intertidal zone (to mean low water). Marine Net Gain is also being discussed; this is not expected to be implemented before 2026 at the earliest.

Of the 91 species listed as important or threatened in this sub-section, 40 are also listed as designated features of the Solent's designated sites. Overall, between the two lists, given these 'duplicates'**, there are 117 marine species in the Solent which are of particular importance, threatened or endangered**. These include 66 bird species, four cnidaria species, 26 fish species, five invertebrate, four mammal and one plant species.

With respect to habitats, essentially all the habitats listed in this sub-section were all also listed as features of designated sites in Section 2.2.1 above. The list in Section 2.2.1 includes functionally linked coastal grazing marsh, as well as subtidal sandbanks as a separate feature, when the latter could be categorised as a sub-feature of 'subtidal sands and gravels'. Consequently, **there are 18 marine habitats in the Solent which are of particular importance, threatened or endangered**, and these are effectively all the habitats listed in Table 10.

2.3 Habitats

2.3.1 Overview

As noted in Section 2.1, the Solent encompasses a major estuarine system on the south coast of England with several estuaries and harbours. The Solent system is considered unique in Britain and Europe for its hydrographic regime, and for the complexity of the marine and estuarine habitats present within the area. Sediment habitats within the estuaries and harbours include extensive estuarine flats, often with intertidal areas supporting eelgrass *Zostera* spp.,, sand and shingle spits, and natural shoreline transitions. The mudflats range from low and variable salinity in the upper reaches of the estuaries to very sheltered almost fully marine muds in the Harbours and open coast.

Many data layers exist which help identify the location and extent of the marine habitats in the Solent. The best and most applicable layers have been combined by ABPmer for the purpose of this project, to arrive at a composite marine habitat map for the Solent and thus facilitate appropriate extent reporting. This map is available on the accompanying data viewer. It is acknowledged that it represents a snapshot of the current situation (as most of the component layers are regularly updated)[10], and that there is reduced confidence in extent of some habitats, particularly in the subtidal zone, with some of the mapping likely based on modelled data of habitat type and extent. Smaller patches of biogenic habitats, and particularly those in the subtidal, are particularly difficult to map. Notably, seagrass extent in the Solent is believed to be greater than mapped, and there are likely areas of other habitats, for example mussel beds and *Sabellaria* reef, which have not been plotted.

For the purpose of this report, broadscale habitat classes were used for all the component datalayers, using categories applied for the NERC Section 41 Act habitats of principal importance, and also WFD sensitive habitats and Local Nature Recovery Strategies (LNRS). The area of the various habitats is shown in Table 11, categorised according to three tidal zones[11]; a map is provided as Figure 5. Within the study area, subtidal habitats cumulatively occupy the largest area at just under 40,000 ha, followed by intertidal habitats with around 11,300 ha and supratidal habitats at 250 ha.

[10] This is not to say that the information is necessarily very recent. For example, for saltmarsh, a national datalayer is regularly updated by the Environment Agency. However, the age of the survey / data interpretation for any given area varies. For most of the Solent, the saltmarsh extent was last mapped in 2016, and only in Portsmouth Harbour is an update planned in the near future (Environment Agency, pers. comm.). Similarly, most of the seagrass data for the Solent in the 2024 national layer is based on 2016 data. The composite layer contains seagrass data from the national seagrass layer, a HIWWT layer, and a 2021 study undertaken for the Channel Coastal Observatory (CCO). Further seagrass surveys are being undertaken across the Solent such that the spatial information for seagrass beds in the Solent will continue to be improved.

[11] 1) Supratidal = splash or spray zone; the area above the spring high tide line that is regularly splashed, but not submerged by seawater; 2) Intertidal = the area between high and low tide marks; 3) subtidal = the area below low tide marks.

Table 11. Extent of various coastal and marine habitats in the Solent region

Tidal Zone	Habitat	Area (ha)
Supratidal	Coastal sand dunes	81
	Coastal vegetated shingle	103
	Maritime cliff and slopes	59
	Saline lagoons*	2.6
	Sandy beaches	0.01
	Shingle beaches	4.4
Intertidal	Tidal reedbeds	219
	Coastal saltmarsh	1,386
	Intertidal - unspecified	4.5
	Intertidal underboulder communities	312
	Intertidal chalk	97
	Intertidal coarse sediments	502
	Intertidal rocky habitats	3.2
	Intertidal soft sediments (mud, sand and mixed)	8,362
	Seagrass beds – intertidal**	424
Subtidal	Kelp beds	147
	Seagrass beds – subtidal**	290
	Subtidal - unspecified	2,132
	Subtidal coarse sediment	0.1
	Subtidal mixed sediments	5,719
	Subtidal muddy sediments	6,328
	Subtidal rocky habitats	1,487
	Subtidal sands and gravels	23,783
Grand Total		**51,446**

* Noting that those behind defences / embankments are excluded from this total

** Intertidal versus subtidal seagrass split calculated on the basis of tidal elevations, not species (as not enough information available on the latter, i.e. it is often not specified what type of seagrass occupies a given area)

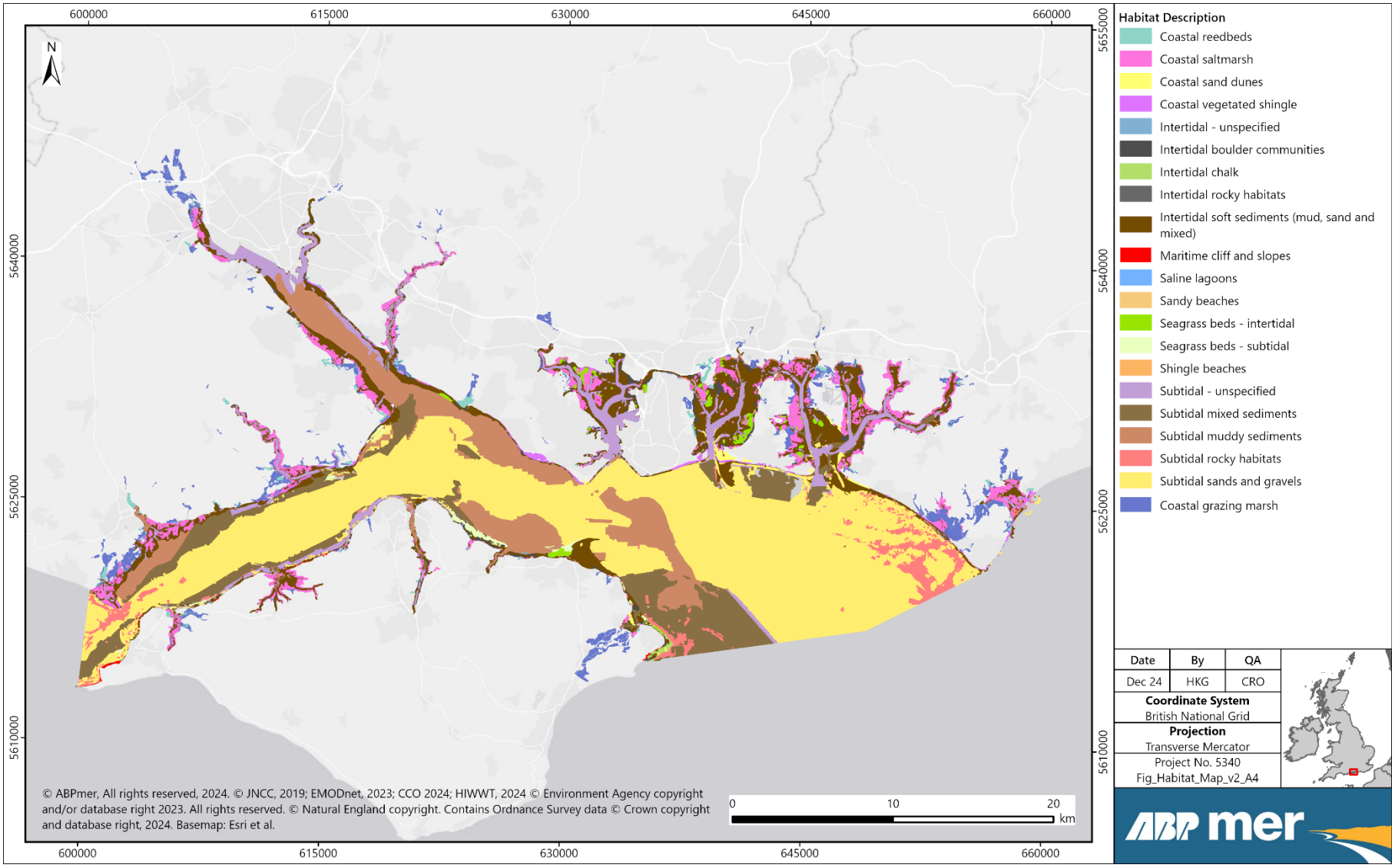


Figure 5. Coastal and marine habitats of the Solent

(copyright (all): Andrew Pearson; all taken in the Solent region)

Image 5. Photos of saltmarsh (sea lavender), mudflat (with Avocet) and seagrass habitats

Many of the adjacent 'terrestrial' rivers and habitats are also often important to birds and other animals which use these coastal and marine areas. For example, many wading birds and waterfowl such as brent geese also forage and rest in adjacent fields and grazing marshes. In addition, there are several species of fish which migrate between the sea and the Solent's rivers.

A Solent wide project identifying important 'terrestrial' areas has mapped 3,600 ha[12] of arable fields and grassland next to the Solent's marine and coastal habitats as being of importance to waders and brent geese (Solent Waders and Brent Goose Steering Group, 2020). Some of this grassland will be classed as coastal floodplain grazing marsh; according to the Natural England priority habitat inventory[13], within 2 km of the shoreline / tidal limits around the Solent region, just under 2,300 ha of this habitat has been mapped.

The remainder of the habitat section firstly focusses on key habitats of the Solent in turn; saltmarshes (Section 2.3.2), mudflats (Section 2.3.3), seagrass beds (Section 2.3.4) and native oyster beds (a lost habitat) (Section 2.3.5). Condition is discussed in Section 2.3.6., future predictions are summarised in Section 2.3.7, and ecosystem services and benefits are summarised in Section 2.3.8.

2.3.2 Saltmarshes

Overview

In the Solent, saltmarshes are present in the harbours, estuaries and behind shingle ridges, in areas where sediment can accumulate due to shelter from wave action. The wide range of specialist plants and algae they are made up of are adapted to the regular inundation by the sea during tidal cycles. The Solent is the only site in the UK that supports smooth cordgrass (*Spartina alterniflora*) and is one of only two sites where a significant amount of small cordgrass (*S. maritimae*) can be found. It is also one of few sites still containing Townsend's cordgrass (*S. townsendii*) and extensive areas of common cordgrass (*S. anglica*) and contains the second-largest aggregation of Atlantic salt meadows in south and southwest England. It additionally has historical and scientific interest, and is of international importance due to the hybrid *S. anglica* originating from here[14].

[12] As calculated from datalayer available at Solent Waders and Brent Goose Steering Group (2020).

[13] As calculated from datalayer available at Natural England (2024b).

[14] Natural England (2004) notes that, in Europe, *S. alterniflora* was introduced accidentally by shipping into Southampton (England) c.1816. This then hybridised with the relatively uncommon native *S. maritima* to produce the sterile *S. townsendii* (thought to have occurred at Hythe in the Solent c.1870), which then '*underwent a doubling of its chromosomes to produce the fertile amphidiploid S. anglica shortly afterwards*'. Since its introduction, *S. anglica* has led to a '*marked reduction in the distribution of both S. maritima and S. alterniflora in the UK, largely due to the destruction of much of the saltmarsh in which the species are found*' (Natural England, 2004); mudflats and eelgrass beds were also displaced by *S. anglica* (JNCC, 2024). The sole remaining site of *S. alterniflora* in Britain is at Marchwood in Southampton Water (Maskell and Raybould, 2001).

Saltmarshes are highly productive ecosystems which support many species and are valuable for nutrient / pollution cycling /absorption and carbon storage. Saltmarshes can have an important coastal protection role, accreting sediments to stabilise the intertidal and (where there is a sufficient sediment supply) keep pace with sea level rise, whilst protecting seawalls and other coastal habitat from wave impact. Where there is safe access through them, they are an important recreational resource for walkers and bird watchers. Saltmarshes are a vitally important resource for wading birds and wildfowl, particularly in the Solent. They act as high tide refuges for birds feeding on adjacent mudflats, as breeding sites for waders, gulls and terns and as a source of food for passing birds, particularly in autumn and winter. In winter, grazed saltmarshes are used as feeding grounds by large flocks of wild ducks and geese. Areas with high structural and plant diversity, particularly where freshwater seepages provide a transition from fresh to brackish conditions, are particularly important for invertebrates. Saltmarshes also act as shelter and nursery sites for several species of fish, including commercially important species such as bass (e.g. Solent Forum, 2024b). Please see Section 2.3.8 for further detail on ecosystem services and benefits, and Section 2.4.2 for further detail on birds.

As shown in Table 11, just under 1,400 ha of saltmarsh have been mapped in the Solent. Their location of this habitat (together with historic extent) is shown in Figure 6. The Environment Agency regularly maps saltmarsh extent and zonation across England; this is achieved via the interpretation of aerial mapping, supported by ground truthing studies. The results of the zonation mapping are presented in Table 12. This demonstrates that the zone with the highest percentage within the project area are *Spartina* saltmarshes, where over half of the saltmarshes in the Solent belong to this zone. Compared to other English regions, there is a low percentage of mid- to upper marsh vegetation types; the latter tend to have a higher diversity of plants and invertebrates, and also fulfil valuable functions for breeding and roosting birds for example. The fact that such a high percentage of the Solent's saltmarshes is very low lying makes them very vulnerable to climate change and other pressures and not particularly resilient (see Section 3.5 for more detail on climate change)

Table 12. Saltmarsh zonation % within the project area

Saltmarsh zone	Total % within project area
Spartina	52
Pioneer	5
Mid-low	29
Upper marsh	7
Reedbeds	4
Unclassified	2

It is interesting to note that, in the Solent, saltmarshes tend to occupy a slightly narrower tidal niche (also referred to as 'window of opportunity' (Hu *et al.,* 2015)) than one would typically associate with saltmarshes. This is likely related to a range of factors, including the particular tidal characteristics of much of the Solent (which effectively leave the intertidal areas inundated for longer periods when compared with other UK regions). Substrate and exposure are also known to play a role in the window of opportunity. Saltmarshes are typically expected to develop at the following tidal elevations (e.g. Nottage and Robertson, 2005):

- Low to mid saltmarsh between MHWN and MHWS; and
- Upper saltmarsh between MHWS and Highest Astronomical Tide (HAT).

However, within the Solent, the lowest saltmarsh elevations tend to occur at higher levels, and often the bulk of the vegetated areas are found at, or around the MHWS mark, and do not generally extend down to MHWN. For example, at Lymington, they are 0.2 to 0.6 m higher than MHWN (ABPmer, 2022); at Hythe, the saltmarsh edge is around 0.1 to 0.6 m above MHWN, and at Itchenor in Chichester Harbour it is 0.1 to 0.8 m above. Generally, more exposed frontages exhibit higher marsh edge elevations, and *Spartina* marshes are (predictably) closest to MHWN elevations. .

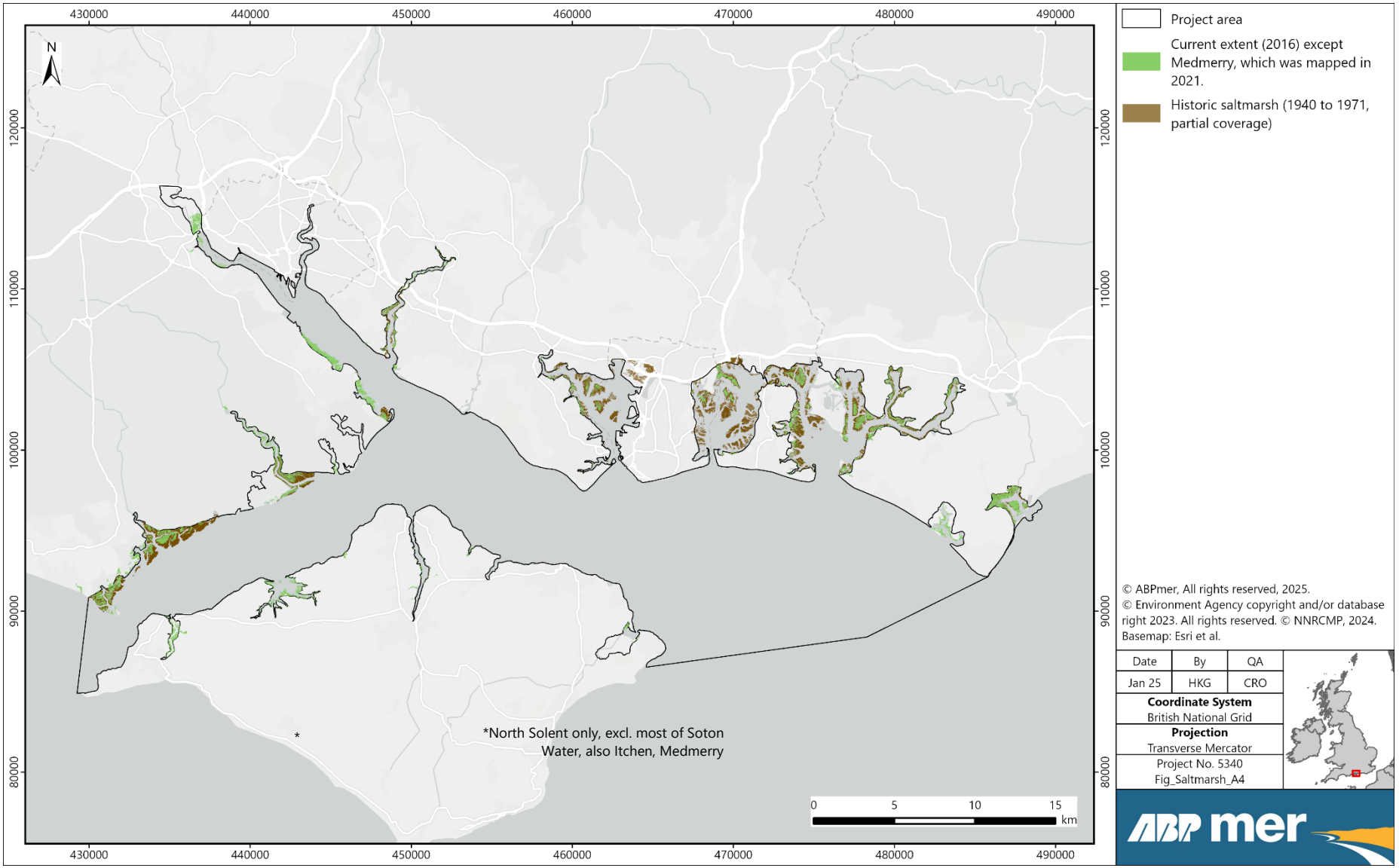


Figure 6. Current and historic (1940s and 70s) saltmarsh extent in the Solent

Recent saltmarsh change (post 2000)

The Environment Agency publishes a saltmarsh change datalayer, which compares the extent from 2008/09 (when a national aerial imagery interpretation exercise was undertaken for the first time) with the most recent survey (this varies from region to region). For much of the Solent, this effectively compares 2008 data with 2016 data. The results of this exercise are displayed in Table 13; this ostensibly indicates that there has been a net gain of saltmarsh in the project area in that time. This gain is due to saltmarsh which has established in habitat creation schemes implemented since 2008 (such as Medmerry and Cobnor). If these schemes were to be disregarded, then there would have been a net loss. of 3.2 % across the Solent between 2008 and 2016.

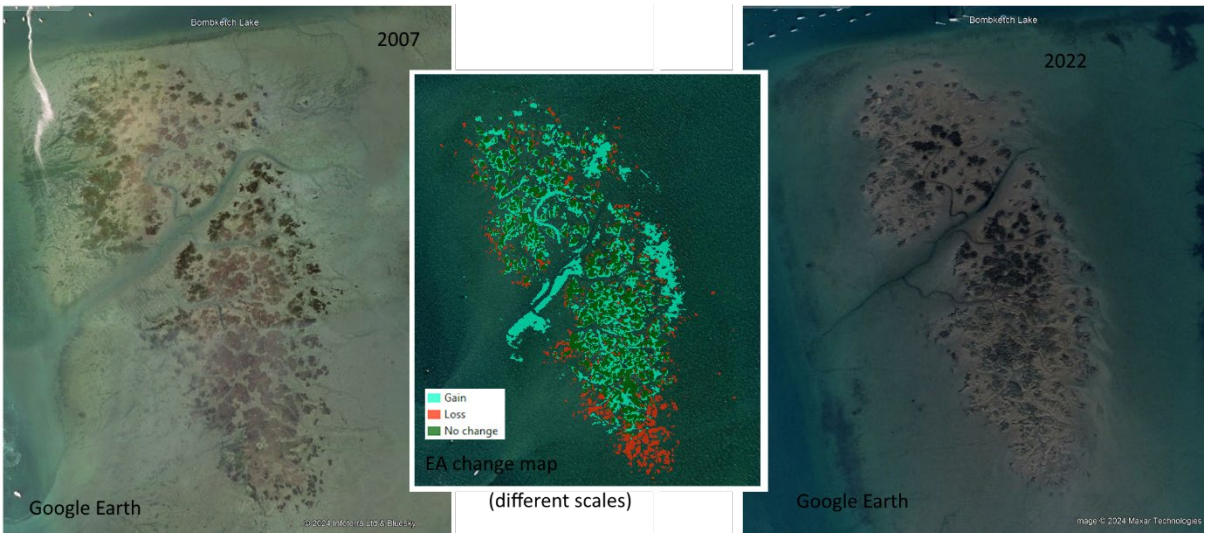
Table 13. Change in saltmarsh area within the study area (mostly 2008 to 2016)

Saltmarsh Change	Area (ha)
Gain	220 (of which 61 are within post-2008 habitat creation sites)
Loss	204
No change	974
Total area	**1,398**

It is also worth noting that saltmarshes are subject to seasonal and inter-annual variations in vegetation cover. They can be negatively impacted by sustained stormy conditions, as well as short-term sea-level changes such as those brought on by the influence of the lunar nodal cycle. This cycle causes the tidal range to vary by up to around 4% over an 18.6-year cycle (the last time the maximum was reached was 2015). For example, at Lymington, with an average spring tidal range of 2.4 m, this could thus influence water levels by ± 0.1 m.

Furthermore, aerial imagery interpretation is subject to some pitfalls which cannot fully be overcome by sporadic ground truthing. For saltmarshes, such limitations can often be attributed to erroneous mapping of macroalgae – this is believed to have occurred at several locations in the Solent where ostensible gains have been mapped. This is, for example, evident in the mapping shown in Image 6 for the Bombketch Lake saltmarsh in Portsmouth Harbour. Google Earth imagery interpretation indicates that all of the gains mapped in the Environment Agency layer between 2008 and 2016 are likely to be false, as a loss of saltmarsh is evident in available historic imagery from 2007 and 2022 (see Image 6). Google Earth aerial imagery from 2016 also indicates comprehensive macroalgal mats in locations where saltmarsh gains were mapped in 2016.

In the Solent, other erroneous 'gain' mapping is thought to have occurred in areas where the 2008 mapping exercise recorded reedbeds, but where such areas were consequently re-classified as upper saltmarsh. This is, for example, evident at the top of Fishbourne Channel in Chichester Harbour, at several locations in the Hamble, and on the eastern shore of the Western Yar on the Isle of Wight. Conversely, there are also some locations where saltmarsh loss has been mapped, but where this does not appear to have occurred, e.g. where an area might have been erroneously mapped as saltmarsh in 2008, but not again in 2016 (e.g. a small 0.5 ha section of West Hayling golf course grassland mapped as saltmarsh in 2008, but no longer in 2016). On balance, however, it is believed that saltmarsh gains have been overestimated more than losses have been. Consequently, recent losses across the Solent are likely to have been slightly underestimated by the Environment Agency saltmarsh change layer.



Copyright: Google Earth; Environment Agency 2024 saltmarsh change datalayer

Image 6. Environment Agency change map (middle) comparison with 2007 and 2022 Google Earth aerial imagery – example of Bombketch Lake saltmarsh, Portsmouth Harbour

In 2022, Natural England published a review of saltmarsh changes across the Solent's SSSIs (Parry and Hendy, 2022); this drew on the above Environment Agency data, as well as 2019 saltmarsh mapping (which is not contained in the national datalayer discussed above). This research determined that, between 2008 and 2016, 13 of the 17 SSSI sites containing saltmarsh across the Solent showed a loss in saltmarsh extent (Table 14). The four SSSI units which appeared to show an increase in extent of saltmarsh were Thorness Bay (where a habitat creation scheme had taken place), King's Quay Shore and Brading Marshes to St. Helens Ledges on the Isle of Wight and Portsmouth Harbour. There was generally no change found between 2016 and 2019, with the exception of small gains in the Lower Test Valley and Portsmouth Harbour (noting that this gain may have been as a result of mapping issues discussed above). The authors also provided updated best and worst case predictions for when there would be no more saltmarsh in a given SSSI; the best case ranged from 2045 for the Pitts Deep and Sowley Marshes in the Western Solent to 2323 for the Chichester Harbour saltmarshes (Table 14) (please see Section 2.3.7 for other future predictions on saltmarsh, and other marine habitats, in the Solent).

Saltmarsh losses in the Solent are particularly pronounced in more exposed areas, especially along the edges, whereas more sheltered saltmarshes, and the rear of extensive saltmarsh complexes, are often stable. As noted above, some localised expansion appears to have occurred.

These patterns can become particularly evident when available Light Detection and Ranging (LiDAR) data is compared. For example, for the second phase of the Beneficial Use of Dredge Sediment in the Solent (BUDS) project, 2007 LiDAR was compared with 2017 data (ABPmer, 2020a). Difference plots were prepared; the plot for the Lymington marshes has been included as Figure 7 below (noting that differences ± 15 cm are not shown due to LiDAR accuracy limitations). This shows that there have been varying levels of vertical erosion at these saltmarsh complexes, which are amongst the most exposed in the Solent region. There has been pronounced erosion of the exposed outer intertidal areas at Lymington, whereas detectable internal accretion was observed along most of the creeks (rather than saltmarsh surfaces). Average lateral annual retreat of between 1.6 m and 3.7 m along the outer edges of these marsh complexes was determined by this study. Those areas where recharge has taken place are also evident in the difference plot and have been highlighted in Figure 7 (for further information on these schemes, please refer to ABPmer, 2024a). With the exception of the RSPB's chenier recharge (which was eroded away relatively quickly and is not immediately evident in the difference plots), all other recharge areas are seen as clear areas of 'accretion' in the figure.

Table 14. Saltmarsh change and predictions for Solent SSSIs containing saltmarsh areas

SSSI Designation	Area of Saltmarsh (ha)			Expected zero saltmarsh (year) (if given)		Summary of proposed saltmarsh condition (if assessed)
	2008	2016	2019	Best case	Worst case	
Chichester Harbour	341.8	315.8 (-)	315.8 (nc)	2323	2054	Unfavourable
Langstone Harbour	73.4	62.8 (-)	62.8 (nc)	2077	2015	Unfavourable
Portsmouth Harbour	42.6	45.9 (+)	48.0 (+)	2255	2017	Unfavourable
Lee on the Solent to Itchen Estuary	27.8	26.4 (-)	27.8 (+)	-	-	-
Lincegrove & Hacketts Marshes	13.5	12.2 (-)	12.2 (nc)	-	2130*	Unfavourable*
Upper Hamble Estuary and Woods	13.2	11.7 (-)	11.7 (nc)	-	2130*	Unfavourable*
Lower Test Valley	58.8	47.0 (-)	47.5 (+)	-	2059	Unfavourable
Eling and Bury Marshes	17.9	16.4 (-)	16.4 (nc)	2176**	2050**	Unfavourable**
Hythe to Calshot	146.6	145.3 (-)	145.3 (nc)	2083	2027	Unfavourable
North Solent	66.8	64.0 (-)	63.9 (-)	2178***	2051***	Unfavourable***
Hurst Castle and Lymington River Estuary	226.7	201.4 (-)	200 (-)		2045	Unfavourable
Yar Estuary	45.7	43.8 (-)	43.8 (nc)		2256	Unfavourable
Newtown Harbour	80.3	70.0 (-)	70.0 (nc)		2025	Unfavourable
Thornes Bay	1.5	1.9(+)	1.9 (nc)	2030	-	Fair
Medina Estuary	12.6	11.1 (-)	11.1 (nc)		2094	Unfavourable
King's Quay Shore	2.2	3.3(+)	3.3 (nc)	2030	-	Fair
Ryde Sands and Wootton Creek	0.3	0.3 (nc)	0.3 (nc)	-	-	Effectively extinct
Brading Marshes to St Helen's Ledges	4.4	7.0(+)	7.0 (nc)	2030	-	Unfavourable

A green box represents a positive change (+) in saltmarsh extent to the previous data set, a red box represents a negative change (-) in saltmarsh extent to the previous data set and a grey box represents no suggestive change (nc) in saltmarsh extent with the previous dataset.

* River Hamble assessed as a whole unit for these aspects

** Southampton Water (excl. Calshot) assessed as a whole unit for these aspects

*** Beaulieu estuary component only assessed for these aspects

Source: Parry and Hendy, 2022

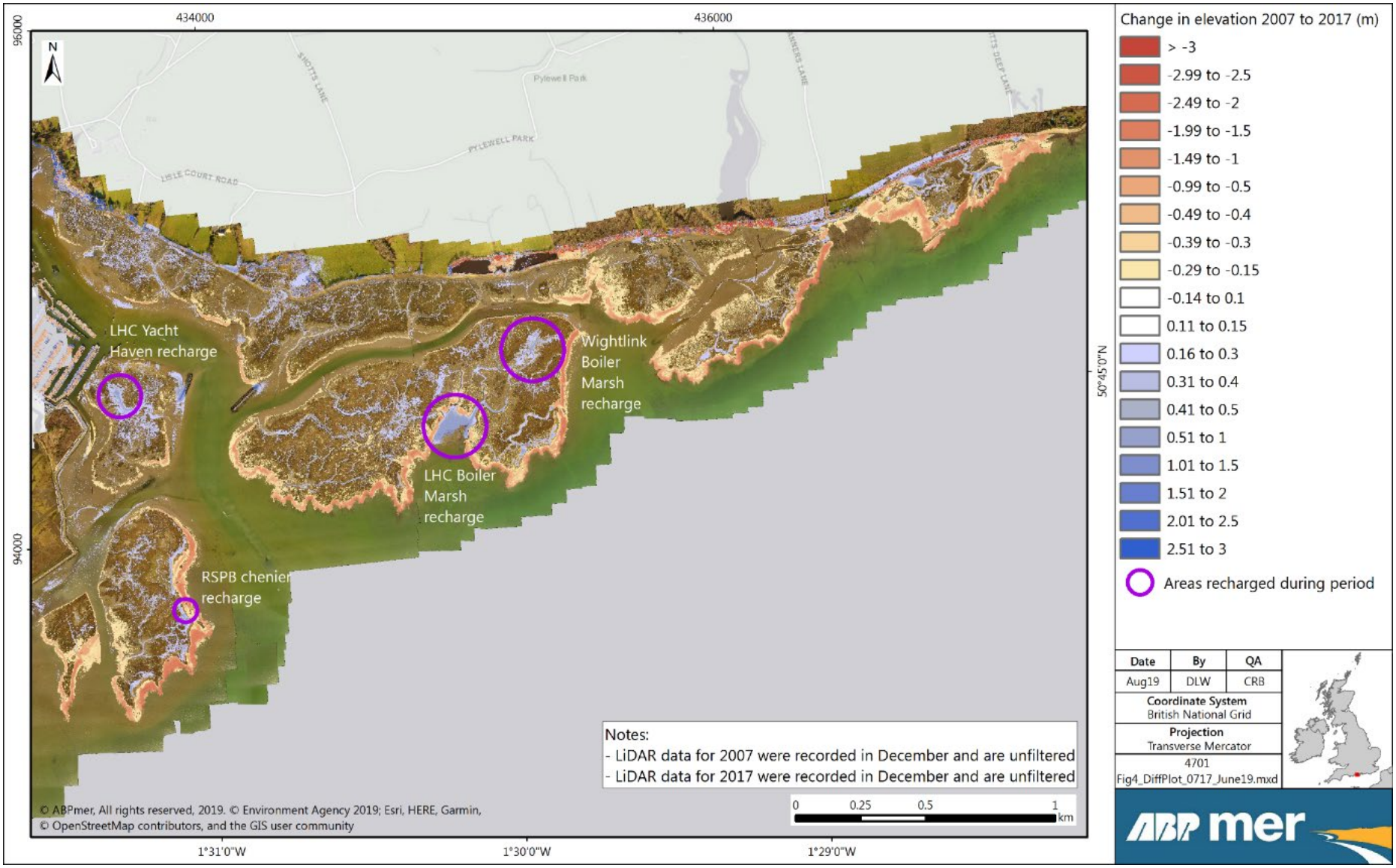
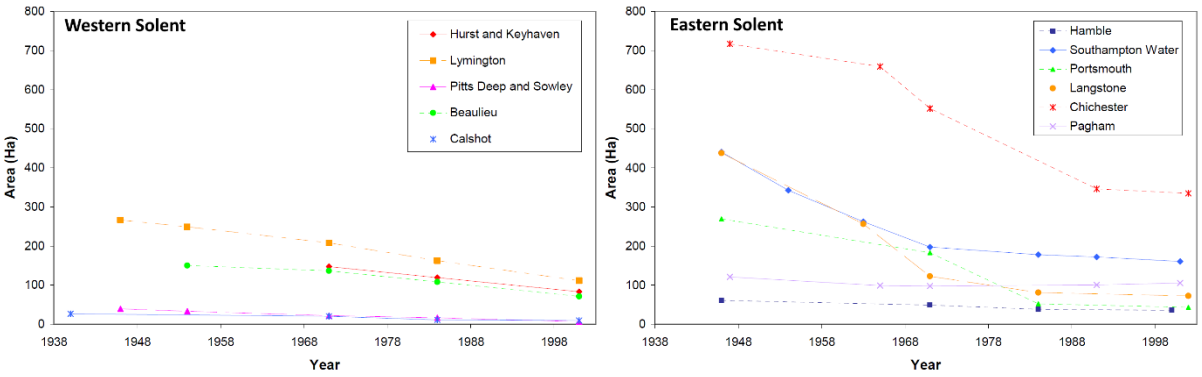


Figure 7. Example 10-year LiDAR difference plot for Lymington Marshes

Historic saltmarsh change

A longer-term review of saltmarsh change in the Solent was undertaken in the early 2000s by the Solent Dynamic Coast project (building on the work undertaken as part of the 2003 Solent Coastal Habitat Management Plan (CHaMP)). This reviewed historic saltmarsh change between the 1940s and 1970s (where 1940s imagery was not available for interpretation) and the early 2000s (Cope *et al.*, 2008). The Isle of Wight was not included in this analysis.

The Solent Dynamic Coast project determined that, overall, from the earliest photography available, there had been a loss of 1,651 ha across the North Solent. In the western Solent, 'a broadly linear trend of saltmarsh loss' had been experienced at all sites. In the east Solent, excluding the River Hamble and Pagham Harbour, the areas of loss have historically been much higher than those in the western Solent, but had appeared to be slowing down since around 1984. Across the study area, the greatest percentage losses were at Pitts Deep/Sowley and Portsmouth and Langstone Harbours. These areas 'underwent approximately 83% loss since 1946, which averaged 1.5% loss per annum'.



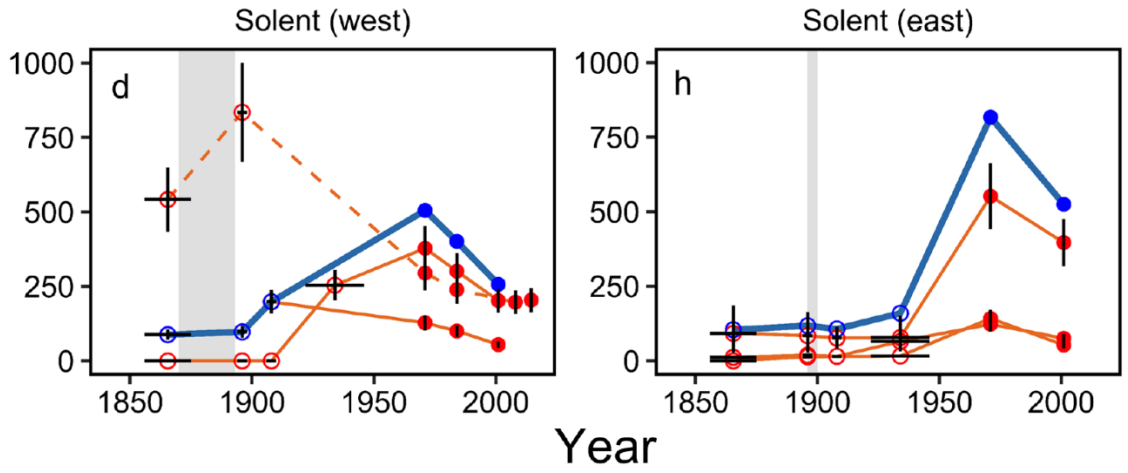
(Source: Cope *et al.*, 2008)

Image 7. Historic (1940s to early 2000s) saltmarsh losses across the North Solent

Historically, it is of note that most of the saltmarsh areas within the Solent are of relatively recent origin (less than 120 years old), although they had been part of the ecosystem for far longer. A recent review by Ladd *et al.* (2019), which built on the CHaMP and Cope *et al.* (2008) work, included graphs which illustrate this detail; these have been included as Image 8 below. On regional scales (blue lines in graphs), *Spartina* colonisation (grey shading) led to the substantial expansion of saltmarsh in both the western and eastern Solent, with recent losses not yet having reduced saltmarshes to extents seen pre-*Spartina* colonisation.

Extrapolating the above studies, and given the available data[15], then it is estimated that, in the 1940s, the Solent region had at least 3,100 ha of saltmarsh. Thus, since around the 1940s, the saltmarsh extent has more than halved.

[15] The historic extent as mapped in Figure 6 measured 2,240 ha (mixture of 1940s and 1970s data), and the post 1940s land claim total quoted in Cope *et al.*, 2008 was 235 ha. The 3,100 ha figure was derived by extrapolating a 2% annual loss since the 1940s onto current saltmarsh figures for the areas where historic coverage is missing (Isle of Wight and most of Southampton Water), and onto those areas where only 1970s data was available.



Regional - (blue line) and estuarine-scale (orange line) change in extent of saltmarshes between 1846 and 2016 from photographs (filled circles) or maps (hollow circles). Gray shading indicates *Spartina spp.* colonisation in each region. Vertical error bars indicate 95% confidence intervals in marsh area extent. Horizontal lines indicate the dates over which surveys of marsh extent were carried out. Regional-scale marsh change (blue line) only includes marsh extent measures for all estuaries in a given region and year. Marsh change in Southampton estuary (panel d: dashed line) was excluded from the regional-scale marsh change line due to paucity of contiguous cover in salt marsh extent across multiple years.

Source: Ladd *et al.,* 2019

Image 8. Long-term change in estuarine-scale marsh extent across the Solent

Factors driving saltmarsh change

There are thought to be several interacting factors influencing the distribution and erosion of the Solent's saltmarshes. These reasons were summarised by New Forest District Council (NFDC) (2007) as follows:

- Wave action;
- Lack of sufficient sediment supply (mainly from offshore, alongshore and to a much lesser extent from downstream), resulting in minor or no sediment accretion;
- Waterlogging of estuarine soils (inundation frequency and duration) and dieback of saltmarsh vegetation (possibly a natural cycle, or as a result of successful establishment of vegetation)[16];
- Tidal currents (velocity, strength, and duration); and
- Sea level rise.

Of these, one of the critical issues affecting the marshes, and their ability to deal with all these factors, will be the sediment supply. Simply put, if this were sufficient, then the Solent system would be experiencing lower net losses. Together with Essex and Kent saltmarshes, the Solent marshes are the key systems which are currently experiencing persistent losses nationally, whereas most saltmarshes elsewhere in England are still seeing net lateral expansion (Ladd *et al.,* 2019).

Parry and Hendy (2022) indicated that, in addition to edge erosion, internal dissection of saltmarsh is considered to be a key contributor to saltmarsh losses in the Solent. This relates to the widening and lengthening of creeks. These authors also theorised that '*the rise in sea level may be a contributing factor to the erosion occurring within creeks, displaying common characteristics of coastal squeeze where natural vertical succession is limited*'.

[16] The process of die-back may well be influenced by waterlogging and limited sediment porosity/drainage (given its tidal elevation, composition and compaction); this would restrict the extent to which oxygen reaches the roots.

These insights were supported by the Solent Dynamic Coast project (Cope *et al.,* 2008), which summarised that post-1940s saltmarsh losses were likely to have been for a variety of reasons, including wave attack and *Spartina* die back, which caused severe edge erosion, particularly in the Western Solent. In Portsmouth and Langstone Harbours, 'both edge erosion and internal dissection were the important processes causing saltmarsh loss', exacerbated by *Spartina* die back. Cope *et al*. (2008) highlighted that another major factor resulting in historic saltmarsh loss was land claim. Between 1940 and 2002, this was estimated to have 'accounted for 1% of the saltmarsh losses at Langstone and Chichester Harbour, 8% at Portsmouth Harbour, 2% at Pagham Harbour, 24% at Calshot, 42% at Southampton Water and 18% at the River Hamble'. Overall, across the study area, some 235 ha of saltmarsh loss was attributed to land claim since the 1940s. Land claim would have also affected substantial areas of saltmarsh in the more distant past, but no study is available on this for the Solent.

Furthermore, there are also ecological factors that will be relevant. For example, it is evident that macroalgal growth is occurring on or around the margins of many of the Solent saltmarshes and that green algal mats can form, or be 'thrown' by exceptionally high tides, on the marsh surfaces (e.g. Image 9). This would then lead to localised shading and marsh plant growth retardation and is likely to contribute to saltmarsh losses[17]. Please see Section 3.4.1 for further information on macro-algal mats in the Solent. Going forward, in addition to accelerated sea level rise, other climate change related effects are likely to impact saltmarshes; please see Section 3.5 for further details on potential impacts of climate change on the Solent's marine habitats.

(copyright: ABPmer)

Image 9. Saltmarsh covered in macroalgae in Chichester Harbour (April 2024)

2.3.3 Mudflats

Overview

In the Solent, mudflats are found in sheltered areas, with sediment deriving mainly from marine sources, with small inputs from the rivers flowing into the estuaries. They range from low and variable salinity in the upper reaches of the estuaries to the sheltered almost fully marine muds in Chichester and

[17] In the US, evidence suggests that macroalgal smothering can shade and smother grasses, leading reduced marsh resilience and marsh loss, reduced flowering and canopy height (e.g. Wasson *et al.*, 2017).

Langstone Harbours. They are characterised by an abundance of organisms, but with a relatively low diversity of species (Solent Forum, 2024b) (see Section 2.4.5 for more detail on benthic invertebrates). As shown in Table 11, just over 8,300 ha of intertidal soft sediments (mud and sandflats effectively) have been mapped in the Solent (see also Figure 5).

Mudflats are deposits of mud, silt and clay found in sheltered intertidal areas. They range from soft muds in the most sheltered inner areas of harbours and estuaries, to firm sands in more wave and current-exposed areas. The habitat represents a transition from subtidal sediment areas that are continually covered by the sea, through areas completely inundated by most tides. In shelter, mudflats usually grade into saltmarsh. This is a dynamic habitat, and its continued presence depends on maintaining the balance between the rate of deposition of sediments from the water column and the erosion of sediment by tidal and wave action (Solent Forum, 2024b).

Mudflats are a very important feeding resource for the region's water birds, and act as feeding, spawning and nursery areas for fish, including bass. They also provide a source of bait for recreational anglers, and some mudflats are furthermore exploited for cockles, pacific oysters, and mussels (see Section 3.3.4 for further detail on intertidal fisheries). Mudflats are important in helping to dissipate wave energy and thus help prevent stress on coastal defences and the hinterland. They also play a role in nutrient and carbon cycling / storage. Further information on ecosystem services and benefits can be found in Section 2.3.8, and more information on species frequenting mudflats is contained in Sections 2.4.2 (birds), 2.4.4 (fish) and 2.4.5 (benthic invertebrates).

Regarding historic trends, little is known beyond the indication that, prior to the extensive colonisation of *Spartina* sp. around 120 years ago, there would have been substantially more mudflats in the Solent. The saltmarsh losses which have occurred post 1940s would have generally led to mudflat gains, whilst mudflats would have transitioned to subtidal habitats at the intertidal/subtidal transition due to relative sea level rise (which has been ongoing in Southern England for centuries).

Factors driving mudflat change

The distribution and extent of mudflats is chiefly influenced by very similar factors to saltmarshes, namely wave and tidal action, sediment supply, sea level rise and macroalgae; please see Section 2.3.2 above for more detail. New mudflat areas have frequently been created in the region's managed realignment schemes; see Section 4.2.2 for more detail.

2.3.4 Seagrass beds

Overview

The seagrass beds that occur within the Solent are especially adapted to varying levels of salinity characteristic of lagoons, and some beds are even unique to this habitat (Solent Forum, 2024b).

Seagrasses are flowering vascular plants, the only flowering plants in the marine environment. They can be found in sheltered subtidal and intertidal zones near the coast in sandy habitats, down to depths of 10 m, depending on water quality and species (Borum *et al.,* 2004; Jackson *et al.,* 2013). They require high light and low nutrient conditions to remain stable and in good health. Three species of seagrass are found in England and the Solent: the common eelgrass (*Zostera marina*), dwarf eelgrass (*Zostera noltei*) and tassle weed (Ruppia species). Dwarf eelgrass is found highest on the shore, often adjacent to lower saltmarsh communities, and common eelgrass predominantly in the sublittoral (below mean low water mark). There can be large areas of mixed species meadows, depending on environmental conditions.

Globally, seagrasses account for less than 2% of the total ocean floor yet are one of the most productive ecosystems in the world. They sequester organic carbon, are a source of organic matter, bind sediment

and can reduce coastal flood risk. Seagrass is an important source of food for wildfowl, particularly brent goose and widgeon which feed on intertidal beds. Where this habitat is well developed the leaves of the plants may be colonised by diatoms and algae, hydroids stalked jellyfish and anemones. The soft sediment infauna may include shrimp-like crustaceans, polychaete worms, bivalve molluscs, and sea urchins. The shelter provided by the beds makes them important nursery areas for many fish (including commercially important species such as cod and pollock) and, in some areas, for cephalopods (cuttlefish) and shellfish (e.g. dog whelk). Adult fish frequently seen include bass, brill, cod, dab, pollack, two-spotted goby and various wrasse. Two species of pipefish, Nilsson's pipefish and deep snouted pipefish, are almost totally restricted to eelgrass beds, and while rare, red algae is often associated with this habitat (Solent Forum, 2024b). Seahorses can also be found here, particularly long-snouted seahorses. It is thought that seagrass provides a varied habitat which the long-snouted seahorses prefer, here, they can hold on to seagrass blades and resist ocean currents which would otherwise drag them into deeper waters. Seahorses are rare species and seagrass meadows are considered to be vital to the survival of this animal (ReMEDIES, 2024).

(copyright Theo Vickers)

Image 10. Seagrass

Based on mapping collated for this project, at least 715 ha of seagrass are found in the Solent; the beds are mainly located in Portsmouth, Langstone and Chichester Harbours, and on the north coast of the Isle of Wight, with some smaller beds also found elsewhere (e.g. at Chilling and at the mouth of the Beaulieu Estuary) (Figure 8). It is however known that more seagrass than currently mapped in this figure is present in the Solent. The seagrass mapping in the figure is based on a combination of the (2024) national seagrass layer by Natural England, as well as the (2019/20) regional inshore habitats map by the Channel Coastal Observatory, and a layer provided by the HIWWT (which is not currently included in the downloadable national seagrass layer). However, it is believed that seagrass is present in further locations. Mapping projects are ongoing to help attain a better understanding of true extent in areas where data is known to be lacking. For example, the University of Portsmouth recently surveyed an area of Langstone Harbour where seagrass had been mapped historically. The authors (Ward and Preston, 2024) found that a large *circa* 90 ha, mixed Z. *noltei* and *marina,* bed was in fact still present in the south-east of the Harbour, and at likely similar extents as was mapped previously.

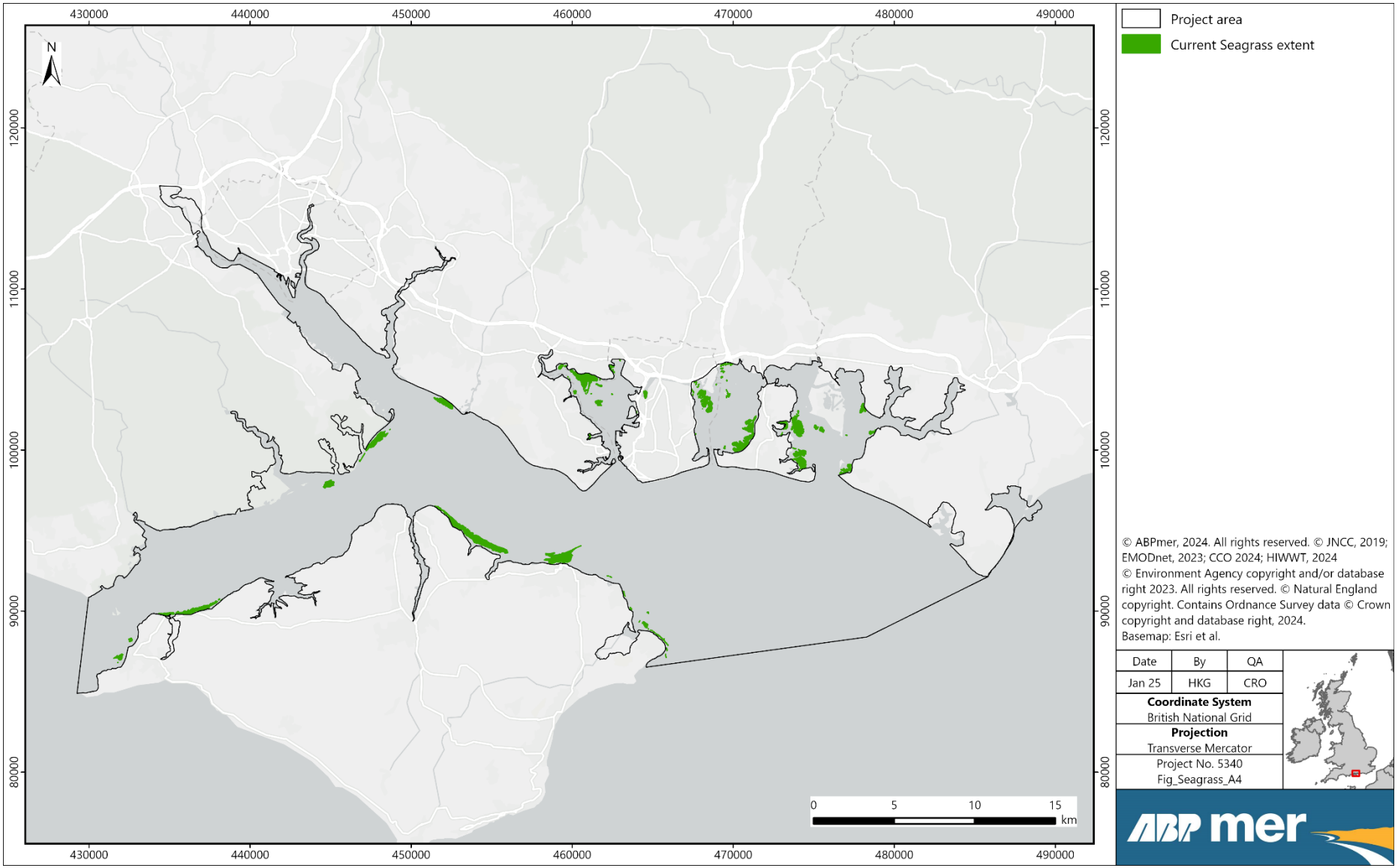


Figure 8. Mapped Seagrass in the Solent

Regarding historic extent, Natural England conducted a condition assessment of the extent of subtidal seagrass beds in the Solent during 2018. Results indicated that seagrass extent had not declined within the previous 10 years, however the results had medium confidence and the overall condition was deemed unfavourable due to water pollutants and disturbance (Natural England, 2018a and b). As for the intertidal seagrass beds, similar results exist where neither change nor increases were recorded in the short term, and some areas in the long term exhibited a decline (Natural England, 2019a), and the beds in general were determined to be in unfavourable condition.

It is believed that, historically, seagrass beds covered much larger areas of the Solent. For example, Tubbs (1999) notes that these used to form '*luxuriant green meadows across the intertidal flats, streaming in the tide in the low water channels and creeks of the estuaries and harbours'*. It is unclear how much has been lost, but UK wide, it has been estimated that the loss of seagrass might be as high as 92 % (Green *et al.,* 2021).

Factors driving seagrass change

Seagrasses are sensitive habitats which are subject to numerous pressures. Historic losses have likely been due to a variety of factors. Unsworth *et al*. (2024) summarise that '*causes for these losses are many; coastal land reclamation, water quality problems, historic metal mining and early industrialisation of the UK*'. Furthermore, '*as seagrass habitats are located near-shore, they are especially sensitive to anthropogenic pressures such as eutrophication, habitat fragmentation and destruction, overfishing and forestry and commercial developments'*. Crucially, in the 1930s a 'wasting disease' (commonly attributed to the slime mould *Labyrinthula zosterae*) substantially reduced seagrass extent across all North Atlantic regions. Along the Atlantic coasts of Europe and North America, up to 90% loss was estimated (Muehlstein, 1989). This had dramatic knock-on effects on fishing industries and bird populations (Orth *et al.,* 2006). The mould continues to affect eelgrass beds, but with no outbreaks as severe as the epidemic of the 1930s (Short *et al.,* 1988).

Many of the remaining seagrasses are apparently in a stressed state and '*are subject to a range of cumulative stressors that are often poorly understood*' (Jones and Unsworth, 2016; Jones *et al.,* 2018). Elevated nitrogen and phosphorus, poor light availably and poor environmental conditions have been summed as being the key reason for seagrass beds being in a perilous state across the UK (Unsworth *et al.,* 2024). Further direct pressures include mechanical damage as a result of coastal zone development, mobile fishing gear and recreational boating activities (anchoring and chain moorings (Gamble *et al.,* 2021). In addition, historically, the expansion of *Spartina anglica* is considered to have substantially impacted the *Zostera noltei* beds in the Solent in particular, given that their niches overlap somewhat (Tubbs, 1999).

Seagrass beds are also highly sensitive to increases in wave exposure, which may increase erosion and result in the uprooting and loss of individual plants. They are also susceptible to low light and algal overgrowth. Therefore, changes in seagrass distribution, abundance and condition can be related to environmental conditions (McMahon *et al.,* 2013).

2.3.5 Native oyster beds

Overview

The bivalve *Ostrea edulis* (European flat oyster) is found from the low intertidal shore down to sublittoral zones throughout the Atlantic and Mediterranean coasts of Europe. It is the UK's native oyster species (Laing *et al.,* 2005). *O. edulis* are a key species that, at high enough densities, colonise areas of dead

and living native oyster shells (preferentially), and form species-rich biogenic "reef" habitats, generally referred to as oyster beds[18].

Oyster beds provide substrata, food, shelter, and spawning grounds for a number of species (Smyth and Roberts, 2010), and support species including ascidians, sponges, polychaetes, juvenile fish and crabs. Turf seaweeds are also likely to be present. Native oyster habitats provide various ecosystem services, including improvement of water quality, removal of excess nutrients / contaminants, habitat provision, recreation, carbon sequestration and the supply of a commercially important food source (Preston *et al.,* 2020; see also Section 2.3.8 for more detail on ecosystem services).

Naturally occurring native oyster beds have all been lost from the Solent, leaving fragmented remnant populations of oysters and historic beds which are not generally home to high densities of oysters. None of the historic beds are thought to meet the OSPAR criteria whereby they would be officially classed as oyster beds (see paragraph on IFCA surveys below)[19].

In the Solent, oyster beds used to be extensive, particularly in areas such as Lymington, Beaulieu, and Newtown.

Populations in the Solent region have exhibited a complex pattern of exploitation, decline, and restoration efforts. Similar to other regions in Northern Europe, the effective extinction of oyster beds in the Solent was likely mostly due to overfishing of the oyster beds, which is an issue which goes back many centuries (industrial-scale fishing is believed to have started in the late 18th Century in the Solent) (e.g. Whitaker, 2023). In the more recent past, severe winters and diseases and parasites further contributed to the decline of the remaining oyster beds. For example, the severe winter of 1962/63 furthermore caused large mortalities among the oyster populations, particularly in the western Solent. Despite this, during the 1970s, various areas within the central Solent, such as Stanswood Bay and Calshot, experienced high reproductive success and increased population densities (Key and Davidson, 1981).

In the 1970s and 1980s, the Solent was one of largest *O. edulis* fisheries in Europe. For example, in 1978, 450 vessels harvested 15 million oysters (Key and Davidson, 1981) (see Image 11 for historic beds in the Solent itself[20]). However, since 2006, *O. edulis* populations in the Solent have fluctuated, but with an overall downward trajectory in population density. In 2007, *O. edulis* populations notably 'collapsed' and have not recovered since. For example, research has revealed that the population density of *O. edulis* within Chichester Harbour has decreased by 96% over the past two decades (Helmer *et al.,* 2019).

It is also important to understand that not only did the Solent used to have large areas of oyster beds, but, prior to overfishing, these would have been substantial three-dimensional structures, and would have often likely reached several metres in height, possibly as high as houses in some deeper locations (pre industrial fishing) (e.g. Thurstan *et al.,* 2024).

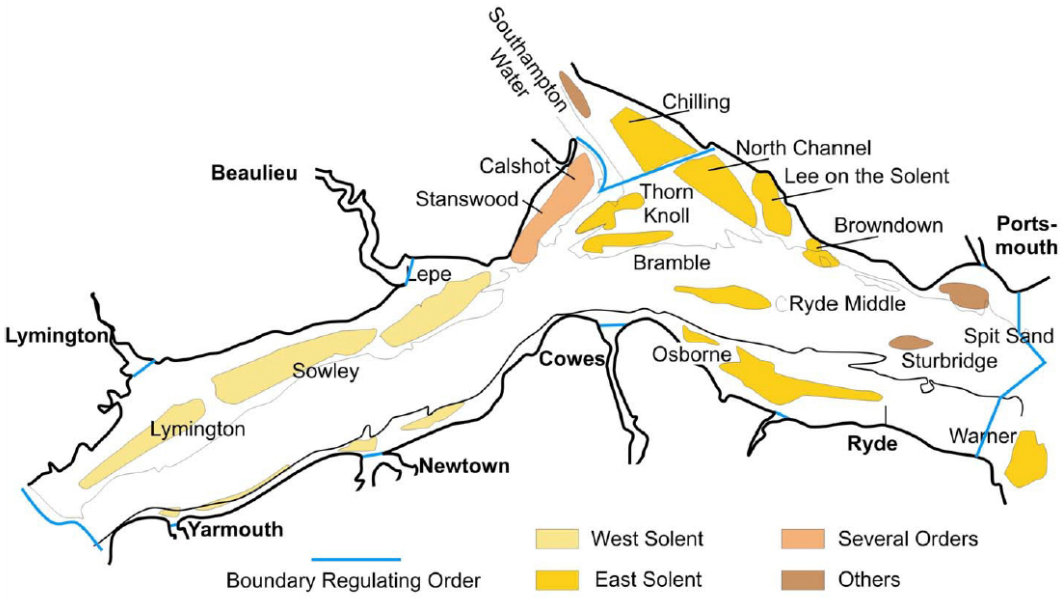
Since 2013, the Southern Inshore Fisheries and Conservation Authority (IFCA) has regarded the *O. edulis* fishery in the Solent to be severely depleted, and therefore the fishery has remained closed to protect the remaining oyster stocks. The 2024 Solent oyster survey, undertaken by SIFCA, showed that population densities were still very low, and that most of the surveyed oyster beds did not reach the

[18] 'Bed' and 'reef' are often used interchangeably in Europe (Preston *et al.*, 2020). For the remainder of this report, 'bed' has been adopted.

[19] The conservation advice for minimum bed density set by the OSPAR commission states that an oyster bed requires a minimum density of five oysters per square metre (Cameron, 2023). It is however acknowledged that there is no commonly agreed defined threshold density or spatial extent for oysters beds and reefs.

[20] noting that there would have also been extensive beds elsewhere, including Portsmouth, Langstone and Chichester Harbours and Southampton Water.

threshold value required for considering changes to the current fishery closure (Southern IFCA, 2024a). During the latest (2024) survey, only 98 oysters in total were caught across the entire survey, over 72 tows. Very few of the 'beds' reached the required catch per unit effort threshold for consideration of management. The highest catch per unit effort was found on two beds in the Northern Solent ('Browndown' and 'North Channel'), though the densities observed were likely too low for these to be classed as beds as per the OSPAR minimum bed density threshold.



(Source: Vanstaen and Palmer, 2009)

Image 11. Historic Solent oyster beds (2009, as surveyed by Cefas stock survey)

Factors driving oyster population change

The decline of oyster populations in the Solent has been influenced by multiple factors, including overfishing, habitat degradation, disease (notably the protozoan parasite, *Bonamia ostreae*), invasive species (such as the slipper limpet, *Crepidula fornicata*), and water quality (Helmer, 2019 (and references therein); Helmer *et al.,* 2019). The scarcity of remaining *O. edulis* populations has prevented natural recovery, as there are not enough oysters to produce necessary larvae for population regeneration. Native oysters have internal fertilisation to produce larvae; therefore, low density populations have low rates of fertilisation and are unable to reproduce successfully. Low density of populations and large distances between these populations prevent natural recovery (e.g. Preston *et al.,* 2020). All these challenges have led to the effective extinction of natural oyster beds in some parts of the Solent, and hence the subsequent implementation of restoration initiatives (Harding *et al.,* 2016); see Section 4.2 for more detail.

The ecological niche of *O. edulis* extends from the low intertidal to depths of 50 m+, however they historically populated shallow coastal waters. Larvae prefer clean calcium carbonate hard substrates (specifically other oyster shells) to settle upon, although beds as deep as 80 m have been identified (Korringa, 1946; Thurstan *et al.,* 2024). While oysters tolerate a spectrum of environmental conditions, factors such as temperature, salinity, food availability and hydrodynamic conditions affect growth and morphology (see Preston *et al.,* 2020 for environmental parameters table). Oyster habitat is generally associated with very weak to weak (<1 knot) currents. The species can survive in a wide range of salinities (18 to 40), although low salinity may inhibit feeding. Similar to other bivalves, oysters inhale water and filter it through a gill chamber, thereby removing suspended food particles. Although oysters are adapted to turbid waters, high concentrations of suspended inorganic particles and sediment can result in reduced feeding efficiency, and thus growth (Grant *et al.,* 1990).

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Image 12. Native Oysters with crab in Portsmouth Harbour

2.3.6 Habitat condition

There are various sources of evidence on habitat condition in the Solent, using various indicators, and information is mostly focussed on intertidal and seagrass habitats.

Firstly, as discussed in Section 2.2.2, qualitative condition assessments are regularly undertaken for SSSI units. Units do not necessarily translate into habitats however, as SSSI units relate to sediment type. Thus, for example, seagrass beds, saltmarshes and mudflats would all be classed as 'littoral sediment' units. Analysis of SSSI unit condition data undertaken for this report reveals that the majority of the marine and coastal SSSI units in the Solent (56%) are in unfavourable condition, as illustrated in Image 1 above. The most frequently highlighted reasons were related to high nutrient loads and opportunistic macroalgae cover; coastal squeeze and erosion were also frequently highlighted.

A saltmarsh specific assessment undertaken for the Solent SSSIs in 2022 (by Parry and Hendy, 2022) suggested that all bar two of the Solent's saltmarsh complexes should be considered to be in unfavourable condition (see Section 2.3.2).

Condition assessments for non-SSSI MPAs are a relatively recent development and have to date been undertaken for five of the 16 MPAs in the Solent, as also noted in Section 2.2.2 above. Two of these assessed the condition of bird features only, and hence only three of these related to habitat features. Out of all the habitats assessed, the only habitats which were judged to be in favourable condition were the coastal lagoons of the Solent and Isle of Wight Lagoons SAC. All the intertidal and subtidal units of the Solent Maritime SAC (including seagrasses) were considered to be in unfavourable condition, as were the seagrasses of the Pagham Harbour MCZ. Reasons for the unfavourable condition status mostly related to poor water quality (high nutrient loads and contaminants), species composition, and extent and distribution.

The 'status' of saltmarshes and seagrasses is furthermore assessed as part of the government's regulatory water body assessments under the Water Environment (WFD) (England and Wales) Regulations 2017. The results of a review of the latest (2022) assessments for the transitional and coastal (TraC) waterbodies in the study area are summarised in Table 15[21]. This reveals that most of the saltmarsh units in the study area (where these have been assessed) are considered to be at 'good' or 'moderate' status[22]. Seagrass status has only been assessed in the Solent, Portsmouth Harbour and Pagham Harbour water bodies, where the status has been judged to vary from 'high' to 'poor'.

Table 15. 2022 angiosperm assessments for study area WFD water bodies

Classification	Saltmarsh	Seagrass
High	None	Portsmouth Harbour
Good	Southampton Water, Western Yar, Newtown Estuary, Beaulieu Estuary	Solent
Moderate	Solent, Langstone Harbour, Portsmouth Harbour	None
Poor	None	Pagham Harbour
Bad	None	None
Not assessed	Chichester Harbour, Medina, Wotton Creek, Eastern Yar, Lymington, Langstone Oysterbeds, Sowley Marsh, Old Mill Ponds, Black Water Lagoons, Great Deep	All other TraC water bodies

(Source: Environment Agency, 2022)

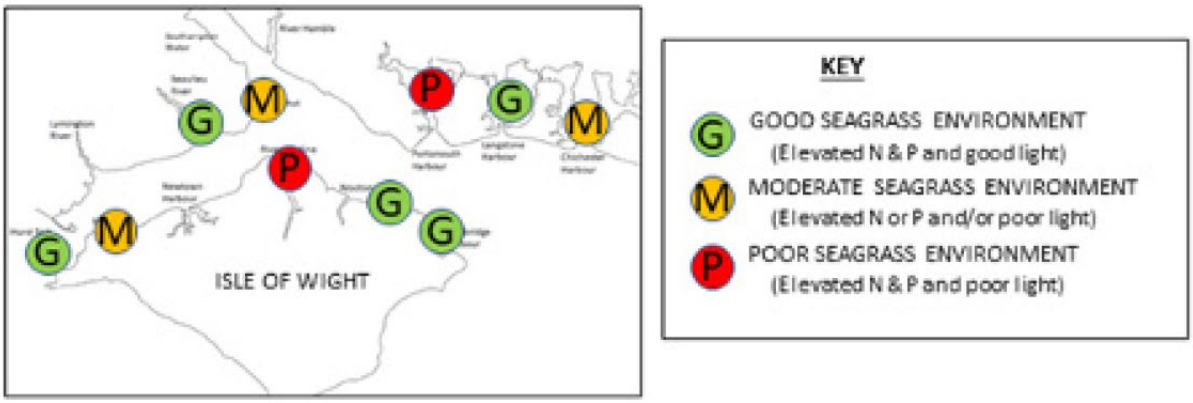
Condition assessments are also undertaken by other bodies. For example, as part of the 'Sea the Value' project, Portsmouth University has been undertaking habitat quality assessments for seagrass beds, oyster beds and saltmarshes in Langstone and Chichester Harbours. Results are not yet available, but quality is being assessed based on the following indicators::

- Seagrass - percentage coverage and shoot density;
- Native oyster beds - presence of *O. edulis* and *Crassostrea gigas*; and
- Saltmarsh - species diversity.

For seagrass, Unsworth *et al.* (2024) undertook a water quality-based condition assessment of seagrass beds across the UK, and categorised sites into three levels of condition (good, moderate, poor). This was '*based on levels of these indicators in global studies, together with an understanding of the percentile distribution within the current dataset*'. For the Solent, this considered two areas to be a poor environment for seagrasses, namely Cowes and Portsmouth Harbour (in contradiction of the 2022 the WFD assessment), and three 'moderate'; as illustrated in Image 13.

[21] This forms part of the ecological status assessment for applicable water bodies. Ecological status is assessed for all water bodies designated in rivers, lakes, transitional and coastal waters. It is based on assessing the status of biological quality elements and supported by physico-chemical and hydromorphological quality. The outcome of the ecological status assessment falls into one of five status classes. The overall objective is to achieve good or high status.

[22] Saltmarsh status is assessed based on six individual components / metrics, these are: extent as proportion of 'historic saltmarsh'; extent as proportion of the intertidal; change in extent over two or more time periods; proportion of saltmarsh zones present (out of five); proportion of saltmarsh area covered by the dominant saltmarsh zone; proportion of observed taxa to historical reference value or proportion of observed taxa to 15 taxa.
For seagrass, a tool composed of the following three metrics is applied to intertidal seagrass beds: taxonomic composition; shoot density (as a percentage cover loss or gain in a single year) or shoot density (as a rolling mean of percentage cover loss or gain); and bed extent (percentage area loss or gain).



(Source: Unsworth *et al.,* 2024 (extracted from national image))

Image 13. Seagrass environmental condition for Solent water bodies (as determined by their elemental nitrogen, phosphorus and carbon:nitrogen ratio)

2.3.7 Future predictions

Intertidal habitats

Several studies have investigated how marine habitats may fare in the Solent going forward. Notably, for intertidal habitats, the Solent Dynamic Coast project provided coastal squeeze projections to inform the North Solent Shoreline Management Plan (SMP)[23] Appropriate Assessment report, and a similar exercise was also done in relation to the SMP applying to the north coast of the Isle of Wight[24].

The SMP Appropriate Assessments concluded that there was a need to compensate for anticipated intertidal and freshwater habitat losses, and these losses were forecast for three 'epochs' covering the period from 2005 to 2105. The results are presented in Image 14 below. Image 15 then presents the results which take account of existing restoration actions[25] (Southern Coastal Group, 2024). Please see Section 4.2 on further detail about habitat creation and restoration actions in the Solent. The Environment Agency, and other coastal defence authorities, have a duty to provide compensation for designated habitat related costal squeeze losses caused by public defences. This is achieved through its Habitat Compensation and Restoration Programme (HCRP) (previously known as the Regional Habitat Compensation Programme or RHCP). In the Solent, local authorities, including Coastal Partners, are closely involved in this process. For flood and coastal risk management schemes to progress, the HCRP needs to be in positive balance.

[23] SMPs help to deliver the ambitions of the National Flood and Coastal Erosion Risk Management Strategy. They set out a planned approach to managing flood and coastal erosion risk around the coast of England to 2105. There are 20 SMPs covering the English coast; three of these overlap with the Solent region, namely: Beachy Head to Selsey Bill (East Sussex and the South Downs); Selsey Bill to Hurst Spit (North Solent); Isle of Wight (Environment Agency, 2024b).

[24] Not for Pagham Harbour, as that falls within the Beachy Head to Selsey Bill SMP, for which an Appropriate Assessment was not undertaken as it was a pilot SMP undertaken before the requirement for Habitats Regulation Assessment was realised. Therefore, there are no habitat requirements currently recorded for the Beachy Head to Selsey Bill SMP, but this has been recommended to be addressed in future work and may be picked up via the SMP Refresh (Southern Coastal Group, 2024).

[25] Namely: the Medmerry managed realignment scheme (intertidal habitat creation), the Lymington Water Level Management Plan (intertidal), and the Manor House Farm scheme (grazing marsh, freshwater habitat) (Southern Coastal Group, 2024).

Image 14. Solent and South Downs habitat balance predictions (excl. restoration and habitats fronting naturally rising land and non-public defences)

SMP Habitat Group	Habitat Balance (Ha)			
	Epoch 1 (2005 - 2025)	Epoch 2 (2026 - 2055)	Epoch 3 (2056 - 2105)	Total
Intertidal Mudflats	43	72	-72	43
Saltmarsh	-124	-149	-163	-435
Coastal Grazing Marsh	0	-70	-6	-76
Freshwater Habitats	0	-4	0	-4
Saline Lagoons	0	0	0	0

(Source: Southern Coastal Group, 2024)

Image 15. Solent and South Downs habitat balance predictions (incl. restoration; excl. habitats fronting naturally rising land and non-public defences)

SMP Habitat Group	Cumulative Habitat Balance (Ha)		
	Epoch 1 (2005 - 2025)	Epoch 2 (2026 - 2055)	Epoch 3 (2056 - 2105)
Intertidal Mudflats	43	76	-32
Saltmarsh	-20	-208	-392
Coastal Grazing Marsh	61	61	61
Freshwater Habitats	17	17	17
Saline Lagoons	0	0	0

(Source: Southern Coastal Group, 2024)

It is important to note that compensation requirements only arise where a hold the line policy will lead to coastal squeeze of a designated intertidal habitat (SAC, SPA or Ramsar). Thus, it only applies to sections where there is a seawall or embankment in place and where a decision is made to hold that in the same position. In the Solent, effectively all the inter- and supratidal habitats are SPA/Ramsar and/or SAC designated, as illustrated in Figure 3 above. Around 55% of the Solent's shoreline is not defended with hard defence structures, so landward movement is not impeded by human constructs (though it might be by rising land), and compensation is thus not required in such locations. In addition, many defences in the Solent are privately owned, and again, the above compensation calculations do not apply to those.

Thus, the projections provided above do not apply to all the intertidal habitats in the Solent. This is illustrated by the original calculations by the Solent Dynamic Coast project, which (regardless of defences or designations) predicted 812 ha of saltmarsh losses over the three epochs overall, and 60 ha of mudflat gains, noting that this prediction did not include Pagham Harbour or the Isle of Wight (Cope *et al.*, 2008).

The mudflat gains listed above are all related to gains from saltmarsh losses (i.e. the latter being submerged for too long or eroding). The figures quoted in the previous paragraph imply that, over the next 100 years (without restoration/creation), there would be a net intertidal habitat loss of 752 ha due

to coastal squeeze across the North Solent, whereby mudflat effectively becomes subtidal. This represents at least 9% of the total intertidal soft sediment listed above.

The grazing marsh and freshwater habitat losses listed above are attributed to anticipated losses due to no active intervention policies, i.e. where the preferred SMP option is to *'maintain or encourage a more natural coastline, which may involve discussing adaptation to the risk from flooding or erosion'* (Environment Agency, 2024b).

In addition to the above calculations, for saltmarshes, an updated assessment for Solent SSSIs was undertaken by Parry and Hendy in 2022, with summary conclusions presented in Table 14 above (in the saltmarsh sub-section). In summary, this work indicates that without habitat creation or restoration, at best, all the saltmarshes in the Solent are likely to have been lost by 2323. At worst, this could occur much earlier than that.

It is furthermore worth noting that an update of the Solent Dynamic Coast project has recently been initiated, and more up to date intertidal habitat loss predictions, taking account of most recent developments and sea level rise predictions, will soon be available.

Non-intertidal marine habitats

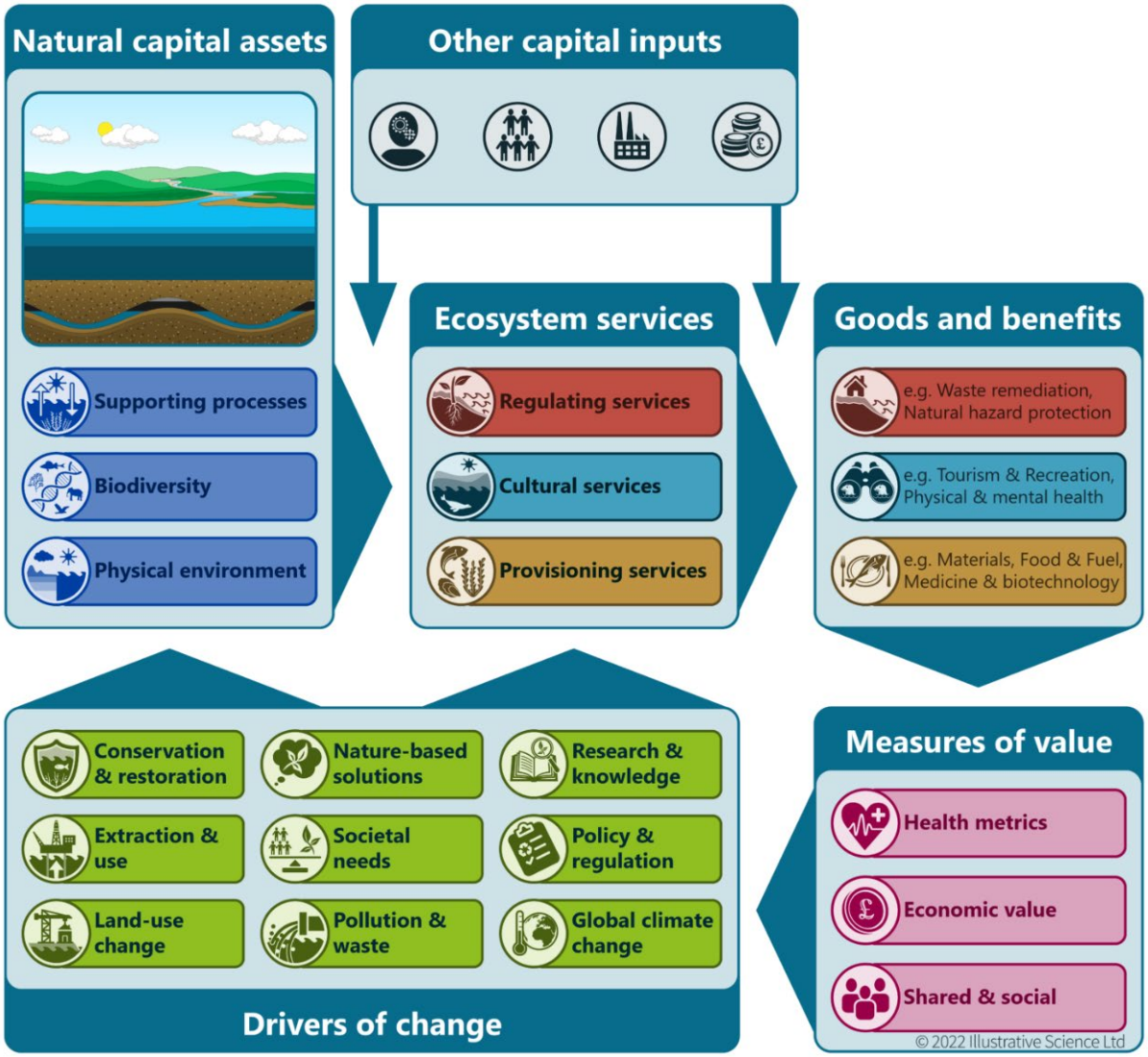
Future predictions for other habitats than those listed above are not available. However, it is reasonable to assume that other habitats would be impacted by sea level rise and climate change. For example, intertidal seagrass, which resides on mudflats, would be lost wherever mudflat is lost, and subtidal seagrass would also eventually not receive enough light as water depths increase. Supratidal habitats will, without intervention, slowly turn into intertidal habitats, and lastly, there will be gains in subtidal habitats as intertidal habitats become subtidal. Please see Section 3.5 for further details on potential impacts of climate change on the Solent's marine habitats.

2.3.8 Ecosystem services and benefits

The marine habitats of the Solent, with their flora and fauna, make up part of the natural capital of the Solent. Natural capital can be defined as '*the world's stocks of natural assets which include geology, soil, air, water and all living things*'. Marine natural capital assets underpin the provision of vital goods and services that support the economy and human well-being. The flows of ecosystem services and goods from natural capital assets (along with other forms of capital e.g., financial capital) enable benefits to be generated for the economy, society, and the environment (Cefas, 2024). A recent state of natural capital report assigned marine and coastal, wetlands habitat all at high or very high risk (Lusardi *et al.,* 2024).

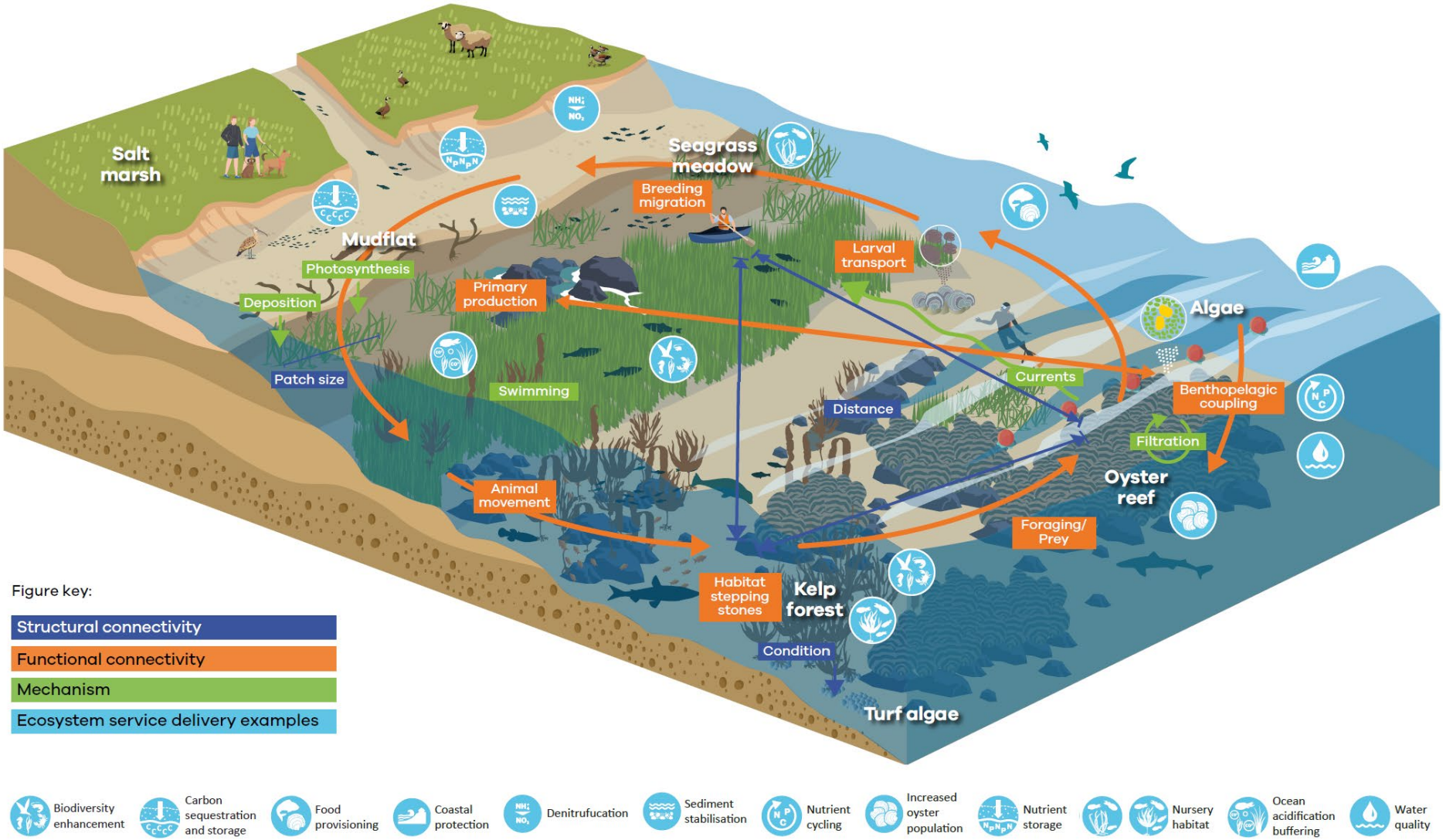
The ecosystem services framework explicitly links ecosystem structure, processes and functioning to outcomes in the form of services which contribute to human wellbeing / welfare. Intertidal habitats in particular have long been known to be very valuable habitats which provide a wider range of beneficial ecosystem services.

A recent report by Garbutt *et al*. (2024) summarised the ecosystem goods and benefits derived from the key seascape habitats found in the UK: mudflat, saltmarsh, oyster reef, seagrass meadows and kelp forest. This included a summary graphic which illustrates the relationship between structural connectivity, functional connectivity, mechanisms, and ecosystem service delivery in a healthy seascape displayed below in Image 17.



(Source: Cefas, 2024)

Image 16. **Summary diagram of the links between natural capital assets, other types of capital, and the links to ecosystem services, goods and benefits, measures of value as well as societal / environmental drivers of change**



(Source: Garbutt *et al.*, 2024)

Image 17. **Graphic illustrating the relationship between structural connectivity, functional connectivity, mechanisms and ecosystem service delivery in a healthy seascape**

The graphic illustrates that the habitats of a healthy seascape have the potential to provide a myriad of goods and services to society. Providing a detailed review of the ecosystem services and benefits provided by the marine habitats of the Solent is beyond the scope of this report, but it is considered that, out of those shown in the image, key ecosystem service benefits which arise are the following: sea defence, clean water and sediments, healthy climate, wild food and recreation and tourism based around nature watching. A summary of the evidence on these is provided below, and the contribution of the Solent's habitats to these key goods and benefits is illustrated in Table 16.

Marine habitats can serve an important function in protecting shorelines, as they can lessen the power of waves by breaking up or absorbing the wave energy as it approaches the shoreline (Ondiviela *et al.,* 2014). Physical barriers such as those provided by littoral rock habitats dampen wave energy and contain rising water, which is enhanced through the colonisation by epibenthic communities (Gonzalez *et al.,* 2021). Saltmarsh, seagrass and kelp beds dampen wave energy and attenuate currents whilst seagrass beds may also help to build sandbanks (e.g. Potts *et al.,* 2014; Moeller *et al.,* 2014). Soft substratum habitats also dissipate wave energy and provide protection to saltmarshes, cliffs, coastal defences, and infrastructure (e.g. Earlie *et al.,* 2018). Intertidal habitats can furthermore keep pace with sea level rise (to varying extents), and potentially migrate, thus potentially providing such a function well beyond the lifetime of man-made coastal defence structures.

The process of capturing and sequestering carbon plays a crucial role in maintaining a stable climate. Saltmarsh and seagrass meadows, along with their root systems, absorb and retain carbon within their environment. Saltmarsh plants are thought to have the highest carbon burial rate per unit area compared to other blue carbon habitats (Stewart and Williams, 2019). Whilst not directly sequestering carbon into sediment necessarily, algae and kelp communities on rocky substrate absorb carbon through their biomass. This carbon is subsequently moved around as debris, a part of which gets stored or sequestered in the ocean floor's sediments. (e.g. Smale *et al.,* 2013; Hynes *et al.,* 2021;). The water column supports the carbon cycle by facilitating oceanic primary production which utilises light to transform inorganic to organic carbon (Burrows *et al.,* 2014). Terrestrial carbon is also input via rivers and estuaries, through terrestrial detritus and sewage inputs to the coastal zone (e.g. Queirós *et al.,* 2022).

Marine living organisms store, bury and transform waste though assimilation as well as chemical decomposition and re-composition. Vegetation within saltmarsh and seagrass habitats can trap sediments, resulting in organic matter and nutrients becoming stored within the accreting sediments, sequestering carbon, nitrogen and phosphorous (e.g. Queirós *et al.,* 2022; Reynolds *et al.,* 2016). Bioturbation (biogenic modification of sediments through particle reworking and burrow ventilation) by benthic organisms living within soft substratum habitats provides a mechanism for nutrient cycling (e.g. Sturdivant and Shimizu, 2017). Filter feeding bivalves, such as mussels, pump water and contaminants such as bacteria, algae, microplastics and detritus into their gill chambers as they feed, effectively reducing concentrations within the water column (e.g. Scott *et al.,* 2019). For example, just one adult native oyster can filter over 140 litres of water per day (Native Oyster Network, 2024).

Commercial fisheries, aquaculture and hand gathering directly benefit from the flow of 'wild food' ecosystem service benefits, related to stocks of fish and shellfish species within the Solent. Habitats such as saltmarsh, sublittoral seagrass beds and coastal infralittoral rock habitats, and littoral sediments, provide important nursery habitat, supporting shelter and food resources for many commercial fish species (notably bass, sole, plaice, pollack, whiting, crab and lobster) (Ashley *et al.,* 2021). Deeper rock habitats support adult life stages of shellfish species and some finfish, and sublittoral soft substratum habitats support adult life stages of all commercial species (e.g. Jackson-Bue *et al.,* 2023).

Marine natural capital assets provide the basis for a wide range of recreation and tourism activities. Recreation and tourism opportunities include water sports, wildlife watching, recreational fishing, appreciating scenery, swimming outdoors, visits to a beach, walking as well as access and interaction with nature, cultural heritage and all education and investigation (Natural England, 2016; 2020).

Table 16. Contribution of key marine habitat features to important ecosystem benefits

Key Intertidal and Subtidal Natural Capital Assets of the Solent		Contribution to ecosystem service goods and / or benefits*					
		Food (wild food)	Tourism, nature watching and recreation	Prevention of Coastal erosion	Sea defence	Healthy climate	Clean water and sediments
Intertidal habitats	Coastal saltmarshes and saline reedbeds	H; 3	H; 3	H; 3	H; 3	H; 3	H; 3
	Intertidal soft sediments	M; 3	H; 2	M; 3	M; 3	M; 3	L; 1
	Intertidal coarse sediment	L; 1	M; 1	M; 3	M; 3		L; 1
	Intertidal rocky habitats	M; 3	M; 1	H; 1	H; 1	L; 2	L; 1
	Intertidal underboulder communities	L; 2	L; 1	L; 1	L; 1		
	Seagrass beds	M; 3	M; 2	M; 2	M; 1	H; 3	H; 1
Subtidal habitats	Kelp beds	H; 3	M; 1	M; 1	M; 1	M; 3	L; 1
	Sublittoral biogenic reefs (Mussel beds)	M; 1	M; 1	M; 1	M; 1	L; 2	H; 1
	Sublittoral biogenic reefs (Native oyster beds)	H; 1	M; 1	M; 1	M; 1	L; 2	H; 2
	Sublittoral coarse sediment	M; 2		L; 3	L; 3	L; 2	M; 3
	Sublittoral sands and gravels	M; 2		L; 3	L; 3	L; 2	M; 3
	Subtidal mixed sediments	M; 2		L; 3	L; 3	L; 2	M; 3
	Subtidal muddy sediments	M; 2		L; 3	L; 3	L; 2	M; 3
	Subtidal rocky habitats	H; 3	M; 1	M; 1	M; 1	M; 2	

* Shading and capital letters: Scale of ecosystem service contribution; numbers: Confidence – see keys below

Scale of ecosystem service contribution (shading & capital letters) – relative to other habitats	
H	significant / high contribution
M	moderate contribution
L	Low or negligible
[blank]	not assessed (no colour)

Confidence in existing evidence for ecosystem service provision assignation	
3	UK related peer reviewed literature
2	Grey or overseas literature
1	Expert opinion
[blank]	not assessed)

(contributions reviewed from Rees *et al.,* 2019 and Saunders *et al.,* 2015; scoring updated where relevant)

2.4 Species

2.4.1 Overview

The Solent is home to a large variety of species which depend on the marine habitats discussed in the previous sub-section. The Solent is very important for overwintering coastal and marine birds, feeding mainly on the invertebrates found in the mud, but many birds also frequent the region during other seasons, and important seabird breeding colonies can be found here. A small seal colony is present within the Solent, whilst other marine mammals pass through the region on occasion. A wide variety of fish can be found, with the harbours and estuaries being of particular importance to juvenile fish, and also as corridors for migratory fish.

The individual sub-sections below provide more detail on the key animal groups of the Solent, discussing in turn: birds (Section 2.4.2), marine mammals (Section 2.4.3), fish (Section 2.4.4), invertebrates (Section 2.4.5) and plankton (Section 2.4.6). Trends and condition are discussed within the various sub-sections, where such information is available. The situation regarding invasive species is summarised in Section 2.4.7.

2.4.2 Birds

This section provides a summary on the abundance and distribution of coastal waterbirds in the Solent region. The review has been split into the following sub-sections:

A) **Shoreline and coastal waterbirds:** This sub-section focuses on describing the waterbirds that feed wholly or mainly along the coastline within the intertidal environment and associated functionally linked land. This includes waders (charadrii), some species of waterfowl (anatidae), specifically geese, swans and dabbling ducks), coots and moorhens (rallidae), herons and egrets (ardeidae); and
B) **Marine birds:** This section focuses on species that forage wholly or mainly in the marine environment (both offshore and coastal), through either diving or feeding on the water surface. In the UK, these species consist of seabirds (petrels, shearwaters, cormorants, skuas, gulls[26], terns and auks), divers (gaviidae), grebes (podicipediformes), seaducks (mergini) and some diving ducks (aythyini). For the purposes of this report, they have been collectively termed 'marine birds'.

Sub-regional narratives are provided in Section 5, with Appendix B containing further information on insights from regional data interpretation.

A) Shoreline and coastal waterbirds

The Solent Region supports internationally important numbers of waders and waterfowl which feed and roost on the foreshore and nearby functionally linked coastal habitats. Over the last 30 years, more than 100 species have been recorded in the Solent region, with approximately 35 species regularly occurring.

These species typically occur in the largest numbers in the region during the non-breeding season (i.e. overwintering and passage months), with wintering populations regularly exceeding 100,000 birds (see Appendix B). Low numbers of some species also breed in the area. Table 17 provides an overview on the feeding ecology, habitat preferences and broad distribution of key waterbird species in the Solent region.

[26] Some gull species regularly forage in the intertidal but by convention these species are normally classified as seabirds.

Table 17. Overview information for key shoreline and coastal waterbirds species within the Solent region

Species	Coastal habitat requirements[1]	Feeding behaviour in the marine environment[2]	Diet[3]	Solent distribution[4]
Wader				
Oystercatcher *Haematopus ostralegus*	Feeds on intertidal areas (more sandy sediment than most other waders), and rocky shores. Also feeds on earthworms in grassland.	Intertidal benthivore	Predominantly bivalves especially large cockles, mussels, and tellins. Diet might also include polychaete worms on mudflats and earthworms from wet fields.	Commonly recorded in winter and passage periods feeding and on intertidal habitats and roosting in upper foreshore areas such as in Chichester Harbour, Langstone Harbour and Portsmouth Harbour and Southampton Water. Low numbers also breed in the region.
Avocet *Recurvirostra avosetta*	Shallow water in estuaries and lagoons.	Intertidal benthivore	Benthic crustaceans e.g. *Corophium* spp. and worms / ragworm. Insects, especially Chironomidae larvae, in freshwater habitats.	Recorded during winter and passage periods including in Chichester Harbour, Langstone Harbour and the Lymington area. Low numbers also breed in the Solent region such as in the Lymington area, Farlington Marshes and Medmerry.
Ringed plover *Charadrius hiaticula*	Feeds on intertidal areas (more sandy or gravelly substrates than most other waders). Breeds on shingle.	Intertidal benthivore	Mainly marine worms, crustaceans (such as *Corophium* spp.) and molluscs (such as *Peringia ulvae*).	Recorded during winter and passage periods. Lower numbers breed at several locations in the Solent region in shingle areas.
Golden plover *Pluvialis apricaria*	Mainly feeds on short well established grassland, and (more rarely) on bare arable land. Roosts on intertidal areas, but rarely feeds there.	Roosts but rarely feeds in the intertidal	Mainly on earthworms and tipulids, but also other terrestrial insects and spiders.	Recorded roosting on foreshore habitat in the areas, particularly in Chichester and Langstone Harbour.
Grey plover *Pluvialis squatarola*	Mudflats and sandflats. Typically roosts on shingle, saltmarsh and small islands.	Intertidal benthivore	Polychaete worms and bivalves (cockles, tellins) and crab *C. maenas*.	Large winter and passage populations recorded in the region, particularly in Chichester, Pagham and Langstone Harbours.

Species	Coastal habitat requirements[1]	Feeding behaviour in the marine environment[2]	Diet[3]	Solent distribution[4]
Lapwing *Vanellus vanellus*	Mainly feeds on short well-established grassland, and (more rarely) on bare arable land. Roosts on intertidal areas, but rarely feeds there.	Roosts but rarely feeds in the intertidal	Various invertebrates including earthworms, beetles, moth, flies, spiders, caterpillars, ants, and other insects.	Wintering populations predominantly recorded roosting on or near saltmarsh habitat in the region as well as upper estuary areas, lagoons and feeding on nearby coastal short grassland such as in Southampton Water and Chichester Harbour. Breeds in Solent region, on some coastal grasslands and arable areas.
Dunlin *Calidris alpina*	Intertidal habitat (particularly mudflat and mixed sediment).	Intertidal benthivore	Oligochaetes, polychaete worms (such as ragworm, *Nephtys* spp., bristleworms), bivalves (such as Baltic tellin) and the mud snail.	Widely distributed wintering populations recorded feeding on intertidal sediment habitat in the region. Dunlin roost on sediment islands and spits, saltmarsh and coastal and freshwater grazing marsh in the region.
Curlew *Numenius arquata*	Mudflats and rocky shores but will also feed on short grassland.	Intertidal benthivore	Primarily bivalves (such as cockle and Baltic tellin*)*, ragworm and lugworm). Earthworms on terrestrial habitats.	Widely distributed wintering populations recorded feeding on mudflats and roosting on upper foreshore habitats (such as shingle banks, marshland and manmade structures) as well as feeding on nearby coastal grassland.
Knot *Calidris canutus*	Intertidal habitat (particularly mudflat and mixed sediment).	Intertidal benthivore	Mainly molluscs, including the Baltic tellin, cockles, and mud snail,	Recorded wintering in the Solent region, such as in North West Solent and around Chichester Harbour.
Sanderling *Calidris alba*	Open sandy beaches and outer estuary areas.	Intertidal benthivore	Polychaete worms (such as ragworm), crustaceans and insects.	Recorded in outer estuary and harbour areas, particularly Southampton Water, Chichester and Langstone Harbours. Roost on shingle, saltmarsh and sand; feed in small groups at the edge of the tide line.
Black-tailed *godwit Limosa limosa*	Mudflats, but also on short grassland and shallow fresh and brackish water.	Intertidal benthivore	Invertebrates, including polychaetes (bristle-, rag-, catworms), molluscs (such as Baltic tellin*),* crustaceans, some plants. Grassland-feeding birds feed mainly on earthworms and beetles.	The Solent supports important populations of this species with large abundances recorded in Portsmouth Harbour, Southampton Water, Chichester and Langstone Harbours and North West Solent. Wintering populations recorded feeding on mudflats and roosting on upper

Species	Coastal habitat requirements[1]	Feeding behaviour in the marine environment[2]	Diet[3]	Solent distribution[4]
				foreshore habitats as well as feeding on nearby coastal grassland.
Bar-tailed godwit *Limosa lapponica*	Mudflats and sandflats in estuaries and sheltered bays	Intertidal benthivore	Polychaete worms are the principal food source during winter such as rag- , cat- and bristleworms`	Wintering populations recorded principally in Chichester Harbour and Langstone Harbour.
Whimbrel *Numenius phaeopus*	Coastal mud and sandflats and also coastal grassland.	Intertidal benthivore	On passage the species consumes shrimps, molluscs, worm, and crabs.	Recorded in passage periods feeding sand and mudflats and coastal grassland in the Solent region.
Redshank *Tringa totanus*	Feeds mainly on mudflats, saltmarsh creeks but also on rocky shores. Also feeds in areas of short grassland.	Intertidal benthivore	Polychaete worms, the bivalve Baltic tellin, crustaceans (e.g. brown and mud shrimp), mud snail. Also some terrestrial invertebrates.	Widely distributed in the Solent on intertidal habitats during the winter months with the largest counts recorded in Chichester Harbour, Portsmouth Harbour and Langstone Harbour.
Turnstone *Arenaria interpres*	Mainly rocky or gravelly shores including strandlines, but will also occasionally feed on grassland, particularly at high tide.	Intertidal benthivore	Wide range, including polychaete worms and mud shrimp on mudflats. Also rocky shore species, including mussels, amphipods, molluscs and crabs.	Found year round with a preference for rocky or gravel habitats in area (often seen turning over stones and seaweed to find prey). Turnstone roost on both natural (shingle and marshland) and artificial (pontoons and boats) habitat in the region.
Waterfowl				
Dark-bellied brent goose *Branta bernicla bernicla*	Mainly short coastal grassland, arable fields, saltmarsh, eelgrass beds and mudflats.	Herbivorous waterfowl	Mainly grasses, and on arable land the shoots of winter cereals, and oilseed rape. On estuaries, eelgrass *Zostera* spp. and saltmarsh plants. Also feeds on algae on mudflats.	Internationally important wintering populations* occur on intertidal habitats in the region as well as nearby coastal grazing marsh, short grassland and fields with the largest abundances recorded in Chichester Harbour and Langstone Harbour.
Shelduck *Tadorna tadorna*	Feeds almost exclusively on mudflats.	Intertidal benthivore	In Britain, specialises in feeding on the mud snail; also to lesser extent on other	Feeds on mudflat during the winter and passage months. Often roosts on saltmarsh and the open water in the region, preferably close to their feeding areas.

Species	Coastal habitat requirements[1]	Feeding behaviour in the marine environment[2]	Diet[3]	Solent distribution[4]
			invertebrates, such as cockles, tellins and ragworms.	Breeds in Solent region, on some coastal grasslands and pools with embankments.
Northern shoveler *Anas clypeata*	Feeds in shallow fresh or brackish water.	Omnivorous waterfowl	Plant material and invertebrates taken from the water, predominately invertebrates.	Recorded in shallow pools, coastal lagoons and sheltered saltmarsh creeks in the Solent region
Eurasian wigeon *Anas penelope*	Feeds on short grassland, but also on saltmarsh and algae on mudflats.	Herbivorous waterfowl	Feeds mainly on grasses, but also eats algae, aquatic plants and eelgrass *Zostera* spp. in estuaries.	Recorded in saltmarsh areas, upper estuaries, grazing marsh and short grassland near the coast. Wigeon roost on open water in the region.
Eurasian teal *Anas crecca*	Feeds in shallow fresh or brackish water, including on estuaries; at creek edges, in ponds and on grazing marsh	Omnivorous waterfowl	Seeds of saltmarsh and other wetland plants, including glasswort and oraches; invertebrates (esp. small oligochaetes).	Recorded in sheltered saltmarsh areas in creeks, upper estuaries, lagoons and grazing marsh such as in Newtown Estuary, Southampton Water, North West Solent, Langstone and Chichester Harbour. Often roost on open water in the region.
Mallard *Anas platyrhynchos*	Feeds in a wide variety of habitats: shallow or deeper water, grassland and arable.	Omnivorous waterfowl	A wide variety of plant material and invertebrates.	Present throughout the Solent region. Largest abundances typically near freshwater inputs and in sheltered locations .
Pintail *Anas acuta*	Feeds in shallow fresh or brackish water, and in shallow water estuaries.	Omnivorous waterfowl	Plant material and invertebrates taken from the water. On estuaries feeds mainly on *Hydrobia ulvae*.	Recorded in sheltered estuary and harbour locations with the largest abundances typically recorded in Langstone Harbour and the North West Solent.
Herons and egrets				
Little egret *Egretta garzatta*	Feeds in shallow fresh, brackish and marine waters.	Piscivores	Feeds on fish predominately.	Widely distributed feeding in creeks, shallow pools on mudflats and at the edge of channels in the region. Numbers in the region have increased over the last 30 years.
Grey heron *Ardea cinerea*	Feeds in shallow fresh, brackish and marine waters.	Piscivores	Mainly freshwater and marine fish. Occasionally small mammals, birds, amphibians and insect larvae.	Widely distributed feeding in creeks, shallow pools and at the edge of channels in the region.

Species	Coastal habitat requirements[1]	Feeding behaviour in the marine environment[2]	Diet[3]	Solent distribution[4]
Coots and moorhens				
Coot *Fulica atra*	Sheltered coastal habitats including upper estuaries, lagoons, creeks and nearby ponds / freshwater habitats.	Omnivorous	Consumes algae, pondweeds, marginal and marsh plants, grasses as well as invertebrates such as fly larvae, moths and beetles.	Commonly recorded in the upper sections of estuaries and harbours including saltmarsh creeks, sheltered channels as well as lagoons and nearby freshwater habitats such as ponds and ditches.
Moorhen Gallinula chloropus	Sheltered coastal habitats including upper estuaries, lagoons, creeks and nearby ponds / freshwater habitats.	Omnivorous	Consumes algae, pondweeds, duckweed as well as invertebrates such as worms, snails, insects and small fish.	Commonly recorded in the upper sections of estuaries and harbours including saltmarsh creeks, sheltered channels as well as lagoons and nearby freshwater habitats such as ponds and ditches.

1. Based on Holden and Gregory (2021); BirdLife International (2024); Natural England (2024a). 2. Feeding behaviour based on Mander *et al.* (2021): Intertidal benthivore: Waterbird species feeding on infaunal and/or epibenthic invertebrates in intertidal habitats; Herbivorous waterfowl: Geese, swans and ducks feeding on plant material; and
Omnivorous waterfowl: Ducks feeding on a range of animal and plant food. 3. Based on Stillman *et al.* (2005); Stillman *et al.,* (2012); Holden and Gregory (2021); BirdLife International (2024); Natural England (2024a). 4. Natural England (2024a); Woodward *et al.* (2024); Going Birding (2024).
* based on the latest five-year mean peak of 27,854 (BTO, 2024a), the wintering population equates to 5.7 % of the global population (490,000 mature individuals (BirdLife International, 2024)

Waders

Intertidal mudflat and other soft sedimentary habitats provide important benthic invertebrate prey resources for a wide variety of wintering waders, including nationally important populations of dunlin, redshank, black-tailed godwit, curlew, grey plover, and sanderling in some areas, as well as large numbers of other species such as ringed plover, knot, bar-tailed godwit and turnstone.

Particularly extensive areas of mudflat used by waders is seen in Chichester Harbour, Langstone Harbour, Portsmouth Harbour, Pagham Harbour, Southampton Water, the New Forest coast between Hurst and the Beaulieu River and estuaries on the Isle of Wight (Newton River and Medina River). Waders such as curlew, oystercatcher, black-tailed godwit, as well as lapwing[27], also feed on nearby grazing marsh and short grassland near the coast in the Solent region on terrestrial worms and other soil invertebrates. Upper shore wader roosts in the region include shingle banks, small islands, the edge of lagoons and higher areas of saltmarsh.

In the Solent, mudflats in particular are important to wading birds, and these have been protected by SPA (and SAC) designations. In addition, as noted above and in Table 18, many terrestrial and non-designated areas are of importance to waders and waterfowl. In the Solent, areas which are of particular importance to waders and Brent Geese have been mapped (and classified) as part of the Solent Waders and Brent Goose Strategy project; please see Image 18. This demonstrates that numerous fields surrounding the Solent and its harbours, estuaries, as well as adjacent terrestrial wetlands, are crucial for the coastal and marine bird population of the Solent.

(Source: Solent Waders and Brent Goose Network, 2024)

Image 18. Solent Waders and Brent Goose Strategy mapping

Whilst numbers are highest over the winter, some waders are present year-round in the Solent, and various species are known to breed in the Solent; based on the latest Hampshire bird report (Hampshire Ornithological Society, 2023, unless otherwise stated), this mostly includes:

- Oystercatchers - these breed in many locations in the Solent, with relatively large numbers observed in Langstone Harbour (17 pairs in 2022), Needs Ore/Beaulieu (17 pairs in 2022), and the Keyhaven area (12 pairs in 2020);

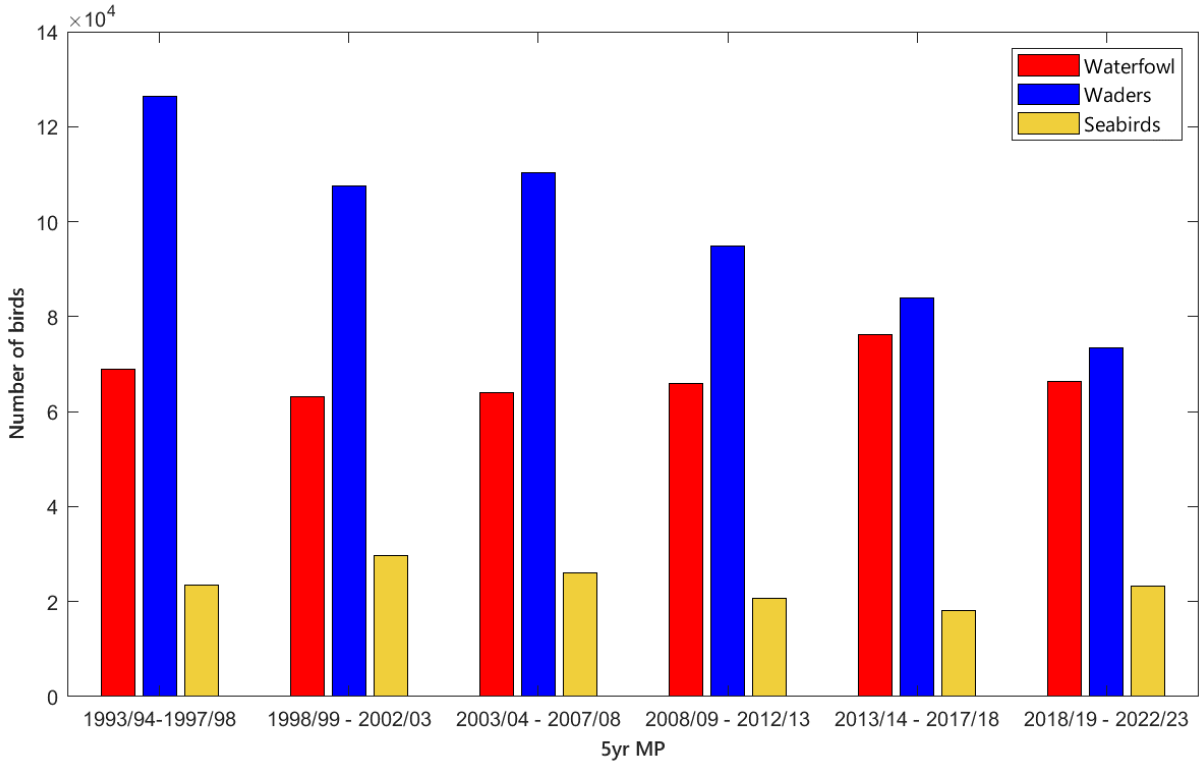
[27] This species also roosts but rarely feeds on intertidal habitats.

- Avocet - these breed at several locations, with highest numbers in Hampshire seen at Lymington-Hurst (34 pairs in 2022) and Titchfield Haven (at least 19 pairs). Breeding often fails due to predation (e.g. by marsh harrier or fox). In Sussex, Avocet are also known to breed at Medmerry (e.g. 35 pairs in 2018 (Environment Agency, 2019));
- Lapwing – in Hampshire, they breed at around 50 sites, although fledging success is often poor. In 2022, some 220 territories, pairs or nests were found; sites with high numbers included Needs Ore/Beaulieu Estuary, Lymington-Hurst, Farlington Marshes, and Testwood Lakes;
- Ringed plover - breed at a few shingle beach sites in the Solent. In Hampshire, a dedicated 2022 survey campaign (see Codlin and Ward, 2022) revealed that there were at least 55 breeding territories across 24 sites; this comprised 21 in the Eastern Solent and 34 in the Western Solent. Overall productivity based on 55 pairs rearing 39 chicks was 0.71 per pair, and productivity was highest where access was restricted or virtually non-existent (e.g. the RSPB islands in Langstone Harbour and the private estates or restricted access nature reserves in the Western Solent). Locations with several pairs included Bakers and Long Island and South Binnes in Langstone Harbour, Gunner Point on Hayling Island, Hurst beach/Castle, Pylewell/Thorns Beach and Needs Ore/Warren Shore. At the latter, the highest number by far, 17 breeding pairs, was recorded (nest cages were employed here to improve hatching success; see Section 4.2.3 for more detail on Ringed Plover breeding projects). Codlin and Ward (2022) noted that there used to be much higher numbers of breeding ringed plover in Hampshire in the past, with 140 to 160 pairs estimated across the county in the 1980s for example;
- Curlew - breed inland in the New Forest, with 38 territories and 36 breeding pairs found in 2022; this is one of the only areas of southeast England where this species still breeds;
- Redshank – breed at several locations inland, and along the coast. For example, in 2022, there were 21 pairs with six chicks at Normandy Lagoon: four pairs at Farlington Marshes and two pairs on Fowley Island in Chichester Harbour. Redshanks breed on coastal saltmarshes and inland wet grasslands, and nests are notoriously tricky to find due to redshank's secretive nature when returning to the nest site and nests being located in long grass or tussocks. Thus, it is highly likely that more Redshank breed in the region than has been observed.

Please note that seabird breeding is discussed under the 'marine birds' sub-section below.

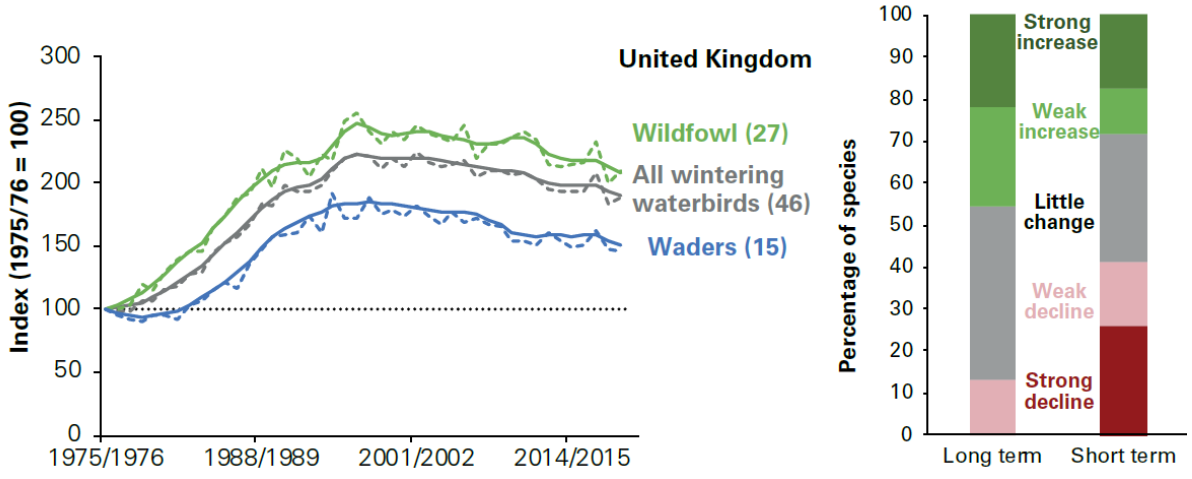
Overall, the numbers of non-breeding waders in the Solent have shown a large decline over the last 30 years, including dunlin, curlew, grey plover, ringed plover, bar-tailed godwit and lapwing. Other species such as black-tailed godwit, redshank and oystercatcher have been more stable. These trends are also evident in Image 19, which was derived from an analysis of relevant BTO Wetland Bird Survey (WeBS) Core Count Data[28]. This shows that overall wader numbers as observed during these counts over the years have declined dramatically, by almost 60%. These trends are generally consistent with wider regional and sometimes national patterns linked to broad-scale populations tends (see Image 20) (Woodward *et al.,* 2019; Burns *et al.,* 2020).

[28] WeBS core count data is collated by the BTO, in collaboration with various other bodies and many volunteers. WeBS surveyors regularly monitor the UK's internationally important non-breeding waterbirds. Counting is done once a month, at high tide, and generally year-round; although the main counting season is September to March. Only birds seen or heard are recorded. When presenting the results of these surveys, it is standard practice to present the average of the annual peaks for a certain duration of time (often referred to as the 'mean peak' or mean of peaks). This is calculated as the average of the maximum annual counts, and for the most recent five years of available data if possible. Mean peaks (using five years of winter values) is the approach presented in the WeBS annual reports. For most migratory species, the WeBS 5-year mean of peak is also the value that is used when identifying qualifying features for SPAs. Using mean of peaks is also useful for characterising the relative importance of sectors within a site, as it gives a good indication of how many individuals of a given species a sector typically supports (Austin and Ross-Smith, 2014)



(Source: created by ABPmer based on BTO, 2024a)

Image 19. Solent bird numbers for 5-yearly mean peaks (MP) since 1993/94 (by bird group)



(Source: Burns *et al.*, 2020)

Image 20. UK wild bird indicator for wintering waterbirds

Waterfowl

The Solent region supports one of the largest populations of wintering dark-belled brent goose (bernicla) in the UK and is of international importance for this species. This species is widespread in the region and feeds in the intertidal (on seagrass and green algae) as well as on nearby grazing marsh, grassland, and arable fields. This species typically roosts on areas of open water, often nearby to feeding areas.

Dabbling ducks such as wigeon, teal, pintail and mallard have also been recorded in the region in significant numbers. These duck species are often recorded in sheltered locations such as upper sections

of estuaries, lagoons, creeks, and sheltered channels as well as freshwater pools and ponds near the coast. Wigeon particularly also feeds extensively on nearby coastal grassland habitat. Shelduck is reliant on mudflat habitat to feed on benthic invertebrates and is commonly occurring and widespread in the region.

Some marine waterfowl also breed in the Solent; for example, Shelduck regularly breed at several locations, including Farlington Marshes in Langstone Harbour and the Beaulieu Estuary. Shoveler, gadwall, teal, little grebe, and great crested grebe are also found breeding at many coastal wetland sites. Mallard breeding is recorded in numerous locations throughout the region, both coastal and inland (e.g. Hampshire Ornithological Society, 2023). The numbers of non-breeding waterfowl in the Solent over the last 30 years overall appear to be relatively stable, which is mainly attributable to the populations of dark-bellied brent geese, pintail and mallard which have remained broadly consistent as well as Wigeon which has increased. Other species such as shelduck have declined in the region, with Teal showing wide inter-annual fluctuations in abundance in the long-term (see also Image 19; Woodward *et al.,* 2019).

Other species

Grey Heron and little egret are regularly recorded feeding on fish and other aquatic prey in shallow pools, creeks, and the edge of channels in intertidal areas in the Solent region. The number of little egret in the Solent has increased over the last 30 years, which is in-line with a UK wide population increase. Grey Heron numbers have remained more stable (Woodward *et al.,* 2019). There has also been a recent colonisation by, and presence of, cattle egret, with at least two sites being used in the Eastern Solent (RSPB, personal communication).

Coots and moorhens are also commonly recorded in the upper sections of estuaries and harbours including saltmarsh creeks, sheltered channels as well as lagoons and nearby freshwater habitats such as ponds and ditches.

Two birds which are relatively recent additions to the Solent wintering bird population include the Eurasian spoonbill and glossy ibis. The Western Solent area of the region is known to support important wintering populations of spoonbill (WeBS 5-year mean peak of 19 birds in the Beaulieu Estuary and 15 birds in the North West Solent). Spoonbill have, however, also been recorded in the east, for example at Farlington Marshes. Glossy ibis were scarcely recorded pre-2008, but numbers have since grown dramatically, with 679 records across Hampshire in 2022 for example. These trends mirror the increase in their breeding population in South-West Europe (Hampshire Ornithological Society, 2023). Cattle egret have furthermore been recently observed to have colonised at least two sites in the Eastern Solent (RSPB, personal communication).

B) Marine birds

A summary of the ecology, distribution and abundance of relevant key bird species occurring in the region is shown in Table 18, and a summary of 2023 breeding data is given in Table 19. The latter demonstrates that over 11,000 seabirds bred in the Solent region in 2023, with generally low productivity ranging from 0.4 to 0.9. Please note that Table 19 presents a snapshot of one year only, and that breeding seabird numbers and locations can often vary significantly between years. Please see below for insights on the individual species.

Terns

The Solent region supports important populations of breeding little tern, common tern and sandwich tern (Natural England, 2024a). Numbers breeding, and breeding success in terms of fledged young, have typically been highly variable at many sites in the region, particularly in recent years as a result of avian

influenza, predators and storm events. A summary table for the different count regions, based on 2023 nest count data, as collated by the RSPB for the Solent Seascape project, is presented in Table 19.

Common terns breed at multiple sites around the Solent, where habitat is available (Table 19). They nest on lagoon islands and offshore islands as well as purpose built nesting rafts. Common terns have shown the ability to adapt to nesting on artificial structures with an aggregate capping. In Langstone Harbour, numbers have benefited from the tern rafts the RSPB have been constructing since around 2017. This species is known to forage in a wide variety of freshwater, brackish and marine aquatic habitats with a mean maximum foraging range of 18 km ±8.9 km reported in Woodward *et al.* (2019). However, research suggests that most common tern foraging occurs inshore, much closer to nesting colonies (Wilson *et al.,* 2014). Foraging habitats utilised by the species include the open sea, lagoons, estuaries, rivers, lakes, reservoirs, ponds, and marshes (Eglington and Perrow, 2014; Holden and Gregory, 2021). This species is known to feed on a variety of prey in the UK, including fish (marine and freshwater), crustaceans, squid, and marine worms. They also feed on aquatic and terrestrial insects more frequently than other tern species. The main prey delivered to chicks in the marine environment are herring, sprat, sandeel and small gadoids. Overall, common tern is a foraging generalist and displays considerable plasticity in foraging and provisioning strategy, with a capacity to exploit diverse prey resources by utilising a variety of foraging methods (Eglington and Perrow, 2014).

Large aggregations of over 50 to 100+ feeding and roosting common terns are regularly recorded in locations such as Southampton Water, the Solent (including offshore from Hill Head and the Isle of Wight) and Langstone Harbour, particularly during the late summer (Going Birding, 2024).

Sandwich terns breed in Langstone Harbour, Pagham Harbour and in the Lymington area of the Solent. In the Solent, sandwich tern colonies are primarily on saltmarsh and shingle islands within areas sheltered by a harbour or spit (Table 19). Colonies located on lagoon islands are a feature elsewhere both nationally and internationally, and there is strong potential for this in the Solent area. This species forages in the marine environment in inshore and offshore waters in depths of typically <15-20 m and has relatively large foraging range from breeding colonies (mean maximum foraging range of 34.3 km ±23.2 km reported in Woodward *et al.,* 2019). However, like common tern, the majority of sandwich tern foraging typically occurs relatively close inshore and nearer to nesting colonies (Wilson *et al.,* 2014). Sandwich terns feed mainly on clupeids (herring and sprat) and sandeels as well as crustaceans (such as shrimps). Sandwich terns appear to prefer waters with sandy bottoms, and therefore usually feed at sea, sometimes following the tide into sandy parts of estuaries and lagoons (Eglington and Perrow, 2014). This species is also frequently recorded during passage months moving through the region.

Little terns have a breeding history at many sites along the Solent coast, with a focus in Pagham, Chichester and Langstone Harbours, as well as the Lymington to Hurst areas. Within the Solent, little terns breed on lagoon islands, offshore shingle and cheniers, and occasionally beaches and spits (Table 19). This species typically forages very close inshore from breeding colonies (maximum recorded foraging range of 5 km) in sheltered habitats such as lagoons, shallow sandbanks and channels (Woodward *et al.,* 2019; Holden and Gregory, 2021; Eglington and Perrow, 2014)). Little tern adults and chicks consume a relatively wide variety of prey types, although diet consists predominantly of small fish such as clupeids (e.g. herring and sprat) and sandeels, as well as crustaceans, annelid worms and even insects (Eglington and Perrow, 2014).

The roseate tern used to regularly breed in the Solent area (an average of two pairs nested between 1993 and 1997 and one or two pairs nested each year between 2002 and 2006) but is now mostly recorded as a rare visitor in summer or passage months. In 2024, a pair bred successfully near

Lymington and raised two chicks to fledging. This was the first for some time, and followed 'concerted efforts' to create a tailor-made habitat for birds on one of the lagoons in this area, as comprehensive work to safeguard the nest and eggs during the critical months (BBC, 2024a).

Gulls

Gull species are the most abundant and widespread of the seabirds in the Solent region.

Herring gulls breed on the roofs of building in towns and other urban areas near the coast in the Solent region, with the largest breeding populations in large urban conurbations such as Southampton, and Portsmouth (Burnell, 2021). A large colony of around 200 pairs can furthermore be found at an industrial estate at New Milton, where a member of the Hampshire Ornithological Society has been undertaking annual surveys over the past four years. This location is apparently favourable as it contains many roofs which Herring Gull prefer, namely corrugated iron type roofs (modern smooth roofs are not used) (Hampshire Ornithological Society member, personal communication). Established natural nesting colonies of Herring Gull occur on cliffs around the Isle of Purbeck (approximately 50 Apparently Occupied Nests (AON)) and on the Isle of Wight (around the Needles rocks and nearby headland), with approximately 40 Herring Gull nests (AON) recorded in recent counts (Lake and Rush, 2023; BTO, 2024b). This species has a relatively extensive foraging range from breeding colonies (with a mean maximum foraging range of 58.8 km ±26.8 km reported in Woodward *et al.,* 2019).

Source: provided by Hampshire Ornithological Society member

Image 21. Herring Gull (green) and Lesser Black-backed Gull (red) nest locations at the New Milton Industrial Estate in 2023

Herring gull also winter in the region in large numbers and are widely distributed, with relatively large wintering aggregations of over 300 to 1,000 birds recorded in Southampton Water, Portsmouth Harbour, Chichester Harbour and around the Isle of Wight as well as occurring further offshore (Woodward *et al.,* 2024; Austin *et al.,* 2017; Waggitt *et al.,* 2020; Going Birding, 2024). This species forages in a wide variety of habitats in inland areas (such as fields, rubbish tips, parks, and other urban areas), coastal locations (including the foreshore) and on the sea both inshore and further offshore (Holden and Gregory, 2021; Dunn, 2012).

Small numbers of lesser-blacked gull and greater-backed gull also nest in urban areas with a wintering population also present in the region (but in much lower numbers than Herring Gull) (BTO, 2024b; Lake and Rush, 2023). A few great-blacked backed gull and kittiwakes also breed on the cliffs along the Isle of Purbeck, Dorset (4 AON of each species in 2023), with nesting numbers of both species showing a large decline in recent years (Lake and Rush, 2023). These birds may forage in the Solent.

Large numbers of black-headed gull breed in the region at coastal sites. This species typically nests on coastal saltmarsh, shingle and lagoon islands, but also make use of platforms and nesting rafts. and typically forages on agricultural fields, rubbish tips and intertidal habitats, as well as inshore marine areas including estuaries, inlets, and the open sea (Holden and Gregory, 2021). Key coastal breeding sites for black-headed gull in the region include Langstone Harbour, Pagham Harbour and the Lymington area of the Solent (Table 19). Isolated saltmarsh islands are particularly important for this species in the Solent; with the islands of Cockleshell and Pylewell/Boiler Marsh at Lymington and South Binnes in Langstone Harbour currently providing habitat to just over 80% of the Solent total (2023 data). Large numbers of this species also winter in the region with populations exceeding several thousand birds in estuaries and harbours such as Southampton Water, Chichester Harbour, Portsmouth Harbour (Table 18) (Woodward *et al.,* 2024).

Mediterranean gull also nests and forages in similar habitats to black headed gull (Natural England, 2024a), with key breeding sites in the region including Langstone Harbour and the Lymington area of the Solent (Table 19). The numbers of this species breeding (and wintering) have increased substantially since the 1950s at a UK wide and regional scale with nationally important populations recorded in Chichester Harbour, Pagham Harbour, Langstone Harbour, Southampton Water and the North-West Solent (Woodward *et al.,* 2024). Whilst exact annual breeding abundance trends are not known, it has been estimated that the Solent population represents the overwhelming majority of the UK and Ireland population, likely well over 90% in any given year (RSPB, personal communication).

Woodward *et al.* (2019) reported mean maximum foraging ranges for both black-headed gull and mediterranean gull of approximately 20 km (Table 18).

Little gull does not breed in the UK but is a scarce winter visitor to coastal waters of the region, with larger numbers noted during passage months. This species is recorded in low numbers inshore in the region as well as offshore (Holden and Gregory, 2021; Going Birding, 2024; Woodward *et al.,* 2024).

Common gull is a regular winter visitor to the region (peaking at over 1,000 during the recent WeBS counts), and has recently been added to the red list.

Table 18. Summary of the distribution, ecology and abundance of marine birds within the region.

Species	Mean Max. Foraging Range from Colony+ 1 SD (km) [1]	Foraging Habitat[2]	Diet[3]	Foraging Behaviour, Dive Depth[4]	Distribution Within the Region[5]
Black-headed gull *Chroicocephalus ridibundus*	18.5	Coastal and offshore	Worms, insects, small fish, crustacea and carrion	Surface feeder	Breeds in the local region such as Langstone Harbour, Pagham Harbour, in the Lymington area of the Solent and Newtown (Isle of Wight). Large and widely distributed wintering and passage populations in the region with large numbers also occurring during passage periods.
Great black-backed gull *Larus marinus*	73	Predominantly coastal but also offshore	Carrion, seabirds, small mammals, fish and shellfish	Surface feeder, kleptoparasitism and feeds on other seabirds	Very low numbers breed in urban coastal areas in the region, as well as on cliffs along the Purbeck coast (Dorset) and the Isle of Wight. Widely distributed wintering population in the region.
Mediterranean gull *Ichthyaetus melanocephalus*	20	Terrestrial and marine	When breeding; insects, gastropods, small numbers of fish and rodents. When not breeding: Marine fish, molluscs, insects, berries, seeds, offal	Surface feeder	Breeds in the local region such as Langstone Harbour and the Lymington area of the Solent. Widely distributed wintering population in the region.
Herring gull *Larus argentatus*	58.8 (±26.8)	Coastal and offshore	Omnivorous-fish, discards, offal	Splash diver, kleptoparasitism (also other seabirds, small mammals)	Breeds in urban coastal areas as well as on cliffs along the Purbeck coast (Dorset) and the Isle of Wight. Large and widely distributed wintering population in the region, with large numbers also occurring during passage periods.
Lesser black-backed gull *Larus fuscus*	127 (±109)	Coastal and offshore	Omnivorous- fish, discards, offal, seabirds	Feeds on the surface or shallow plunge dives. Mainly coastal foraging range in summer	Low numbers breed in urban coastal areas in the region. Widely distributed wintering population in the region.
Common gull *Larus canus*	50	Coastal and offshore	Worms, insects, carrion, fish, small birds, small mammals, eggs, berries.	Surface feeder	Common winter visitor to the region.
Black-legged kittiwake *Rissa tridactyla*	156.1 (±144.5)	Coastal and offshore	Sandeel and clupeids.	Surface feeder, shallow dipping, or plunge diver	Very low numbers breed at Blackers Hole (Isle of Purbeck, Dorset). Also small numbers in Sussex by Newhaven (may forage in Solent). Winter visitor and passage migrant.
Little gull *Hydrocoloeus minutus*		Coastal and offshore	Wide variety of food including insects, aquatic invertebrates. zooplankton and fish	Surface feeder using dipping	Does not breed in the region but is recorded during winter and passage months in low numbers in the region.
Little tern *Sternula albifrons*	5	Coastal	Small fish such as clupeids and sandeel. Small invertebrates.	Shallow plunge diver and dipper	Breeds in the local region such as Langstone Harbour, Pagham Harbour and in the Lymington area of the Solent. Common passage migrant.
Common tern *Sterna hirundo*	18.0 (±8.9)	Coastal	Small marine and freshwater fish and aquatic invertebrates	Shallow plunge diver	Breeds in the local region such as Langstone, Chichester and Pagham Harbours, and the Lymington area of the Solent. Common passage migrant
Sandwich tern *Thalasseus sandvicensis*	34.3 (±23.2)	Coastal	Clupeids, gadoids and sandeel	Plunge diver	Breeds in the local region such as Langstone Harbour, Pagham Harbour and in the Lymington area of the Solent. Common passage migrant.
Roseate tern *Sterna dougallii*	12.6±10.6	Coastal	Sandeels, clupeids and small gadoids.	Plunge diver	Rare summer and passage visitor. Used to breed in Solent in low numbers (one or two pairs).
European shag *Gulosus aristotelis*	13.2 (±10.5)	Coastal	Feeds on fish including flatfish, blennies gadoids and sandeel	Plunge diver	Shags breed along the cliffs on the Purbeck coast (Dorset) in low numbers (may forage in Solent). Winter visitor to the region.
Great cormorant *Phalacrocorax carbo*	25.6 (±8.3)	Coastal	Feeds on fish such as flatfish, blennies gadoids, sandeel, salmonid and eels.	Pursuit diver	Cormorants breed on the cliffs along the Purbeck coast (Dorset) in low numbers and the Isle of Wight (the Needles rocks and nearby headland cliff area). Also trees near lakes/pools etc. (multiple such sites around the Solent, e.g. around Langstone Harbour and at Medmerry). Resident overwintering population present in the area.
Northern fulmar *Fulmarus glacialis*	542.3 (±657.9)	Coastal and offshore	Sandeel, sprat, zooplankton, squid, fish discards and offal.	Surface feeder. Also splash dives	Fulmars breed in very low numbers on the cliffs between Ballard Down and St. Aldhelm's Head on the Isle of Purbeck (Dorset), with a few pairs on cliffs on the Isle of wight. Winter visitor to the region.

Species	Mean Max. Foraging Range from Colony+ 1 SD (km) [1]	Foraging Habitat[2]	Diet[3]	Foraging Behaviour, Dive Depth[4]	Distribution Within the Region[5]
Common guillemot *Uria aalge*	73.2 (±80.5)	Coastal and offshore	Sandeel, sprats, herring and small gadoids and small crustaceans	Pursuit diver	Breeds along the cliffs between Durlston and St. Aldhelm's Head (Isle of Purbeck, Dorset) and the Isle of Wight (the Needles rocks and nearby headland cliff area). Winter visitor to the region.
Razorbill *Alca torda*	88.7 (±75.9)	Coastal and offshore	Sandeel, sprats and herring and small crustaceans	Pursuit diver	Breeds along the cliffs between Durlston and St. Aldhelm's Head (Isle of Purbeck, Dorset) (may forage in Solent). Winter visitor to the Solent region.
Northern gannet *Morus bassanus*	315.2 (±194.2)	Coastal and offshore	Mackerel, herring, sandeel, gadoids fish discards	Plunge diver	Common winter, passage and summer visitor.
Red-throated diver *Gavia stellata;* Black-throated Diver *Gavia arctica;* Great-northern Diver Gavia immer		Coastal	Diet consists predominantly of fish (mainly clupeids, mackerels, flatfish, gadoids and sand eels)	Pursuit diver	Winter visitor in low numbers.
Red-breasted merganser *Mergus serrator*		Coastal	Feeds on fish such as clupeids, small gadoids, flatfish and small crustaceans.	Diver	Winter visitor.
Eider *Somateria mollissima*		Coastal	Bivalves such as mussels, crabs, starfish and sometimes fish	Diver	Multiple recent breeding records within Solent[2]. Also winter visitor and passage migrant.
Common scoter *Melanitta nigra*		Coastal	Bivalves such as mussels, clams and cockles. Periwinkles, *Hydrobia* and other crustaceans	Diver	Winter visitor and passage migrant.
Great-crested grebe *Podiceps cristatus*		Coastal	Feeds on a variety of small freshwater and marine fish species	Pursuit diver	Breeds at freshwater lakes in the region and recorded on the sea in sheltered coastal areas year-round.
Little grebe *Tachybaptus ruficollis*		Coastal	Varied diet, but predominately small aquatic invertebrates. Will also feed on fish.	Pursuit diver	Recorded on freshwater and sheltered, inshore coastal water bodies in the region.
Black-necked grebe *Podiceps nigricollis;* red-necked grebe *Podiceps grisegena;* slavonian grebe *Podiceps auritus*		Coastal waters	Feed on insects and fish	Pursuit diver	Winter visitors in low numbers

1. Woodward *et al.* (2019); 2. Birdlife International (2024); Holden and Gregory (2021); 3. Birdlife International (2024); Holden and Gregory (2021); Natural England (2024a); 4 Birdlife International (2024); Holden and Gregory (2021); Camphuysen and Webb (1999); 5. BTO (2024); BTO (2013); Austin *et al.* (2017); Natural England (2024a); Wilson *et al.,* 2014; Lake and Rush (2023); NBN (2024); Going Birding (2024); Burnel (2021); Personal communication RSPB.

Table 19. 2023 Seabird totals for Solent count regions – apparently occupied nests (AON) and productivity (where known) (note: no data available for Isle of Wight, but numbers known to be relatively low)

Count regions (known totals)	Black-headed gull		Mediterranean gull		Sandwich tern		Common tern		Little tern	
	AON	Productivity	AON	Productivity.	AON	Productivity.	AON	Productivity.	AON	Productivity
Hurst to Lymington and North Solent NNR	4,170	No record	34	No record	267	1.12	166	0.60	20	1.25
Southampton Water to Portsmouth	163	No record	0	-	0	-	20	No record	0	-
Langstone Harbour	4,148	0.50	2,184	0.57	217	0.58	88	0.06	13	0.15
Chichester Harbour	146	0.24	0	-	0	-	41	0.29	2	0.50
Manhood Peninsula (includes Pagham Harbour)	18	0.00	0	-	0	-	2	0.00	22	0.06
All Solent Totals (known; productivity where recorded)	**8,645**	**0.50**	**2,218**	**0.57**	**484**	**0.90**	**317**	**0.39**	**57**	**0.59**

Source: data extracted from spreadsheet provided by RSPB

Other seabirds

The only cliff nesting seabirds (other than gulls) known to breed in the Solent region occur on the Isle of Wight. The main seabird nesting site on the Isle of Wight is around the Needles rocks and nearby headland, with approximately 300 guillemots (individuals) and 50 cormorants (AON) recorded during recent nesting counts (BTO, 2024b).

In the wider region, seabirds also nest around the Purbeck coast (Dorset), and may forage in the Solent region. Guillemot is the most abundant seabird along the Purbeck coast with over 1,100 individuals counted in 2023 (Lake and Rush, 2023). This piscivorous feeding species forages over an extensive area (with a mean maximum foraging range of 73.2 km ±80.5 km from colonies reported in Woodward *et al.,* 2019). In addition, small populations of razorbill (approximately 150 birds), as well as lower numbers of shag (22 AON), northern fulmar (28 AON), and cormorant (15 AON) and a few nesting puffin were also recorded nesting along the Purbeck coast in 2023 (Lake and Rush, 2023).

While the seabird population numbers occurring along the Purbeck coast and on the Isle of Wight are small in a national context, they are nevertheless considered regionally important given the low numbers of cliff nesting species breeding more widely along the South Coast.

Northern fulmar and northern gannet have very large foraging ranges (with a mean maximum foraging range of 542.3 km (±657.9 km) and 315.2 km (±194.2 km) respectively from colonies reported in Woodward *et al.,* 2019). No northern gannets breed in the region (with the nearest colony located at Alderney in the Channel Islands) and only small numbers of northern fulmar (as described above). However, given the extensive foraging ranges of these species, individuals from breeding colonies outside the region are likely to forage in the area which is reflected in relatively frequent but widely scattered sightings of these species in the Solent region during the breeding season (Going Birding, 2024; NBN, 2024; Waggitt *et al.,* 2020; Dunn, 2012).

Seabirds including northern fulmar, guillemot, northern gannet and cormorants are also frequently recorded foraging at sea during the non-breeding season in the wider South Coast region (BTO, 2013; Dunn, 2012; Holden and Gregory, 2021; Going Birding, 2024; NBN, 2024; Waggitt *et al.,* 2020).

Divers, grebes and ducks

Divers (family Gaviidae) are piscivorous waterbirds, preying on a variety of small fish such as clupeids, sandeel and small gadoids by undertaking pursuit diving (Holden and Gregory, 2021). Red-throated diver, black-throated diver and great-northern diver are all recorded wintering in the Solent region in low numbers (typically observed as individuals or small groups < 5 birds) and are widely distributed with no areas in the region which are known to support particularly high-density wintering populations in a national context compared to known important areas such as the outer Thames Estuary or Liverpool Bay (BTO, 2013; Holden and Gregory, 2021; Going Birding, 2024; Woodward *et al.,* 2024).

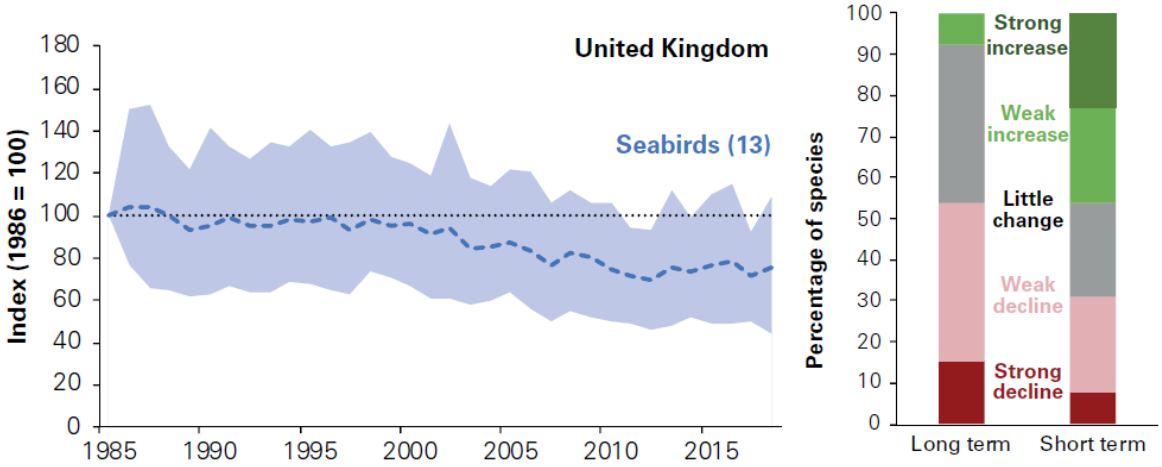
Grebes are also commonly recorded in the region with great crested grebe the most abundant species. This species breeds on lakes and other inland habitats in the region with great crested grebe recorded foraging on the sea year-round with large aggregations of over 50-100+ individuals observed in some areas such as Southampton Water and Langstone Harbour during the winter months. The little grebe is commonly recorded in sheltered, inshore areas such as upper estuaries, channels, and lagoons as well as freshwater habitats such as rivers and lakes. Other grebes such as black-necked grebe and slavonian grebe are also recorded in very low numbers in the region during the non-breeding season (BTO, 2013; Holden and Gregory, 2021; Going Birding, 2024; Woodward *et al.,* 2024).

Small wintering flocks of eider and common scoter are also recorded relatively frequently in the region but in low densities compared to some other areas of the UK where large aggregations of thousands of birds can occur (such as Carmarthen Bay, Liverpool Bay and the Moray Firth for common scoter and Morecambe Bay or the Forth Estuary for eider) (BTO, 2013; Holden and Gregory, 2021; Going Birding,

2024; Woodward *et al.,* 2024). These seaducks undertake diving to capture molluscs such as mussels and clams as well as crustacea (Holden and Gregory, 2021). The red-breasted-merganser (a piscivorous seaduck from the sawbill family) is frequently recorded foraging in inshore, sheltered locations in the region such as estuaries, lagoons, and bays during the winter months (such as Chichester Harbour, Portsmouth Harbour and Langstone Harbour where peaks of over 50-100 birds can be recorded) (Holden and Gregory, 2021; Woodward *et al.,* 2024).

Trends

Regarding seabird trends, historic data in the Solent is often inconsistent or incomplete[29]; however, it is believed that the Solent is broadly following national trends. UK wide, the seabird indicator, which is based on abundance trends for 13 of the 25 seabird species breeding in the UK, shows that since the late 1990s, breeding numbers of seabird species have declined by 28%, on average. This decline appears to have stabilised during the last five years. These trends are illustrated in Image 22. Notable declines have been seen in lesser black-backed gulls and herring gulls in particular (Burns *et al.,* 2020).



(Source: Burns *et al.,* 2020)

Image 22. UK wild bird indicator for breeding seabirds in the UK, 1986 to 2019

Condition

As noted above (Section 2.2.2), condition assessments have to date been undertaken for two of the Solent's SPAs, Pagham Harbour and Portsmouth Harbour[30]. Only Pagham Harbour's Dark-bellied Brent Goose feature is considered to be in favourable condition. Little tern (Pagham), ruff (Pagham), red-breasted merganser (Portsmouth) and dunlin (Portsmouth) were judged to be 'unfavourable declining', black-tailed godwit (Portsmouth) 'unfavourable recovering' and 'dark-bellied brent goose' (Portsmouth) as 'unfavourable no change' (see Table 7 above). Four reasons for the unfavourable condition status were given across the features, with reduction in abundance mentioned for seven of the features, followed by disturbance caused by human activity (n=4), supporting habitat: water quality – nutrients (n=4) and extent and distribution of supporting habitats (n=3).

Erosion of roosting and breeding sites, as well as these becoming too low (due to them not keeping pace with sea level rise) is a known issue in the Solent. This is particularly an issue with the remaining isolated, and thus undisturbed and relatively predator free, saltmarsh islands (and associated shingle

[29] For this reason, the RSPB are undertaking a review of the available data and are also increasing supporting wider monitoring to fully understand the Solent population as part of the Solent Seascape Project.

[30] There are furthermore condition assessments for some of the bird features of some of the SSSIs; some bird features of these SSSIs have been assessed as being in unfavourable condition (please see relevant table in Appendix A for more information): Brading Marshes to St. Helen's Ledges, Chichester Harbour, Eling and Bury Marshes, Hythe to Calshot Marshes, Hythe to Calshot Marshes, Lincegrove and Hackett's Marshes, North Solent, Pagham Harbour, Portsmouth Harbour, and Thorness Bay.

cheniers) of the Solent which affects breeding birds especially (e.g. ABPmer, 2022). In 2023, 87% of seabird adults on nest were breeding on the marine saltmarsh and shingle islands of the Solent (especially sandwich tern, black-headed gull and mediterranean gull). Two island complexes are particularly important for this; the Boiler/Pylewell island in the Lymington area accounted for 27% of apparently occupied nests in 2023, and South Binnes island in Langstone Harbour for 45 %.

Disturbance and predation also often devastates colonies. For example, fox predation in 2021 led to a substantial reduction at the Normandy/Cockleshell black-headed gull colony in 2022 (from over 2,000 to just over 50 pairs), though numbers subsequently recovered to about half of the pre-predation numbers in 2023 (as evidenced by the 2023 data collected by the RSPB). In the last few years, bird flu (Highly Pathogenic Avian Influenza) has also emerged as a major threat to all marine birds, but breeding seabirds in particular. In Hampshire, black-headed gulls and common and sandwich Terns all appear to have been severely impacted (Hampshire Ornithological Society, 2023).

2.4.3 Marine mammals

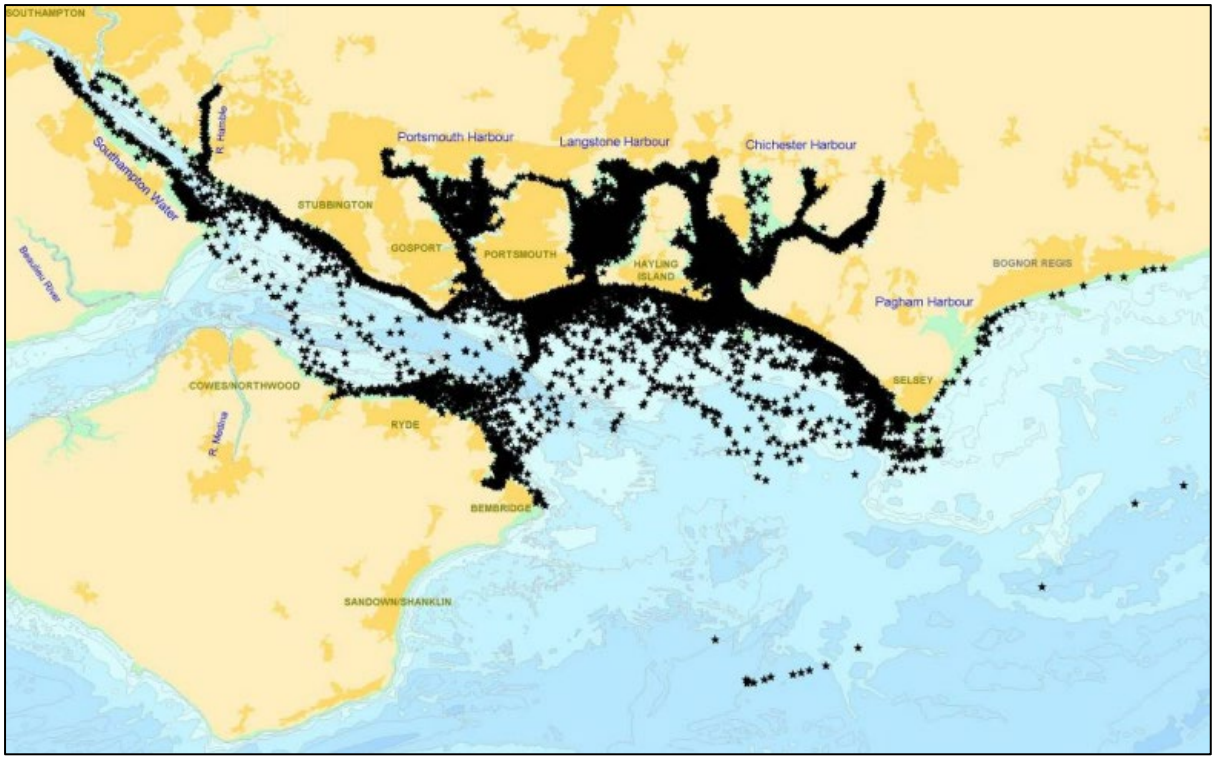
The Solent is home to a small colony of common seals; apart from that, other mammals pass through but are not residents. All the marine mammal species recorded in the region would feed on small fish such as sandeels, cod, mackerel, herring, and sprat as well as squid (Emu, 2012). Seals are now firstly discussed, before the occurrence of other mammals is summarised.

Seals

The Solent region is home to a population of approximately 80 harbour seals (also known as common seals), with haul out sites in Langstone Harbour, Chichester Harbour, and Newtown Harbour (Chichester Harbour Conservancy, 2024). Chichester Harbour is where harbour seals were first reported to have recolonised the region in 1994, with the population continuing to increase ever since.

A study by Chesworth *et al*. (2010) investigated the movement of tagged harbour seals within the Solent region. This determined that, at the time of the study (when the population was estimated at around 25), two haul-out sites were regularly used by this seal population, one in Langstone Harbour and one in Chichester Harbour. Both haul-out sites were used on a more or less daily basis, but Chichester Harbour was used by a higher density of seals (Chesworth *et al.,* 2010). The study also found that the tagged seals predominately foraged in the Eastern Solent, between Southampton and Selsey Bill, often near the haul out sites in Langstone and Chichester Harbour. Visits were also made across to the Isle of Wight (northern coast only), and some limited offshore movements occurred (with one of the five tagged harbour seals) (see Image 23).

Data recorded between 1997 and 2019 reveals sightings of harbour seals throughout the Solent and Southampton Water. Grey seals were also spotted hauling out in Chichester Harbour in recent years, with a peak of 30 grey seals being recorded in 2023 (Chichester Harbour Conservancy, 2024). August is typically when the largest number of both species haul out, with the higher number of grey seals potentially being attributed to their travels through the area on route to breeding sites ahead of the reproductive season. Both harbour and grey seals can also be spotted regularly hauling out in Newton Harbour (Isle of Wight), with numbers substantially increasing over the past ten years (Isle of Wight Natural History and Archaeological Society, 2023). There is evidence of harbour seals exhibiting site fidelity to Chichester Harbour, with 25% re-sighted across three years during a study by Castles *et al*. (2021).

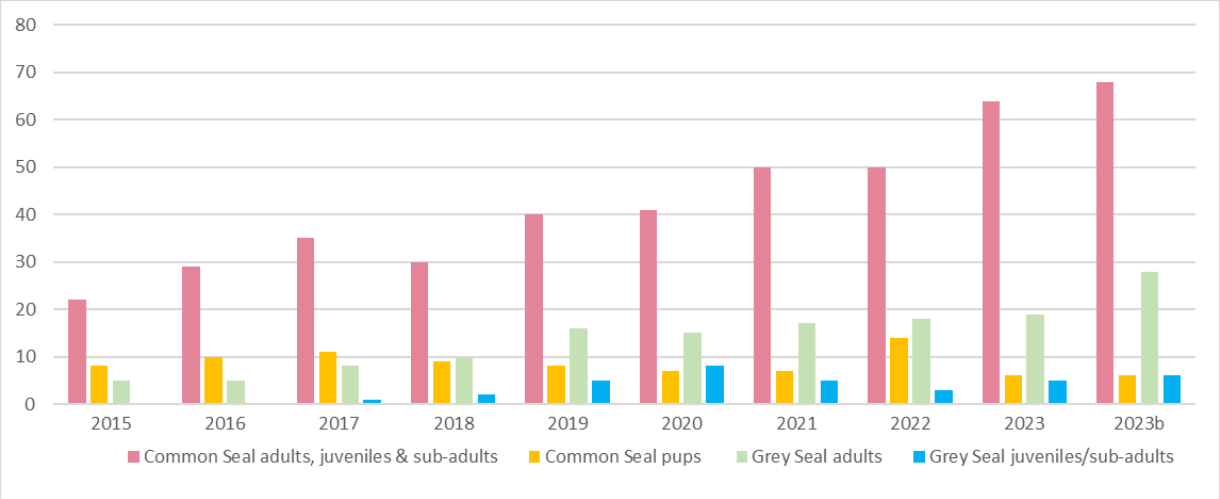


(Source: Chesworth *et al.,* 2010)

Image 23. Map showing all GPS positions for all five harbour seals tracked during 2010 Solent Seal tagging project

Chichester Harbour serves as a pupping site for the local harbour seal population, with pups typically being born from late June to late July. Over the past nine years, the number of pups has varied between six and 14, with 2022 seeing the highest number of births (n=14) to date. In 2023, one harbour seal pup was counted in Langstone Harbour for the first time (Chichester Harbour Conservancy, 2024). In addition, in March 2024, a grey seal pup was born on the Beaulieu River in 2024, in what is believed to be the first of its kind in the Solent (BBC, 2024b).

Image 24 below displays the combined peak counts of seals in Chichester and Langstone Harbours from 2015 until 2023, with the addition of Newton Harbour in 2023 (shown as 2023b in the figure). The group with the highest numbers across the Harbours is the 'common [harbour] seal adults, juveniles and sub-adults' followed by the 'grey seal adults'. It is worth noting that the search area within Chichester Harbour was extended in 2016, and consequently more seals were observed. The counts are done between May and September, with usually eight surveys per summer. In 2023, the highest peak count in Chichester Harbour was 42, in Langstone Harbour, this was 8 and in Newtown Harbour 10 were spotted at most. It is worth noting that, to arrive at population estimates, the Seal Management Research Unit recommends a scaling factor of 0.72, hence a population estimate of 81 individuals (with a range of 66 to 107) was made for harbour seals by the Chichester Harbour Conservancy (2024).



(Created by ABPmer based on spreadsheet supplied by Chichester Harbour Conservancy)

Image 24. Combined peak counts for Chichester and Langstone Harbours 2015 to 2023 (2023b are values including Newtown Harbour counts for 2023)

Cetaceans and other marine mammals

The central part of the English Channel, which incorporates the Solent region, hosts a relatively low diversity and density of cetaceans (McClellan *et al.,* 2014; Gilles *et al.,* 2023; BEIS, 2022; Seawatch Foundation, 2024; NBN, 2024).

The bottlenose dolphin is the most spotted cetacean species in the region and is restricted mainly to coastal waters. Since the early 1990s, a small population resident to the coast of South West England has been documented (Brereton *et al.,* 2018; Corr *et al.,* 2023). This population is estimated to contain around 48 individuals and is a discrete interconnected group that does not seem to mix with conspecifics nearby or in other regions (Corr *et al.,* 2023). They are mostly found to range between North Cornwall and Dorset, however, increased sightings around Sussex combined with a coincidental decrease in Cornwall may indicate a shift in range or an expansion (Corr *et al.,* 2023). This new range is reflected in the update to the Coastal West Channel Management Unit, which now extends from Padstow in North Cornwall to Eastbourne in East Sussex (Inter-Agency Marine Mammal Working Group, 2023).

Harbour porpoise and common dolphins have also been occasionally recorded within the central English Channel region, and the Solent (BEIS, 2022; Seawatch Foundation, 2024; NBN, 2024; Gilles *et al.,* 2023; Heinänen and Skov, 2015; McClellan *et al.,* 2014).

Leatherback turtle is the only sea turtle species that is believed to undertake deliberate, seasonal migratory movement to UK waters to feed on gelatinous zooplankton prey (such as the jellyfish *Rhizostoma octopus*). While the species has been recorded in the English Channel, sightings are generally rare, particularly in the Solent region.

Trends

Seal numbers have generally been increasing nationally, and in the wider North-East Atlantic, though there can be substantial year on year fluctuations (Banga *et al.,* 2023). In the Solent, the seal population, as noted above, has been steadily increasing, with a resident Harbour seal population now estimated to have a population of 80 individuals.

With regard to other mammals, these only visit the Solent on occasion, but are not residents. Generally, nationally, whales and dolphins have apparently shown little change in average abundance since the early 1990s (Burns *et al.,* 2023)'.

(Copyright: Andrew Pearson)

Image 25. Bottlenose Dolphin

2.4.4 Fish

The intertidal and shallow subtidal habitats in the Solent provide food and shelter for resident fish populations and seasonal visitors, as well as juvenile fish. Migratory fish also pass through on their way to and from the rivers, notably Atlantic salmon, eel, and sea trout. The following sections review the baseline fish resource in the study area:

- Finfish;
- Migratory fish;
- Elasmobranchs; and
- Shellfish.

Finfish

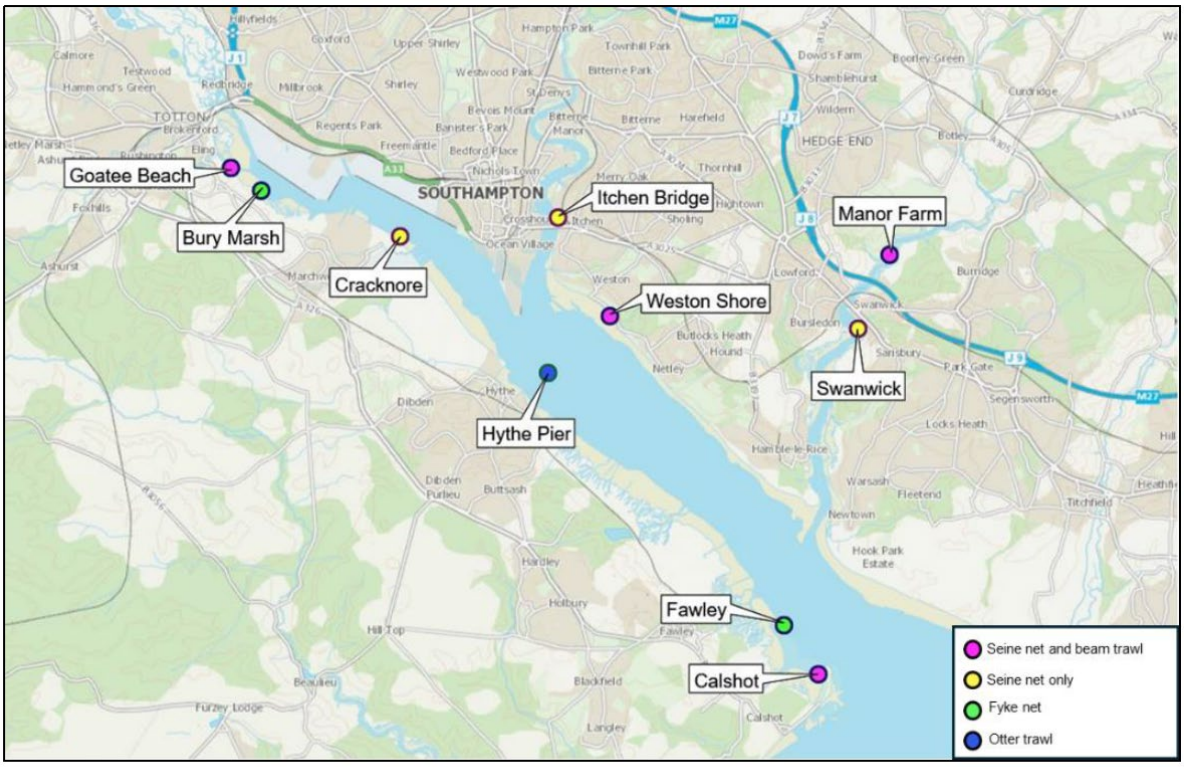
A detailed analysis of annual historical seine net data has recently been undertaken by the University of Portsmouth (in collaboration with the Southern and Sussex IFCAs, Environment Agency, Chichester Harbour Conservancy and Langstone Harbour Board) (Morrall *et al.,* 2024), comparing data from 390 hauls across 11 years and 14 estuarine sites (Image 26). Across the survey years (2007 to 2018), 53 species were observed, and over 130,000 individuals in total. Clupeidae (herrings, shads, sardines, menhadens) were the most abundant family group, comprising 31% of the total count, followed by Atherinidae (silver sides / sand smelt) (30%) and moronidae (bass) (Image 26).

(Source: Morrall *et al.,* 2024)

Image 26. Sites studied by University of Portsmouth (and others) (left) and diversity results (right)

The Environment Agency furthermore collects annual estuarine fish monitoring data (as part of the TraC programme) at ten sites within Southampton Water using a variety of survey techniques (Environment Agency, 2021). Please note that there is no further fish TraC monitoring elsewhere in Solent (although other similar surveys take place on a regular basis[31]). Image 27 shows the location of these ten sites, coloured according to the types of survey carried out at each location. Blue markers are seine net and beam trawl surveys, yellow markers are seine net surveys, green markers are fyke net surveys and the purple marker is the autumn otter trawl (Environment Agency, 2018).

Data for the past five survey years was downloaded for this report, and results for the total catch of different species between 2017 and 2023 are shown in Image 28. No surveys took place during 2020 and 2022 (and the autumn of 2019) due to COVID-19 and resource availability. Image 28 illustrates that the most commonly recorded species caught in these surveys were sea bass, sand smelt, gobies (common goby; sand goby), herring, mullet, (thick lipped, thin lipped, grey and golden grey), Dover sole, and pouting.



(Source: Environment Agency, 2024a)

Image 27. TraC fish monitoring locations in Southampton Water

[31] This includes: three sites in Langstone Harbour (undertaken by Langstone Harbour Board and University of Portsmouth; 2017 onwards); four sites in Chichester Harbour (Chichester Harbour Conservancy with Sussex IFCA), and several sites in the Solent (surveyed by the Southern IFCA).

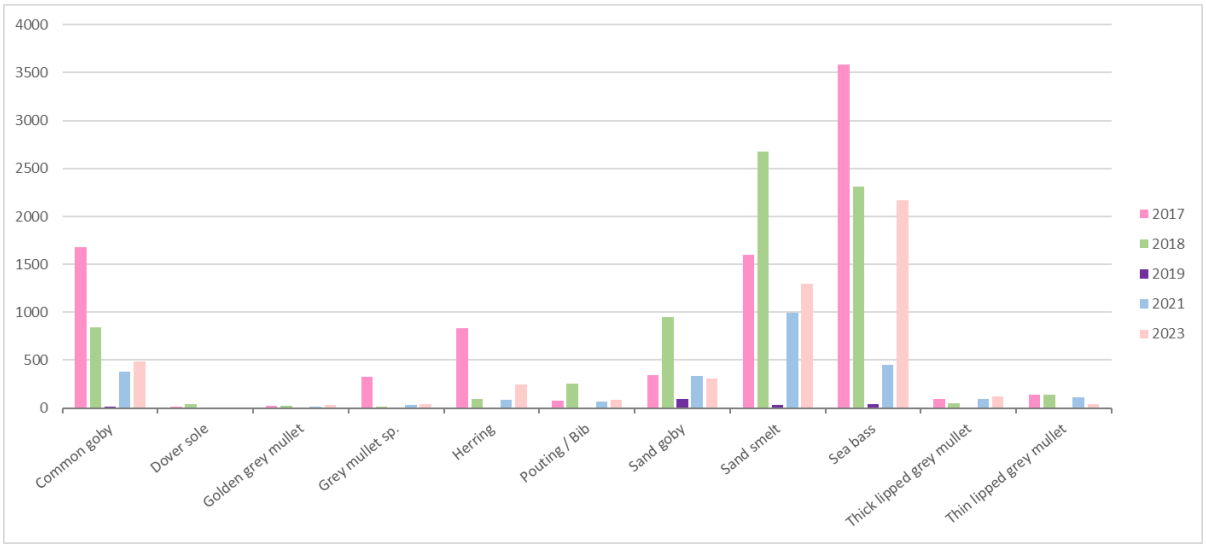


Image 28. Total annual catch (2017 to 2023) of the 11 most frequently caught species during TraC monitoring for sites in the inner section of Southampton Water

Results from the 2023 survey indicate that, whilst the total catch size (n=4,216) was below the long-term (2007 onwards) average (μ=5,306.86), it was greater than the previous autumn surveys in 2021. The number of species caught in 2023 (n=21) slightly exceeded the mean for all survey years (μ=18.5). Sea bass dominated the catch with exceptionally high numbers, as also evidenced in Image 28. Total catch has fluctuated over the years, and was often found to be positively correlated with the average summer sea surface temperature (i.e. the warmer the sea, the more fish are caught); though there have been exceptions, with potential explanations noted by the report to include '*too much commercial removal, or the survey area may have recently been dredged (a regular occurrence in the Solent*') (Environment Agency, 2024a).

A notable observation in 2023 was the number of Pacific oysters that had colonised hard substrate at Cracknore Hard; these were described as considerably higher than seen in previous years and caused difficulty with hauling the seine net. Furthermore, a long-snouted seahorse was caught at Hythe Pier, which was estimated to be around two years old. This is considered to be the first confirmed adult long-snouted seahorse in Southampton Water (Environment Agency, 2024a).

Away from the estuaries and harbours, more fish species will be observed. Recent analysed data is relatively sparse however, despite numerous regular surveys being undertaken by Cefas and the IFCAs for example (e.g. juvenile fish surveys by IFCAs, Cefas annual beam trawls (mostly offshore, but one station in eastern Solent)). The South Coast region is, however, known to support a diverse array of bottom-dwelling and pelagic fish and shellfish. Among the most characteristic are black sea bream, plaice, smoothhound shark, mackerel, sprat (also known as whitebait), brown crab (also known as edible crab) and squid (Emu, 2012).

The Solent region is considered a spawning ground for the following important species by Cefas (Ellis *et al.*, 2012; Coull *et al.*, 1998):

- Dover sole (all, high intensity);
- Cod (all, low intensity);
- Plaice (Eastern Solent and Chichester Harbour only);
- Lemon Sole (middle and eastern Solent, with Portsmouth, Langston, Chichester and Pagham Harbours; no intensity specified);
- Sprat or whitebait (all; no intensity specified); and
- Sandeel (all, low intensity) (sandy substrate only).

Nursery grounds are identified for these species by Cefas (Ellis *et al.,* 2012; Coull *et al.,* 1998):

- Mackerel (western edges of Solent only, low intensity);
- Plaice (all, low intensity);
- Lemon Sole (middle and eastern Solent, with Portsmouth, Langston, Chichester and Pagham Harbours; no intensity specified);
- Sprat or whitebait (all; no intensity specified); and
- Dover sole (all, low intensity).

Generally, inshore areas are home to many juvenile fish, not restricted to the above important species. For example, young bass, mullet, herring, and flounder have been caught in the Medmerry managed realignment (Environment Agency, 2019). Juvenile black sea bream, which move from spawning grounds in the Owers region of the Sussex coast, are known to be present in the Solent (Emu, 2012).

The Solent contains the following protected bass nursery areas (where prohibitions are in place at sensitive times of the year):

- Chichester Harbour;
- Langstone Harbour;
- Portsmouth Harbour;
- Southampton Water (with Itchen and Hamble, excl. area south of a line drawn between Hook and the Fawley refinery); and
- Fawley Power Station

There are strong seasonal patterns to the presence of many of the fish found in the Solent. For example, seaward migration of sea bass occurs in the autumn as they move to offshore pre-spawning and spawning areas to the south and west of the UK (Aprahamian and Barr, 1985). In the summer, bass tend to move back into shallow inshore warmer waters (Pawson and Pickett, 1996). Mackerel similarly tend to move inshore in the spring, from deep offshore water where they winter; they tend to be closest to the coast from June to September, to feed on smaller fish and plankton (Wild Foodie, 2023).

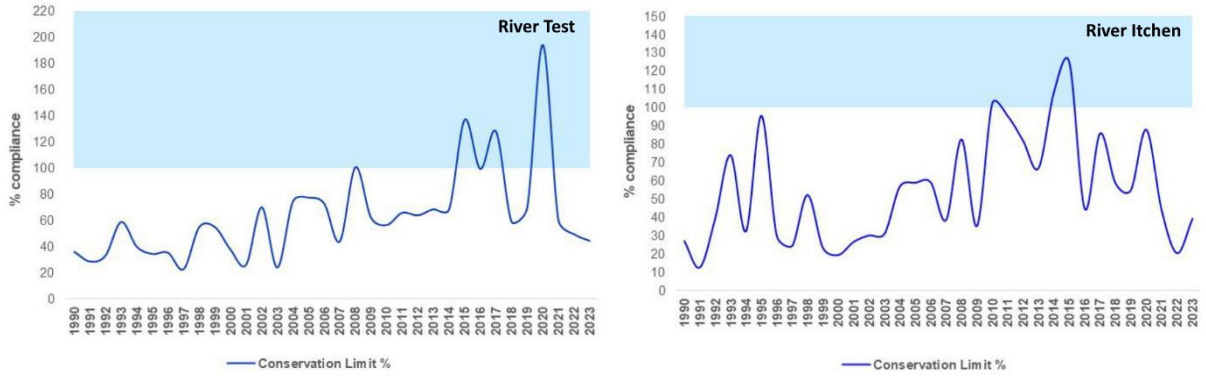
Migratory fish

The Solent is used by important and threatened runs of migratory fish like salmon and sea trout as a gateway to and from spawning grounds in the Rivers Test, Itchen, Meon, Hamble, and other streams.

Atlantic salmon and sea trout are anadromous fish species, migrating upstream from the sea to breed. They are thought to swim near the surface during migratory runs (Moore *et al.,* 1998), and adults display a strong behaviour to return to natal rivers. Salmon only migrate to two rivers in the Solent, the Itchen and the Test. They pass through Southampton Water, firstly as juveniles (smolts) migrating to sea, and again as adult salmon returning to the river to spawn. Similar movement patterns are observed by sea trout, which are found in many rivers of the Solent, most rivers which contain brown trout will also host sea trout, provided that there are no significant obstructions to the sea. For example, all the New Forest and Isle of Wight rivers are known to be home to spawning sea trout, as is the River Meon. Obstructions are believed to inhibit migration on the rivers Wallington (Fareham) and Lavant (which flows into Langstone Harbour south of Havant) (Environment Agency specialist, personal communication).

Comprehensive information on salmon and sea trout numbers along the Rivers Test and Itchen is collected via various means, including underwater video, electric fishing, walking surveys and fish counters. The report for 2023 noted that *'the numbers of returning salmon on both rivers were only slightly better than in 2022 but still very far below the respective Conservation Limits'* (as illustrated by Image 29). This was considered to be of acute concern, because, in contrast with 2022, river flows had remained at or above average throughout the summer and there had been an expectation of a strong

run. The report notes that elevated temperatures, depleted dissolved oxygen and the presence of pollutants are likely to be limiting factors, especially during periods of low river flow. The continuous stream of effluent from the major Sewage Treatment Works (STW) at Portswood was also highlighted as problematic; with the report noting that '*analysis of effluent quality and estuarine water quality in the vicinity of the works in 2023 provide strong evidence that the discharge affects dissolved oxygen and ammonia to an extent likely to impact the behaviour and welfare of returning adult salmon, particularly in combination with hot weather and low river flow*'. For salmon on the Test and Itchen, stock assessment classification of "At Risk" has been determined, and with the anticipation that they will remain in this category in five years' time (Environment Agency, 2024a).



(Source: Environment Agency, 2024b)

Image 29. Salmon conservation limit compliance at the rivers Test and Itchen

The December 2024 salmon counter update report (Environment Agency, 2025) highlights the importance of juvenile salmon conservation in the salmon recovery in the Test and Itchen, noting that there was 'a clear and achievable opportunity' to increase the likelihood of salmon recovery in these rivers by avoiding 'any form of unnecessary disturbance whatsoever in the critical January to June, egg-to parr period', whilst keeping in mind that 'even after June, young of the year parr are always present and always sensitive to disturbance'.

Sea trout have seen an increasing trend over the past 20 years, on both the Test and the Itchen (Environment Agency, 2024a). 2023 saw further increases, and indications for 2024 are for a boom in numbers; this is likely related to above average river flows in combination with a cool spring. Sea trout trends in the Solent contrast strong declining trends elsewhere in the country, and the reasons are not well understood (Environment Agency specialist, personal communication).

River lamprey and sea lamprey are known to migrate to the rivers that feed the Solent to spawn. Their abundance is however thought to be very low, and there are only occasional observations, for example in the Rivers Test and Itchen (Environment Agency specialist, personal communication). As part of the salmon and trout monitoring, the Environment Agency also note records of lamprey. No adult river lamprey have been recorded in the Test or Itchen in fish surveys, on the fish counters or during spawning surveys, so it is assumed that river lamprey are absent, or at least extremely scarce in these rivers. Sea lamprey have been observed (and filmed) spawning in the Test and Itchen in recent years, but very infrequently (Environment Agency, 2024a).

Twaite shad are only very sporadically seen, e.g. one individual was caught during a TraC survey at Calshot a few years ago. Historically, and anecdotally, the Test may have been a shad spawning ground (Environment Agency specialist, personal communication). One individual was also caught in 2023 during a survey in Chichester Harbour (University of Portsmouth, personal communication).

Eels and flounder are two further migratory fish species that have been recorded in Southampton Water. In contrast to salmonids, they are both catadromous species i.e. migrating to the sea to breed.

Eels are also thought to be present in most rivers of the Solent region which are unobstructed (Environment Agency specialist, personal communication). Eels breed in the Atlantic Ocean southeast of Bermuda and the post-larvae cross the Atlantic changing into elvers in British coastal waters. Elvers migrate into estuaries and rivers during late winter and early spring and adult eels leave the rivers and coastal area in late summer and autumn. Eels are understood to follow the saltwater/freshwater interface and move close to the riverbank during strong river currents. Eel index monitoring is undertaken by the Environment Agency on the River Itchen in the Solent region. This reveals a continuing decline, and decreased reach of these species, such that they are now very scarce in the upper reaches of the Itchen. All length categories have furthermore progressively declined, suggesting a loss of mid-aged and older eels. Survey data in 2019 and 2022 indicated slight improvements in juvenile eel numbers, but these were not apparent in the 2023 data (Environment Agency, 2024a).

Flounder is a common and widespread flatfish species found in estuaries and sandy rivers throughout the UK. Adult flounder migrate from the rivers through the estuarine brackish and marine waters out to sea to spawn. Juvenile fish are known to be common close inshore, entering estuaries at an early age and using incoming tides to help them move upstream (e.g. Skerritt, 2010).

Elasmobranchs

The Solent and Isle of Wight area has been highlighted as a shark and ray hotspot and provides a pupping ground for smoothhound, tope and possibly thresher shark (Solent Forum, 2024a). The area also provides a nursery ground for several other shark and ray species, including thornback and undulate ray (low intensity) and tope shark (low intensity, mostly western Solent) (Ellis *et al.,* 2012).

Smoothhound are thought to congregate in the East Solent in large numbers between May and August as part of breeding cycle. Thornback skate/ ray are believed to be widespread throughout South Coast region, and are found on muddy, sandy or gravelly substrate. Tope shark breed between May and September and are believed to congregate in the Eastern Solent in large numbers between May and August as part of breeding cycle (Emu, 2012).

Shellfish

The Solent supports a wide range of shellfish species, including important commercial species typical to the UK such as whelk, king scallop, lobsters, crabs, and cuttlefish. Cockles and clams (particularly Manila clam) are common along the region's sandy beaches and muddy estuaries (Solent Forum, 2024a; Emu, 2012). As outlined in Section 2.3.5, it used to be home to extensive oyster beds, but the population collapsed in the late 2000s (though individuals are still found throughout the Solent, and various restoration efforts are ongoing (see Section 4.2)). Pacific oyster beds (an invasive species) can be found throughout the Solent (see Section 2.4.7 for more detail).

Common lobster are considered to be abundant along most English shorelines, including the Solent. Common whelk are widely distributed throughout the region, with important areas off the east of the isle of Wight. The Solent is believed to be a cuttlefish spawning area (Emu, 2012). Brown crab nurseries occur throughout the shallow coastal waters of the region. Large scale movements occur, with many females moving west or southwest without returning to the region (e.g. Bennet and Brown, 1983); Coull *et al.* (1998) highlighted a crab nursery for the whole Solent, which no intensity specified. East of the Isle of Wight, during late July to December there is an area known as the 'hen crab run' and a spawning area, active from September to December (e.g. Emu, 2012).

Trends

Invaluable insights into fish trends in the Solent's estuaries and harbours have been gained from the recently completed University of Portsmouth study discussed above. This shows that there has been a significant decline in fish abundance in the Solent region over the study period (2007 to 2018), with most sites having seen decreased total fish abundance. A declining trend in marine migrants '*could be attributed to decreasing numbers of Golden Grey mullet*'. Bass seems to go against this trend, with numbers having substantially increased at most sites (Morrall *et al.,* 2024).

Regarding migratory fish, as noted above, salmon are subject to an ongoing declining (if fluctuating) trend, with the only stock in the region, on the Itchen and Test, considered to be considered at risk. Eel numbers have seen a dramatic decline, with no indications of recovery, with a continued loss of mid-aged and older eels indicated (Environment Agency, 2024a). Sea trout numbers are the only migratory fish with increasing (and possibly) booming numbers, contravening national trends.

Nationally, the 2023 UK State of Nature report acknowledged that, generally, there was a lack of understanding on changes in species' abundance and distribution in UK seas. The report did however summarise that '*well-monitored species of demersal fish (those living on or near the seafloor, 105 species) showed an average increase in abundance during the 1990s and early 2000s but have since declined.* The report also stressed that limited information existed regarding most non-commercial fish populations in UK waters, and the trends observed in commercial stocks needed to be evaluated in the context of overfishing which had generally occurred occurring since at least the 1880s (Burns *et al.,* 2023).

2.4.5 Invertebrates

The benthic habitats of the Solent are home to a large number of benthic invertebrates, with generally low species diversity but potentially high biomass. Community insights can mainly be gained from various surveys undertaken for development impact assessment studies, as comprehensive analysis of public sampling (e.g. for WFD) does not tend to be publicly available.

In Southampton Water, many sampling campaigns have taken place over the years in connection with various port developments and dredging campaigns. Intertidally, the most abundant taxa have tended to be the ragworm, the mud scud crustacean, and the molluscs common cockle and mud snail. The studies found that surface grain size had the greatest influence on the nature of the benthic assemblage present on the seabed. The muddy habitat patches along the western shore of Southampton Water and in the Test, Itchen and Hamble Estuaries were defined by the presence of mud snails, ragworms, furrow shells and tellin clams, all of which are found commonly in soft substrata and often in black-muddy sand under brackish conditions. A mixed muddy sand habitat patch between Marchwood and Hythe was defined by the presence of cockles, which are associated with sandy mud, sand, or fine gravel (ABPmer, 2012). A different patch at Marchwood consisting of soft muddy and sandy mud sediments with some gravel and shell debris was found to be predominantly characterised by nematodes (roundworms), oligochaetes (mostly sludge worms) and polychaetes (worms such as *Tharyx* spp. and *Mediomastus fragilis*). Other species included the furrow shell *Abra tenuis*, dwarf brittle star and common shrimp (ABPmer, 2023a). A sandy habitat patch along the eastern shore of Southampton Water was defined by the presence of terebellid worms, which prefer sandy beaches and muddy sand. The species that were consistently found to dominate the subtidal sediments were catworms and terebellid worms. Catworms are polychaetes that lives infaunally in muddy sand in the intertidal and shallow sublittoral, as well as amongst gravel, rocks, and occasionally in Zostera beds (ABPmer, 2012).

In Chichester Harbour, benthic invertebrate surveys undertaken as part of the Itchenor beneficial use scheme revealed that the foreshore at this location had a paucity of invertebrate species, with two to nine species observed across the 14 stations visited over two years. Upper shore sites in particular were profoundly dominated by the mud snail, with modest numbers of the furrow shell *Abra tenuis*. Lower down the shore, the assemblage was slightly richer, but there were still comparatively low numbers of

taxa and individuals in this area. Away from the upper shore, the assemblages were slightly richer at middle shore sites, with species including nepthys polychaetes (including catworms), and deposit feeding annelid worms *Ampharete acutifrons* and bristleworm *Pygospio elegans,* which have adaptable/flexible feeding strategies. Lower mudflat shore sites were again dominated by the furrow shell *Abra tenuis* and mud snail (ABPmer, 2023b). Invertebrates of nature conservation note were listed in Section 2.2 above; these included Lagoon Sand Shrimp, the native oyster, the Defolin's Lagoon Snail and ragworms / Nereididae.

Photos of *A. tenuis* (top left), *Tharyx* spp. (top right), *Streblospio shrubsolii* (bottom left) and mud snail *P. ulvae* (bottom right) Precision Marine Ltd, from ABPmer (2013)

Image 30. Invertebrates images

Condition

The 'status' of benthic invertebrates is assessed as part of the government's regulatory water body assessments under the WFD Regulations 2017. The results of a review of the latest (2022) assessments for the TraC waterbodies in the study area are summarised in Table 20, with the ratings for both the invertebrate status and infaunal quality index[32] shown.

Table 20. 2022 invertebrate assessments for study area WFD water bodies

Classification	Invertebrates	Infaunal quality index
High	None	None
Good	Pagham, Beaulieu, Portsmouth, Langstone, Solent, Southampton Water, Chichester Harbour,	Pagham, Beaulieu, Portsmouth, Langstone, Solent, Southampton Water, Chichester Harbour,
Moderate	Western Yar, Medina, Newtown estuary,	Western Yar, Medina, Newtown estuary,
Poor	None	None
Bad	None	None
Not assessed	Lymington, Eastern Yar, Wootton Creek, Langstone Oysterbeds, Sowley Marsh, Old Mill Ponds, Black Water Lagoons, Great Deep	Lymington, Eastern Yar, Wootton Creek, Langstone Oysterbeds, Sowley Marsh, Old Mill Ponds, Black Water Lagoons, Great Deep

(Source: Environment Agency, 2022)

This reveals that the invertebrate communities of most of these waterbodies in the study area (where these have been assessed) are considered to be at 'good' or 'moderate' status. All these judgments/statuses were unchanged from the previous (2019) assessment.

[32] This is based on three metrics evaluating taxa number, sensitivity to disturbance, and evenness / distribution. Each metric is calculated based on a ratio of the observed value to that expected under reference conditions.

2.4.6 Plankton

The waters of the Solent and Southampton Water hold a rich planktonic flora and fauna. Plankton comprise a wide range of organisms which live at least part of their lives drifting in the water column. Their size ranges from that of a single bacterium to big jelly fish. The Solent Protection Society (2020) noted that, in Southampton Water, plankton includes millions of larvae of crustaceans which, as adults, live on the sea floor as crabs and prawns. This includes for example the larvae of the mantid shrimp or burrowing prawn and the long-clawed porcelain crab. In early summer, these larvae are remarkably abundant in the plankton. Planktonic worms can also be found, including for example, the *Myrianida edwarsi*.

Invasive larvae which have been observed include the skeleton shrimp, *Caprella mutica*, which, only recently entered the Solent's waters from Japan, likely on the hull of shipping. Another invasive species commonly observed in the Solent's plankton is the Pacific pycnogonid or sea spider *Ammothea hilgendorfi* (Solent Protection Society, 2020).

Please note that other non-native species are further discussed in the next sub-section below. Trends
The latest OSPAR quality status report presents data on phytoplankton indicators (based on biomass derived from satellite remote sensing data). An indicator of phytoplankton biomass reveals that certain North Atlantic regions have experienced increases over the past six decades. Variations in diatoms and dinoflagellates, which are two essential groups of phytoplankton that support marine food webs, are linked to alterations in trophic pathways and carbon cycling. Small copepods, a category of zooplankton that serve as vital prey for larval fish, have exhibited long-term increases in abundance in many coastal regions, but not the Solent. Additionally, the population of planktonic larvae, such as sea urchins and crustaceans, has risen in most regions, correlating with increasing sea temperatures. This includes the Solent, and another plankton category. Large copepods appear to also have seen modest increases in this region. Weak decreases are mapped for the Solent for the four other plankton categories, dinoflagellates (phytoplankton), diatoms (phytoplankton), small copepods and holoplankton (zooplankton).

2.4.7 Invasive species

Biological invasions by Invasive Alien Species (IAS) represents a threat to biodiversity everywhere, including the Solent, which is noted as a key entry point for IAS into the UK due to its high volumes of international shipping and recreational boating. IAS pose a threat to the Solent's native biodiversity and fishery industries, especially shellfisheries, due to their potential to threaten native species, habitats, or whole ecosystems. As noted in Section 2.3.5, the Solent was once home to one of the largest self-sustaining populations of native oysters in Europe; however, the growing prevalence of the invasive slipper limpet was one of the contributing factors to their decline. Additionally, the invasive carpet sea squirt is present in the region and poses a risk of spreading beyond marinas and harbours. This species can smother habitats with dense, sheet-like growths, thereby disrupting both fishery and aquaculture activities. A 2020 to 2022 project on behalf of Natural England sought to summarise available data on IAS and involved a series of rapid assessment surveys at 14 marina sites and 28 shore sites (Taylor *et al.,* 2022). This was financed by a European Maritime Fisheries Fund (EMFF) grant.

A total of 36 distinct IAS were identified, with 30 located in marinas and 35 along the shores. Notably, around 13 AS, for which there are currently no shore records in the Solent according to the NBN Atlas, were observed. These included the bryozoan *Watersipora subatra*, which has already established significant populations on shores further west in England, as well as the colonial ascidian (sea squirt) *Didemnum vexillum*, recognized nationally as a considerable threat to both economic interests and native biodiversity. The bryozoan *Tricellaria inopinata* and the colonial sea squirt *Botrylloides diegensis* were found to be prevalent and common along the Solent shores (e.g. Image 31). Certain well-established IAS, such as the brown seaweed and the Pacific oyster (Image 32), raised concerns at some

specific locations, while the colonial sea squirt *Didemnum vexillum* and the Asian date mussel were judged to have the potential to reach problematic levels in the near future (Taylor *et al.,* 2022).

(Source: Taylor *et al.,* 2022; Map imagery: Google Earth, © 2019 TerraMetrics)

Image 31. **Marina records of the alien sea squirt Botrylloides diegensis from previous marina surveys (pale blue), plus new marina records (mid-blue) and new shore records (red)**

(Source: Taylor *et al.,* 2022; Map imagery: Google Earth, © 2019 TerraMetrics.)
Small circles indicate Rare- occasional abundance, medium circles indicate Frequent-common, large circles indicate Abundant-superabundant; split small circles indicate both species present as Rare-occasional.

Image 32. **Occurrence (live) and estimated abundance of the pacific oysters (red) and native oysters (green), at surveyed shore and marina sites in the Solent**

It is worth noting that Pacific oyster is considered to be present (and often prolific) in many other locations across the Solent, with the NBN atlas showing dozens of records, and many anecdotal observations of this IAS being made elsewhere (e.g. Environment Agency, 2024a). In addition, as noted in Section 2.3.2, *Spartina anglica* (now strictly speaking reclassified/named as '*Sporobolus anglicus*') is classed as an IAS by some (and a 'neonative' species by others).

Trends

No data analysis is available on invasive species trends in the Solent. In the North East Atlantic, the latest OSPAR status report indicates that many species are still being introduced, though rates of new records being recorded have decreased since this indicator had first been reported on in the early 2000s. Just under 40 new IAS were recorded between 2015 and 2020 in the wider North Sea and English Channel region, which the Solent falls into (Stæhr *et al.,* 2022).

3 Activities and Pressures on the Solent's Nature

3.1 Overview

Various activities exert pressure on marine and coastal ecosystems, including shipping and port operations, dredging and the extraction of aggregates, fisheries, and aquaculture, as well as offshore developments. Additionally, leisure and tourism activities, along with flood and erosion control measures, can also have significant effects. Moreover, the housing, infrastructure, and agricultural practices necessary to sustain the population contribute to both direct and indirect impacts on the coastal and marine environment. Certain activities, such as agriculture, which influence the quality of coastal and marine waters, may originate from land-based sources, often occurring far upstream within river catchments. Effective management and regulation of these activities can facilitate a balance between their impacts and the benefits they provide (e.g. Environment Agency, 2023a).

The Solent is one of the busiest waterways in the world, with freight and passenger ships frequenting several ports in the region, with Southampton and Portsmouth being the busiest, and Southampton Port being widely recognised as the capital of the country's cruise industry. The Solent's marine industry sector contains a wide diversity of businesses ranging in scale from the large-scale commercial operations at Southampton and Portsmouth down to small boatyards. With a large population and thousands of businesses, the Solent area is a well-recognised functional economic area anchored around the Isle of Wight, the two cities of Portsmouth and Southampton, the M27 corridor and the Solent waterway. Recreational water sports are very important to the region, with sailing being long established, and paddle sports and wind sports having grown in popularity recently.

Further detail on some of these aspects is provided below, with Section 3.2 summarising population numbers and trends, Section 3.3 discussing the various activities that take place, and their potential impacts on nature. Section 3.4 provides detail on pollution and Section 3.5 discusses climate change.

3.2 Population

Information from the 2021 census reveals that the Solent has a population of just under 1.3 million, as derived by summing the population numbers from the nine unitary authorities along the Solent. The population of all the neighbouring counties adds up to 2.7 million people, and the latest numbers and trends when compared to the previous census are shown in Table 21. This reveals that population increases have been seen in all these counties, with those of West Sussex growing the most, by almost 9% between 2011 and 2021, and the Isle of Wight seeing only modest increases of just under 2%.

Table 21. Population numbers and trends (when compared to 2011 census) for the counties neighbouring the Solent

Category	Hampshire	Isle of Wight	Southampton	West Sussex
Resident Population (Female)	718,300 (+6.1%)	72,600 (+2.3%)	123,500 (+5.5%)	455,300 (+8.4%)
Resident Population (Male)	687,800 (+5.9%)	68,300 (+1.2%)	124,200 (+4.0%)	429,800 (+8.9%)
Resident Population (Total)	1,406,100 (+6.0%)	140,900 (+1.8%)	247,700 (+4.8%)	885,000 (+8.6%)

(Source: Nomis, 2024)

3.3 Activities and their potential impacts on nature

The individual sub-sections below provide more detail on the key activities taking places in the Solent, discussing in turn: shipping and navigation (Section 3.3.1), industry and military (Section 3.3.2); flood risk management (Section 3.3.3); fisheries (Section 3.3.4), and recreation (Section 3.3.5). Potential impacts on nature from these are summarised in Section 3.3.6.

3.3.1 Shipping and navigation

Ports are vital to the UK economy, with 95% (by volume) of all imports and exports transported by sea. In the Solent, activity centres on the ports of Southampton and Portsmouth. Cowes Harbour is the main port for the Isle of Wight, and the only location on the Island with deep-water channels capable of handling bulk-cargo carrying ships. The twentieth century has seen a progressive growth in the scale of port operations in both Portsmouth and Southampton, associated in many cases with reclamation of intertidal land. The expansion of the ports industry is driven by trends in the world market for shipping, which are essentially governed by market forces, the demands of the ship operators, and the supply within the ports. Commercial services offered by the ports include providing moorings, marinas and boatyards, events, storage, maintenance and repair, property leasing, fuel provision, pilotage and ferry services (Solent Forum, 2024a).

Associated British Ports (ABP) is the statutory harbour authority for the port of Southampton, whereas the harbour authority for Portsmouth Harbour and the Eastern Solent is the King's Harbour Master. ABP and the King's Harbour Master co-operate in administering shipping movements within the Eastern Solent with ABP taking a co-ordinating role. ABP, Portsmouth International Port and Cowes Harbour Commissioners are the designated Competent Harbour Authorities (CHA) for the Solent waterway[33]. All pilotage of commercial ships is undertaken by pilots licensed by the respective CHA. There are close liaison arrangements between the three CHAs and the King's Harbour Master Portsmouth over pilotage and navigational safety matters. The smaller harbour authorities within the Solent carry similar responsibilities for ensuring navigational safety and close working relationships exist between them and the larger authorities.

Portsmouth is the main 'short sea' ferry port in the Solent region; in 2023, just under 1.3 million passengers travelled through here; this is 30 % less than in 2013. Portsmouth has ferry services to Caen, Le Havre, Cherbourg Octeville, Saint Malo, Bilbao, and Santander. These all carry both passengers and vehicles.

Domestic ferry services in the region include the car ferries between Southampton and Cowes, the Portsmouth and Fishbourne, and Lymington to Yarmouth. Passenger services furthermore run between Portsmouth and Ryde and Southampton and Cowes, amongst others (there are several smaller ferries across estuaries/harbours).

Southampton terminals handle a large range of vessel movements in any given year; between 2009 and 2023, total movements ranged between 43,000 (2020, low due to Covid pandemic) and 70,000 (ABPmer, 2023c). Port ship arrival trends at the Solent's three main ports since 2009 are illustrated in Image 33. Please note that many more ship and vessels movements take place throughout the Solent on a regular basis, as many vessels do not have on board monitoring equipment.

[33] CHAs are those harbour authorities that have been given statutory powers relating to the provision of pilotage in their waters. In the wider Solent study area, the following bodies are CHAs within their respective areas: Chichester Harbour Conservancy, Cowes Harbour Commissioners, Isle of Wight Council (Newport), Langstone Harbour Board, Lymington Harbour Commissioners, City of Portsmouth.

(DfT, 2024)

Image 33. Port ship arrivals from 2009 at Cowes, Portsmouth and Southampton

In addition to freight, Southampton is an important cruise ship calling point; in fact, it is the main such port in the UK, with over 80 % of the nation's cruise traffic typically passing through Southampton. For example, in 2023, 87% of the cruise traffic passed through Southampton, with passenger numbers of 2.6 million observed (Department for Transport (DfT), 2024). This was surpassed in 2024, when Southampton welcomed a record-breaking three million cruise passengers (Daily Echo, 2025).

Shipping intensity to and from these ports is high, with most of the traffic exiting and entering the Solent to the east, via the Nab Channel, though substantial traffic also navigates through the Needles Channel which lies between the western tip of the Isle of Wight and the mainland (Figure 9).

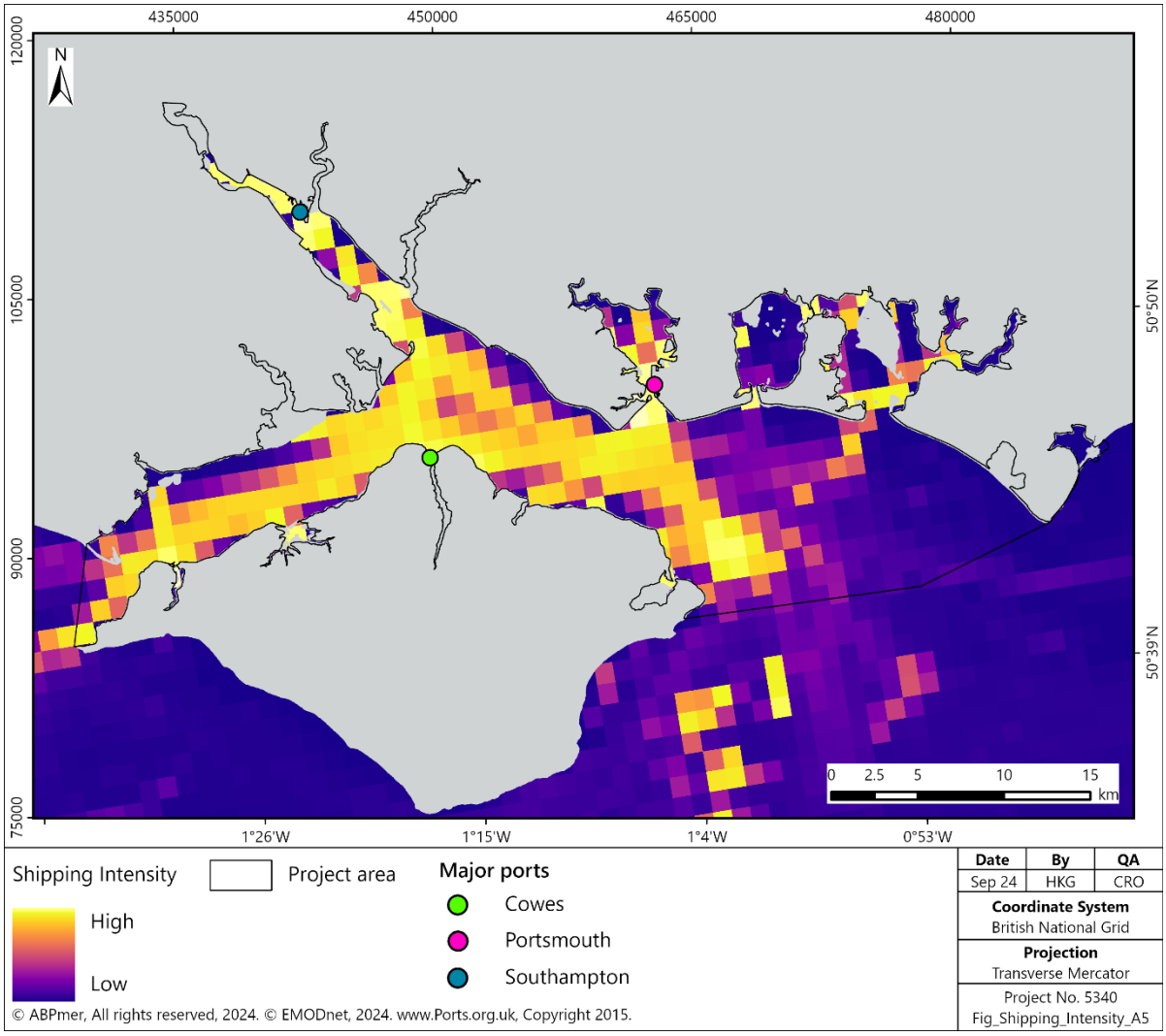


Figure 9. Shipping intensity in the Solent region

Dredging for navigation impacts substantial proportions of the marine environment in the Solent. Active marine navigational dredging licences in the region are shown in Figure 10; more sites will have been dredged in the past (and may again in the future), as a lot of navigational dredging is on a sporadic/as needed basis. Dredge arisings are mostly deposited at offshore disposal sites, of which there are several in the wider region; the most utilised open site is the Nab Tower site, which lies east of the Isle of Wight. Between 2012 and 2022, just over 15,500,000 wet tonnes were deposited here. In the west of the Solent, the Hurst Fort deposit ground is currently mainly used for small dredge volumes from dredge locations in the West Solent. Between 2012 and 2022, just over 370,000 wet tonnes were deposited here. The Needles disposal site is the third offshore disposal site for the ports and harbours of the Solent; this currently receives some of the dredge arisings from Yarmouth and Sparkes Marina in Langstone Harbour. It is used relatively rarely, with just under 11,000 wet tonnes deposited here between 2012 and 2022 (ABPmer, 2024b). Dredged sediments can be used beneficially to reshape shorelines and to protect and restore coastal and estuarine habitats such as mudflat and salt marsh. However, only a very small percentage of the dredged sediment is used that way, although the Solent is home to a relatively high number of such projects (see Section 4.2 for more detail).

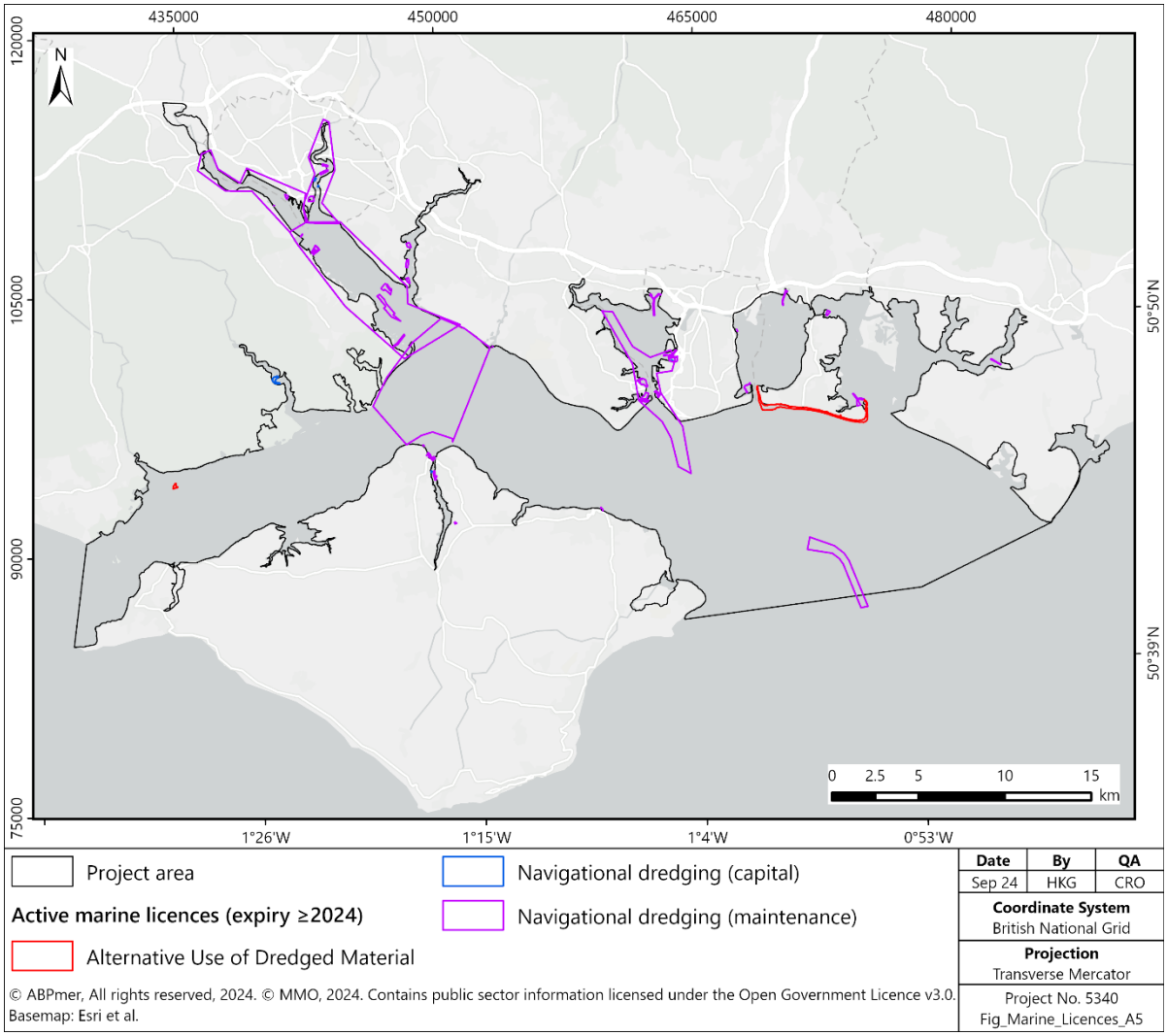


Figure 10. Active marine navigational dredging licences in the region (i.e. those with permission at present)

3.3.2 Industry and military

There are many marine industries in the Solent, often related to the shipping and navigational activities in the region, as well as the fact that the Solent is an internationally renowned location for sailing and other water sports.

The petrochemical industry is of particular importance to the region, with the largest refinery in the UK being located at Fawley on Southampton Water. This facility processes around 270,000 barrels of crude oil a day and provides 20 per cent of UK refinery capacity. Over 2,000 ship movements are handled by Fawley refinery every year. The 1.5 km marine terminal has nine berths, which handle the movement of the ships and 22 million tonnes of chemicals and crude oil per annum. A pipeline runs under Southampton Water from the Fawley oil refinery to supply the BP fuel terminal at Hamble (Solent Forum, 2024a). The latter receives around 25,000 barrels of crude oil each day from a pipeline from BP's Wytch Farm onshore oil field in Dorset (over 90 km away). This terminal also acts as an important hub for the transportation of oil and refined products. Refined products reach the terminal by ship and pipeline and are then distributed to customers by road tanker, ship, and pipeline. In between arrival at the terminal and subsequent distribution, both crude oil and refined products are stored in a series of large tanks (Solent Forum, 2024a).

(Copyright: Susanne Armstrong)

Image 34. Fawley refinery, as seen from Titchfield

Mapping reveals that there are several other underground cables and pipelines in the region. This includes three long distance subsea cables: the IFA2 HVDC C1 and IFA2 HVDC C2 power cables, and the IFA2 Fibre optic telecoms cable. Furthermore, various cables run between the mainland and the Isle of Wight, including six power cables from Hook to Lee on the Solent, and two telecoms cables from Portsmouth to Ryde (Figure 11).

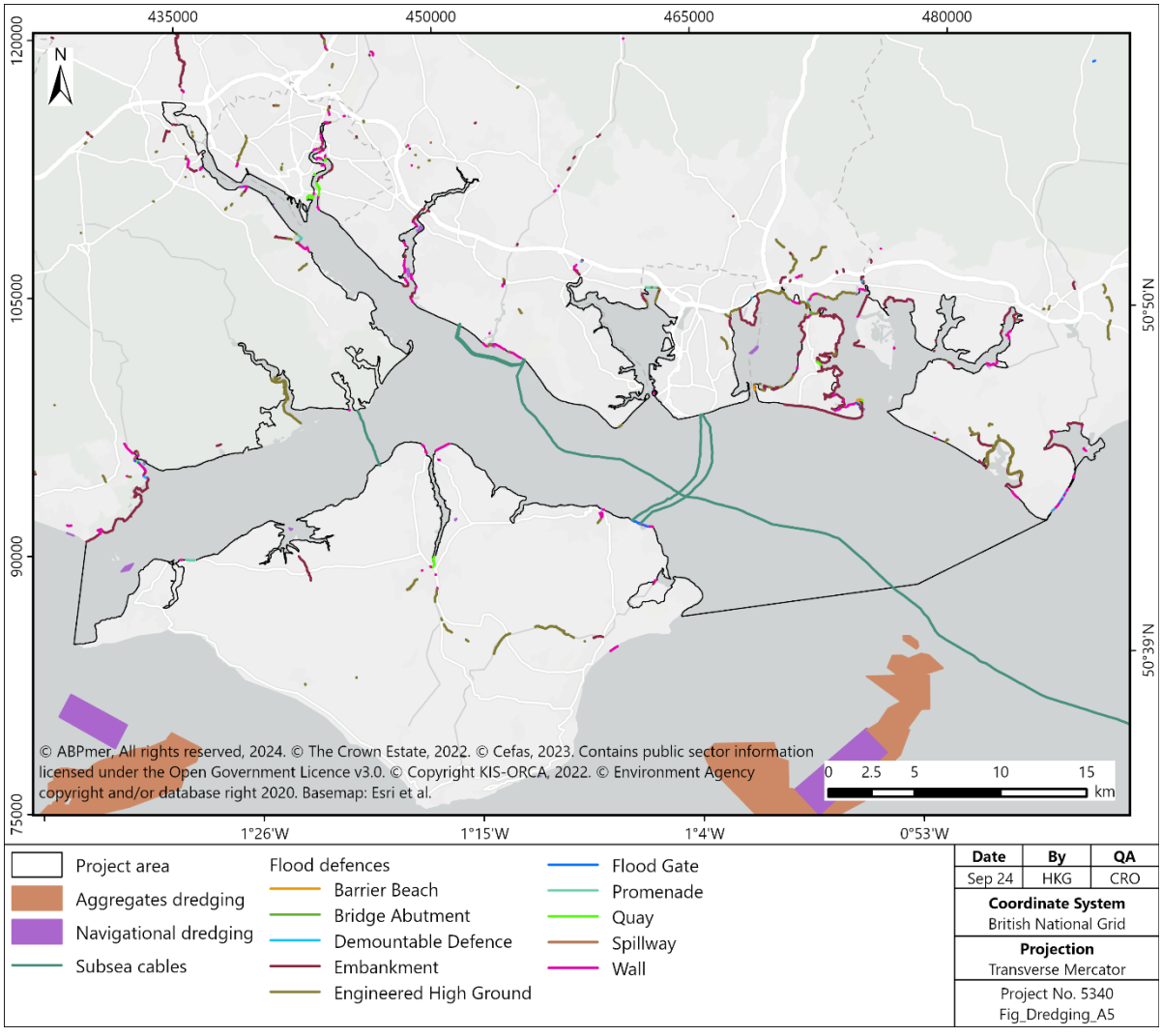


Figure 11. Aggregates dredging, cables and flood defences in the study area

There are no renewable energy projects within the Solent region itself, with the nearest being the Perpetuus Tidal Energy Centre off the south coast of the Isle of Wight, and the Rampion offshore wind farm that lies south of the Sussex town of Lancing. A demonstrator phase of the Perpetuus project is fully consented and hoping to produce 20 MW by 2026 (Perpetuus, 2024). The Rampion wind farm is fully commissioned (as of 2018), and an application for a 1,200 MW extension of this windfarm was submitted in August 2023 (Rampion 2 Wind Farm, 2024).

Marine aggregates dredging takes place near the Solent, but not within the project area itself; 16 licensed marine aggregates areas can be found West of the Isle of Wight, East of the Isle of Wight and in the Owers region (Figure 11). These target relict marine sands and gravels, and around 4 million tonnes tend to be extracted every year; most of the material is utilised by the construction industry, though substantial amounts were also (most years) used to nourish the South Coast's beaches. Most of the aggregate from the region is landed at wharves in the South Coast Region, with Southampton, Cowes and Portsmouth being key wharf locations. For example, in 2023, 58.3% (2.4 million tonnes) was landed within-region, and the majority of the remaining aggregate was delivered to London / the Thames Estuary (24.6% / 1 million tonnes) (The Crown Estate and British Marine Aggregate Producers Association, 2024).

Regarding defence interests, military use of the Solent is of substantial economic importance to the region, and centres primarily on the naval base at Portsmouth Harbour and Marchwood Military Port. Portsmouth Harbour is the traditional home of the Royal Navy, is the base port for the majority of the Navy's surface warships, including aircraft carriers, and is also the major naval stores distribution centre in the UK. Military activity is well established around the harbour and includes the maintenance and building of ships in the Naval Base, helicopter maintenance at Fleetlands, fuelling operations at Clarence Yard and ordnance storage and distribution at the Gosport Armament Depot. The Defence Diving School is on Horsea Island, there is a firing range at Tipner and a training establishment on Whale Island which also accommodates the Fleet Headquarters (Solent Forum, 2024a).

3.3.3 Flood risk management

The construction of hard defences around parts of England's coast has provided coastal communities, farmland, and infrastructure with valuable protection from flooding and erosion (Environment Agency, 2023a).

Around 45% of the Solent's shoreline is defended with hard defence structures. Coastal defence techniques frequently involve groynes and breakwaters, often backed by concrete seawalls, with less exposed frontages in the estuaries and harbours generally protected by earth embankments (Figure 11).

Operational management responsibility of coastal protection structures lies largely with District and Unitary Councils; however, the Environment Agency is responsible for taking a strategic overview of the management of all sources of flooding and coastal erosion in England. Many defences are furthermore privately owned. Organisations with responsibilities and interests in shoreline protection along the south-central coast of England formed the Standing Conference on Problems Associated with the Coastline (SCOPAC) in 1986, providing a forum for debate on the difficulties relating to coastal defence and protection.

Numerous flood and erosion risk management programmes are underway or in development in the region, including for example the Hurst Spit to Lymington Flood and Coastal Risk Management Strategy, which is currently being discussed and due to be completed and approved in 2026 (Hurst Spit to Lymington Strategy, 2024[34]). Additionally, the Southsea Coastal Scheme, the UK's largest local

[34] Environment Agency, 2024f: Hurst Spit to Lymington Strategy:: https://www.hurstspit2lymington.co.uk.

authority-led coastal defences project, is also being implemented in the area, with a budget exceeding £180 million. Its completion is anticipated for 2027 (Southsea Coastal Scheme, 2024). Various other schemes are ongoing in/around Portsmouth, including also the North Portsea Coastal scheme.

As noted previously, coastal squeeze losses to internationally protected habitats anticipated in relation to public flood risk management schemes must be compensated for in line with the requirements of the Habitats Regulations, with a dedicated programme in place and several schemes completed and being planned in the region (see Sections 2.3.7 and 4.2.3).

3.3.4 Fisheries

Commercial

Fisheries constituted 0.03% of UK economic output between 2018 and 2020. Although a relatively small part of national output, it is an important part of local economies (Environment Agency, 2023a). England's South Coast region supports a diverse and highly accessible coastal fishery in easy reach of a number of sheltered harbours that targets a range of high value fisheries. The region is split into two fishery management areas: Southern IFCA and Sussex IFCA; the Southern IFCA is responsible for the vast majority of the study area. The IFCAs are responsible for managing fisheries in the Solent region, and various byelaws are in place to support sustainable fishing, both to protect stocks and sensitive habitats and species. Further detail on byelaws can be found in Section 4.1.4.

A variety of static and mobile fishing gear is used across the region, targeting a range of high value seasonal fisheries, principally Dover sole, plaice, bass, whelk, king scallop, lobster, brown crab and manila clam (Sussex IFCA, 2022; Southern IFCA, 2022). The local fleets have the ability to diversify and be versatile in nature, responding to changes in market conditions, changes to targeted stocks or changes in environmental conditions.

Most of the fleet is multi-purpose, operating throughout the year in pursuit of a large variety of species based on seasonal availability. For example, sole are fished in the spring and autumn, bass are targeted in the summer and cod in the winter. These smaller inshore vessels use a variety of static and mobile gears. Gill, trammel and entangling net fishing takes place across of the region (though net fishing is heavily restricted by IFCA byelaws). Other methods include trawling, beam trawling, pair trawling, drift netting, and dredging (for clam/cockle and king scallop). There is also an important fishery potting for whelk, lobster and brown crab and a cuttlefish trap fishery (Sussex IFCA, 2024).

The Solent region falls into ICES Rectangles 30E8 and 30E9. In 2022, total landings into UK ports from these ICES rectangles amounted to 3,416 tonnes equating to almost £10 million (Marine Management Organisation (MMO), 2022) (Table 22).

Table 22. Landings volume and value by ICES rectangle in 2022

ICES Rectangle	Weight (t)	Value (£)
30E8	1,086	4,136,463
30E9	2,330	5,117,095

Source: MMO 2022

In the Southern IFCA area, shellfish account for the top five most caught commercial species in the Southern IFCA District with the greatest landings attributed to whelk at over 1,700 tonnes in 2021. Bass and sole are two of the most commercially targeted species of fish. In 2021, 91 tonnes of bass and 89 tonnes of plaice were caught within the District (Southern IFCA, 2022). Table 23 shows a summary of the top five species landed by weight and value; much of this will have been landed outside of the Solent, however; Solent specific data is not available.

Table 23. Top five species by value landed in the Southern IFCA District in 2021

Species	Live Weight (t)	Value (£)
Whelks	1,778	1,919,334
Mussels	380	586,800
Clam	374	1,273,913
Scallop	291	587,346
Crab	256	1,016,957

Source: Southern IFCA, 2021

The following table shows fishing vessels registered at ports in the Solent study area, as well as their size, comparing 2015 data with the latest 2024 data. This demonstrates that Portsmouth is the key fishing port in the region, and that most vessels are less than 10 m in size. When compared to 2015, registered fishing vessels have almost halved.

Table 24. Fishing vessels (and size) registered at ports in the study area of study

Home Port	January 2015		December 2024	
	≤ 10 m	> 10	≤ 10 m	> 10
Isle of Wight	31	2	11	0
Bembridge	0	0	1	1
Cowes	4	0	3	0
Keyhaven	4	0	1	0
Lymington	13	2	0	1
Southampton	11	3	9	1
Hamble	0	0	2	0
Langstone Harbour	5	0	2	1
Portsmouth	49	9	38	3
Hayling Island	7	0	0	0
Emsworth	4	0	2	0
Itchenor/East Wittering	1	0	2	0
Total		**145**		**78**

(Source: MMO, 2024)

With regard to employed gear types within the project area, low intensity netting takes place mainly in the Eastern Solent, including Bracklesham Bay (historically in Chichester Harbour). Potting is undertaken throughout the Solent, but less so in the harbours and estuaries, and highest intensities are observed in offshore areas outside of the Solent region itself. Potting activity is intense along the wider South Coast region, targeting crab, lobster and whelk. Trawling has historically been seen in Langstone and Chichester Harbours, as well as the eastern Solent, but now mostly takes place offshore. Historically, shellfish dredging (oysters and clam) was observed at high intensities in many locations of the Solent, including along the north Solent, north west coast of the Isle of Wight, the western shore of Southampton Water, as well as most of Portsmouth, Chichester and Langstone Harbours. Recently, activity is much reduced, but still observed in some of these locations, notably Southampton Water, the Eastern Solent (between Ryde and Portsmouth especially), Portsmouth and Langstone Harbours, and the Emsworth Channel of Chichester Harbour (Emu, 2012; Sussex IFCA, 2024; Southern IFCA, 2024b).

Hand gathering

Hand gathering encompasses both bait digging (for fishing), mainly by recreational anglers (for ragworm, for example), and the collection of clams, cockles or other bivalves (incl. pacific oysters) for consumption. These activities are generally only allowed for personal use/consumption in most locations, but illegal collection (once sold) is believed to take place in several locations; this can,

however, be difficult to prove[35]. Bait diggers typically use a garden fork to turn over the sediment to then pick worms out by hand (e.g. Image 35). A bait collector's code is in place in the Solent (SEMS, undated).

For the purpose of this project, consultation with harbour authorities and other relevant authorities has been undertaken to map bait digging and intertidal gathering hotspots in the Solent; the resulting datalayer is available on the data viewer[36].

This consultation, and available research, has revealed that bait digging is widespread throughout the Solent, with hotspots found in Chichester Harbour (Fishbourne Channel especially), Portsmouth Harbour (Fareham Creek) and the Hamble for example. The collection of bivalves for consumption is particularly pronounced in Chichester Harbour, where it is of concern in the Bosham and Prinstead areas for example (pers. comm., Chichester Harbour Conservancy). A byelaw has been submitted to the Secretary of State to help tackle this issue, but this has not yet been signed off (see Section 4.1.4 for more detail on byelaws).

(Source: River Hamble Harbour Authority)

Image 35. Bait diggers on the Hamble

Research by the University of Portsmouth (Watson *et al.*, 2016) at three Solent sites utilising remote closed circuit television (CCTV) cameras to monitor collectors, revealed that activity at the sites varied widely over the course of the two-month study period. Three sites were studied; Fareham Creek, Portsmouth Harbour; Dell Quay, Chichester Harbour and Pagham Harbour. No activity was recorded at Pagham Harbour during the study, whereas Dell Quay saw a lot of frequent activity; 3.14 collectors per tide on average, with up to 14 collectors recorded during one tide. Individuals were found to dig for up to 3 h per tide, although intensity differed seasonally and between sites. Watson *et al.* (2016) estimated that collectors removed on average around 1.4 kg of ragworm per person per hour (just under 230 worms), walking a considerable distance across the intertidal sediment to reach areas that were usually already dug (up to 1.6 km). The area affected was described as being fairly small; with cumulative area affected (as observed during the two-month survey period) at both Dell Quay and Fareham Creek being measured as 16 ha. Based on the estimated harvesting figures, annual removal rates of 4.9 t were estimated for Dell Quay, and 0.8 t at Fareham Creek, with lower values at the latter reflecting lower average visit numbers and duration. The annual fisheries value for Dell Quay and Fareham Creek combined was estimated as approaching £200,000 (around £270,000 in 2024, when adjusted for inflation). The authors also posited that most of the bait digging took place in previously dug areas,

[35] Commercial bait digging is not necessarily illegal, it requires landowner permission and, in SSSIs for example, consent as an activity.

[36] There is also an ongoing project in the Solent, for which results are not yet available: the Total Ecosystem Management of the InterTidal Habitat (TEMITH) project, which aims to determine the feasibility of using Earth Observation technology to provide the key information for evidence-based decision making by stakeholders (led by the University of Portsmouth).

which might seem counter-intuitive, but may be explained by the remaining smaller worms facing reduced competition and also recolonisation from the subtidal. The authors did caveat that '*it must be recognized that repeated digging can lead to local depletions and those fisheries that collect polychaetes from the subtidal region will be more vulnerable to over collection*'. Whilst many collectors apparently spent considerably longer periods digging than might be expected for personal use, given that worms can be stored for relatively long periods (several weeks), the authors considered it impossible to separate personal from commercial collection.

Recreational fishing

The South Coast region has a well-established and popular recreational fishery due to its population density, as well as good accessibility and numerous sheltered areas. It attracts recreational shore and boat anglers all year round, the vast majority of which are line anglers. Many marinas, ports and harbours support numerous smaller boats which are used by casual hobby fisherman. Marinas, harbours, breakwaters, piers and beaches also offer easily accessible shoreline fishing areas. Fishing is undertaken from vessels both at anchor and whilst drifting over wrecks, reefs and banks. Drifting is generally performed from February through to July.

The Sussex IFCA (2024) notes that, offshore, the Sussex District*:*

> *'contains 'marks' that are nationally recognised as offering a unique angling experience. These include, but are not limited to, an area known as 'Utopia'; famed for tope fishing; 'The Overfalls' (just outside the 6 miles limit), popular for bass angling (both of these sites are in the eastern Solent) and a bream nesting area near 'Kingmere' offshore from Littlehampton. The offshore angling experience is facilitated by a flotilla of small privately owned craft, numerous angling club boats and a good number of professional charter angling boats'.*

Sea angling is important throughout the region and it is estimated that there are 40,000 active sea anglers around the Solent (MMO, 2014). Southern IFCA (2013) reported that there were 50 angling clubs within the Southern IFCA district, over half of which (27) are most popular for sea angling. It also reported that there were 90 known charter boats in 2012; in 2024, The UK Charter Boats website listed 10 charter boats throughout the Solent region itself, and many more in nearby harbours (UK Charter Boats, 2024). In addition, recreational craft are also often operating as angling/diving charter vessels in the region.

Throughout the Solent study area, marinas, ports and harbours support many hundreds of small motor boats allowing access to the wider study area for casual hobby fishermen; for example, there are charter fleets in Keyhaven, Lymington and Yarmouth (Isle of Wight). In addition, some vessels are owned and used by specific angling club members. Vessels typically range from 5-13 m in length, and fish from 20-250 days per year. The main fish species of recreational interest vary by season and include plaice, sole, bass, rays, mackerel, whiting, pollock, turbot, tope, smoothound, spurdog, conger eel, shark and black sea bream. Large cod can also be caught in autumn and winter whilst plaice can be caught in spring. Fish landings are not monitored for recreational fishing and therefore do not appear in official statistics, however, as noted above, there is a high intensity of charter vessels and hobby angling in the region indicating the importance of recreational fishing in this area.

3.3.5 Recreation

Recreation can be counted as the Solent's most significant activity in terms of the number of people which take part. At least twenty different activities take place, each with its own characteristic distribution and pattern of use. Tourism is also significant, particularly for the Isle of Wight. On the Hampshire coast, there are fewer long stay visitors, but the number of day and short stay visitors is significant. Land-based

informal recreation and walking have by far the greatest number of participants. People can participate at country parks, public open spaces, beaches, the rights of way network and a range of visitor attractions and facilities (Solent Forum, 2024a).

The Solent is one of the most densely populated sailing areas in the world and enjoys an international reputation. There are approximately 24,000 moorings and marina berths in the area, with at least 69 marinas located in the Solent study area. Sailing and racing in the region is focused near the shore, where there are sailing and racing areas, sailing clubs and marinas. Cruising routes converge upon most estuaries and harbours, and dinghy sailing occurs inshore throughout much of the Solent. Various regular sailing competitions furthermore take place, notably the Round the Island race, and Cowes Week. Clusters of activity are at Chichester Harbour, Portsmouth Harbour, River Hamble, Southampton Water and Cowes, as is illustrated by Figure 12, showing sailing intensity. Figure 13 shows the location of sailing moorings, anchorages and launches, as well as coastal car parks.

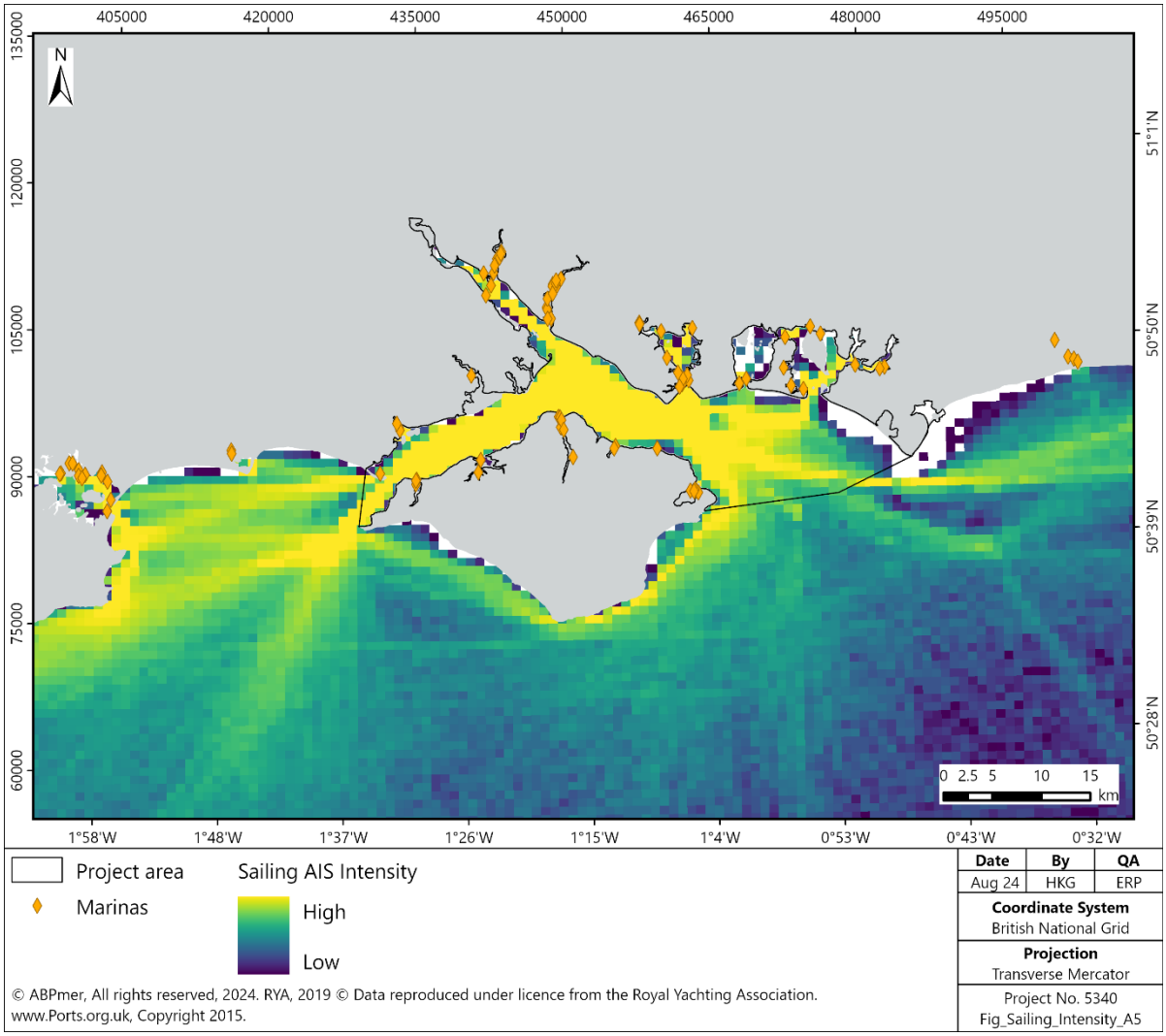


Figure 12. Sailing intensity in the Solent and surrounding areas

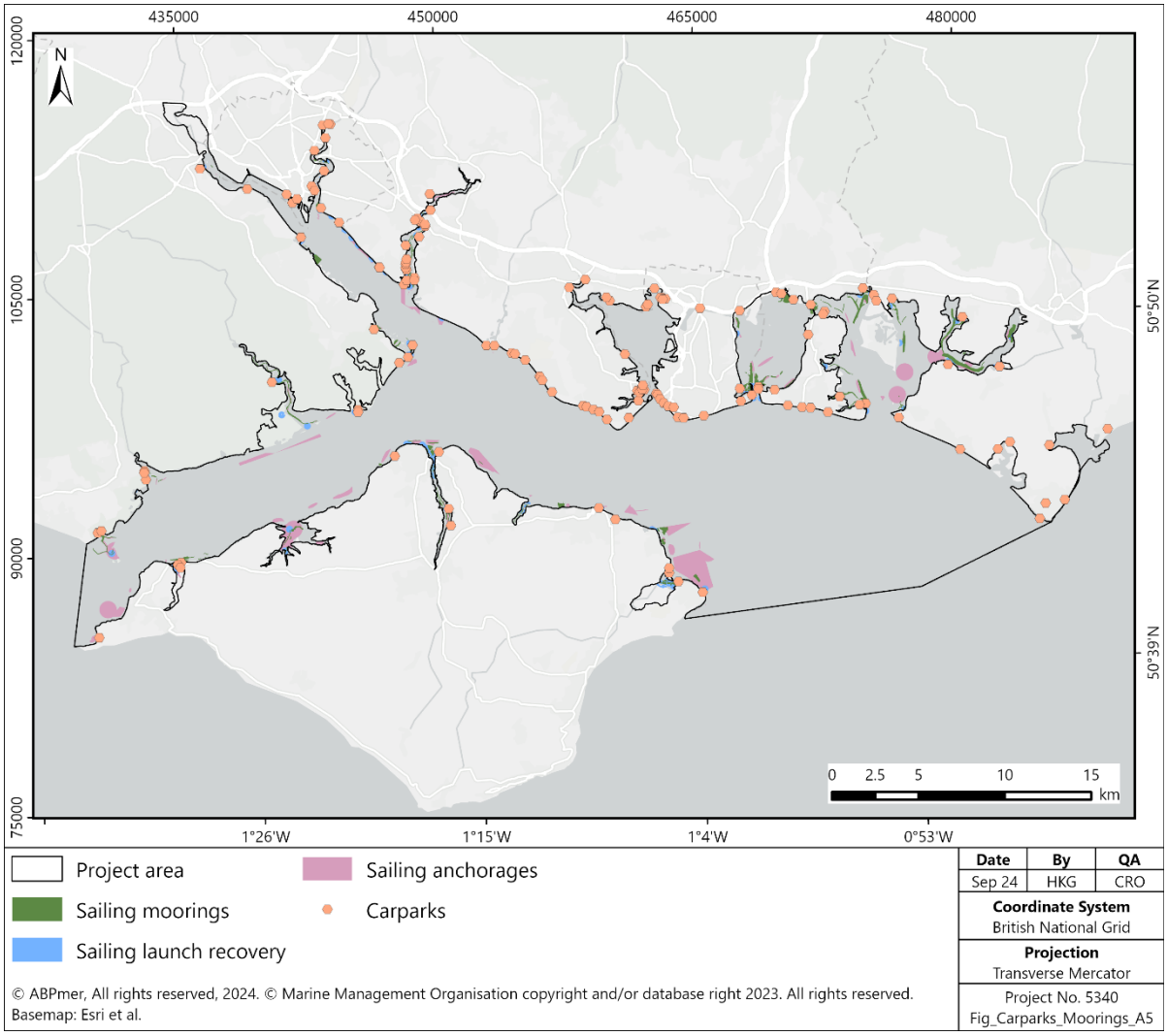


Figure 13. Sailing moorings, anchorages and recovery areas, also car parks, in the region

In summary, water-based activities include:

- Yachting (narrative above);
- Dinghy sailing (narrative above);
- Power boating (widespread, where permitted);
- Paddle sports (narrative below);
- Windsurfing (narrative below);
- Sea angling (see fisheries section for narrative);
- Kite surfing (narrative below);
- Rowing (particularly popular on the Itchen, but also takes place in many other locations);
- Sub-aqua (various diving clubs, though limited diving in Solent itself due to difficult conditions; some diving close to local beaches, e.g. offshore Selsey Bill (the 'Mulberry Harbours' from World War 2)) (Finstrokes, 2024);
- Swimming (at all the beaches, but also some locations within estuaries and harbours – see Section 3.4.1 for bathing water quality); and
- Water skiing (in designated zones).

For the purpose of this State of Nature project, paddle and wind sports were mapped to fill a gap in the spatial information; this is available on the data viewer. This revealed that paddle sports are popular in most estuaries and harbours, as well as along many of the beaches, with Langstone Harbour and parts

of the New Forest coast being notable exceptions. Particular paddle sports hot spots include the Hamble and Beaulieu estuaries, as well as Calshot and the upper reaches of the Emsworth Channel in Chichester Harbour. Wind and kite surfing is mostly practiced along the popular beaches of the region, notably Bracklesham, Stubbington to Gosport, and around Calshot. Some within estuary and harbour activity also takes place, for example at Netley in Southampton Water and in the Emsworth Channel in Chichester Harbour.

On behalf of Bird Aware Solent, Footprint Ecology undertakes car park and coastal visitor surveys. The former have been regularly carried out at around 180 car parks across the Solent since 2016/17; they are focussed on winter months, due to the focus on wintering bird disturbance. The most common activities are noted. For example, in 2020/21, people walking without dogs was the most popular activity (47% of the total people seen), followed by dog walking (31%), and people sitting enjoying the view (4.5%) (Panter and Caals, 2021). Visitor surveys across 10 sites revealed similar activity trends, and indicated that most visitors were locals on a short visit, or day trip from home. 57% of interviewees, across all sites, visited for between 30 minutes and 1 hour, and a large percentage (36%) returned to the same site either daily or most days. 72% of interviewees furthermore said that they visited equally all year round (Caals *et al.,* 2022).

3.3.6 Potential impacts on nature

The many and varied activities and projects carried out in the Solent have the potential to impact its marine nature through many pathways. Some of the key ones are briefly discussed below.

Shipping

The main environmental impacts of shipping relate to emissions to air, water discharges and physical impacts. Shipping fuels are responsible for the release of substantial amounts of air pollutants, such as sulphur oxides and particulate matter, which deteriorate air quality in coastal regions. These pollutants adversely affect human health, and can also affect the marine environment. The reduction of airborne emissions can be achieved through the utilisation of cleaner fuels and the implementation of cleaning systems referred to as 'scrubbers', with many ships having open systems which directly discharge into the marine environment. Annually, approximately 10 gigatonnes of polluted scrubber water are released globally. Additional harmful discharges from shipping activities include antifouling paints, plastic debris, oil, cargo losses from accidents, wastewater, and the introduction of invasive non-native species. The physical impacts of shipping can manifest as noise, light pollution, erosion, wildlife collisions, and the resuspension of sediments. Furthermore, the international shipping industry is a notable contributor to greenhouse gas emissions, accounting for 3% of total global emissions (Environment Agency, 2023a). Anchorage, berthing and dredging for this and navigation in general can also have substantial impacts, and many tonnes are dredged from the region each year for this purpose, as noted above in Section 3.3.1.

Underwater noise levels related mainly to shipping (and fishing and marine aggregates dredging) were modelled for the MMO in 2023; results are shown in Figure 14. This demonstrates that Southampton Water, Portsmouth Harbour and the central and eastern sections of the Solent channel are particularly noisy underwater environments, chiefly due to shipping. Specifically, the figure shows the time (in hours) that typical (mean) noise levels in each grid cell exceed 100 dB re 1 µPa m (sound pressure level) over a year. Based on a literature review of published field measurements, this threshold level was considered to be representative of relatively low levels of background ambient noise along the South Coast. It is clear from the figure that much of the Solent exceeds this low threshold for relatively long periods of time. The main shipping channels in Southampton Water and the eastern Solent exceed this threshold for very long periods (more than 5,000 hours per year which equates to approximately 208 days per year or 57% of the year) (MMO, 2015).

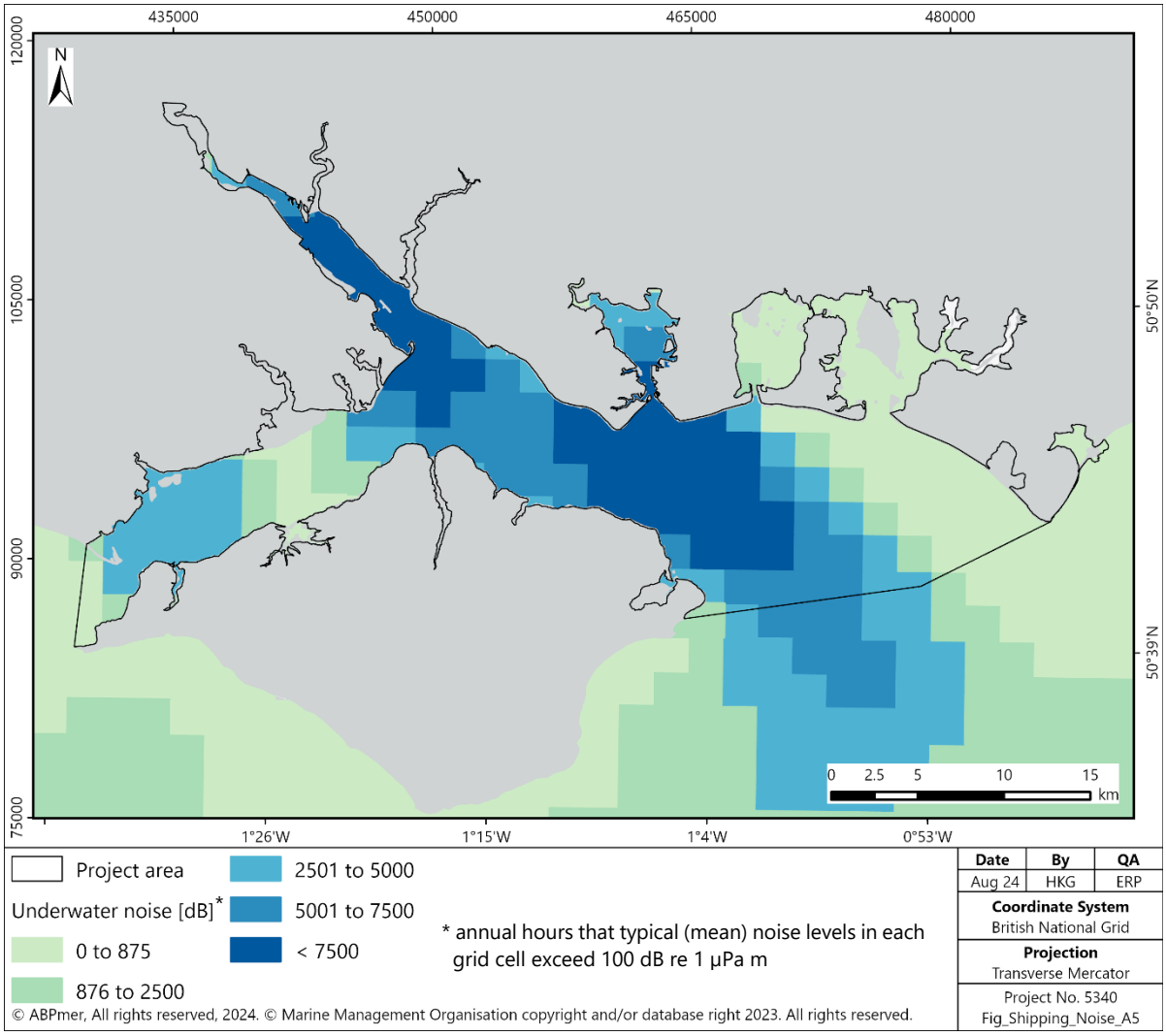


Figure 14. Modelled underwater noise levels in the Solent (annual hours above 100 dB)

Industry and marine developments

The potential impacts of industry and other marine developments/activities on the marine environment are wide ranging and very much depend on the nature of the industry, as well as local environmental conditions and management. Potential pathways can include habitat and biodiversity loss, water quality impacts, noise and light pollution and morphological impacts/disruption of natural processes. Projects, schemes or activities which require permissions such as marine licences would be subject to mitigation and compensation measures identified from various assessment (notably environmental impact and habitats regulations assessments). In addition, all industries and activities will have to adhere to sector specific environmental safety standards and procedures.

Fishing

Effects of fishing on the environment can include damage to seabed ecosystems and fish nursery grounds, release of carbon stored in sediments, through activities such as bottom trawling bycatch of non-target animals in active fishing gear and entanglement in abandoned, lost or discarded fishing gear, noise pollution. Overfishing affects the size, structure and sometimes the viability of fish populations, and in turn, other species throughout the wider food web (Environment Agency, 2023a).

Intertidal fisheries can lead to damage to the seabed/habitats (e.g. through trampling), topographical changes, loss of the finer grained particles and release of sediment-bound pollutants. It also results in changes in size and age structure of the exploited populations (Watson *et al.,* 2016), as well as a significant and long-lasting reductions in other populations of other species of invertebrates. Furthermore, birds are disturbed and their prey densities impacted.

Recreation

Recreational impacts have been summarised by Natural England in marine recreation evidence briefings for various activities (Natural England, 2017). These have been summarised in the table below. This list is not exhaustive, general beach life for example was not discussed by Natural England (2017). The Solent Disturbance and Mitigation Project also reviewed recreational pressures (e.g. Stillman *et al.,* 2009), and this led to the introduction of Bird Aware; see Section 4.1.3 for more information.

Table 25. Potential impacts of key recreational activities as noted by Natural England (2017)

Activity	Potential impacts
Non-motorised watercraft (including paddleboarding)	Abrasion of intertidal and shallow subtidal habitats, visual disturbance of fish, above water noise disturbance to hauled out seals and birds, and finally visual disturbance to marine mammals and birds. These can result from a range of human actions such as erratic and random movements, groups being perceived a threat and being loud, and trampling and/or erosion
Windsurfing and kitesurfing	Visual disturbance of marine mammals and birds, which are related to the presence of people and the equipment involved
Motorised personal watercraft	abrasion/disturbance of surface and sub-surface sediments, underwater noise disturbance of marine mammals and birds, and finally above water noise and visual disturbance of hauled out seals and birds
Motorised watercraft (power-boating and sailing with an engine)	Abrasion/disturbance of surface and sub-surface sediments, underwater noise disturbance of marine mammals and birds, and above water noise and visual disturbance of hauled out seals and birds.
Wildlife watching	Abrasion/disturbance of the seabed or intertidal, above water noise and visual disturbance of hauled out seals and birds, underwater noise and visual disturbance of fish, marine mammals and birds.
Light aircraft	Above water noise changes and visual disturbance of marine mammals and birds.
Motorised and nonmotorized land vehicles	Abrasion/disturbance of intertidal habitats and noise and visual disturbance of hauled out seals and birds due to the movement of people and vehicles.
General beach life	Abrasion/disturbance of the substrate surface in intertidal and shallow subtidal areas (trampling and accessing the sea), abrasion/disturbance of the substrate below the surface in intertidal areas (from digging holes in the sand), and noise and visual disturbance of hauled out seals and birds due to presence and movement of people.
Drones	Potential for above water noise and visual disturbance of hauled out seals and birds.

A recent Solent based study investigating impacts of recreational activities on sensitive seagrass habitat was undertaken on behalf of the ReMEDIES project[37] (see Section 4.2.3 for further detail on this project). This reviewed activities at five inshore shallow subtidal and intertidal locations, and noted the occurrence and frequency of a number of recreational activities such as boat movements, anchoring and mooring, and activities like bait digging, beach recreation and dog walking. Of the five sites, Osborne Bay and Yarmouth West on the Isle of Wight were the two sites that attracted most boating activity, with Kings Quay (Isle of Wight) being the least visited site. Yarmouth West recorded the highest number of vessels traveling outside the seagrass zones, whereas Osborne Bay recorded the highest incidence of boats traveling over and anchoring inside and outside the seagrass meadows. Yarmouth West also had relatively high instances of mooring outside and some inside seagrass meadows. It is worth noting that while Kings Quay was the least visited site by boats, it recorded the third highest incidence of anchoring over seagrass meadows. As for vessel type, small yachts were the most frequently recorded vessel type across the region. Overall, general beach recreation was the most frequently recorded activity, particularly at Yarmouth West and Osborne Bay. Swimming was a close second at those two locations, and dog walking came second at Langstone Harbour, Yarmouth West and Bouldnor. Other recreational activities like water sports and angling were recorded across several sites; albeit in relatively low numbers (Ferrero, 2022).

Solent Marine Sites (SEMS) annual survey on non-licensable activities

Every year, the Solent Forum undertakes a survey of thirty-one Relevant Authorities in the Solent to find out how sixteen non-licensable coastal and marine activities might be impacting the Solent Marine Sites (SEMS)[38]. The latest report notes that the trends in the type of activities in the Solent which are considered to be impacting the sites had not changed in 2023 when compared to previous years. It highlights that '*activities such as coastal walking (including dog walking), general beach recreation and paddle and windsports have been at elevated levels for some time as people increasingly value the physical and mental health benefits of visiting the coast and using the marine space*'. Concerns were raised at high levels of baseline activity having negative impacts at some of the sensitive sites. The top three activities/pressures highlighted for 2023 as likely to be affecting the SEMS sites include coastal walking, flood risk management operations and littering. A summary of activities considered to be impacting on designated sites by percentage of responses from the report is provided in Image 36.

[37] ReMEDIES stands for Reducing and Mitigating Erosion and Disturbance Impacts Affecting the Seabed. This project works in five English SACs, including the Solent, and aims to 1) reduce recreational pressures on sensitive habitats; 2) restore and protect sensitive habitats; and 3) promote awareness of these habitats and their importance.

[38] The responses by the relevant authorities form their statutory return under the Habitats Regulations to monitor the effects of activities on designated sites under their jurisdiction.

Activity	Yes	No	Total Responses	Percent 'yes'	Percent 'no'
Land recreation (incl. walking with dogs)	12	5	17	71%	29%
Operation of coastal flood and erosion risk management schemes	10	5	15	67%	33%
Littering and removal of litter	13	9	22	59%	41%
Recreation - non-motorised watercraft	8	10	18	44%	56%
Recreation - powerboating or sailing with an engine	7	10	17	41%	59%
General beach recreation	6	10	16	38%	63%
Anchoring and mooring	6	11	17	35%	65%
Grazing and Foraging	2	5	7	29%	71%
Fishing (shore-based activities)	5	14	19	26%	74%
Fishing (including shellfisheries)	4	13	17	24%	76%
Recreation - light aircraft	2	9	11	18%	82%
Accidental vessel discharges/emissions including oil spill and clean-up	3	15	18	17%	83%
Wildfowling	1	7	8	13%	88%
Operation of ports and harbours (maintenance of infrastructure)	2	15	17	12%	88%
Boat Repair and Maintenance	1	12	13	8%	92%
Slipway and jetty cleaning and maintenance	1	14	15	7%	93%

(Source: Solent Forum, 2024c)

Image 36. Summary of activities considered to be impacting on Solent designated sites by percentage of responses by relevant authorities to annual Solent Forum survey

3.4 Pollution

Pollutants originating from various sources exert significant pressure on coastal and marine ecosystems. It is estimated that approximately 80% of marine pollution is derived from land-based sources. Both point source and diffuse pollution are discharged directly into estuaries and coastal waters from urban areas, transportation systems, agricultural practices, and other contributors. Additionally, activities occurring inland have repercussions for the coastal and marine environments. Contaminants entering rivers and streams from agricultural activities, stormwater overflows, wastewater treatment facilities, urban and transportation runoff and other contributors are carried downstream into estuaries and coastal waters, leading to a variety of adverse effects on ecosystems and wildlife (Environment Agency, 2023a).

Water quality monitoring insights from a variety of sources will now firstly be discussed (Section 3.4.1), before shellfish monitoring insights are presented in Section 3.4.2, and sediment quality monitoring insights in Section 3.4.3. Brief sections on historic landfills, abandoned boats and litter are also included in Sections 3.4.4 to 3.4.6. Potential impacts on nature from these pathways are summarised in Section 3.4.7.

3.4.1 Water quality monitoring insights

In the UK, water quality is tested for a wide variety of reasons, with most of the responsibility for monitoring and enforcement in the hands of the Environment Agency. This monitoring informs various status assessments, as well as wider management. WFD status and bathing water monitoring are now firstly summarised, before sewage discharge insights are then given. Then, a 2023 report by the Environment Agency on eutrophication (Environment Agency 2023b) in the Solent is discussed, and finally, relevant research by the University of Portsmouth is presented.

WFD status monitoring

Overall status

For WFD status assessments, a wide variety of parameters are monitored to determine overall water body status. Some of the parameters have been discussed in previous sections; for example, angiosperms and invertebrates. Prior to discussing the three specifically water quality related parameter categories which are included in the WFD package (specific pollutants, physico-chemical quality element status and chemical status), overall status results for the 20 coastal and estuarine waterbodies of the Solent study area are provided in Table 26 below; Figure 15 shows their location and Figure 16 presents the status. This demonstrates that the overall status of all the waterbodies is moderate, ecological status is mostly moderate, and chemical status 'fail'.

Table 26. Overall status of coastal and estuarine waterbodies in the Solent study area

WFD water body name	Water body type	Total area (ha)	Overall water body status	Ecological status	Chemical status
Isle Of Wight East	Coastal	26,370	Moderate	Good	Fail
Solent	Coastal	25,958	Moderate	Moderate	Fail
Southampton Water	Estuarine	3,091	Moderate	Moderate	Fail
Chichester Harbour	Estuarine	3,013	Moderate	Moderate	Fail
Langstone Harbour	Estuarine	1,891	Moderate	Moderate	Fail
Portsmouth Harbour	Estuarine	1,642	Moderate	Moderate	Fail
Beaulieu River	Estuarine	307	Moderate	Moderate	Fail
Pagham Harbour	Estuarine	257	Moderate	Moderate	Fail
Lymington	Estuarine	245	Moderate	Moderate	Fail
Newtown River	Estuarine	192	Moderate	Moderate	Fail
Medina	Estuarine	163	Moderate	Moderate	Fail
Eastern Yar	Estuarine	81	Moderate	Moderate	Fail
Western Yar	Estuarine	51	Moderate	Moderate	Fail
Wootton Creek	Estuarine	23	Moderate	Moderate	Fail
Great Deep	Coastal	17	Moderate	Good	Fail
Langstone Oysterbeds	Estuarine	16	Moderate	Good	Fail
Black Water Lagoons	Estuarine	12	Moderate	Good	Fail
Bembridge Harbour Lagoon	Estuarine	9	Moderate	Good	Fail
Old Mill Ponds	Estuarine	8	Moderate	Good	Fail
Sowley Marsh	Coastal	8	Moderate	Good	Fail

(Source: Environment Agency, 2022)

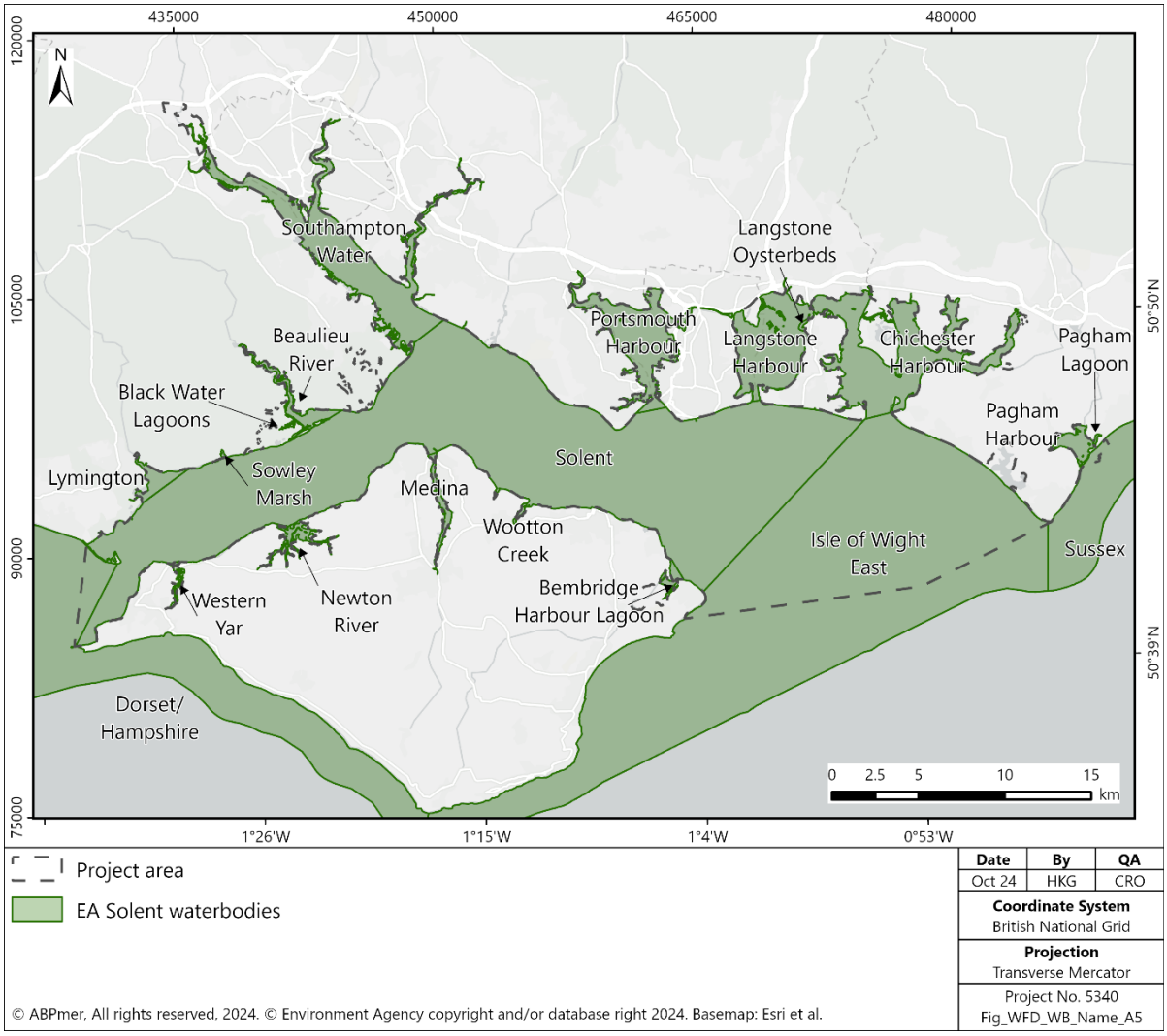


Figure 15. WFD waterbodies of the Solent

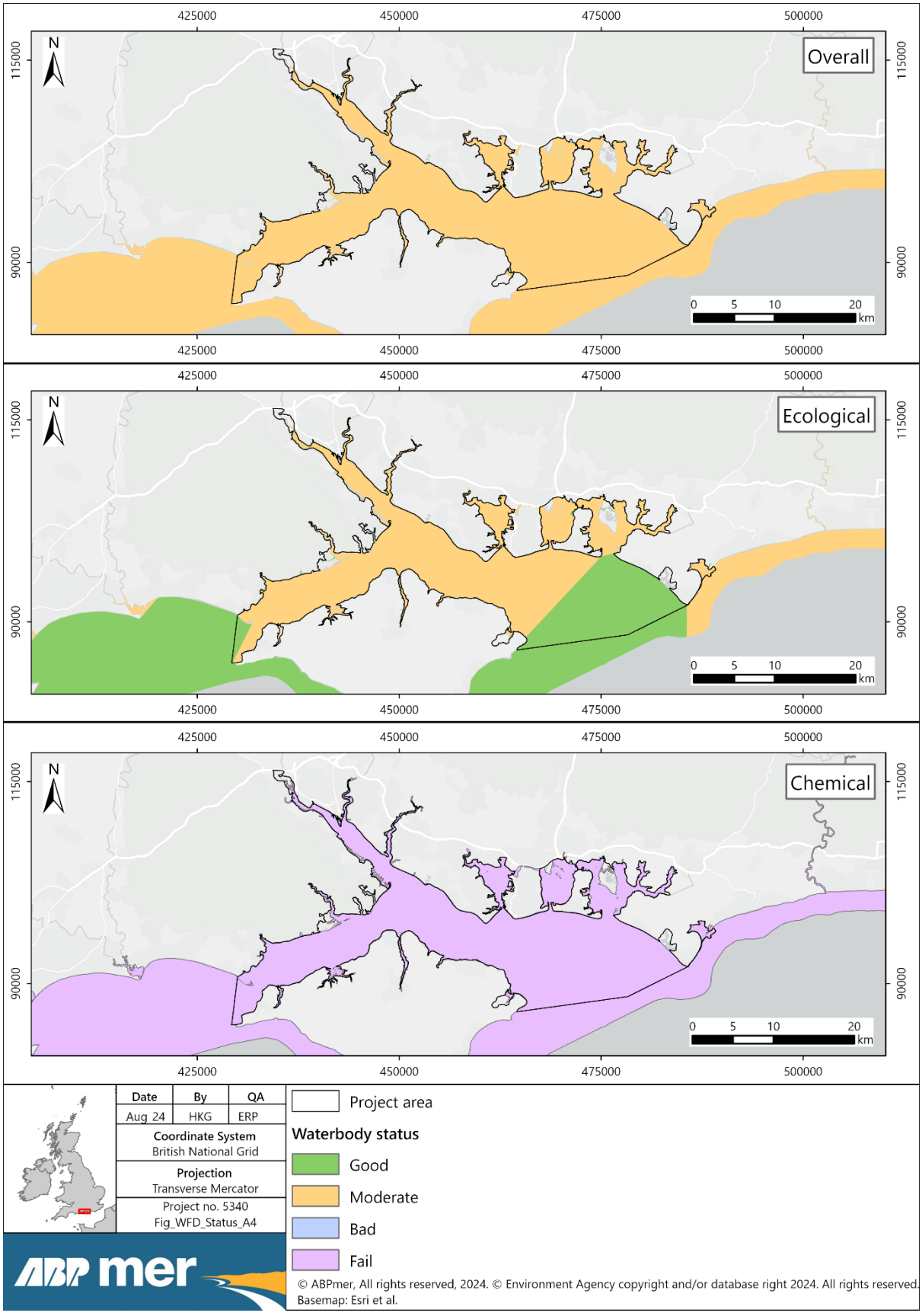


Figure 16. **WFD waterbody status for the waterbodies overlapping with the Solent region**

WFD status for specific pollutants

Specific pollutants are substances that may have a harmful effect on biological quality and which have been identified by technical advisors as being discharged to the water environment in significant quantities in the UK. Specific pollutants are monitored at most of the larger Solent water bodies; though the status assessment is based on a varying number of substances tested. The highest number, 18, are tested in Southampton Water, and the lowest number (of those assessed) in the Eastern Yar, the Western Yar and Langstone Harbour (where two are tested). All of the assessed water bodies have a 'high' status, meaning all of the assessed substances are also scored as 'high'.

Table 27. 2022 assessments for specific pollutants of study area WFD water bodies

Classification	Overall assessment
High	Southampton Water[1], Solent[2], Portsmouth[2], Pagham[3], Beaulieu[4], Chichester Harbour[4], Eastern Yar[5], Western Yar[5], Langstone[5]
Good	None
Moderate	None
Poor	None
Bad	None
Not assessed	All other estuarine and TraC waterbodies
[1] 18 assessed: 2,4-dichlorophenol; 2,4-dichlorophenoxyacetic acid; arsenic; chlorothalonil; chromium (vi); copper; diazinon; dimethoate; iron; linuron; mecoprop; pendimethalin; permethrin; phenol; toluene; triclosan; un-ionised ammonia; zinc. [2] Five assessed: arsenic, chromium (vi), copper, iron, un-ionised ammonia; [3] Four assessed: arsenic, copper, iron, un-ionised ammonia; [4] Three assessed: copper, zinc, arsenic; [5] Two assessed: copper and zinc.	

(Source: Environment Agency, 2022)

WFD physico-chemical quality element status (inorganic nutrients and dissolved oxygen)

Dissolved inorganic nitrogen and dissolved oxygen is monitored at most of the Solent's WFD water bodies. Dissolved oxygen status was assessed as 'high' in all of the water bodies. However, for dissolved inorganic nitrogen, the status was generally considered to be 'moderate'. This was with the exception of Lymington, which was assessed as 'good' for the last assessment in 2022 (having been assessed as 'moderate' during the previous 2019 assessment), and Isle of Wight East, which was classified as 'high'. Status changed from good to moderate at two waterbodies (Beaulieu and Pagham Harbour), at all other 'moderate' status water bodies, the status did not change.

Table 28. 2022 assessments for physico-chemical quality elements of study area WFD water bodies

Classification	Dissolved inorganic nitrogen	Dissolved oxygen
High	Isle of Wight East	All assessed bodies
Good	Lymington, Langstone Harbour	None
Moderate	Eastern Yar, Medina, Newtown River, Solent, Southampton Water, Chichester Harbour, Pagham Harbour, Beaulieu, Portsmouth Harbour	None
Poor	None	None
Bad	None	None
Not assessed	Bembridge, Langstone Oysterbeds, Sowley Marsh, Old Mill Ponds, Black Water Lagoons, Great Deep	Langstone Oysterbeds, Sowley Marsh, Old Mill Ponds, Black Water Lagoons, Great Deep

(Source: Environment Agency, 2022)

WFD chemical status

WFD chemical status is determined for each WFD water body on the basis of two indicators, priority substances and priority hazardous substances. In the UK, the former is determined on the basis of monitoring of 77 substances which are considered to be toxic, persistent and likely to bioaccumulate. Some of these priority substances are also priority hazardous substances.

The classification for the individual elements are assessed as either Good or Fail. The classification is then based on a one out all out process meaning that if a single element fails then the sub element classification will fail. In the Solent, all the water bodies failed for priority hazardous substances; see also Table 29. For all the water bodies, this was due to failures for both mercury and its compounds, and polybrominated diphenyl ethers (which are used as flame retardants).

Table 29. 2019 assessments for chemical and priority substances of study area WFD water bodies (considered to 'not require assessment in latest (2022) review)

Classification	Priority hazardous substances	Priority substances
Good	None	ALL
Fail	ALL	None

(Source: Environment Agency, 2022)

Bathing waters

The UK has over 600 designated Bathing Waters – sites that are popular for swimming and paddling and have been designated under the Bathing Water Regulations 2013. The UK Government's target is to achieve 'sufficient' for all bathing waters (originally by 2015) under these regulations. Bathing waters are monitored during the summer to determine their status; with water tested for two types of bacteria, *E. coli* and intestinal enterococci. There are 21 designated bathing waters in the Solent, all at beaches of the region. Most of these have consistently achieved 'excellent' status, as can be seen in Table 30.

Table 30. Bathing water status at the region's designated bathing waters

Bathing Water	Year				
	2019	2020	2021	2022	2023
Lepe	Excellent	Excellent	Excellent	Excellent	Excellent
Calshot	Excellent	Excellent	Excellent	Excellent	Excellent
Cowes	Good	Excellent	Excellent	Excellent	Excellent
Gurnard	Excellent	Good	Good	Good	Good
Colwell Bay	Excellent	Excellent	Excellent	Excellent	Excellent
Totland Bay	Excellent	Excellent	Excellent	Excellent	Excellent
East Cowes	N/A	N/A	Excellent	Excellent	Excellent
Ryde	Good	Excellent	Good	Good	Good
Seagrove	Excellent	Excellent	Excellent	Excellent	Excellent
St Helens	Excellent	Excellent	Excellent	Excellent	Excellent
Bembridge	Excellent	Excellent	Excellent	Good	Good
Hillhead	Good	Good	Excellent	Good	Good
Lee-on-Solent	Excellent	Excellent	Excellent	Excellent	Excellent
Stokes Bay	Excellent	Excellent	Excellent	Excellent	Excellent
Southsea East	Excellent	Good	Sufficient	Poor	Poor
Eastney	Excellent	Excellent	Excellent	Good	Good
Beachlands West	Excellent	Excellent	Excellent	Excellent	Excellent
Beachlands Central	Excellent	Excellent	Excellent	Excellent	Excellent
Eastoke	Excellent	Excellent	Excellent	Excellent	Excellent
West Wittering	Excellent	Excellent	Excellent	Excellent	Excellent
Bracklesham Bay	Excellent	Excellent	Excellent	Excellent	Excellent

(Source: relevant bathing water data on Environment Agency Swimfo 'Find a bathing water' explorer)

The above table demonstrates that Southsea East is the only bathing water to have been classed as being of 'poor' status in recent past. It is important to note that these are results of long term annual monitoring, when sampling is undertaken during the bathing water season between May and September only (when stormflow discharges for example are less frequent).

Community and academic research

Itchen/ Friends of the Itchen 2024 report

It is worth noting that community groups are increasingly undertaking their own water quality monitoring. For example, the Friends of the Itchen undertook regular (monthly) sampling throughout the summer of 2023 at two locations of the urban Itchen estuary in Southampton. This took place at Cobden Bridge (around 1 km downstream from the tidal limit, and 800 m from the Portswood Wastewater Treatment Works) and on the freshwater side at Woodmill (just above the tidal limit). Samples were tested for E. coli (EC) and Enterococci, and results compared against Environment Agency bathing water quality standard thresholds. Water quality was judged to equate to 'poor' bathing water status at both locations (whilst these locations are not official bathing waters, many people swim in, or practice paddle sports on, the Itchen). Results of further sampling in March/April 2024, at four estuarine locations, testing for EC only, saw many of the 48 water samples reach the limit of what could be measured (i.e. values were equal to or greater than 10,000 EC 100 ml^{-1}). The average across the 48 samples ranged from 832 to 5,600 EC 100 ml^{-1}, depending on survey day and location. Again, when compared against Environment Agency bathing water standards, then it was considered that the Itchen would receive 'poor' status if it were an official, designated, bathing water. The 12 March and 4 April 2024 results were also compared against shellfish water standards, and 33 to 100% of samples were considered to have failed against the lower threshold value (100 EC 100 ml^{-1}), whereas 17 to 67% were above the higher (1,500 EC 100 ml^{-1}) threshold (Friends of the Itchen, 2024).

The report furthermore quotes a 2016 Southern Water Wastewater Risk Assessment for the Portswood Works which the group had obtained, and highlights that these works had not received additional upgrades (improved disinfection) to protect the downstream shellfish waters, unlike four other works on Southampton Water. In addition, an approximation based on data provided in the Southern Water risk assessment is given in the report which is of interest in the context of storm overflows, in that it was estimated that, from this plant, *'the E. Coli bacterial load from continuous effluent is 34 times greater that the E. Coli load from stormwater spills'*. The plant has an estimated annual average effluent volume of just under 7 million m^3 (Friends of the Itchen, quoting 2016 Southern Water report). In addition to the EC results, the report also quotes a recent Environment Agency report as identifying '*alarmingly high levels of ammonia*' in the continuous effluent, which can lead to '*very low levels of estuary BOD*'[Biochemical Oxygen Demand], which in turn can act as a barrier to the migration of Atlantic salmon. It should be noted that the report acknowledged that the treatment plant was not the only cause of EC and other pollution in the estuary, but was likely to be '*a major contributor*' (Friends of the Itchen, 2024).

Chichester and Langstone Harbour community and university monitoring

An ongoing study looking at water quality in and around Chichester and Langstone harbours has furthermore revealed high levels of potentially harmful chemicals. The Clean Harbours Partnership campaign group, a collaboration between local interest groups and Portsmouth and Brunel Universities, collected hundreds of samples in these two waterbodies in 2022. Across 288 samples (at 22 sites), more than 50 compounds were detected, including a variety of pesticides pharmaceuticals and recreational drugs. A post storm seawater sample taken near an outflow pipe from Budds Farm treatment works, near Langstone, showed a reading of 380,000 EC 100 ml^{-1} (University of Portsmouth, 2023).

Sewage effluent and storm overflow monitoring

Sewage treatment plants

Thirty six sewage treatment plants can be found along the rivers and shores which are attributed to the Solent region and its catchments. These are required to monitor the effluent which is discharged on a day to day basis, and also storm sewage overflow events and duration. Figure 17 shows the location of the sewage treatment plants and storm overflow locations. Standard sewage treatment plant effluent is closely monitored by the water companies, but there is no comprehensive, publicly available analysis of this 'continuous effluent' data. Many of the plants on the Solent are however likely to be relatively high emitters of E.coli and nutrients, as indicated by the Itchen report above, and also the fact that 32 of the region's water treatment plants are considered to require urgent improvements (including Portswood). This is in relation to nutrients; all 32 require improvements for nitrogen, but four plants also require works to reduce phosphorus emissions. Most of the plants will need to deliver the required upgrades by 1 April 2030, or else be in breach of their licence (see Defra, 2024b).

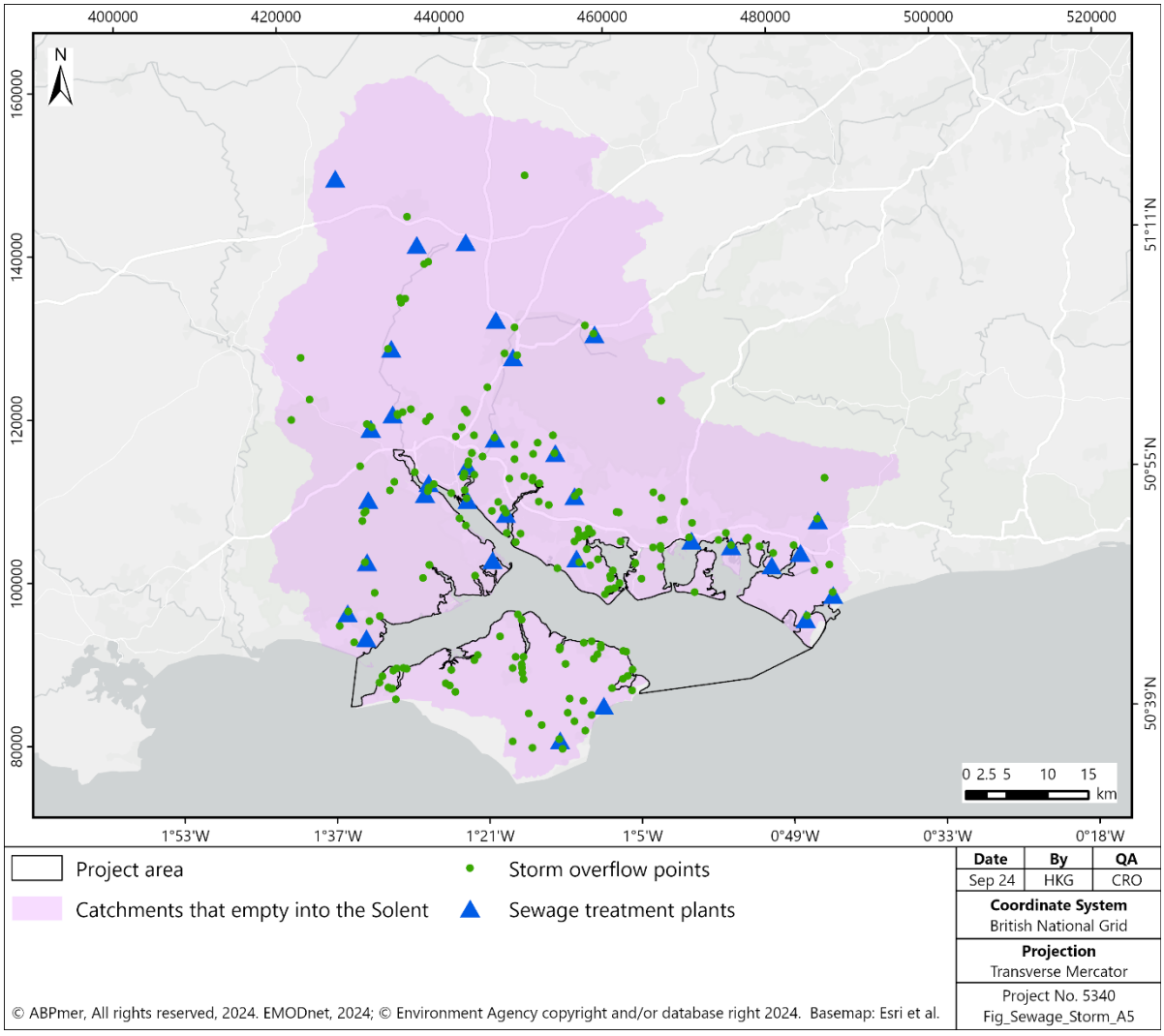


Figure 17. Sewage treatment plants and storm overflow points in Solent catchments

Storm overflow monitoring

Since 2021, water companies have been required to install monitoring at all their sewage storm overflow locations, which may be utilised by the companies in exceptional circumstances during storms to stop sewage backing up into homes. Monitoring from the last two available years has been analysed, with

summary data displayed in Table 31. This shows that, over the past two years, there have been almost 100,000 hours of discharge into the Solent via the catchment rivers and direct discharges along the coast. In 2023, duration almost tripled, whilst spill occasions more than doubled, when compared to 2022.

Table 31. Storm overflow discharges into Solent catchments in 2022 and 2023

Year	Cumulative duration (hours)	Cumulative spill occasions	Stations with spill duration > 0 hours
2022	27,512	3,075	164
2023	71,898	6,169	177

Table 32 below lists those waterways where more than 1,000 hours of discharge occurred during both 2022 and 2023. This demonstrates that the River Test (both directly and via its tributaries) was the most affected waterway, followed by the River Lavant and the River Meon. Three waste water treatment works were responsible for a quarter of the spill duration over these two years, namely the Lavant water treatment works north of Chichester (River Lavant), and the Kings Somborne and West Wellow works, both on tributaries of the River Test near Romsey.

Table 32. Cumulative discharge hours and receiving waterways 2022/23 (>1,000 hours only)

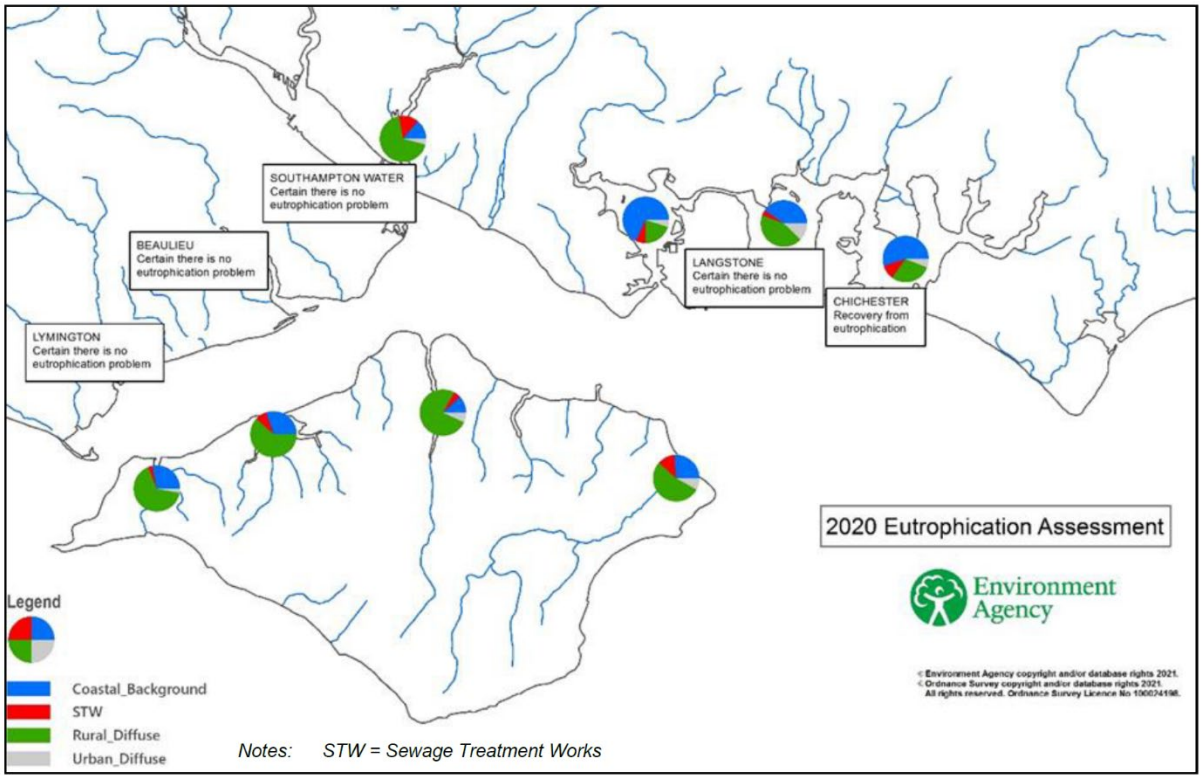
Receiving waterway	Cumulative hours 2022 and 2023	Receiving waterway	Cumulative hours 2022 and 2023
River Lavant & Gw Via Wetland	10,536	Bartley Water	1,926
River Blackwater [Test tributary]	10,156	Southampton Water	1,806
Tributary Of The River Test	4,995	River Hamble Estuary	1,773
River Meon	4,635	The River Itchen	1,673
The River Test	4,058	Avon Water	1,669
Tributary of the Eastern Yar	3,410	Lymore Stream	1,525
Pagham Rife	3,241	Wallington River	1,293
Lymington River	3,221	The Ham Brook	1,192
River Medina	3,161	Chichester Hbr via Little Deep	1,135
Caul Bourne	3,044	The Solent	1,121
Tributary Of The River Yar	2,916	River Itchen Estuary	1,100
The Broad Rife	2,165	Ditch Trib of River Yar	1,088
Ford Lake Via Stream	2,049	Sheepwash Tributary	1,025

Environment Agency eutrophication report

In 2023, the Environment Agency published a summary report on eutrophication in the Solent. Eutrophication was described as occurring '*where increased nutrients in the water result in excessive plant growth, seen in the Solent as green macroalgal mats which cover intertidal mudflats, negatively affecting the ecology and the designations*'.

The report concluded that, at the larger waterbody scale for the purposes of the WFD, there had been a reduction in the amount of macroalgae within the estuaries of the Solent, compared to the previous two decades, and that '*recovery from eutrophication in parts of the Solent area is well underway*'. Changes were attributed to a range of nutrient reduction measures introduced at wastewater treatment works, but also due to changes in agricultural practice over the last 20 years. It was however acknowledged that at a more local, feature scale level, impacts on designated features from nutrients may still be seen.

Source apportionment work undertaken for the report confirmed that the main sources of nitrogen (N) to Solent estuaries were diffuse sources from agriculture (on average about 50% N is from agriculture, often via rivers), followed by point sources from sewage discharges (on average about 10% N is from sewage). The remainder includes coastal background and urban sources. The exact proportions vary between different estuaries, as was illustrated by a map included here as Image 37. This map also highlights the estuaries where there are considered to be no eutrophication impacts at waterbody scale, as levels of macroalgae achieve Good status under the WFD Regulations.



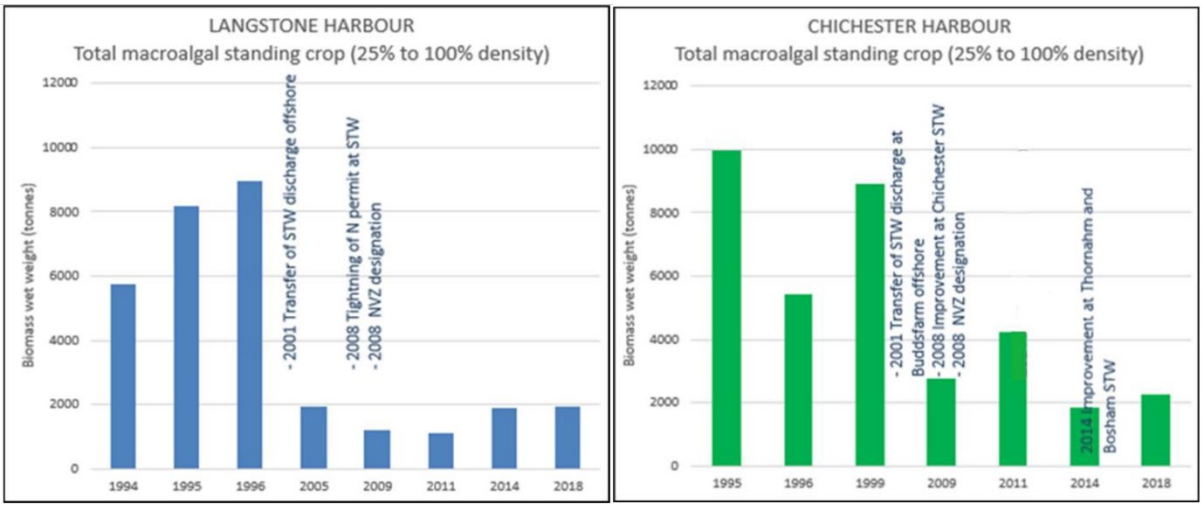
(Source: Environment Agency, 2023b)

Image 37. Sources of Nitrogen into Solent Estuaries (and eutrophication impacts at waterbody scale)

The report includes graphs demonstrating substantial improvements in N discharge rates at several sewage treatment plants, as well as figures illustrating percentage load reductions for N and P for the various Solent systems (when compared to baseline (*circa* 1997 to 2000) conditions). Reductions for N loads appear to have been highest in Langstone Harbour, the Medina, Portsmouth Harbour and Chichester Harbour (49%, 44%, 36% and 35% respectively), and generally very high values are furthermore quoted for P loads for these locations (reductions of 75%, 77%, 48%, and 43% respectively). The report furthermore notes that *'there has also been a trend of decreasing nutrients in the Solent itself, as well as in the coastal background water, due to nutrient reductions from many sources' (*Environment Agency, 2023b).

Most of the Solent catchments are designated nitrate vulnerable zones (NVZs), where changes in farming practices can be encouraged; a resulting approximate 8% reduction in N inputs from agriculture has been estimated. Also, where treatment plants were given reduced N permits, then generally N concentrations in the discharges decreased by over half. The report caveats that, in rivers with chalk geology, such as the Test and Itchen, N may still be increasing, as these rivers are strongly fed by groundwater which can accumulate historic N (related to historic farming practices) (Environment Agency, 2023b).

As a result of all the reductions in nutrients that have occurred over the last 20 years, the report notes that generally, there had been sustained reductions in harmful macroalgae cover amounts compared to historic levels. Illustrative graphs were included for Langstone and Chichester Harbour, which are reproduced here as Image 38. These show macroalgal monitoring data illustrating the reduction in macroalgal standing stock from 1994/5 to 2018; the timings of some of the key N reduction measures are also given.



(Source: Environment Agency, 2023b)

Image 38. Reducing macroalgal standing stock in Langstone and Chichester Harbours over time (showing dates of some of the key N reduction measures)

The report concludes, based on trends and modelling, that there were anticipated to be further reductions in macroalgae '*even if no additional nutrient reduction measures*' were undertaken. There is expected to be '*an ecological time lag*' before the full extent of reductions will be seen. However, the Environment Agency is anticipating continuing to pursue catchment measures '*to tackle the large diffuse agricultural sources of N that affect rivers and groundwater as these are the dominant N sources*'.

WFD macroalgae monitoring

For the above 2023 Environment Agency eutrophication report, macroalgal monitoring as reported for many of the waterbodies of the Solent was analysed. For completeness, and consistency with other sections, the table below lists the status for each of the Solent region's coastal or estuarine water bodies for fucoid extent and opportunistic macroalgae.

Table 33. 2022 assessments for macroalgae elements of study area WFD water bodies

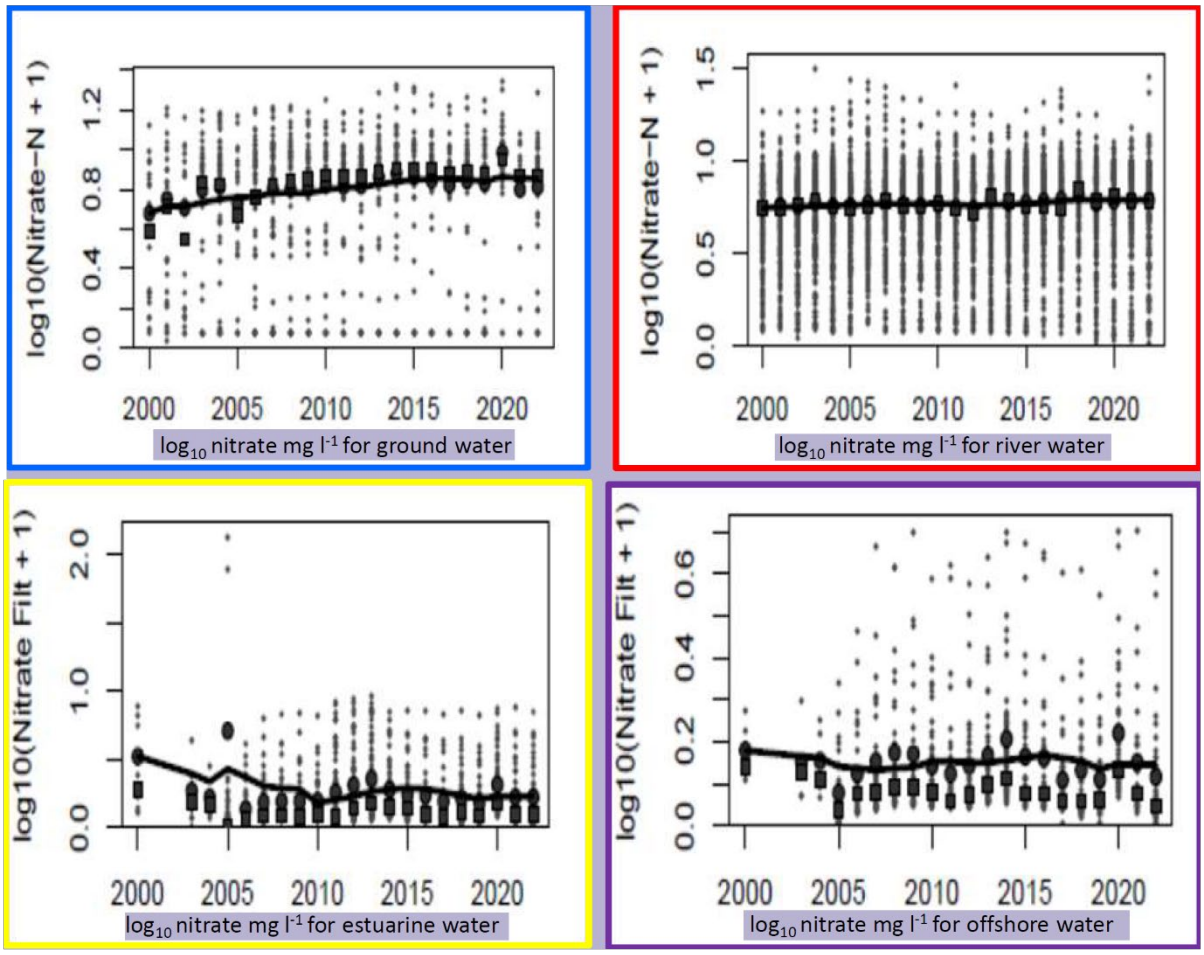
Classification	Fucoid extent	Opportunistic macroalgae
High	None	None
Good	Southampton Water (2019)	Southampton Water, Solent, Chichester Harbour, Pagham Harbour, Beaulieu River, Lymington, Langstone Harbour
Moderate	None	Eastern Yar, Medina, Wootton Creek, Western Yar, Portsmouth Harbour
Poor	None	None
Bad	None	None
Not assessed	All other water bodies	Isle of Wight East, Bembridge, Newtown River, Langstone Oysterbeds, Sowley Marsh, Old Mill Ponds, Black Water Lagoons, Great Deep

(Source: Environment Agency, 2022)

The former was not reported at all for the 2022 assessments, and in 2019 only for Southampton water, when this was considered to be at 'good' status. For the opportunistic macroalgae, during 2022, 'moderate' status was concluded for all of the major Isle of Wight waterbodies, and Portsmouth Harbour. For all other assessed water bodies, a 'good' status was determined.

University of Portsmouth analysis of government monitoring data

In 2023, the University of Portsmouth presented a poster on water quality at the annual Restoring Meadow, Marsh and Reef (ReMeMaRe) conference on preliminary results from a meta-analysis of water quality monitoring data from hundreds of stations around the Solent and within its catchments. This aimed at determining trends for nitrogen, phosphorous and bacterial E. coli counts. The results indicate that the Solent's water quality '*has not improved in 25 years*', and does '*not support current [Environment Agency] eutrophication assessments*'. The authors furthermore summarise that '*concentrations of N and bacterial counts show either an increase or have remained relatively constant over 25 years*' (as illustrated for nitrogen in relevant graphs shown in Image 39) and that '*only a small proportion of estuarine sites have had significant reductions for nitrogen, although the majority have decreasing trends for phosphorus*'.



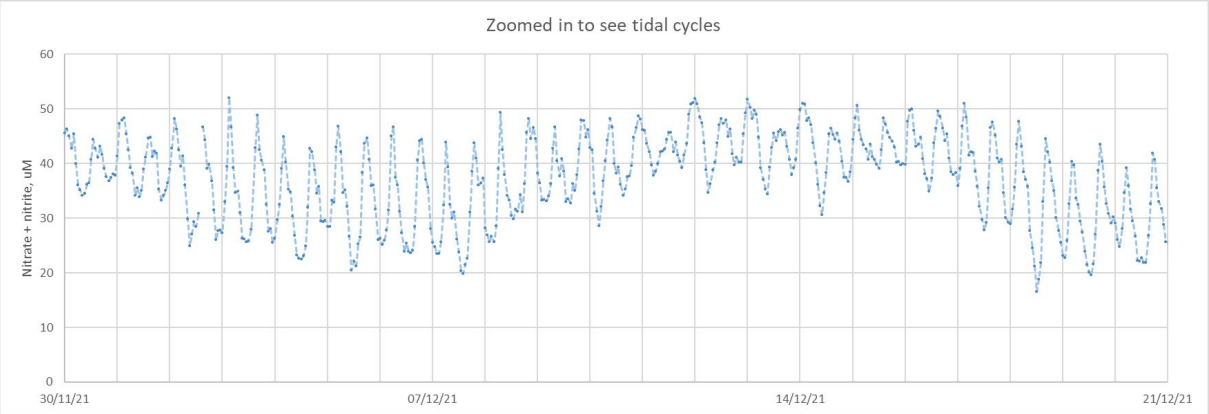
(Source: Watson *et al.*, 2023)

Image 39. Post 2000 nitrate trends for ground water (top left), river water (top right), estuarine water (bottom left) and offshore water (bottom right) in the Solent

University of Portsmouth nitrate monitoring (Hamble and Langstone Harbour)

Between 2021 and 2023, the University of Portsmouth deployed continuous nitrate monitoring equipment in the Hamble and Langstone Harbour. Results have yet to be analysed in detail, but the data indicates that there are significant temporal variations in concentrations, depending on seasons,

weather, and stages of the tide. To illustrate this, a two-month period from the Hamble sonde is shown in Image 40 below.



(Source: provided / created by Prof. G. Watson, University of Portsmouth)

Image 40. Nitrate concentrations in the Hamble over a two-month period in 2021

3.4.2 Shellfish monitoring insights

Shellfish waters

The Shellfish Water Protected Areas (England and Wales) Directions 2016 require the Environment Agency (in England) to endeavour to observe a microbial standard in all 'Shellfish Water Protected Areas'. The microbial standard is 300 or fewer colony forming units of *E. coli* per 100 ml of shellfish flesh and intervalvular liquid. The Directions also requires the Environment Agency to assess compliance against this standard to monitor microbial pollution (75% of samples taken within any period of 12 months below the microbial standard and sampling/analysis in accordance with the Directions).

There are 20 Shellfish Water Protected Areas within the Solent.

- Pennington;
- Lymington and Sowley;
- Yarmouth;
- Newton;
- Lepe Middle Bank;
- Cowes and Medina;
- Central Solent;
- Stanswood Bay;
- Approaches to Southampton Water;
- Southampton Water;
- Cowes and Medina;
- Central Solent;
- Approaches to Southampton Water;
- Spithead and Stokes Bay;
- Ryde;
- Portsmouth Harbour;
- Langstone Harbour;
- Stanswood Bay;
- Chichester Harbour (Emsworth Channel);
- Chichester Harbour (Thornam Channel); and
- Chichester Harbour (Chichester Channel).

Shellfish production areas

In England, shellfish can only be commercially harvested in designated production areas. These are regularly monitored for *E. coli* bacteria and classified depending on levels present. The class categories determine the level of sampling and cleaning required; these are as follows:

- Class A: minimum of 10 samples required per year; 80% of sample results must be less than or equal to 230 E. coli/100 g. Shellfish can be harvested for direct human consumption if the end product standard requirements are met;
- Class B: minimum of 8 samples required per year; 90% of sample results must be less than or equal to 4600 E. coli/100 g. Shellfish can be supplied for human consumption after one of three processes (purification in approved establishment; relaying for at least one month in a classified Class A relaying area; or after an approved heat treatment process); and
- Class C: minimum of 8 samples required per year; all sample results must be less than or equal to 46000 E. coli/100 g. Shellfish can only be sold for human consumption after completing one of three possible processes (relaying for at least two months in an approved class B relaying area followed by treatment in approved establishment; relaying for at least two months in a classified Class A relaying area; or after an approved heat treatment process).

In the Solent, there are six classified shellfish production areas at present, for various species, including oyster (native and pacific), clam (hard and manila) and common cockles, noting that various byelaws, i.e. restrictions and closures, are in place for some of these fisheries (see Section 4.1.4 for more detail). The production areas are listed in Table 34, which also demonstrates that most of the areas are Class B, though one is class C and another both B and C.

Table 34. Shellfish production areas in the Solent

Production Area	Classification Zone	Species	Classification
Langstone Harbour	Langstone Channel	Native oyster, pacific oyster	B/C
Langstone Harbour	South East Langstone Harbour	Clam	B
Portsmouth Harbour	East Harbour	Clam, native oyster, pacific oyster	B
Portsmouth Harbour	Fareham Lake	Hard clam	B
Portsmouth Harbour	Paulsgrove and Portchester	Manila clam, native oyster	C
Portsmouth Harbour	West Harbour	Hard clam, native oyster, pacific oyster	B

Harvesting was previously permitted in several areas, but is now prohibited due to E. coli levels failing the above monitoring standards; these are:

- Beaulieu River - Bailey's Hard (all species);
- Chichester Harbour - Prinstead (all species);
- Portsmouth Harbour - Fareham Lake Middle (all species); and
- Southampton Water - Eling (all species); Hythe (all species); Itchen River (all species); Near Netley (all species); Weston Shelf (all species).

3.4.3 Sediment quality monitoring insights

University of Portsmouth analysis of government monitoring data

Richir *et al.* (2021) undertook a comprehensive analysis of available government sediment contamination monitoring data, including several sites in the Solent. The study found that, whilst trace

element contamination markedly declined up to the 1980s due to improved waste treatment and increased recycling, improvements then slowed and a distinct increase in some elements can be seen after 2010. Zinc, arsenic and lead scores showed low pollution, whilst cadmium and mercury scores were found to be moderate, with concentrations of these five trace elements being judged to be generally temporarily stable. Increasing levels of pollution were found for nickel and iron (but still at low pollution levels). A moderate pollution score was determined for copper, which has apparently steadily worsened since the mid-1990s. The authors noted that increasing site trends were not universal and, conversely, that minimal temporal change could mask some site-specific increases and decreases. Ship antifouling paints, ship scrubbers and sacrificial anodes were considered to be substantial causes for increases in some trace elements, notably copper, zinc and nickel. For the Solent, the authors estimated that 94 t of copper was being added to the Solent system every year (mainly due to antifouling paint, but also scrubbers); as well as 377 t of zinc (mainly from anodes, but also scrubbing and anti-fouling), and 0.2 t of nickel (scrubbers).

Sediment testing for dredging schemes

When dredging campaigns are undertaken, sediment sampling is required to prove that the dredged sediments can safely be deposited at licensed deposit grounds. There are no formal quantitative environmental quality standards (EQSs) for the concentration of contaminants in sediments, although the WFD has introduced optional standards for a small number of priority (hazardous) substances. Cefas has prepared a series of guideline Action Levels (ALs) to assist in the assessment of dredged material (and its suitability for disposal to sea). In general, contaminant levels in dredged material below Action Level 1 (AL1) are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 (AL2) is generally considered unsuitable for disposal at sea. Dredged material with contaminant levels between AL1 and AL2 requires further consideration before a decision can be made. The Cefas Guideline ALs should not be viewed as pass/fail thresholds. However, these guidelines provide an appropriate context for consideration of contaminant levels in sediments and are used as part of a 'weight of evidence' approach to assessing dredged material.

Contamination analysis undertaken at various locations across the Solent show that materials do not tend to exceed AL2 but exceedances of AL1 often occur, although these are generally small. It is worth noting that maintenance dredging tends to dredge recently deposited materials only, and will thus generally reflect background concentrations of contaminants; i.e. surface level contamination is generally likely to be similar elsewhere in a given estuary. Whilst there will be local variations, in the Solent, a review of returns and maintenance dredge protocols reveals that there are often small exceedances for chromium, copper and nickel as well as total hydrocarbon content. Such exceedances are fairly rare for arsenic, lead and zinc, and very rare for mercury, cadmium, tributyltin (TBT) and dibutyltin (DBT). Generally, materials are deemed to be safe for deposit at sea (e.g. HR Wallingford, 2011; ABPmer, 2022; ABPmer, 2023a).

3.4.4 Landfills

There are many historic landfills in the region, and some of these are immediately adjacent to the coast. Historically, coastal wetlands were considered to be of low value and waste disposal thus often occurred in saltmarshes for example. A 2019 study by the Eastern Solent Coastal Partnership (ESCP, 2019) highlights the legacy of historic landfills at risk of flooding and/or erosion. 144 areas were identified, with around half being considered high priority due to their proximity to the coast, lack of defences, and no imminent replacement scheme planned. Some sites are now releasing waste, with growing concerns for human health and the release of plastic litter. Other issues like deterioration or lack of defences and sea level rise threaten to exacerbate the issue. The study stressed the importance of defence upgrades, maintenance and monitoring at historic landfill locations.

3.4.5 Seafloor debris and abandoned boats

Seafloor debris related to industrial and recreational activity is widespread across the Solent; these have the potential to create a hazard to marine ecology and reduce available space for marine habitats to flourish. A 2022/23 project on behalf of Natural England, which aimed to map such debris in the intertidal areas of the Solent Maritime SAC, found a variety of debris, with the most frequently found category being tyres, followed by abandoned structures and scrap metal. However, the largest areas covered by debris was from abandoned structures, followed by fly-tipped waste and abandoned boats (APEM, 2024).

Abandoned boats create a host of environmental problems. Apart from the aesthetic impact, 'fuels and oils leak into the water, the hull slowly breaks down and sheds glass fibres that have recently been identified in shellfish, and plastic components such as ropes and fittings release microplastics into the environment' (Royal Yachting Association (RYA), 2024). Disposal is expensive, as recycling or reuse is difficult, and hulls are contaminated by antifoulants and oils. Most harbour authorities have rules on abandoned boats and wrecks in their byelaws or general directions, however, enforcement can be difficult.

Options for overcoming the abandoned boat issue include a vessel registration system, or a levy on new boat sales which would fund disposal, with the latter being favoured by the RYA for example (RYA, 2024), similar to a system in France. Meanwhile, harbour authorities are often left to clear abandoned boats. For example, in 2021/22, ABP's Port of Southampton completed a programme to clear wrecked and abandoned vessels across its jurisdiction, with 22 wrecks from the Itchen removed in one month alone in June 2021. In total, 150 wrecks were removed. This was described as a complex issue, and involved '*tracing owners, serving 28 days' notices and carrying out full risk assessments for each vessel, but also in the physical process of securing each vessel, checking for contaminants and other hazards on board, and then lifting out, breaking down and disposing of the vessels safely*'. For larger wrecks, divers needed to secure vessels before they could be lifted onto barges and broken down (ABP, 2021; 2024).

3.4.6 Litter

Marine plastic litter refers to waste products containing plastics which have entered the marine ecosystem. The UN Environment Programme defines this as '*any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment*.' Once it has arrived in the marine environment, plastic litter is extremely hard to remove and can take hundreds of years to disappear. Most of the input of marine plastic litter (80%) is thought to be land-based sources (littering on beaches or from sewage systems or rivers), whereas 20% is attributed to marine sources; predominantly from the fishing industry (Solent Forum, 2024a, quoting the International Maritime Organization). Plastics are found on the surface, in the water column, and in seabed sediment, affecting wildlife through ingestion, smothering and entanglement (Environment Agency, 2023a).

There are no regional studies on levels of plastics pollution in the Solent; though numerous litter picking (with reporting) and reduction campaigns are ongoing (see Section 4.1 for more detail). A 2023 study for the Itchen Estuary revealed that, whilst the evidence base was limited, '*research does indicate that levels of microplastic pollution are higher in the Itchen estuary (both in the water column and surface level sediment) than in other parts of Southampton Water and the wider Solent estuarine complex*' (Evolved Research, 2023, quoting Gallagher *et al.,* 2016). The shores of the Chessel Bay nature reserve on the eastern bank of the estuary were considered to be particularly badly affected by a build-up of plastic bottles and pellets in 2022. This led to community litter picks and a trial to clean-up the nature reserve in collaboration with Nurdle, a not-for-profit organisation; resulting in the removal of approximately 4 tonnes of plastic waste (Evolved Research, 2023).

The Gallagher *et al.* (2016) paper reported on a water column testing study by Southampton Solent University, undertaken in Southampton Water and its tributaries. Microplastics were common within the water column of the estuarine complex, and the Itchen Estuary had the most microplastic particles (with 1,155 particles found), whilst the Hamble Estuary had the fewest (296 found).

3.4.7 Potential impacts on nature

There are numerous potential impacts on nature from pollution, some of which have been indicated in the preceding sections.

Sewage discharges, along with run-off from agricultural land, and from towns and cities, can result in contamination of water bodies with faecal organisms, bacteria and viruses that can cause problems in areas used for bathing or shellfish production, and also damage habitats and affect species.

Excessive nutrient inputs to estuaries and coastal waters can lead to problem levels of growth of macroalgae in some locations. There can furthermore be wider ecological effects because of impacts on inshore phytoplankton abundance and community structure. Some marine plants can to some extent benefit from excess nutrients, but too high loads can result in eutrophication, negatively affecting marine ecosystems. There may also be increased growth of epiphytic algae on seagrass for example (smothering and reduced light) (Environment Agency, 2023a; Bardsley *et al.,* 2021).

Indirect impacts of opportunistic macroalgae growth on intertidal and shallow subtidal environments can include (as summarised by Bardsley *et al.,* 2021):

- Changes in sediment structure and deposition of subtidal habitats;
- Changes in benthic fauna;
- Smothering of saltmarsh and other vegetation;
- Changes to saltmarsh structure and function;
- Smothering or shading of eelgrass beds; and
- Changes in the prey availability distribution and type.

The potential impacts of excessive macroalgal growth on saltmarshes were briefly highlighted in Section 2.3.2; and a 2019 masters thesis on the saltmarshes of Chichester Harbour's responses to environmental factors (Rogers, 2019) is furthermore worth highlighting. The author found a relationship between the localised erosion of saltmarsh in years where there were higher nitrate values in Chichester Harbour. Rogers' work furthermore determined a statistically significant relationship between higher nitrogen (nitrate) rates resulting in greater annual saltmarsh losses at a local level, when combined with other factors likely to correlate with high nitrogen such as increased wave action (as they are related to increased wind and rainfall). Though all attributes correlated to saltmarsh, wave action and nitrate levels had the strongest correlation to losses of saltmarsh, with the correlation to winter nitrate stronger than summer nitrate (however both were statistically significant).

On seagrass beds, Unsworth *et al.* (2024) noted that, when these are subject to high nutrient levels, their resilience and productivity can increasingly be compromised. In addition, sustained uptake of water-column nitrates, along with poor light availability, are thought to both reduce the build-up of carbon stores in seagrasses (which are critical for survival during periods of stress). Furthermore, '*there is evidence that seagrasses have reduced growth rates under ammonia enrichment*' (Unsworth *et al.,* 2024, quoting Burkholder *et al.,* 2007).

With regard to littering, a 2017 government report titled 'The Future of the Sea: Plastic Pollution' (Government Office for Science, 2017) emphasized the detrimental effects of plastic debris on marine life related to entanglement and ingestion, with the former predominantly caused by fishing gear. Ingestion is frequently documented, especially concerning small debris fragments such as bottle caps,

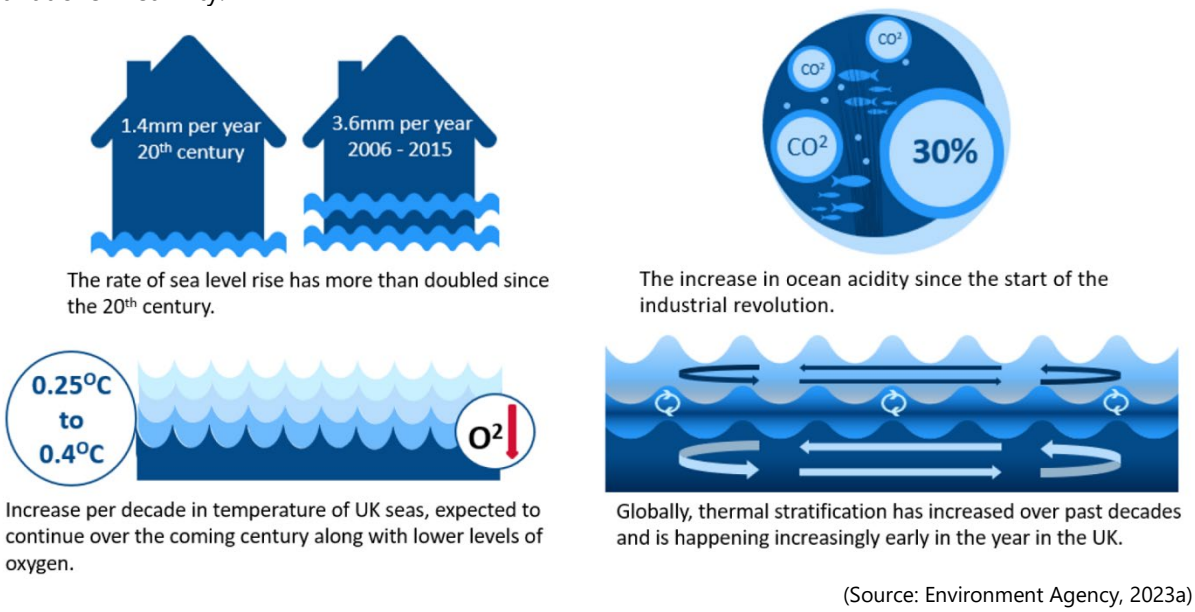
balloons, and sewage-related waste. Approximately 300 species have been identified as having ingested plastic waste in their habitats. Laboratory studies indicate that microplastics can be transferred from prey to predator. Microplastics are known to affect marine life and bird species through suffocation and starvation; as well as being a source of persistent organic pollutants.

A 2020 evidence review of plastics on marine habitats and features by ABPmer (for Defra) concluded that smaller marine organisms (such as fish and invertebrates) were exposed to smaller plastic particles (microplastics and nanoplastics), which have been shown to exhibit biological effects(ABPmer, 2020c). However, lethal effects are rarely observed, and where they are, the plastic concentrations tested tend to far exceed environmental relevance. Larger marine species (such as birds and marine mammals) are considered to be more vulnerable to larger plastic debris that they may ingest or become entangled with. However, no evidence was found to suggest that this was having population level effects. Similarly, whilst studies suggest some potential effects on habitat functioning, it was concluded that '*the decline of habitats due to plastic pollution is not evidenced*'.

There is furthermore growing recognition and understanding of the threats posed by chemical pollution to coastal and marine environments. A vast range of chemicals, including pharmaceuticals, heavy metals and pesticides enter the coastal and marine environment. Many of these substances have been identified as posing risks as a result of their toxicity, ability to accumulate in plants and animals, and persistence in the environment for long periods (Environment Agency, 2023a). Research by the University of Portsmouth has for example revealed tiny quantities of antidepressants in water can affect wildlife, such as crustaceans and molluscs. It also found drugs will affect the behaviour and biological make-up of these creatures, including changing colour, growth and reproducing less or more (University of Portsmouth, 2023). Threshold levels are often lacking, as is evidence identifying typical levels of contaminants which cause ecological damage.

3.5 Climate change

The Environment Agency's 2023 'state of the coastal and marine environment' notes that climate change is having a significant impact on the physical properties of oceans worldwide, including those in the UK. The intensity of these effects varies by location, influenced by factors such as prevailing weather patterns and ocean currents. Key physical changes are summarised in Image 41, and encompass changes in water temperature, thermal stratification, acidification (indicated by a decrease in pH), sea level rise, and variations in salinity.

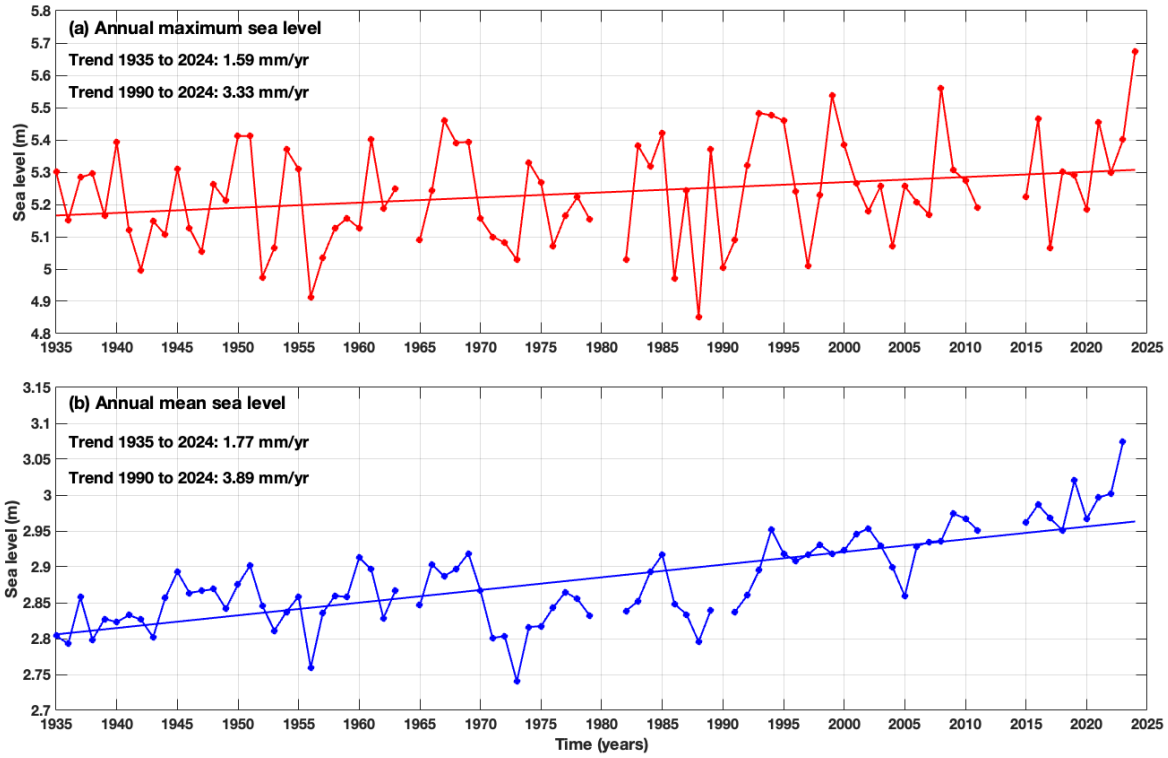


(Source: Environment Agency, 2023a)

Image 41. Infographic on the physical impacts of climate change on the ocean

Additionally, there is growing evidence that river flow patterns may be disrupted, which could adversely affect water quality in estuarine environments. The increasing occurrence of severe rainfall and storms may further exacerbate the influx of nutrients and pollutants into estuaries and coastal waters. Climate change is also influencing species distribution, the structure of ecological communities, and the overall functioning of ecosystems, thereby impacting the services they provide. The extent to which climate change can be mitigated will significantly influence the severity of these impacts (Environment Agency, 2023a).

Sea level rise is of particular concern for low lying coastal regions such as the Solent. This rise is as a result of melting glaciers and ice sheets, as well as thermal expansion of the ocean's water as it warms. UK mean sea levels have risen by about 12 to 16 centimetres (cm) since 1900 and will continue to rise. The Climate Change Committee state that a mean rise of 1 m is now inevitable at some point in the future. Exact levels will vary around the country, and Southern England will see the highest rises, because the land is still sinking after the last ice age (Environment Agency, 2023a). In Southampton for example, sea level rise is now on average almost 4 mm year^{-1} (Image 42; courtesy of University of Southampton), and forecasts for the region are for a rise of 1.2 to 1.6 m by 2125 (Environment Agency, 2024c). Larger rises than this are considered possible due to potential marine ice sheet instabilities, but assessing their likelihood is almost impossible (Environment Agency, 2023a).



(Source: provided / created by Prof. I. Haigh, University of Southampton, May 2024)

Image 42. Sea level rise at Southampton Dock Head

Some of the environmental impacts of sea level rise highlighted as major risks by the most recent UK climate risk assessment include (Environment Agency, 2023a):

- localised, and over time, more widespread loss of coastal habitats, such as seagrass and salt marsh, that provide flood protection and carbon storage as well as critical wildlife habitats and fish nurseries. Indications from the review provided in Section 2.3 are that many habitats, notably saltmarshes, in the Solent are already struggling to keep pace with sea level rise;

- risk to marine environments from erosion exposing old landfill sites. There are several such sites in the Solent, as noted above; and
- risks to aquifers and agricultural land from saline intrusion.

With regard to the key habitats of the Solent, potential impacts from climate change can be summarised as follows:

- **Mudflats and saltmarshes**: the primary threats related to climate change are relative sea level rise, changes to wind and wave energy, temperature and precipitation. Where sufficient sediment is present in a given system's water column, then these habitats are relatively resilient and can keep pace with sea level rise to various extents by accreting / increasing in height. However, their landward movement is often impeded, and coastal squeeze could thus occur. If storms become more frequent, then this would also cause cumulative damage, as storms often cause substantial intertidal habitat erosion, particularly along their seaward edges. Changes in temperature could lead to the decline in cover for several invertebrate and marsh plant species, as suitable conditions shrink with rising temperatures (Marine Climate Change Impacts Partnership (MCCIP), 2018a).
- **Seagrass beds**: effects on sea temperature, sea level, storminess and rainfall patterns could affect seagrass species. Impacts could be both positive and negative, and could affect seagrass productivity, growth and flowering rates, as well as habitat distribution. For example, warmer winters may lead to less damage during exceptionally cold winters, whereas hotter summers could lead to more beds suffering from a reduction in productivity. Whilst, similar to saltmarshes and mudflats, seagrass beds can shift inland in response to sea level rise, they are then also threatened by coastal squeeze and a potential loss of supporting habitat in the correct tolerance range. Seagrass beds are not considered to be sensitive to ocean acidification (MCCIP, 2018b; Marine Life Information Network, 2019), although combined with heat stress, it is likely to impair seagrass performance (Ravaglioli *et al.,* 2024).
- **Oyster beds**: Native oysters are considered to be fairly insensitive to most of the related pressures, including gradual increases in temperatures, acidification and sea level rise (Marine Life Information Network, 2023). Heatwaves can however affect oysters, as for example evidenced by die off of oysters during heatwaves in oyster cages (Helmer, 2019).

4 Restoration, Recovery and Management of the Solent's Marine Nature

This section summarises the ongoing measures which are being taken to manage and restore the Solent's marine nature. Potential opportunities and measures are furthermore highlighted. However, it is not within the scope of this report to suggest what measures should be taken going forward.

Management and regulation is first summarised in Section 4.1, before restoration and creation is discussed in Section 4.2.

4.1 Management and regulation

The Solent is a highly managed and regulated system, reflecting its high population density and the myriad of commercial and recreational activities which take place in a very designated (and important) marine environment. The annual SEMS report provides overviews of ongoing measures for the non-licensed activities it monitors, and a summary is provided in the next Section (4.1.1). Thereafter, designated site management is discussed in Section 4.1.2, then wildlife disturbance management measures are summarised in Section 4.1.3, byelaws and guidance are outlined in Section 4.1.4 and finally pollution management and reduction is specified in Section 4.1.5.

4.1.1 Summary of SEMS report measures

As previously noted in Section 3.3.1, every year, the Solent Forum undertakes a survey of thirty-one Relevant Authorities in the Solent to help gauge the impact of sixteen non-licensable coastal and marine activities on the SEMS (Solent Forum, 2024c). As part of this, ongoing measures aimed at addressing specific issues are outlined for each of the activities. A table summarising these has been created for this report, and is provided below. This demonstrates that a vast array of measures, encompassing regulation, guidance/best practice, monitoring, voluntary measures and awareness raising are already in place in the Solent. Many of these are Solent specific and some of them can arguably be considered pioneering (e.g. Bird Aware Solent; see Section 4.1.3 for more detail).

Table 35. Summary of management measures in place in the Solent marine sites, as summarised from latest SEMS annual report

Activity	Summary of ongoing management measures / initiatives	Suggested actions for SEMS members
Accidental Vessel Discharges/Emissions	Various policies and procedures in place to address accidental discharges. Regular emergency spill exercises by relevant organisations to keep equipment and skills up to date. Information on procedures is available on the relevant authorities' websites and other publications. The Blue Green have resources on oil and fuel spills for boating, including best practice guidance and posters.	No specific activity action proposed
Boat Repair and Maintenance	The Green Blue initiative produces detailed guidance and undertakes education programmes on how to minimise the environmental impacts from boat maintenance and repair. The Solent Forum, in partnership with Natural England, has prepared Biosecurity Actions plans for the Solent.	Promotion and sharing of best practice
Fishing (including shellfisheries)	Various byelaws are in place, including these Southern IFCA byelaws on bottom towed fishing gear, net fishing, Solent dredge fishing. Also Sussex IFCA byelaws for nearshore trawling, scallops and oysters. Chichester Harbour byelaw which prohibits the use of towed fishing gears, digging, collection and hand gathering of marine fisheries resources in specified areas. Also, various IFCA byelaws and codes of practice that apply to commercial, recreational and charter fishers.	Reporting of illegal fishing activity to IFCAs and MMO
Fishing (shore-based activities)	Inspection by fishery officers. Sussex Voluntary Code of Conduct on Bait and Hand Gathering. Various Southern IFCA byelaws which specify minimum size requirements, approved shore-gathering practices, and a prohibition on gathering sea fisheries resources in seagrass beds. Also Southern IFCA guidance and codes of practice for hand gathering of shellfish and bait. Ongoing project by Southern IFCA reviewing shore gathering in relation to MCZs, SACs and SPAs to determine if any new or updated management measures are required. Also, available Guidance for Solent Relevant Authorities for monitoring shore-based fishing to help record this activity.	Reporting to and liaising with the local IFCA, and if necessary, the marine police
General Beach Recreation	Natural England 2021 (relaunched) Countryside Code in 2021. Many organisations use the hashtag #ProtectRespectEnjoy to promote best practice across social media platforms. At sensitive locations, relevant authorities and partners have been fencing off areas to protect nesting birds, using increased staff presence to manage visitors at peak times and controlling access via car parking restrictions. Information boards with QR codes are also being used to educate the public. Bird Aware Solent's educational work.	Include information on impacts on designated sites when updating local codes of conduct or signage; work with partners to protect sensitive sites
Grazing and Foraging	Seaweed harvesting is being reviewed as part of an ongoing Southern IFCA review on Shore Gathering Review. This activity could be managed by multiple authorities. Also Solent Waders and Brent Goose Strategy maps highlight where birds graze and roost. Natural England has produced a seaweed harvesting code of conduct.	Reporting of any concerns with foraging in designated sites to the local IFCA.
Land Recreation (including dog walking)	Natural England assess the impacts from opening access to the coast as part of their work to deliver the King Charles III Coast Path. Comprehensive signage has been installed in many locations, in collaboration with Bird Aware Solent. Implementation of alternative green spaces away from the coast (e.g. Gosport's Alver Valley). Investigation of potential measures at Ryde Sands SSSI re. Sanderlings by Natural England. Increased presence of managers at the North Solent NNR to monitor disturbances. Various disturbance events by Milford on Sea community group. LIFE on the Edge project (RSPB and National Trust) is working to create and improve habitat Chichester and Langstone Harbours SPA in the Solent. Also, revised 2021 Countryside Code and 2023 Marine	1) Support of Bird Aware Solent and other partnership projects in the delivery of their work on recreational disturbance issues. 2) Local authorities to consider the use of Public Space Protection Orders and

Activity	Summary of ongoing management measures / initiatives	Suggested actions for SEMS members
	and Wildlife Coastal Code in 2023. Furthermore, many dog specific measures are being implemented, including Bird Aware Solent's Coast and Country Canines initiative (encourages dog owners to walk in a safer, more wildlife aware way; includes a dog friendly zone map). Also work under way to encourage dog walkers to visit other areas and less sensitive parts of the coast. Fareham Council's Public Spaces Protection Order (PSPO) to protect Hill Head beach from dog walkers in winter. The New Forest National Park Authority engages with the dog owners and operate a project officer. At Lepe, Hampshire County Council have implemented areas of no dog access as well as guidance around the site; they also have a Countryside Canines campaign.	alternative spaces away from coast as measures to mitigate dogs disturbing birds, particularly disturbance to overwintering birds.
Littering and Removal of Litter	Numerous litter campaigns, initiatives and clean-ups take place around the Solent, both national and local. The Solent Forum collates information on these as part of its Solent Plastics Pollution hub and Clean Solent Shores and Seas work to help people coordinate and access information. The Great British Beach Clean provides data and information on the amount and type of litter found. Harbours and marinas have comprehensive waste facilities, and encourage their users to make use of these facilities. The Green Blue have numerous resources on best practice for boating. ABP's recent significant project to remove wrecks from the River Itchen, with over 100 vessels removed. Also, there are various local authority initiatives to minimise littering. There is a partnership for Preventing Plastic Pollution for the Itchen estuary. Southern Water's Bluewave Innovation team are working with University of Portsmouth to baseline their understanding of microplastics in their wastewater systems.	Solent Forum will continue to maintain the Solent Plastics Pollution Hub as a legacy output of the Agency's Preventing Plastic Pollution Interreg funded project. This hub will link closely with the Forum's work on Clean Solent Shores and Seas.
Mooring and Anchoring	The Green Blue have an 'Anchoring with Care' campaign. Advanced Mooring Systems / eco moorings, have been installed at some locations (Osborne Bay, Cowes and Yarmouth). Through LIFE Recreation ReMEDIES, recreational activity surveys monitor anchoring and mooring at several locations every year inform potential management. Interpretation Panels have been installed at many locations as part of the project to inform people of the presence and location of seagrass beds and their importance. A Voluntary No Anchor Zone has been installed at Osborne Bay. The ReMEDIES project also commissioned a report that mapped areas impacted by anchoring and mooring pressure in the intertidal areas of the Solent Maritime SAC.	Use and share the available information and best practice. Support the work of the LIFE ReMEDIES project (due to complete in October 2024) and the Solent Seascape Project.
Operation of Coastal Flood and Erosion Risk Management Schemes	Assessment of SMPs and new plans or projects within SEMS to determine whether compensation may be required. Also ongoing habitat compensation programme is in place, led by Coastal Partners.	No specific activity action proposed.
Operation of Ports and Harbours (maintenance of infrastructure)	The UK Marine SAC project produced guidance, including good management practice. Natural England and the Solent Forum have worked together to develop biosecurity plans for the Solent. Harbours are also beginning to look at ways to ecologically enhance their coastal infrastructure. Solent Forum has a Building Biodiversity in the Solent hub to promote and share best practice. Some greening the grey measures have been implemented (e.g. e-concreting of the River Hamble's sea wall involved inclusion of textured concrete plus pools).	Utilise the resources and implement relevant actions in the Solent Biosecurity action plans.
Aerial Recreation (light aircraft, paramotors, drones)	There is 2018 Natural England guidance on regulations of unmanned aerial vehicles. Natural England's related evidence briefing contains guidance on management options; including site management access, education and communication techniques and legal enforcement. Bird Aware Solent rangers record if drones disturb birds when out on duty, but sightings are apparently rare. Hampshire Constabulary provide information on the legal	No specific activity action proposed.

Activity	Summary of ongoing management measures / initiatives	Suggested actions for SEMS members
	aspects of flying drones. Hampshire County Council request that a filming form be completed before filming in Hampshire's countryside, including drones. The Crown Estate has published guidelines on Metal detecting and drone flying. The Civil Aviation Authority provides detailed information about drone use, regulations and best practice. It recommends that drone users seek advice from Natural England if flying over a SSSI.	
Recreation (non-motorised watercraft)	Natural England's related evidence briefing lists management options, including on-site access management, education and communication with the public and site users, and legal enforcement. The user groups for the activities in this category also provide advice to their members on how to minimise their environmental impact, for example, The Green Blue's 'Green Wildlife Guide for Boaters'. Relevant authority management measures include charging a harbour due or permit, implementing car parking charges, slipway booking systems, erecting information signs at sensitive areas and conducting more water and roaming warden patrols. Harbour authorities put environmental educational material in harbour guides/websites. Guidance on best practice for paddle sports users is available from the British Canoe Union and the Go Paddling website. Through LIFE Recreation ReMEDIES, recreational activity surveys monitor such activities at various locations, and interpretation panels have been installed at five locations. Bird Aware Solent have produced a water sports with wildlife map and guides to help paddle and wind sports enthusiasts coexist with nature. Educative signage has been installed at public launch/access points throughout some of the Solent's harbours. Biosecurity action plans are in place to help prevent the spread of marine invasive species, including from these sports.	Support Bird Aware Solent's water sports with wildlife campaign and use the Solent Biosecurity plan information to help prevent marine invasives spread. Partners/lead: SEMS MG members.
Recreation (powerboating or sailing with an engine)	Harbour General Directions / byelaws, including speed restrictions, effectively manage this activity. For activities like waterskiing and jet skiing, these commonly require permits and participants are encouraged to stay away from sensitive sites. A maritime partnership has produced a 'Wash and Slow' leaflet that shows Solent speed limits. A partnership of several authorities is raising awareness of the importance of proper engine maintenance. Bird Aware educative signage has been installed at public launch points throughout the River Hamble. Hampshire Police Marine Support Unit launched Operation Wave breaker to address issues relating to anti-social behaviour on the water and to start to look for some long-term solutions, in collaboration with various authorities.	No specific activity action proposed.
Slipway and Jetty Cleaning and Maintenance	Solent harbours try to avoid using harmful chemicals and use plain seawater or environmentally sound cleaning materials when cleaning, where possible. The Green Blue, the RYA and the MMO provide guidance on cleaning of slipways. The Green Blue provide guidance on best practice in cleaning of both boats and infrastructure.	No specific activity action proposed.
Wildfowling	Licences and consents are in place to manage this activity. Landowners/occupiers, such as wildfowling clubs, need to apply to Natural England for consent (though this does not apply to third parties). The Joint Group for Wildfowling on Tidal Land was set up to advise The Crown Estate on issues relating to wildfowling on designated intertidal land. Operation Seabird is a multi-agency operation to allow the reporting of wildlife disturbance (including wildfowling) to try and afford some protection to coastal wildlife, whether birds, seals, dolphins etc. It involves explaining how disturbance effects the wildlife and with the final option of enforcement if necessary.	No specific activity action proposed.

4.1.2 Designated site management

The UK's Statutory Nature Conservation Bodies (SNCBs) are responsible for assessing the condition of habitats and species protected the designated sites; this is supported by the commissioning of monitoring studies where appropriate. Condition assessments available for the Solent region sites have been reviewed for this report, and are summarised in Section 2.2.2. Conservation advice is also provided for all the sites, and provide important insights into the designated features and the pressures they face, in addition to helping with site assessments.

Site Improvement Plans have furthermore been prepared for international sites; these provide high level overviews of the issues (both current and predicted) affecting the condition of the features on the site(s) and outlines the priority measures required to improve the condition of the features (where remedial action is not already in place or ongoing). For example, the 2014 Solent Site Improvement Plan applies to Chichester and Langstone Harbours SPA, Portsmouth Harbour SPA, Solent and Southampton Water SPA and Solent Maritime SAC. Issues highlighted in the 2014 Site Improvement Plan are listed in Table 36, together with the proposed measures included (some of which have since been implemented or progressed). Various delivery bodies were suggested for these measures, please refer to the improvement plan (Natural England, 2014) report for a full list.

Table 36. 2014 Site Improvement Plan priorities, issues and proposed measures

Priority and issue	Proposed measure as per 2014 Site Improvement Plan
Public access and disturbance	Reduced bird disturbance through access management, awareness raising and wardening
Coastal squeeze	Investigation of options to create alternative habitat
Fisheries - commercial marine and estuarine	Introduction of 'appropriate management measures' for fisheries, where required and to ensure compliance
Water pollution	Implement actions in the Diffuse Water Pollution Plan, and investigate further pollution
Changes in species distribution	Investigate the causes of change
Climate change	Investigate the effects of climate change
Change to site conditions	Investigate the reasons for change
Invasive species	Implement the management options to control invasive non-native species
Direct land take from development	Option appraisal for private coastal defences
Biological resource use	Appropriate egg collection licensing
Change in land management	Ensure appropriate ditch management, and assess the effects of tidal sluice operation
Inappropriate pest control	Increase control of foxes
Air pollution: impact of atmospheric nitrogen deposition	Reduce the impacts of air pollution
Hydrological changes	Review abstraction licenses
Direct impact from third parties	Assess the activities and their effects
Extraction non-living resources	Investigate the extent and impact of shingle extraction
Other	Consider/explore boundary change to amend the SAC / SPA designations, to include habitats outside of the existing boundaries

Within SSSI designated areas, land owners or tenants are obliged to manage their land effectively and appropriately to conserve their special features and work towards achieving or maintaining a favourable condition. There are restrictions as to what can be done on SSSI land, and each SSSI will have a list of

operations that require consent from Natural England. The operations requiring consent differ for each site, but typically include a long list of operations 'likely to damage the special interest'. For example, 28 are listed for the North Solent SSSI. These include cultivation, mowing or grazing; drainage; tidal creek modification; storage of materials; structure erection, etc.

With regard to the SEMS, a dedicated management scheme was established in 2000; its aim is to conserve and enhance the designated habitats and species through appropriate management measures achieved by co-operation between the Solent's 31 relevant authorities. As noted above, the scheme's focus is on managing non-licensable activities, as development is deemed to being effectively dealt with through existing statutory licensing and regulations procedures.

It is also worth noting that the MMO also has responsibilities, alongside other governmental bodies, for managing marine non-licensable activities to further the conservation objectives of MPAs in English waters. This includes a requirement to introduce appropriate management measures if required[39]. MMO has prioritised six MPAs for assessment, engagement, management and monitoring in relation to marine non-licensable activities. This includes one in the Solent, the Solent Maritime SAC. The aim is to have identified appropriate management and work collaboratively to have measures in place in 2025. Further MPAs will then be considered in subsequent phases (MMO, 2022).

4.1.3 Disturbance management

Throughout the Solent and its many nature reserves, various efforts are ongoing to minimise disturbance to wildlife, including through:

- Encouraging modified behaviour or activities;
- Increasing access provision elsewhere, to dilute or spread the pressure (including away from the coast);
- Increasing resilience of sites (e.g. screens); and
- Limiting problematic activities through rules, regulations and restrictions.

Bird Aware Solent is a relatively recent initiative which oversees efforts in this respect for substantial lengths of the Solent's shorelines. More information on this is provided below.

Bird Aware Solent

Bird Aware Solent is a strategic mitigation Partnership initiated in 2017 which operates across the Solent, to reduce potential recreational impacts on protected birds from increased local housing development[40]. It is the public facing brand name of the Solent Recreation Mitigation Partnership. Fifteen of the Solent's local authorities are members of this Partnership and use it to help fulfil their duties to mitigate bird disturbance from recreational activity.

In 2023, Bird Aware published its Bird Aware Solent Strategy Review 2023 (Liley *et al.,* 2023a). The data shows that a range of activities have increased over the review period, notably kitesurfing, kayaking, paddleboarding, walking (without a dog) and dog walking. While the number of dog walkers (and dogs) have increased, the proportion of dogs now kept on a lead has also increased.

[39] This is in relation to the 2023 Environmental Improvement Plan, whereby Government has committed to ensuring that 48% of MPA features are in favourable condition by 2028, and 70% by 2042, with the remaining in recovering condition.

[40] The rationale being that most visits to the Solent's SPAs are made by people who live in close proximity (5.6 km used in relevant assessment). Thus, new homes built within that 5.6 km zone are considered to be likely to lead to more people visiting the SPAs with a potential to have an impact on the birds. Mitigation is thus required, either to be provided by house builders themselves, or by them making a 'developer contribution' towards implementing the Bird Aware Solent Strategy. The contributions from 1 April 2024 range from £465 for a 1-bed property to £1,207 for a 5 bedroom property.

Mitigation over the first five years of the partnership has included (Liley *et al.,* 2023b):

- 3,046 visits conducted by rangers (7,476 hours of ranger time);
- 39,846 visitors engaged by rangers during site visits;
- Attendance at 174 community events (engaging with over 7,055 people);
- Social media outreach (over 2,500 followers on Twitter, Facebook and Instagram);
- A range of site-specific projects, such as access infrastructure to make locations more resilient; and
- Enhancement of existing greenspaces to create alternative visitor destinations away from the coast.

A review report by Footprint Ecology (Liley *et al.,* 2023a) made some recommendations for further consideration, and these include:

- The suggestion to increase ranger provision;
- The potential to review the use of volunteers, perhaps in the medium to long term;
- The further exploration of the role and potential of social media;
- A review of the potential for 'harder' mitigation measures (e.g. enforcement, restricting access, reducing parking opportunities);
- Widening of mitigation delivery to include breeding birds and coastal habitats;
- A focus on access infrastructure and Suitable Alternative Natural Greenspace (SANG) provision in the short to medium term;
- Proposed activities and priorities for mitigation are dog walking, alongside water sports and activities involving access onto (or close to) the intertidal such as kayaking, kitesurfing, windsurfing, paddleboarding and wild swimming;
- Clear communication of the role of Bird Aware Solent to stakeholders ;
- The use of case studies to document successes and how different measures have worked in different locations, to help inform future decision-making; and
- Flexibility to allow mitigation to adapt and respond to change over time.

4.1.4 Byelaws, codes of conduct, best practice guidance and similar measures

Byelaws and similar measures

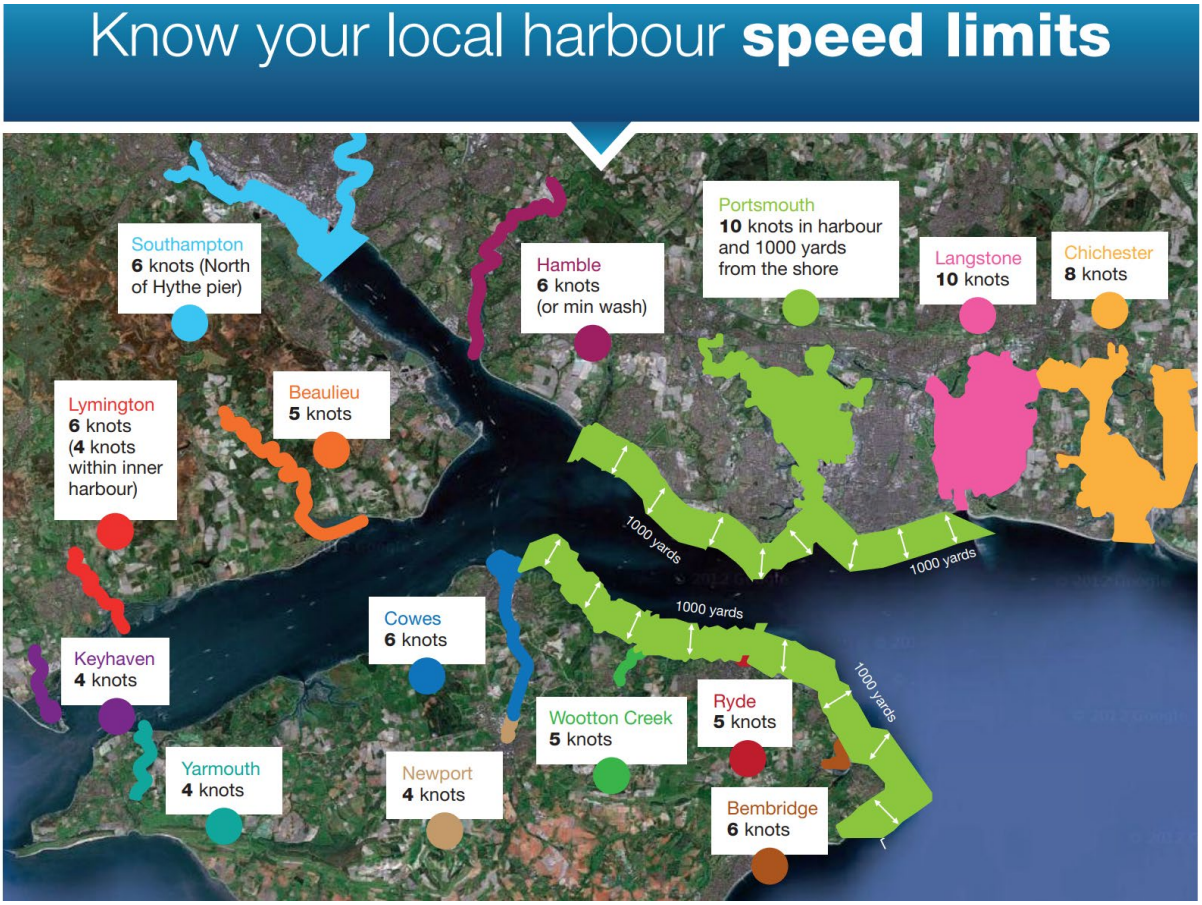
Many bodies, including local authorities, the MMO, IFCAs, harbour authorities and Natural England has powers to make byelaws under various Acts – for example, the powers for Natural England relate to SSSIs and area provided by Section 28R of the 1981 WACA (as amended). The Secretary of State has to sign off / approve byelaws; a process which can take a long time. For example, the Sussex IFCA Hand Gathering Byelaw was submitted in 2021, and has yet to be approved. Some harbour authorities have powers, through their local enabling legislation, to give 'general directions' to enable a harbour authority, after due consultation, to lay down general rules for their area. These effectively replace byelaws once general directions powers have been granted, and do not require Secretary of State approval (though bodies such as the RYA and chamber of shipping are typically consulted)[41].

A myriad of byelaws (and general directions) are in place in the Solent region, with most having been implemented by the IFCAs and relevant Harbour Authorities. These are discussed below.

[41] General directions could extend to those motivated by environmental reasons; the Portland Harbour Authority in Dorset has for example recently enacted an overwintering zone in its inner harbour where no vessel access is permitted between November and March to reduce disturbance. In the Solent, the authorities for Lymington, Cowes and Yarmouth harbours/ports have powers to make so-called general directions, whereas there are applications with the MMO for Harbour Revision Orders to grant such powers by both the Chichester Harbour Conservancy and the Port of Southampton. These have yet to be granted, having been submitted in 2020 and 2021 respectively.

Harbour authority byelaws and general directions

Where Harbour Authorities have introduced byelaws or general directions, these would have mostly been prompted by navigation and safety concerns. By way of an example, the Lymington Harbour Authority has issued 52 general directions related to navigation, recreation, mooring and management of vessels and the commissioner's property. None have been specifically implemented for nature protection, but around 14 of the directions would have direct benefits for nature. For example, vessel speed is mostly restricted to 6 knots, to limit wash. In this location this would reduce the risk of (shore-located) nests being washed away, and habitats such as saltmarshes being eroded. Water sports are also often restricted by general directions, and bait digging is generally forbidden within close proximity of moorings, piles, jetties or similar structures. The Hampshire Marine Unit has produced a leaflet illustrating the speed restrictions throughout the Solent; this is included below as Image 43.



(Source: Hampshire Marine Unit, undated)

Image 43. Harbour speed limits in the Solent

IFCA byelaws

Fishing related byelaws have often been prompted by environmental concerns/regulations, for example, in 2023, the MMO introduced restrictions in 13 MCZs across England, though none of these are however in the South Coast region.

In 2016, the Southern IFCA introduced a bottom towed fishing gear byelaw prohibiting such fishing across large areas of the Solent. In 2023, a new byelaw was drafted to consider feature based management interventions for MPAs, resulting in an increase of 46.8 km^2 in overall closure area. There is furthermore a Sussex IFCA MPA byelaw which protects two MCZs in the Solent region, Utopia and Pagham Harbour, from various forms of fishing – e.g. in Pagham Harbour, towed, net, line, and pot gear is prohibited, and shore gathering and rod and line fishing restricted. The Sussex IFCA Nearshore

Trawling Byelaw 2019 includes Chichester Harbour (and also Medmerry and Pagham Harbour) and furthermore extends east along most of this shoreline; it prohibits the use of trawl gear throughout these areas. This byelaw was put in place with the aim of promoting the (largely passive) recovery of the once abundant kelp forests (which in turn supported abundant marine wildlife, including important commercial fish species such as bass, black seabream, lobster and cuttlefish).

Several other byelaws are in place throughout the Solent prohibiting fishing in certain areas or during certain times of the year (or with certain gear) and requiring permits to undertake fishing. Data layers showing these have been included on the data viewer, and full lists of byelaws are available on the Sussex and Southern IFCA websites.

Fareham Council Hill Head Public Spaces Protection Order (PSPO)

Whilst not a byelaw or general direction in its strictest sense, the following is pertinent to this report. In 2023, prompted by Bird Aware, Fareham Council incorporated an area at Hill Head (next to Titchfield Nature Reserve) into its Public Spaces Protection Order (PSPO) for Dog Control (granted under the Anti-Social Behaviour, Crime and Policing Act 2014). This stipulates that dogs are not allowed onto the specified area of beach or foreshore between 1 October and 31 March (Fareham Council, 2023) (see related signage in image below).

(Source: Bird Aware, 2024a)

Image 44. Example of Bird aware signage at Hill Head

Codes of practice / conduct and best practice guidance

Codes of practice / conduct and guidance documents which are of relevance to this report abound, and an exhaustive list cannot be provided here, though many have been listed in the SEMS summary table (Table 35). For example, the two IFCAs, amongst others, have codes of practices on hand gathering, bait digging, cuttlefish, net fishing, salmonid handling, recreational angling, spearfishing, etc.

Harbour Authorities will have many guides tailored to how their water bodies may be used; for example, the Chichester Conservancy has a guide for paddle sports users and one for essential safety for new or less experienced mariners, as well as a Solent Seals code of conduct.

Bird Aware Solent has produced a Coastal Code to minimise disturbance to birds, which asks coastal users to 'look out for birds', 'move further away if birds become alert', 'keep dogs alongside', and 'follow requests on signs' (Bird Aware Solent, 2024b). Bird Aware Solent have also published guidance for wildlife aware paddle sports and wind sports, and have developed an interactive map to help water sports users reduce disturbance to protected birds and habitats. This purposely does not provide an exhaustive list of entry and exit points, as it aims to only recommend places that are wildlife friendly (thus avoiding known disturbance areas) and safe, with public parking (Bird Aware Solent, 2024c).

The Green Blue programme by the RYA is also worth highlighting; this was launched in 2005 and aims to 'inspire, inform and enable the recreational boating community to make more environmentally sustainable choices to help protect and enhance our environment for people and nature'. The website (RYA, 2024) contains various resources for marine businesses and boat users, including many awareness posters, five green boating guides and numerous video guides as well as an environmental facilities map. The boating guides of note to coastal and marine users include a 'Green Wildlife Guide for Boaters', a 'Green Guide to Anchoring and Moorings', and an 'Antifoul Best Practice Leaflet'. There is also additional guidance on general water pollution prevention, anchoring with care, and end of life boats, amongst others. The programme also encourages users to support a 'save our seabed' campaign and make 'the Green Blue Boating Pledge'.

The ReMEDIES 'Save our Seabed' website points to a lot of these resources, and also has its own on boating best practice, anchoring and mooring (Save our Seabed, 2024).

4.1.5 Pollution management and reduction

There are many ways in which nutrient and pollution loads in estuaries can be reduced, many of which are briefly mentioned in Section 3.4. They include, amongst others:

- Litter avoidance, reduction and picking;
- Use of alternative ship cleaning, antifouling and scrubbing materials, also slipway cleaning and pile maintenance, etc.;
- Sewage treatment plant upgrades (which could be prompted by further Environment Agency permit reviews);
- Increased sewage storage capacities;
- Further improvements to water companies' monitoring and reporting requirements;
- Increased use of sustainable urban drainage systems;
- Controls on industrial discharges, dredging / sediment management and product controls (e.g. 2021 REACH regulations (REACH stands for Registration, Evaluation, Authorisation and restriction of chemicals)); and
- Encouraging further changes to agricultural practices / catchment sensitive farming;

Individual measures are too numerous to mention, but nutrient neutrality, which is another concept which effectively originated in the Solent is worth highlighting, and is briefly discussed below.

Nutrient neutrality

Although a small proportion of the overall nutrient loading, the additionality of nutrient pollution from new housing development has been the focus of recent attention to satisfy new Habitats Regulations requirements. Natural England published a position statement in 2020 that advised that there was

uncertainty about the potential in-combination impacts of new housing upon the Solent's designated sites. As sufficient certainty is required at the Appropriate Assessment stage, the onus was put upon new housing plans to show that the housing is nutrient neutral; this would show that the housing would not result in any additional nutrients entering into the Solent. Natural England has since developed a methodology which provides specific guidance, including a nitrogen budget calculator, to enable Developers and Local Authorities to understand the issue and work out how best to respond (Solent Forum, 2024a). In essence, in the nutrient advice areas, new developments in most catchments cannot proceed if they increase levels of nutrients; mitigation actions (or the purchase of credits) are typically required before permission is granted.

In order to progress the development of new housing, local authorities in the Solent have been working individually and together (through the Partnership for South Hampshire) with Southern Water, Portsmouth Water, Natural England and the Environment Agency to identify potential nutrient mitigation solutions. A range of mitigation projects have been initiated, provided by individual Councils, the HIWWT and by private land owners (see Partnership for South Hampshire, 2024a for a full list). Developers will be able to purchase offsetting nitrogen credits from these projects equivalent to the additional total nitrogen load their new housing would generate. Defra also piloted a nutrient trading platform in the Solent which ended (as planned) in March 2023, but '*provided valuable insights into the delivery of mitigation projects, successful engagement with farmers, landowners, and local authorities, modelling and mapping, and the design of market mechanisms for trading nutrient credits'*. Learning from the pilot has also apparently been applied to the national Nutrient Mitigation Scheme (NMS) led by Natural England (Partnership for South Hampshire, 2024b). It has been estimated that, to date, the mitigation collectively adds up to approximately 23 tonnes of additional nitrogen having been prevented from entering the Solent (personal communication, Natural England).

4.2 Restoration and creation

In this section, options and opportunities for restoration are firstly summarised in Section 4.2.1, before implemented (past) schemes are outlined in Section 4.2.2 and then key ongoing initiatives of relevance to restoration and creation are discussed in Section 4.2.3.

4.2.1 Options and opportunities

Options and techniques are now firstly summarised, before opportunity mapping is discussed.

Options (and techniques)

Broadly, and very simply, there are four main approaches that can be taken for habitat restoration (Scott and Armstrong, 2022). These are as follows:

- **Seawall realignment**: Relocating or removing often vulnerable coastal defences and extending areas of tidal inundation to create intertidal habitats across low-lying land (often in coastal areas that have been historically claimed from the sea). This can be achieved through managed realignment[42] and / or Regulated Tidal Exchange (RTE)[43];

[42] Managed realignment is generally viewed as the main option for the creation of intertidal habitats, but it can also be used to create subtidal habitat in low lying areas, or in combination with sediment reprofiling. It involves the deliberate breaching, or removal, of existing seawalls, embankments, or dikes in order to allow the waters of adjacent coasts, estuaries or rivers to inundate the land behind (e.g. Armstrong *et al.*, 2021).

[43] RTE is a form of managed realignment / intertidal habitat creation that allows the controlled inundation of defended land by saline water using weirs, sluices, culverts and / or pipes inserted into a flood protection embankment. RTE differs from managed realignment in that the sea wall remains intact. Furthermore, through the use of tidal exchange mediums such as sluices and culverts a high degree of control is retained, the tidal flow and water exchange volumes are restricted and the existing defence tends to require continued maintenance, and possibly, upgrades (e.g. Armstrong *et al.*, 2021).

- **Coastal intervention**: Influencing or adjusting existing coastal processes to change environmental conditions to protect habitats or promote their recovery;
- **Sediment recharge (or beneficial use)**[44]: Replenishing deteriorating habitats, islands, and barriers with sediment, including silt, sand, shell and/or shingle, as appropriate to the habitat in question; and
- **Habitat recreation**: Adopting a technique to restore and create specific habitat types either by (re)introducing keystone species (e.g. seagrass, kelp or native oyster) and/or altering seabed substrata to promote species recruitment and habitat change.

Each of these techniques can, or at least has the potential to, create and enhance habitats at a large scale.

There are also many smaller-scale and complementary measures which can be adopted for newly created or existing habitats. These include, for example, management measures for enhancing habitats such as clearing vegetation to facilitate bird nesting, or the installation of structural features to achieve specific goals such as providing bird nesting platforms on infrastructure or adding reef blocks to the seabed.

In addition to these active measures, there is also the crucial option of using site management to remove or reduce damaging marine activities; relevant measures in the Solent have been outlined in the previous section (Section 4.1).

There is a large practical evidence base from which many existing initiatives that can be drawn upon. There are also many online sites and ongoing initiatives which are seeking to share lessons across different projects or to improve this information sharing. For example, the Environment Agency's ReMeMaRe team host regular meetings and an annual conference. They also recently oversaw the production of guidance handbooks on saltmarsh (Hudson *et al.,* 2021), seagrass (Gamble *et al.,* 2021), native oyster restoration (Preston *et al.,* 2020) and beneficial use (Manning *et al.,* 2021). A new online habitat restoration platform is also being pursued. ABPmer maintains an online database containing information on many of the completed habitat creation schemes in Northern Europe (the Online Marine Registry (OMReg) (ABPmer, 2024a)); furthermore, for the Solent, there is a Solent to Sussex Bay Seascape Restoration Inventory hosted by the Solent Forum (Solent Forum, 2024d).

Within and across the above listed broad categories, an extraordinary variety of techniques has been applied in the UK across varied environments for over 30 years. The scale and net benefits of these different methods have also varied greatly, from impressive landscape-scale initiatives achieving distinctive and extensive benefits to small-scale proof-of-concept trials; see Section 4.2.2 for past initiatives in the Solent.

First though opportunity mapping is discussed.

Opportunity mapping

Opportunity mapping refers to maps which have been developed to help identify locations where certain habitats could theoretically be created or restored. These often vary substantially in their granularity and factors considered, and more detailed local investigations will always be required in addition to available mapping (i.e. they should only be viewed considered as initial aides to identifying sites). For the key habitats of the Solent, relevant mapping is now briefly summarised (and key techniques defined).

[44] Beneficial use or sediment recharge in intertidal areas is a process by which dredged sediments are placed over or around intertidal mudflats and saltmarshes to either create habitat (most often saltmarshes), or) or restore or protect intertidal habitats from ongoing erosion (Manning *et al.*, 2021). This approach is particularly valuable for protecting habitats that are sediment starved or subject to erosion and where the introduction of dredge arisings will allow the habitat to cope with, or respond to, sea level rise (e.g. Armstrong *et al.*, 2021).

Saltmarshes and mudflats

These can be created and restored mainly via managed realignment, regulated tidal exchange (RTE) and beneficial use, although coastal intervention, for example in the form of brushwood or coir log fencing, is also practiced.

There have been many studies which have investigated, or are currently investigating, the opportunities for managed realignment nationally and regionally; these include the following:

- Two RSPB projects, called Seas of Change and Sustainable Shores, have examined, and mapped potential sites for managed realignment in the UK;
- A 2019 study undertaken for the MMO, which reviewed opportunities within the tidal floodplain in England and mapped locations where potential for managed realignment exists (MMO, 2019);
- Various studies by the Environment Agency and partners to identify sites across regions of England which can provide compensatory habitats for coastal defences work under the Habitats Regulations, i.e. for the HCRPs (in the Solent, this was done under the auspices of the Solent Dynamic Coast project, see Cope *et al.,* 2008);
- Additional studies by the Environment Agency (under the ReMeMaRe initiative) which used the MMO data-layer to create, update and then further review and prioritise a saltmarsh 'restoration potential map' for England;
- A review that has been commissioned by Natural England to investigate the restoration of saltmarsh. This review is being undertaken by UK Centre For Ecology and Hydrology (CEH) and is one of several reviews that Natural England is progressing to understand where priority habitat could be restored (also investigating other priority habitats maritime cliff, sand dunes and shingle); and
- The Blue Recovery Initiative by the Wildfowl and Wetlands Trust (WWT), which is reviewing where 100,000 hectares of freshwater and saline wetlands can be created and restored, and which includes a 'saltmarsh' map for 'wetlands with carbon potential' (WWT, 2024).

The MMO layer is the key datalayer which is publicly available. The outcomes of the ReMeMaRe exercises are not yet being shared beyond the immediate project team (Environment Agency, personal communication). The MMO layer on opportunities in the floodplain is displayed in Figure 18 below, together with other opportunity mapping for oysters and seagrass which is explained below. Please note that this layer shows areas where there is theoretical potential based on land elevations and the absence of substantial above ground infrastructure. However, further investigations of local conditions will always be required with such layers, and even apparently ideal sites regarding elevation and land use may not be suitable or available for intertidal habitat creation once they are investigated further. Most crucially, landowners are often not looking to sell, or the land is frequently already of substantial nature conservation value, and realigning it would be difficult and require comprehensive secondary compensation. This is often the case in the Solent.

Identifying opportunities for beneficial use (of soft sediments) is less straightforward, and there is no opportunity mapping available for this technique. Ultimately, it could be undertaken anywhere in the existing intertidal or even subtidal. The questions which should be asked when investigating beneficial use potential are around the need for this and potential issues and challenges (ABPmer, 2020a). Habitats which are in a particularly poor condition or eroding, and may for example no longer be fulfilling crucial ecological functions (e.g. breeding or roosting areas for birds) could be key sites for beneficial use (and have been in the Solent, see Section 4.2.2). Issues and challenges need to also be considered, with nature conservation value, recreational pressures, sediment sources and vessel access being key considerations. A beneficial use data viewer has been developed by ABPmer on behalf of several UK SNCBs, which is anticipated to go public soon. This provides relevant mapping to help answer these questions.

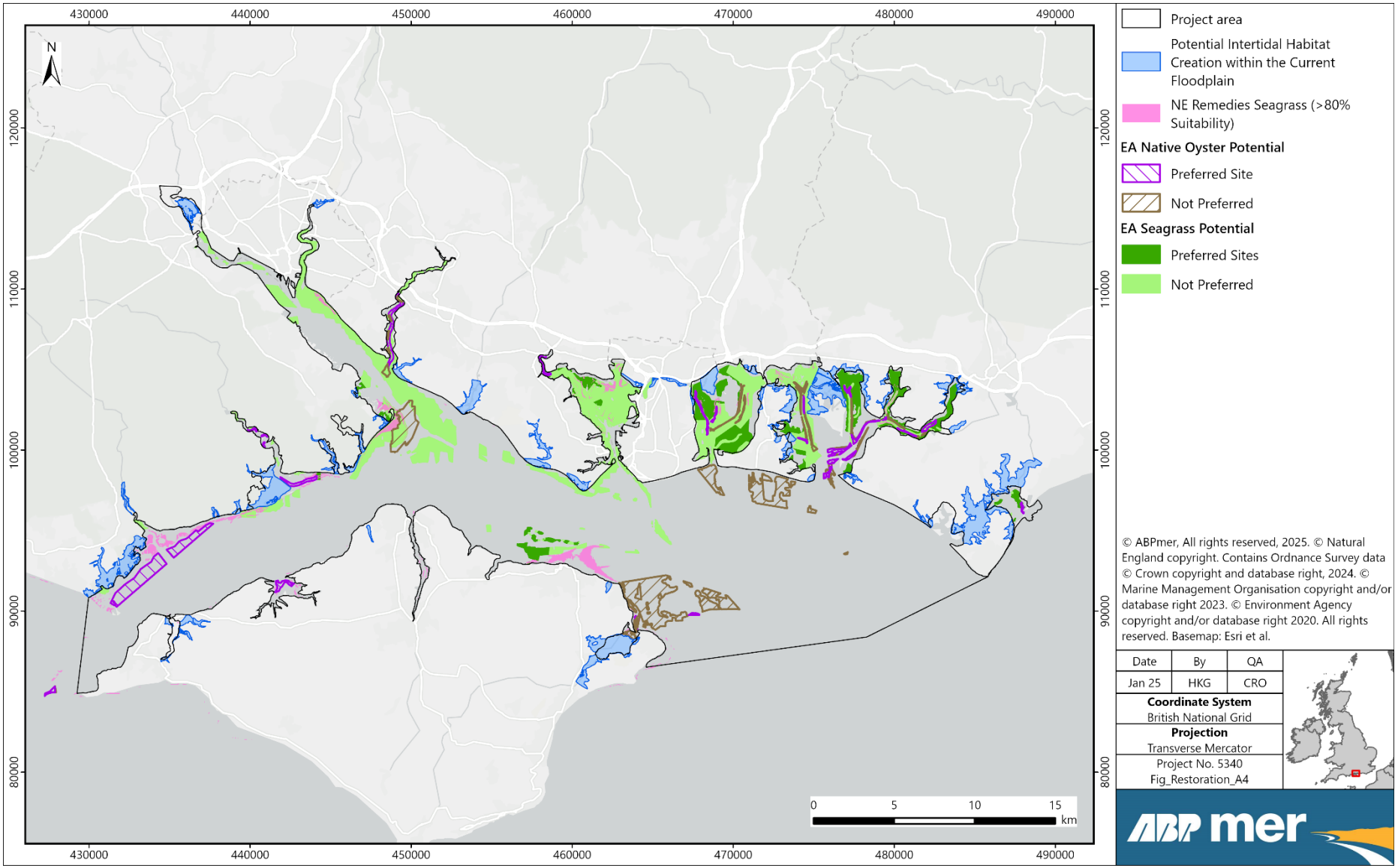


Figure 18. Restoration opportunity areas in the Solent

Seagrass

Over the last few years in the UK, there has been a growing drive to restore intertidal and shallow subtidal seagrass habitats. Several seagrass projects are underway that involve planting shoots or inserting seeds at carefully selected receptor locations, or moving established plants with mature roots systems to new areas. This includes many ongoing Solent based initiatives, which are discussed further in Section 4.2.3 below.

Various opportunity mapping exercises have been undertaken, with the key ones for seagrass being:

- The Environment Agency ReMeMaRe team have created a potential restoration map for seagrass in England. This is based on some key physical attributes and constraints and shows potential areas for both intertidal and subtidal seagrass. It was last updated in July 2024 and is displayed in Figure 18;
- The ReMEDIES project has undertaken suitability modelling for seagrass in their areas of interest, including Plymouth Sound and Estuaries and the Solent; the layer for the Solent is displayed in Figure 18 (areas with a probability greater than 80% are shown; some of these already have seagrass within them); and
- JNCC produced a UK habitat suitability map to describe where subtidal seagrass habitats (*Zostera marina* only) could be restored / where these might be found (this is not included in the above figure due to the other layers already showing potential across substantial areas).

In addition, Project Seagrass / Swansea University is also known to have developed suitability maps (Bertelli *et al.,* 2022), though these are not publicly available.

Oysters

In recent years, many partner organisations have also been working to restore native oyster beds by introducing brood stock adults, juvenile spat or managing seabed habitats. In the Solent, such efforts are currently spearheaded by Blue Marine Foundation and the University of Portsmouth; see Section 4.2.3 for more detail.

There is one known opportunity layer for oysters, which is an Environment Agency ReMeMaRe team datalayer, which was last updated in July 2024. This was again based on some key environmental variables, and shows a subset of 'preferred sites', '*identifying areas of minimal overlap with pressures and existing activities that may hinder restoration*' (Environment Agency, 2024d).

Other habitats

Habitat suitability modelling also exists for other marine habitats, including:

- JNCC produced a UK habitat suitability for **horse mussel** and ***Sabellaria spinulosa*** reefs (as part of the same project for which the *Z. marina* maps were created) (JNCC, 2022);
- Natural England and The Crown Estate's Offshore Wind Evidence and Change program have jointly undertaken the Marine Restoration Potential (MaRePo) project, which examines the potential opportunities for restoring beds of maerl, kelp, native oyster, and horse mussel as well as sea pens and burrowing megafauna (Johnson *et al.,* 2023). New opportunity mapping was only created for **maerl** (latter for Cornwall and Dorset only) and **kelp** (in collaboration with the Environment Agency). For all other habitats, existing models were used (sea pens: Downie *et al.* (2021); seagrass: JNCC (see above); native oyster: Environment Agency (see above));
- Natural England is also understood to be progressing a series of studies to understand where priority habitat can be created and restored.

4.2.2 Implemented schemes

At least 13 existing managed realignment, RTE and beneficial use schemes have been undertaken in the Solent, which have together led to the creation of just under 250 ha. These schemes include (please see ABPmer, 2024a for more information):

- **Five managed realignment schemes** ranging from 0.25 to 300 ha in size. The oldest is the 7 ha Thornham Point scheme in Chichester Harbour, which was implemented in 1997. The smallest is the 2017 Great Salterns Quay scheme in Langstone Harbour, which involved the removal of chalk fill and sheet piles to create new mudflat. The largest scheme is the Medmerry scheme west of Selsey, which led to the creation of just over 180 ha of intertidal habitats (lagoons, mudflats and saltmarshes), with the remainder being transitional and terrestrial areas. Implemented in 2011, uniquely, it is a major realignment through a coastal shingle barrier (still the only one of its kind in the UK). Implementing Medmerry took well over 10 years of preparatory work, with getting an initially highly sceptical community on board being a significant factor in this long timescale, as were landowner negotiations, and difficult conditions during construction (wet summers, many archaeological artefacts encountered, etc.);
- **One unmanaged realignment**, the 7 ha scheme at Southmoor (this site's poor condition defences breached in 2020 during an exceptionally high tide);
- **Four RTE schemes** – Chalkdock and West Wittering in Chichester Harbour, the RTE at the Dark Water at Lepe and the Lymington River scheme;
- **Four beneficial use schemes**, including the ongoing bottom placement at Boiler Marsh (Lymington), the one of the schemes at Lymington Yacht Haven and Wightlink Boiler Marsh, and the West Itchenor scheme which still has permission for further campaigns

Of these, Medmerry, Great Salterns Quay and the Lymington RTE were coastal squeeze compensation schemes (there was also a related coastal grazing marsh scheme at Manor House Farm on the Test). The Wightlink Boiler Marsh and Cobnor managed realignment schemes were compensation for ferry and port developments respectively, and the remaining schemes were undertaken for general habitat restoration reasons.

Oyster restoration efforts have also been undertaken (and are still being pursued, see next section). Based on historical significance, current environmental suitability and presence of residual populations; restoration efforts are currently focused on Chichester Harbour, Langstone Harbour, Portsmouth Harbour, Beaulieu River, Hamble River and Newtown Harbour. Several restoration methods have been employed in an attempt to restore native oyster populations in the Solent region, and such methods have been tailored to address the specific challenges faced in the area, such as low oyster densities, the presence of invasive species, and habitat degradation. The following restoration methods have been trialled.

- Broodstock Relaying: One of the early efforts involved re-laying broodstock oysters at specific densities in areas such as Chichester Harbour. This approach aimed to boost the local oyster population by providing a source of larvae to enhance natural recruitment;
- Suspended Broodstock Cages: These have been recommended as a short to medium-term solution to address larval deficits in recruitment-limited areas. This method also helps engage local communities in the restoration process;
- Habitat Preparation and Cultch Deployment: Restoration projects have focused on preparing the benthic environment to be more suitable for oyster larvae settlement. This involves deploying cultch (i.e., materials such as shells or stones) to provide a substrate for larvae to settle on; and
- Reef Structure Implementation: Creating or restoring reef structures which incorporate considerations like orientation, height, and inclusion of other species to promote oyster settlement and long-term reef stability.

In general, native oyster restoration initiatives and methods are still at the research and development stage, with research being undertaken both in the laboratory and in the field, to maximise restoration success (e.g. Sawusdee, 2015; Holbrook, 2020; Fabra, 2023). Restoration efforts are also vulnerable to limited and unreliable availability of oyster larvae and broodstock.

In addition to the above, many smaller scale enhancement measures have been undertaken. These have included:

- The installation of vertipools and other '**greening the grey'** measures. Vertipools were invented by an Isle of Wight company, Artecology), and have been installed at several locations on the Isle of Wight in recent years, having first been trialled at Bouldnor in 2013. The Southsea works which are currently being implemented also include many greening the grey' measures, including textured seawalls (Coastal Partners, 2024);
- The installation of **tern rafts**. For several years now, the RSPB has been constructing rafts for Common Terns at the Hayling Oysterbeds reserve (e.g. Image 45), these have been instrumental in the success of the colony in recent years (see Section 2.4.2);
- The creation of **new island features** for breeding birds; this has for example been done at Pagham Harbour, utilising the materials 'won' when cutting the spit in 2021 (RSPB, personal communication) and at North Solent NNR in 2024 (Natural England, 2024c);
- The **topping up of existing** islands or spit **features with shingle**. This has, for example been done at several of the islands in Langstone Harbour (e.g. four shingle placements between 2008 and 2014 (two on Bakers Island and two on South Binness Island) (RSPB, personal communication)), and at Stakes Island in Chichester Harbour by ChaPRoN (CHaPRoN, 2024); and
- The implementation of **fish passes or ladders** to allow migratory fish to pass over or around and obstacle; also the removal of obstacles and modification of weirs. This has been done at many locations – e.g. a new fish pass was installed along the River Dun, a tributary to the Test, in 2017/18 to improve eel passage (at a cost of £220,000 at the time); during the same period, fish passages at North Fareham on the Wallington and on the Meon were also improved (Environment Agency, 2018).

Source: RSPB, 2018

Image 45. The RSPB's Hayling Island (Langstone Harbour) tern rafts

Seagrass schemes are discussed under 'ongoing initiatives', as they have all been undertaken relatively recently, or are still being pursued.

Existing and planned active restoration measures have been mapped in Figure 19 according to the habitats which have been/might be restored; see next sub-section for ongoing/planned schemes.

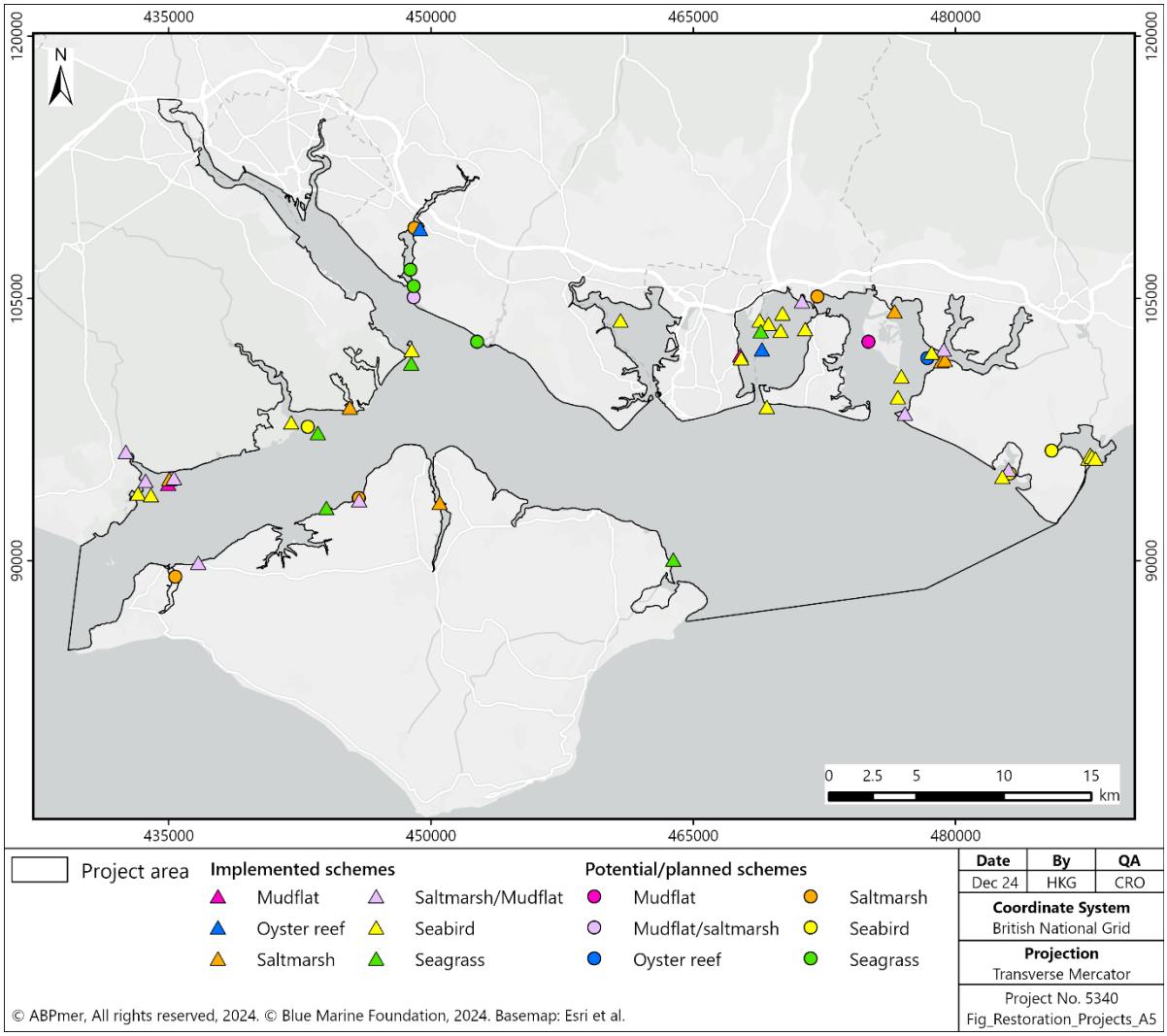


Figure 19. Implemented and planned restoration schemes in the Solent

4.2.3 Ongoing initiatives

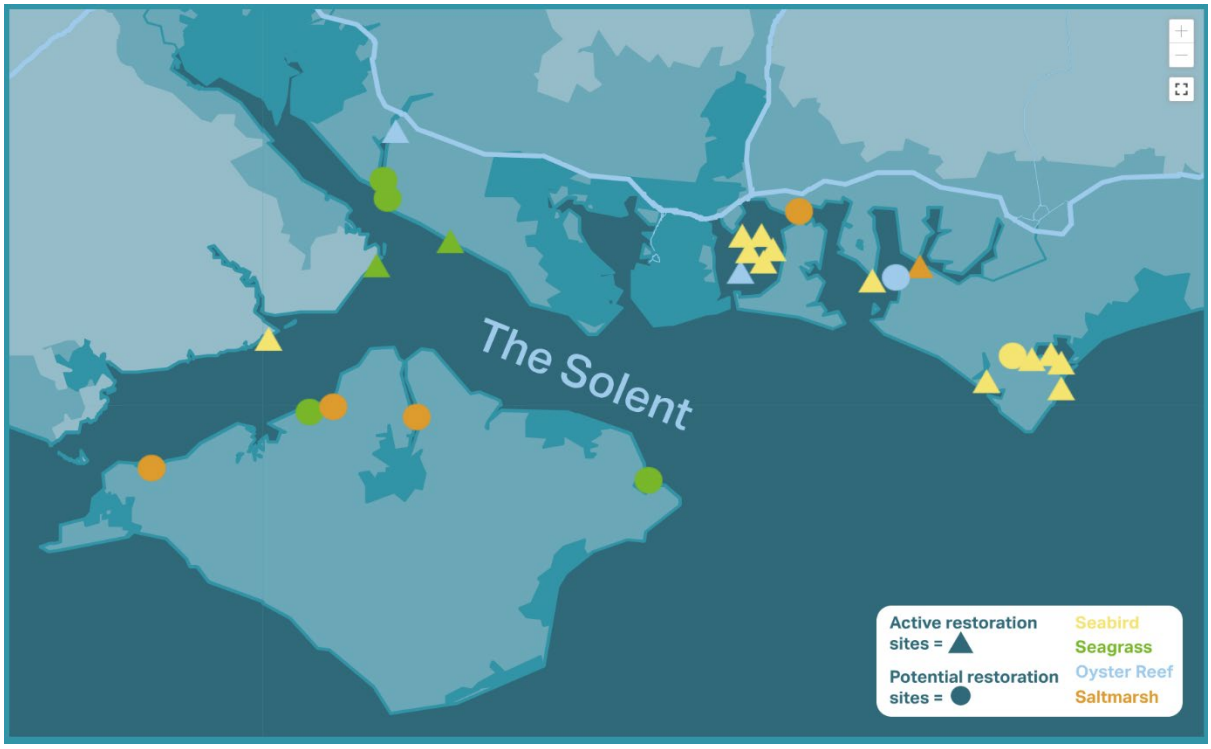
There are many ongoing initiatives and programmes which are occurring the Solent, and there is often some overlap and also close collaboration between these. Key initiatives, and related restoration activities are briefly summarised below.

Solent Seascape Project

This report has been undertaken for the Solent Seascape project, and a high level description of this project has been included in Section 1.

Numerous active restoration schemes are either under way, or have been undertaken for, or been supported by, this project, and several further such measures are being considered. A still from the interactive map available on the project website has been included below as Image 46 to illustrate the location and type of projects being pursued by Blue Marine Foundation and the other partners on the project (including the RSPB, HIWWT, CHaPRoN, Isle of Wight Council, Project Seagrass, Coastal Partners and Natural England). Often, these projects also receive(d) funding from other sources, such as Life on the Edge (see below). Projects currently labelled as active include:

- Vegetation clearance and predator fencing installation at many island sites in Pagham Harbour and at Medmerry, and also at several island locations in Langstone and Chichester Harbours (mostly led by the RSPB);
- Shingle island creation in Langstone Harbour (five created as part of the project, more planned) and in waterbodies of the North Solent NNR ;
- The installation of tern nesting rafts in Langstone Harbour;
- A beneficial use trial at Itchenor;
- Oyster reef restoration at Russel's Lake in Langstone Harbour, with the laying of a total of 36,000 native oysters in 2021 and 2022 (led by Blue Marine Foundation); and
- Seagrass restoration using direct seed injection at Chilling and Calshot (led by HIWWT), and Project Seagrass led trials at Thorness, Priory Bay and Beaulieu (using five different planting methods, funded by WWF Seagrass Ocean Rescue).



(Source: Solent Seascape Project, 2024)

Image 46. Solent Seascape projects (still from interactive map)

ReMeMaRe

ReMeMaRe is a national estuarine and coastal restoration initiative led by the Environment Agency. Its mission is to restore at least 15% of England's lost seagrass meadow, saltmarsh and native oyster reef habitats around the coast by 2043. A national Environment Agency programme office supports area teams and local partners in their habitat restoration work.

The ReMeMaRe, and local Environment Agency colleagues, have recently been instrumental in helping to (part) fund various restoration projects in the Solent via the Water Environment Improvement Fund (WEIF) (Defra, 2024c). This includes the Medina Estuary saltmarsh restoration scheme being led by the Isle of Wight Council, and the first phase of the Boiler Marsh Habitat Restoration scheme (a collaboration by Lymington Harbour Commissioners and Land and Water). As noted earlier in this report, the ReMeMaRe team has also overseen the production of various restoration handbooks, is responsible for organising annual conferences, and has led on the production and development of opportunity mapping (amongst many other work streams).

Habitat Compensation and Restoration Programme (HCRP)

As noted in Section 2.3 above, the Environment Agency, and other coastal defence authorities, have a duty to provide compensation for designated habitat related costal squeeze losses caused by public defences. This is achieved through the HCRP. In the Solent, local authorities, including Coastal Partners, are closely involved in this process. Past projects were listed in Section 4.2.2. Projects which are known to be in the advanced planning stage as part of the HCRP include:

- The Thorney Island Habitat Creation Scheme (Marker Point), which aims to create around 30 ha of intertidal habitat on the south-western edge of Thorney Island via managed realignment. For this, the Environment Agency has partnered with the landowner, the Ministry of Defence (MOD), and the Chichester Harbour Conservancy (Environment Agency, 2024e).
- The Hook Lake (Warsash) scheme, where a two year study was recently undertaken to look at the future coastal management of the site and options for habitat creation (Coastal Partners, 2022).

Chichester Harbour Protection and Recovery of Nature (CHaPRoN)

The CHaPRoN partnership brings together organisations that are able to take practical steps to improve habitats around the Harbour, both in the water and on the land. Formed in 2021, it aims to 1) reduce the pressures on the natural environment to enable habitats to naturally regenerate; 2) restore habitats through active interventions and give nature a helping hand to recover; and 3) realise the benefits society gains from the natural environment by quantifying and determining their economic value.

To date, CHaPRoN has for example been instrumental in helping to bring the 2023 beneficial use trial at Itchenor to fruition, and is currently leading on the facilitation of future phases (with funding from WEIF). CHaPRoN is furthermore one of the project partners to the Solent Seascape project. In addition, CHaPRoN led the Return of the Tern Project, which was initiated in 2021, financed the installation of tern rafts at Thorney Deep, and also a shingle recharge at Stakes Island in 2022 (CHaPRoN, 2024).

LIFE on the Edge (LOTE)

LIFE on the Edge is a 4-year LIFE Nature project (ending in October 2024) led by the RSPB with the National Trust with the aim to improve the condition of the target coastal sites while also building their long-term resilience and informing future work elsewhere. The aims of the project are to 1) increase the area and improve the quality of coastal habitats within the target protected areas; 2) develop recommendations for wider scale and longer-term coastal habitats management/creation; and 3) Strengthen links with practitioners elsewhere in north-west Europe.

One of the seven sites for this project is located in the Solent, namely the Langstone and Chichester Harbour SPAs. Here, the project has focussed on the restoration and reprofiling of several key nesting islands in Langstone Harbour (covering 1.7 ha in total). These activities aim to provide new and safer nesting habitats for Little, Common and Sandwich Terns, and will also benefit a variety of roosting shorebirds. There has also been partnership work on beach nesting birds. This has involved engaging local volunteers to find nests, protect them during the breeding season (through fencing and signage mainly, but also nesting cages) and engage with site visitors. There has also been investment in interpretation boards, equipment and skill development of the volunteers. In addition, a beach nesting officer has been employed, part financed by the Solent Seascape project (LOTE, 2024).

LIFE Recreation ReMEDIES

LIFE Recreation ReMEDIES is a five-year marine conservation partnership project at five SACs, including the Solent. ReMEDIES has planted 8 ha of seagrass seed across two sites in the Plymouth Sound and

Estuaries SAC and Solent Maritime SAC, using multiple techniques. Numerous other outputs have also been produced as part of the project, including monitoring reports, habitat suitability modelling and best practice guides. In partnership with the RYA, LIFE Recreation ReMEDIES is also working on reducing pressures from recreational activities such as boating through extensive behaviour change work. This work has been instrumental in the implementation of the voluntary no anchor zone at Osborne Bay. The project has also installed the first Advanced Mooring Systems (AMS) in the Solent.

Solent Seagrass Restoration Project

The HIWWT are working in partnership with Boskalis Westminster Ltd to undertake a seagrass restoration project within the Solent, starting with an important research and development phase. The project aims to identify the best methodology for restoring this important marine species within the Solent, whilst also monitoring the habitat as a provider of carbon sequestration.

Solent Oyster Restoration

Blue Marine Foundation's creating a model for restoration of this key habitat by relaying millions of oysters into the Solent. Blue Marine Foundation's team has placed mature "brood stock" oysters at high densities in cages hung in the water beneath many pontoons in the Solent, facilitating the release of millions of larvae into the Solent (estimated to be over 1 billion larvae in 2017). To promote natural recruitment and re-establish wild oyster beds, Blue Marine Foundation's Solent team are also re-seeding selected seabed sites with juvenile oysters. Blue Marine Foundation have also worked with the University of Portsmouth and the Wild Oysters Project to develop a guide to nurseries for the native flat oyster, with the aim of enabling marina companies, pontoon or jetty owners, and other restoration projects to establish their own nursery system for oyster restoration. In addition, an oyster hatchery has been installed at the University of Portsmouth, in order to overcome a major barrier to oyster restoration by providing a reliable source of native oysters. To date, the project has involved the release of 105,000 native oysters to the Solent across 12 restoration sites (Blue Marine Foundation, personal communication).

Local Nature Recovery Strategies (LNRS)

Local Nature Recovery Strategies (LNRS) were brought in under the Environment Act, 2021. Responsible Authorities (usually local authorities) are required to develop such strategies and report on progress every five years. The Solent's coast is covered by the Hampshire, Isle of Wight and West Sussex LNRSs. These strategies are currently being produced, and focus on terrestrial areas only. There will, however, be overlap with areas which fall within a 'coastal zone of influence' such as saline lagoons, coastal grazing marsh and wader roosting and feeding sites. It will also be important to consider sea level rise and sites where intentional habitat creation through managed realignment may be an option.

5 Focus on Key Areas of the Solent

Brief summaries are now provided for some of the key regions of the Solent in Sections 5.1 to 5.7; covering the Isle of Wight, the North West Solent, Southampton Water and its tributaries, Portsmouth Harbour, Langstone Harbour, Chichester Harbour and Pagham Harbour. In each sub-section, overviews on the following six topics are given: human activities, habitats, birds, other wildlife, and restoration and management measures.

5.1 Isle of Wight – Northern Shoreline and Estuaries

5.1.1 Habitats

The intertidal and shallow subtidal habitats along the northern shore of the Isle of Wight are of national and international importance, and most of the intertidal as well as some of the shallow subtidal areas are designated features of SSSIs, the Solent Maritime SAC and also three MCZs. There are around 1,030 ha of intertidal soft sediments here, and also substantial areas of intertidal chalk (89 ha), intertidal underboulder communities (69 ha) and intertidal coarse sediments (85 ha). 120 ha of saltmarsh are mapped, and a large percentage of the region's seagrass is found in this locality (at least 300 ha, around 60 ha of which is intertidal). The seagrass beds are mostly found east of Yarmouth, east of Cowes and at Ryde.

The SSSI and SAC units for which condition has been assessed are considered to generally be in unfavourable condition (mostly no change, with some recovering). There are, however, several units which are considered to be in favourable condition, e.g. most of the foreshore areas at the Brading Marshes to St. Helen's Ledges SSSI. Reasons for unfavourable condition status centre around species composition, coastal squeeze and water quality (nutrients and contaminants).

(Source: ABPmer)

Image 47. Tidal reedbeds at the Thorness Bay managed realignment

5.1.2 Birds

Along the north coast of the Isle of Wight, the Newtown River Estuary, River Medina Estuary and Wootton Creek provide extensive estuarine mudflats and areas of saltmarsh habitat which are used by a wide variety of coastal waterbirds. The largest numbers of wintering waders and waterbirds recorded along the north coast of the Isle of Wight are typically found in the Newtown River Estuary, with Dunlin and Brent Geese being the most abundant species.

5.1.3 Other wildlife

Seals have started to haul out in Newtown Harbour over recent years. This includes visiting grey seals and common/harbour seals from the Chichester Harbour colony. In 2023 (when official counts first began), a peak count of 4 common seals and 10 grey seals was observed here (in August). Numbers generally ranged from 1 to 4, and common seals were more frequently seen than grey seals. Seals will also be foraging in the water off the coast of the Isle of Wight, particularly along the north eastern shores which are closest to the main haul outs in Chichester Harbour. Cetaceans are sometimes spotted from the shore or boats (chiefly common or bottlenose dolphins). For example, two common dolphins were spotted off Yarmouth in March 2024, and logged on the Seawatch Foundation's sightings database (Seawatch Foundation, 2024). Sea trout and eel are likely to be key migratory species which frequent this region's rivers (see Section 2.4.4); Atlantic salmon are not encountered here.

5.1.4 Human activities

The Isle of Wight is less densely populated than other areas of the Solent, and the population here is also growing at slower rates. It is, however, a popular tourist destination, and a renowned sailing and yachting destination. Ferries to the island run from Lymington to Yarmouth, Southampton to Cowes and Portsmouth to Fishbourne and Ryde. Recreational water sports are very prevalent in this area. Thousands of berths and moorings are available in the estuaries of the island, both for visitors and on a year round basis. There are also many anchoring areas both within estuaries (notably Newtown) and along the northern shores, in the Solent. Cowes week attracts thousands of visitors to the island every year, both on land and by boat. Sailing and yacht clubs abound, and Cowes is also home to the UK sailing academy. Various boat and shipyards build and repair numerous types of vessels, with a particular concentration of these in the Medina at Cowes.

Paddle sports are also popular, with kayaking and paddle boarding taking place in all the estuaries and along most of the shore (with hotspots between Bembridge and Ryde and along the Gurnard frontage). Rowing is chiefly seen in the Medina and off Ryde and Bembridge, whilst wind and kite surfing is mostly undertaken at Gurnard west of Cowes. Walkers can access substantial percentages of the shoreline; the Bembridge to Ryde, Cowes to Gurnard and Yarmouth to Totland sections tend to be particularly busy. Quieter shores are found between Gurnard and Yarmouth, along much of the Newtown Estuary and also around King's Quay. Cycling is also possible along many shoreline paths.

There are several fishing ports on the Island, including Bembridge and Cowes, though boat numbers have dwindled over recent years, with only 16 registered as of December 2024 (when there used to be 37 in 2015 for example).

5.1.5 Restoration and management efforts

Disturbance management is undertaken in this area as part of Bird Aware Solent, who also have a water sports with wildlife map and guides. Reserve managers will also be undertaking wardening as appropriate, for example at the RSPB's Brading Marshes reserve, or the National Trust's Newtown and

Old Town Hall reserve. Various IFCA byelaws are also in place for fishing (see Section 4.1.4 for more detail).

Several seagrass planting schemes have been undertaken here recently, chiefly as trials, led by both the HIWWT and Project Seagrass. For example, in March and April 2024, the HIWWT carried out seagrass seed deployments at Seaview on the north-eastern shore of the Isle of Wight, as part of the Solent Seagrass Restoration Project. In addition, since 2022, Project Seagrass has been undertaking seagrass planting method trials at three sites around the Solent and Isle of Wight to better inform the best planting method and technique for restoration. Monitoring of existing seagrass beds at Seaview is also being done by volunteers. A Voluntary No Anchor Zone has been installed at Osborne Bay, as have advanced mooring systems as part of the ReMEDIES project. An existing managed realignment scheme can be found at Thorness Bay (originally implemented by Island2000), and the Isle of Wight Council is currently pursuing a marine licence for a small scale beneficial use scheme at Werrar Marsh in the Medina.

5.2 North West Solent Shoreline and Estuaries

5.2.1 Habitats

Along the North West Solent shoreline stretching from Hurst Spit to Calshot Spit, there are extensive mudflats measuring 970 ha along this stretch of the Solent, and some 285 ha of saltmarsh. Many of these are rapidly eroding, particularly the more exposed saltmarshes between Keyhaven and Tanner's Lane (east of Lymington). The isolated saltmarsh islands present along this shoreline stretch are of particular importance to breeding seabirds, but also for general roosting purposes. 50 ha of seagrass are mapped in this area, the beds are mainly found in shallow subtidal areas between Calshot and Lepe.

The condition assessments for the SSSI and SAC units which have been documented along this stretch of coast are variable. There are some units which are considered to be in favourable condition, notably the lagoons of the Hurst Castle and Lymington River Estuary SSSI, the mudflat units of the North Solent SSSI, and some of the saltmarsh units in the upper Beaulieu Estuary. Many littoral sediment units incorporating saltmarsh are judged to be in an unfavourable recovering condition due to habitat creation measures having been undertaken (the Lymington RTE mostly), whilst some are some are judged to be unfavourable declining due to erosion (e.g. those along the eastern shore of the mouth of the Beaulieu Estuary).

Reasons for unfavourable condition are related to coastal squeeze, water quality (nutrients) and harmful blooms of macroalgae.

5.2.2 Birds

This section considers coastal waterbird populations on the New Forest coast between Hurst Spit and the Beaulieu River. These are covered by two broad WeBS areas-North West Solent (which covers from Hurst Spit to the promontory east of Sowley) and the Beaulieu Estuary (which includes the North Solent Nature Reserve). The New Forest coast regularly supports over 20,000 waterbirds with extensive areas of saltmarsh, mudflat and also numerous lagoons which all provide important habitat for feeding and roosting birds.

Wader and waterbird species seen in high numbers include Brent Geese, Dunlin, Knot, Redshank, Curlew, Lapwing, Golden Plover and Black-tailed Godwit, Wigeon and Teal.

Important seabird breeding colonies are located at the Pylewell/Boiler Marsh and Cockleshell saltmarsh islands off Lymington, as well as the Normandy Lagoon at Pennington and the De L'Orne Lagoon at Needs Ore. In the context of the Solent, over 30%[45] of the region's breeding seabirds breed at these (and a few other) sites within the Hurst to Lymington and North Solent NNR areas. Some waders furthermore breed around Needs Ore/Warren Shore, notably oystercatcher and Ringed Plover.

5.2.3 Other wildlife

Marine mammals are sometimes spotted in the waters from this shore, and a grey seal pup was born in the Beaulieu Estuary this year. Sea trout and eel are likely to be key migratory species which frequent this region's rivers (see Section 2.4.4); Atlantic salmon are not encountered here.

5.2.4 Human activities

Population levels along this shoreline are fairly low, with the town of Lymington having the largest population at just over 15,000. The Lymington Estuary is a very popular yachting and sailing location, with many berths and moorings for visitors and residents alike. Marinas are also found at Keyhaven and Buckler's Hard in the Beaulieu Estuary. In addition, there are dozens of moorings in the creeks of the Keyhaven saltmarsh in the lee of Hurst Spit. Several sailing clubs and boat yards can also be found along these shores. A passenger ferry runs from Lymington to Yarmouth.

Paddle sports are popular here, with paddle boarding taking place in the Lymington Estuary, and kayaking and paddle boarding being popular in the Beaulieu Estuary, around the Keyhaven Marshes and along the beach frontages at Lepe and Calshot. Some wind and kite surfing is also undertaken at Keyhaven Marshes (and off Tanner's Lane, east of Lymington). Walking along the shore is widespread along those stretches where access exists, with the Lymington to Keyhaven, Buckler's Hard to Beaulieu, and Calshot to Lepe frontages seeing fairly high numbers. Due to a lack of access, the shoreline between the mouth of the Lymington Estuary and the Beaulieu Estuary is undisturbed by walkers and other shore based activities, as are large stretches of the eastern shore of the Beaulieu Estuary.

Keyhaven and Lymington used to be substantial fishing ports, with 19 commercial fishing vessels registered in 2015 for example. As of December 2024, only two remain across both ports.

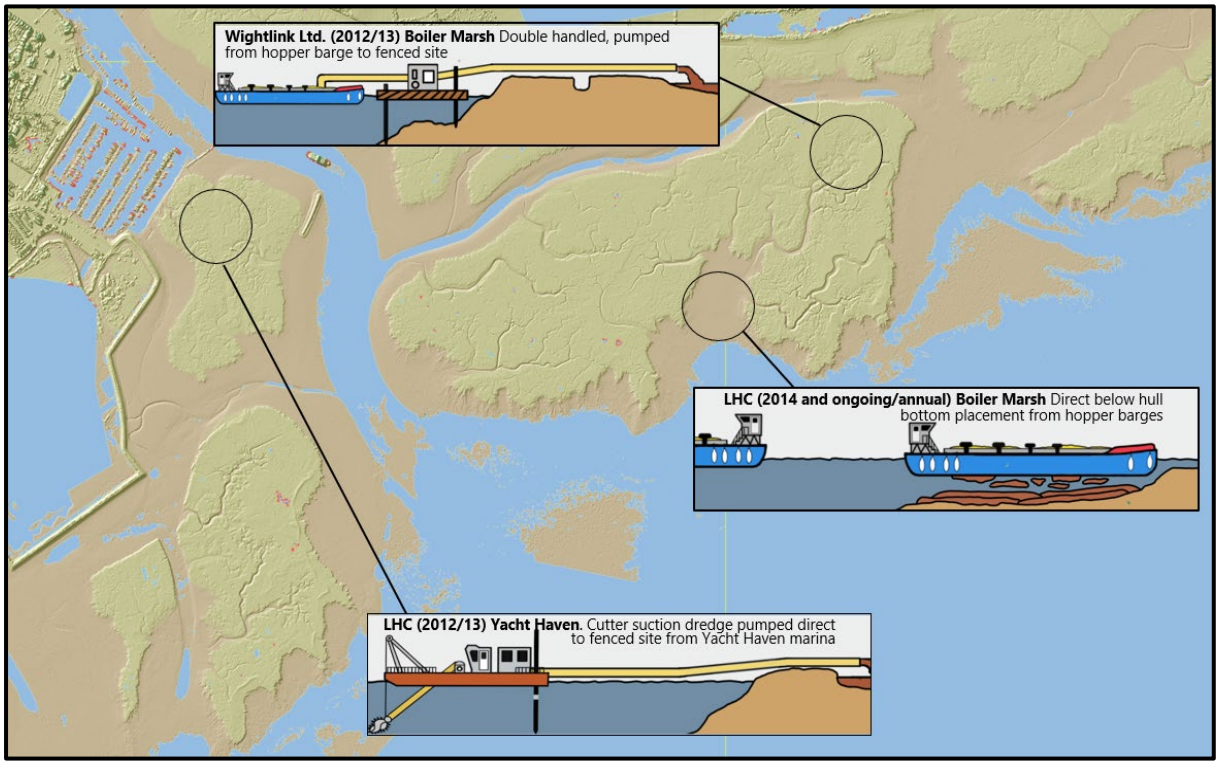
5.2.5 Restoration and management efforts

Disturbance management is undertaken along this stretch of coast as part of Bird Aware Solent, who also have a water sports with wildlife map and guides. New Forest National Park and managers of local and national reserves will also be undertaking wardening as appropriate; for example at Natural England's Needs Ore reserve, and Hampshire County Council's (and HIWWT's) Lymington and Keyhaven Marshes Local Nature Reserve. Various IFCA byelaws are also in place for fishing (see Section 4.1.4 for more detail).

Several beneficial use schemes have been implemented in this region, with annual bottom placement having been undertaken at Boiler Marsh by Lymington Harbour Commissioners since 2014. This year, Land and Water, in collaboration with Lymington Harbour Commissioners, are dragging some of that material up the shore using a drag box technique, with the aim of restoring saltmarsh by raising the intertidal. Two one-off beneficial use campaigns have also taken place at Yacht Haven and Boiler Marsh in the past (by Lymington Harbour Commissioners and Wightlink) respectively. A self-regulating tide gate was installed at Lymington in 2009, to allow controlled amounts of water up-river on larger tides (ABPmer, 2024a). Seagrass restoration efforts are also being undertaken along this stretch of coastline,

[45] As calculated based on total numbers presented in the 2023 spreadsheet provided by the RSPB.

with the ReMEDIES project having placed 20,000 seed bags at a site west of the Beaulieu River mouth in March 2022 (ReMEDIES, 2022) and planted a further 1.5 ha of seagrass seed over two campaigns (November 2023 and March 2024) using a direct injection seeding methodology . Furthermore, in March and April 2024, the HIWWT carried out seagrass seed deployments at Calshot (Hampshire) as part of the Solent Seascape Project. Monitoring of existing seagrass at Calshot and Chilling is also done by HIWWT. Sea and shorebird restoration measures have also been undertaken in the North Solent NNR, this included the installation of a tern raft, and the creation of six nesting islands in two lagoons landward of the embankment (Natural England, 2024c).



Source: ABPmer using Environment Agency LiDAR data

Image 48. Three different beneficial use projects undertaken at Lymington

5.3 Southampton Water and Tributary Estuaries

5.3.1 Habitats

The marine habitats of Southampton Water and its tributary estuaries measure around 3,200 ha in total, most of which (58%) is subtidal. There are extensive mudflats measuring just over 1,000 ha, and also saltmarshes at around 250 ha. The latter are mainly found along the western shore of Southampton Water and in the Hamble. Seagrass beds can be found at Chilling west of Lee-on-Solent.

The SSSI and SAC units which have been assessed are considered to generally be in unfavourable condition (with a mixture of no change and recovering). Nutrient enrichment, algal mats and coastal squeeze are highlighted as issues here.

5.3.2 Birds

Southampton Water regularly supports over 12,000 waterbirds and is considered both important nationally and in an international context (Woodward *et al.*, 2024). The upper eastern side of Southampton Water is heavily modified as a result of the Port of Southampton. However, the New Forest

side and outer sections of this estuary along with the tidal areas of the River Itchen, River Test and River Hamble supports extensive areas of intertidal sediment and saltmarsh with reedbeds and grazing marsh in upper areas. Overwintering Dunlin, Lapwing and Oystercatcher are typically the most abundant wading bird species recorded in Southampton Water. Black-tailed Godwit, Curlew and Redshank are also recorded in relatively high abundances. With regard to waterbirds, Southampton Water supports nationally important numbers of Dark-bellied Brent Goose as well as large numbers of Eurasian Wigeon. Other commonly occurring waterfowl species include the Eurasian Teal and Canada Goose (Woodward *et al.,* 2024; Natural England, 2024a; ABPmer, 2024c; ABPmer, 2021).

Overall, the numbers of waterbirds have showed a steady decline over the last 30 years, particularly with respect to wading birds. For example, the total 5-year WeBS Core Count mean peak count of waders was 10,659 in 1993/94-1997/98 but was only 5,764 birds in the period 2018/19 - 2022/23 (BTO, 2024a).

Feeding occurs throughout the system on intertidal soft sediment habitat, with a focus on the mid and outer sections of Southampton Water including the Dibden Bay foreshore, between Hythe and Fawley and the mouth of the Hamble. Adjacent grassland is often also utilised, with Dark Bellied Brent Geese for example often recorded feeding on such grassland at Dibden Bay and in the Chilling to Meon area. Curlew are also known to feed and roost extensively on wet grassland habitat at Dibden Bay.

Two interesting tagging studies have recently taken place in Southampton Water; firstly, Oystercatcher tagging data found that individuals in Southampton Water showed a high degree of site fidelity with localised movements between feeding and roosting sites linked to the state of the tide (ABPmer, 2020b). In addition, Curlew tagging data suggesting Curlew in Southampton Water generally show relatively high site fidelity to the same core feeding and roosting areas in winter periods (ABPmer, 2020b).

5.3.3 Other wildlife

Seals can be seen in Southampton Water fairly frequently, whereas other marine mammals are occasional visitors, and many species of fish are found here, as evidenced by the TraC monitoring which is focussed around Southampton Water. Large parts of Southampton Water are designated as a bass nursery area. The Test and Itchen are the only rivers which support Atlantic salmon in the region, and various other migratory fish, including sea trout and eel, are furthermore known to frequent these rivers.

5.3.4 Human activities

Southampton Water, the Itchen and the Hamble are very busy estuaries, reflecting the high population densities in the city of Southampton and surrounding boroughs. Southampton is an important freight port, and also the biggest cruise port in the country. Domestic services to the Isle of Wight also run from here, and it is homeport to several fishing vessels. The UK's biggest refinery is found along its shores, and large marinas are located at Town Quay and Hythe, and several smaller facilities and sailing clubs can also be found here. Navigational dredging is frequently undertaken in this estuary, and large volumes are disposed of at sea, chiefly at the Nab Tower to the east of the Isle of Wight. Smaller volumes are also dredged from the marinas and wharves in the Itchen, and the marinas of the Hamble.

The urban Itchen Estuary is home to several aggregates wharves, a few marinas and boatyards as well as many sailing and rowing clubs. Paddle sports and sailing take place throughout the estuary, with the latter particularly focussed in the southern extents, south of restrictive road and rail bridges.

The River Hamble is a major recreational harbour and is home to over 3,000 vessels; it is an important centre for yachting and motorboating, as well as a popular destination and launching point for visiting craft. Kayaking and paddle boarding take place throughout, whereas sailing is restricted to south of the

railway and motorway bridges near Swaythling. Bait digging and hand gathering of bivalves occur at several locations within this estuary.

Most of the foreshore in this area is accessible to walkers and cyclists, and paths are generally busy where paths exist, particularly in Southampton and along the lower Hamble. Rare exceptions are the Dibden foreshore and large parts of the Hythe to Calshot marshes, where access is restricted mostly due to industrial use.

Copyright: Nicola Dewey

Image 49. Netley shore

5.3.5 Restoration and management efforts

Disturbance management is undertaken in this estuary as part of Bird Aware Solent, who also have a water sports with wildlife map and guides. Reserve managers will also be undertaking wardening as appropriate, for example at Hampshire County Council's Manor Farm / River Hamble country park / reserve. In the Hamble, several small scale saltmarsh restoration schemes have been, or are currently being undertaken. For example, Blue Marine Foundation has recently (summer of 2024) installed coir fencing to enhance sediment retention here. Fish pass improvements have been made on the migratory rivers of this system, to facilitate the improved passage of migratory fish (see Section 2.4.4 for more information).

5.4 Portsmouth Harbour

5.4.1 Habitats

The marine habitats of Portsmouth Harbour measure around 1,530 ha in total, with some 30% of this being sub-tidal. Mudflats, at 870 ha, occupy the majority of the Harbour (57%), whereas relatively small areas of saltmarsh (49 ha (likely an overestimate)) and seagrass (81 ha) are also mapped. The latter is mainly located in the north west of the Harbour, around Fareham Creek.

The SSSI units which have been assessed in the Harbour are largely in unfavourable condition (either no change or recovering), noting that the SSSI designation does not cover the south eastern areas of the Harbour. A wider variety of reasons are given for unfavourable condition status, depending on the unit assessed, but frequently observed reasons were nutrient enrichment, poor quality of habitat / harmful macroalgae mats, and water quality issues. Recreational use, litter and bait digging were also mentioned for some units.

5.4.2 Birds

Portsmouth Harbour is a large natural harbour that regularly supports over 10,000 waterbirds. Important habitats for coastal waterbirds in the area include intertidal mudflats and sandflats with seagrass beds, areas of saltmarsh, shallow coastal waters, coastal lagoons and coastal grazing marsh. The waterbird species typically occurring in the largest (and nationally important) numbers in Portsmouth Harbour is Dunlin. Black-tailed Godwit are also recorded in Portsmouth Harbour in nationally important numbers. Other abundant wading birds include Oystercatcher as well as Redshank and Curlew. Portsmouth Harbour is furthermore a nationally important site for Dark-bellied Brent Goose. Other commonly occurring waterfowl species include Wigeon, Shelduck and Teal (Woodward *et al.,* 2024). Preferred feeding areas for Black-tailed Godwit include the mudflats of Paulsgrove Lake and the western and north western sections of Portsmouth Harbour, and Dark-bellied Brent Geese often feed at Paulsgrove Lake and Porchester in the north and also at Foulton Lake in the west of Portsmouth Harbour. Important high water roost sites include around Bedenham and Pewit Island, as well as pontoons near Wicor Shore.

5.4.3 Other wildlife

Seals are frequent visitors to the Harbour, particularly harbour/common seals on foraging trips from the main haul outs in Chichester Harbour. Cetacean sightings are believed to be rare. Many fish species typical of estuarine settings are likely to be present in the Harbour, which is furthermore considered to be a bass nursery area. Trout and eel are likely to be key migratory species which frequent this region's rivers (see Section 2.4.4); Atlantic salmon are not encountered here.

Image 50. Short spined scorpion fish at Portsmouth South Parade Pier

5.4.4 Human activities

Portsmouth Harbour is bounded by the cities of Portsmouth on the east and the towns of Portchester, Fareham and Gosport to the north and west respectively. Portsmouth is a busy naval, ferry and freight port, and thousands of ship movements take place every year due to these activities. Regular navigational dredging takes place to facilitate access for deeper-draughted vessels. Portsmouth is the main fishing port in the region, with 41 vessels registered here (around a third less when compared to 10 years previously). There are several marinas in the Harbour, particularly near its mouth at Gosport and Old Portsmouth, but also at Port Solent. However, no moorings or anchorages are found here. Several sailing clubs and the Royal Navy's sailing centre are also located in the Harbour. Many boat and ship yards can furthermore be found. Portsmouth and (to a lesser extent) Gosport are popular tourist destinations, particularly in relation to their historic naval attractions. Foot and cycle paths can be found along many stretches of shoreline of the Harbour, and are all well used. The few quieter shorelines which exist are mainly found around some of the restricted / low access areas, including the Royal Naval Armaments Depot at Bedenham north of Gosport, and the MOD firing range at Tipner, north west Portsmouth.

Paddle sports tend to only take place in a few locations in the Harbour, mostly around Fareham Creek, Stoke Lake (Gosport) and Whale Island (Portsmouth), and wind or kite surfing is not generally observed. These activities are, however, prevalent along the beaches outside of the Harbour. Bait digging is widespread in Fareham Creek. Uniquely, this is subject to a 2001 Special Nature Conservation Order (SNCO) issued by the Department of the Environment, Transport and the Regions (DETR). This prohibits all bait digging except for personal use for sea fishing and also prohibits the taking, uprooting or destroying of algae, sea lettuces, or seagrass beds.

5.4.5 Restoration and management efforts

Disturbance management is undertaken in this Harbour as part of Bird Aware Solent, who also have a water sports with wildlife map and guides. There is also the above mentioned SNCO in place for bait digging in Fareham Creek, and various IFCA byelaws for fishing also apply (see Section 4.1.4 for more detail).

The only known active restoration measure which has taken place here is the Pewit Island shingle topping which took place in 2021; this was led by HIWWT and done with the help of the MOD, who transported 56 tonnes of shingle onto the island with a Chinook helicopter (HIWWT, 2021). There are no known planned measures in this Harbour.

5.5 Langstone Harbour

5.5.1 Habitats

The marine habitats of Langstone Harbour measure around 1,950 ha in total, most of which (70%) is intertidal mudflat, with only a fairly small percentage (14%) of subtidal. Cumulative saltmarsh area is very low, at 66 ha. 121 ha of seagrass beds are mapped, most of which are located south west of Farlington Marshes, and along the western and south western shores of Hayling Island. As noted previously, it is believed that this is an underestimate of the seagrass extent in this Harbour.

The SSSI and SAC units which have been assessed for condition are considered to generally be in unfavourable condition (with a mixture of no change and recovering). Two exceptions are the Kench and Eastney Lake littoral sediment units which are considered to be in favourable condition. Coastal

squeeze, nutrient enrichment, poor quality of habitat and harmful blooms of macroalgae are highlighted as causes of the unfavourable conditions for some units.

5.5.2 Birds

Langstone Harbour is a large natural harbour which supports internationally important numbers of waterbirds with over 25,000 birds regularly recorded. In line with wider Solent trends, the number of waders has declined in Langstone Harbour with the waterfowl population remaining more stable. Important habitats for waterbirds in the harbour include extensive intertidal mudflats, sandflats, saltmarsh, seagrass beds, shiggle ridges and islands.

In the context of the Solent, Langstone Harbour is particularly important for wintering birds. When considering the Solent wide population (and reviewing WeBS core count data), over the past 30 years, Langstone Harbour has accounted for between 11 to 15% of waterfowl populations and 22 to 29% of wader populations.

Dunlin is the most abundant wading bird species typically recorded in Langstone Harbour (and also occur in nationally important numbers), with a WeBS 5-year mean peak of 13,407. Black-tailed Godwit and Grey Plover occur in nationally important number (WeBS 5-year mean peak of 535 and 587 birds respectively). Other abundant waders include Oystercatcher, Curlew and Redshank. Knot, Turnstone and Ringed Plover are also commonly recorded. Important roosts for waders in Langstone Harbour include RSPB Islands, Farlington Marshes, Oysterbeds and Kench Spit (Woodward *et al.,* 2024; Natural England, 2024a). Waders are generally widely distributed at low water feeding on mudflat and other soft sediment intertidal habitats. Langstone Harbour is also a key site for Dark-bellied Brent Geese in the UK with internationally important numbers recorded. This species is widely distributed throughout Langstone Harbour with the wintering population remaining relatively stable over the least 30 years (Woodward *et al.,* 2024; Natural England, 2024a; Woodward *et al.,* 2019).

Pintail have been recorded in nationally important numbers, with other dabbling ducks including Wigeon, Teal, Mallard and Pintail also abundant. The main concentrations of Wigeon are typically recorded to the west of Langstone Bridge, Farlington Marshes and east of Farlington Marshes. Teal, Mallard and Pintail are also typically distributed around Farlington Marshes and the inner sections of Langstone Harbour (Woodward *et al.,* 2024; Natural England, 2024a). Shelduck typically roost on the RSPB islands as well as at Farlington Marshes and feed around low water on intertidal mudflats and sandflats throughout much of Langstone Harbour. Langstone Harbour furthermore supports nationally important numbers of Little Egret.

Important seabird breeding colonies are located on the islands in the east of the Harbour, particularly Binness Island, and also at the West Hayling LNR. In the context of the Solent, almost 65%[46] of the region's breeding seabirds breed in Langstone Harbour. Some waders also breed around Gunner's Point (Hayling Island, just outside of the Harbour), notably Ringed Plover.

5.5.3 Other wildlife

Many fish species typical of estuarine settings are known to be present in the Harbour, which is furthermore considered to be a bass nursery area. Sea trout and eel are likely to be key migratory species which frequent this region's rivers (see Section 2.4.4); Atlantic salmon are not encountered here. Harbour seals forage and haul out in the Harbour (the latter in low numbers), and also pupped here for the first time in 2023. Grey seals are also seen relatively frequently.

[46] As calculated based on total numbers presented in the 2023 spreadsheet provided by the RSPB.

5.5.4 Human activities

Langstone Harbour is bounded by the City of Portsmouth to the west, the town of Havant to the north and Hayling Island to the east. Commercial vessel traffic on this body of water takes place to an aggregates wharf located near Anchorage Park in north-east Portsmouth; furthermore, three commercial fishing vessels are registered here. One marina is found in this Harbour, Southsea Marina in the south west; there are however numerous mooring and anchoring areas for boats throughout the Harbour. Sailing is hardly practiced within the Harbour due to its largely shallow nature; this is with the exception of those sailing small boats from a water sports centre located next to the aggregates wharf. Paddle sports are also concentrated mostly around this centre, though some kayakers and paddle boarders enter the harbour from nearby beaches, and mostly then progress along the western shore of the Harbour. Some limited wind surfing takes place (with kite surfing being prohibited in the Harbour). Footpaths, many of which also allow cycling, circle most of the Harbour, and are well used. Bait digging has been recorded south of Southmoor and west of Langstone Bridge; whereas hand gathering is noted at the Hayling Oysterbed spit.

5.5.5 Restoration and management efforts

Disturbance management is undertaken in this Harbour as part of Bird Aware Solent, who also have a water sports with wildlife map and guides. Reserve managers will also be undertaking wardening as appropriate, for example at the RSPB's Langstone Harbour Nature Reserve, HIWWT at Farlington Marshes, and volunteer wardens also protect Ringed Plover nests at Gunner's Point. Vegetation clearance and predator management is comprehensively practiced by the RSPB in particular, to encourage and protect the breeding seabirds in this Harbour. Tern rafts are employed at the Hayling Oysterbeds (by the RSPB).

Active restoration in this Harbour relates to shingle topping of some of the breeding islands(by the RSPB), and also the oyster reef creation at Russell's Lake (Blue Marine Foundation). In addition, the unmanaged realignment at Southmoor is located along the northern shore of the Harbour. Furthermore, several feasibility studies have been undertaken to consider options at Farlington, and a bird roosting island was created as part of the North Portsea Coastal scheme (The News, 2023).

5.6 Chichester Harbour

5.6.1 Habitats

The marine habitats of Chichester Harbour measure around 3,200 ha in total, most of which (61%) is intertidal soft sediment. There are extensive areas of saltmarsh measuring 355 ha, and seagrass is also widespread in the Harbour, at some 128 ha. This is mostly found along the eastern shores of Hayling Island.

The SSSI and SAC units which have been assessed are considered to generally be in unfavourable condition. The SSSI assessment concluded an unfavourable declining status for the vast majority of the units in this Harbour, as previously discussed in this report. Reasons listed include coastal squeeze, nutrient enrichment, poor quality of habitat and harmful mats of macroalgae.

Copyright: Andrew Pearson

Image 51. Sea aster in Chichester Harbour

5.6.2 Birds

Chichester Harbour is a large natural harbour which regularly supports over 35,000 waterbirds including a wide range of waders and waterfowl recorded in internationally or nationally important numbers (Woodward *et al.,* 2024). At low water, extensive intertidal mudflats and sandflats provide important feeding habitat with extensive saltmarsh, shallow coastal waters, coastal lagoons, coastal grazing marsh, shingle ridges and islands also important habitat for wintering waterbirds.

In the context of the Solent, Chichester Harbour is particularly important for wintering birds. When considering the Solent wide population (and reviewing WeBS core count data), over the past 30 years, Chichester Harbour has accounted for between 22 to 27% of waterfowl populations and 28 to 34% of wader populations.

Overall, the number of waders in Chichester Harbour has declined over the last 30 years. This is thought to be largely as a result in a reduction in the number of Dunlin as well as lower abundances of other species such as Grey Plover, Ringed Plover and Sanderling. The declines observed in Chichester Harbour are consistent with wider regional trends (Woodward *et al.,* 2019).

The most abundant wading bird recorded in Chichester Harbour is typically Dunlin. Redshank, Curlew and Grey Plover are also commonly recorded throughout Chichester Harbour. Other species typically occurring in WeBS mean peaks in the order of 1,000 to 2000 birds include Black-tailed Godwit (nationally important numbers), Lapwing, Oystercatcher, Golden Plover and Knot. Chichester Harbour also supports nationally important populations of Sanderling, Bar-tailed Godwit, Turnstone and Ringed Plover.

At low water, these waders tend to be widely dispersed, feeding on intertidal sediments throughout Chichester Harbour, with key feeding areas including south of Thorney Island and in the Emsworth Channel, and Pilsey Sands for some species. Key high water roosts for many of these species include Thorney Deeps, Pilsey Island, Black Point, Ellanore Spit, East Head, Stake Islands (off Cobnor Point) and Gutner Point. Some species such as Curlew will also use fields, both arable and grassland to feed. Small breeding populations of Ringed Plover also occur in Chichester Harbour.

The most abundant waterfowl species in Chichester Harbour is Dark-bellied Brent Geese. The wintering population in Chichester Harbour is one of the largest in the UK and is of international importance. Wintering population numbers of this species have been relatively stable over the last 30 years. Dark-bellied Brent Geese feed on green algae and eelgrass in Chichester Harbour and are distributed widely, with important feeding areas including on the foreshore around West Thorney, Chidham and Itchenor. Dark-bellied Brent Geese roost on the water overnight and will often roost close to preferred feeding areas. Dark-bellied Brent Geese also feed extensively on nearby arable fields and coastal grassland around Chichester Harbour. Mute swan and Canada Goose are also commonly recorded, and Wigeon and Teal are the most abundant duck species. Important populations of other dabbling ducks including Mallard, Pintail and Shoveler are also recorded. Shelduck are also recorded in high (if declining) numbers and known foraging areas include the Fishbourne, Thorney and Bosham Channels, whereas roosting areas including Fowley Island and Thorney Deeps (Woodward *et al.,* 2024; Natural England, 2024a).

Chichester Harbour supports nationally important numbers of Little Egret, along with large numbers of Coot.

Relatively low numbers of seabirds breed in the Harbour (around 2% of the Solent total in 2023, though numbers have varied historically), with Thorney Deeps and Pitsea Island (off Thorney) being key locations.

5.6.3 Other wildlife

As previously noted, Chichester Harbour is home to a colony of harbour seals with ever increasing numbers, and grey seals are also often observed. Harbour seals haul out and pup in the Harbour, mainly west of Thorney Island, and are known to forage throughout the Solent. Many fish species typical of estuarine settings are known to be present in the Harbour, which is furthermore considered to be a bass nursery area. Sea trout and eel are likely to be key migratory species which frequent this region's rivers; Atlantic salmon are not encountered here.

5.6.4 Human activities

Chichester Harbour is mainly a rural location, with many relatively small villages dotted around the Harbour. Exceptions to this are the larger settlements along the south of Hayling Island, as well as Emsworth, Bosham and Fishbourne. There is no commercial shipping in the Harbour, which is instead well used by recreational boaters. Four fishing vessels are registered in the Harbour, two at Emsworth and two at Itchenor. Many marinas and sailing clubs are located here, and moorings and anchorages abound, particularly in the upper reaches of this Harbour's many channels, and also along the eastern shores of Hayling Island.

Many paths can be found here which often run right along the shoreline. Numerous types of visitors access the Harbour via these paths; these include walkers and cyclists, though the latter cannot access substantial stretches of shoreline. Paddle sports are very popular here, with rowing, stand up paddle boarding and kayaking all practiced. Particular hotspots for these activities are the Emsworth, Bosham and Chichester Channels, and the mouth of the Harbour, with paddlers often originating from the

beaches at Hayling and the Witterings. Wind, and foil surfing are also undertaken within the Harbour, particularly in the Emsworth Channel, and east of Hayling Island.

Hand gathering is seen at the tops of the Bosham and Thorney Channels, and bait digging is popular around Dell Quay in Chichester Channel.

5.6.5 Restoration and management efforts

Disturbance management is undertaken in this Harbour as part of Bird Aware Solent, who also have a water sports with wildlife map and guides. Reserve managers will furthermore be undertaking wardening as appropriate, notably the rangers and volunteers of the Chichester Harbour Conservancy. In addition, as previously noted, Chichester Harbour Conservancy undertook management measures at Pilsey Island (on the southern tip of Thorney Island), in the form of vegetation clearance, the erection of protective fencing at, and also the reinstatement of signage (noting that access is prohibited across most areas of this 'island'). There are furthermore various existing byelaws which prohibit or restrict fishing (see Section 4.1.4 for more detail). In addition, a byelaw which, it is hoped, will help tack illegal hand gathering (amongst others), is awaiting approval from the Secretary of State.

With regard to active restoration, several schemes have been implemented in this Harbour to date, with most of them having previously been discussed in Section 4.2. These include two managed realignment schemes, two RTEs and the 2023 beneficial use trial at Itchenor (where more campaigns will likely take place going forward) (see ABPmer 2024 for more detail). Also, there has been a shingle recharge at Stakes Island (led by CHaPRoN), west of Cobnor Point. Undertaken in 2021, this involved adding 500 tonnes of shingle to parts of the island, to raise them back to above high spring tide levels, in the hope that it could once again act as a safe nesting sites for shorebirds and seabirds. In 2023, Oystercatcher and Little Tern nested here. Furthermore, the Tern rafts put up at Thorney Deep since 2019 have been 'a huge success', with 54 fledglings counted in 2022 (CHaPRoN, 2024). In terms of future initiatives, these include the planned managed realignment at Thorney Island (Environment Agency), and a possible one at Apuldram, where Chichester Harbour Conservancy is currently exploring options.

5.7 Pagham Harbour

5.7.1 Habitats

Pagham Harbour is a relatively small tidal inlet in West Sussex; its marine and coastal habitats measure 360 ha in total. Saltmarshes and mudflats occupy the majority of the Harbour, amounting to 135 ha and 138 ha respectively. Seagrass beds have also been found in the Harbour in the past, though extent and biomass of seagrass has decreased considerably in recent years; these currently only measure around 0.02 ha (Natural England, 2022). The subtidal area of the Harbour is very small at 17 ha or 5% of the total. Several saline lagoons can be found around the perimeter of the Harbour, with the largest being the 11 ha Pagham Lagoon.

The condition of the coastal or marine SSSI units in Pagham Harbour is generally favourable (via the most recent assessments, although many of these are in the process of re-assessment). The only habitat units which are considered to currently be in unfavourable condition are the two supralittoral units of the SSSI, and also the unit containing Pagham Lagoon. The shingle units are mainly in unfavourable condition due to non-native species having spread onto the shingle beach at Pagham from adjacent private gardens. Pagham Lagoon is in unfavourable condition due to issues with water quality and a lack of presence of the starlet sea anemone (Natural England, 2023). The seagrass beds, which area a feature of the MCZ, have been assessed as being in unfavourable declining condition (Natural England, 2022), mainly due to a dramatic decline in extent. The reasons for the decline in seagrass area are not

entirely clear, though it is known that seagrass beds in Pagham Harbour have often fluctuated in extent. According to the MCZ condition assessment, '*it is suspected that changes to the hydromorphology of Pagham Harbour entrance and intertidal area may have contributed to the deterioration and reduction in extent of the seagrass bed. However, this is an expert judgement and further evidence is required*'.

5.7.2 Birds

The sheltered inlet of Pagham Harbour is an internationally important wetland site for birds, utilising its saltmarshes and mudflats, lagoons, reedbeds, surrounding farmland, the shingle spit and shingle islands. It is managed by the RSPB, who manage the Harbour together with the neighbouring reserve of Medmerry. The Harbour regularly supports over 11,000 to 13,000 waterbirds.

With regard to waders, Pagham Harbour supports nationally important numbers of wintering grey plover (WeBS 5-year mean peak of 741 birds). This species is commonly recorded feeding throughout mudflat habitat in Pagham Harbour. Dunlin also occur in large numbers in during the winter, particularly in central and outer areas on intertidal mudflats (WeBS 5-year mean peak of 1,930). Lapwing is also abundant, particularly in north eastern sections of Pagham Harbour (WeBS 5-year mean peak of 1,864). Other commonly occurring wintering waders include golden plover, black-tailed godwit and knot (Woodward et al., 2024).

Waterfowl also frequent Pagham Harbour in large numbers. Internationally important populations of dark-bellied brent geese occur in Pagham Harbour (WeBS 5-year mean peak of 2,653). This species is widely distributed throughout Pagham Harbour feeding and roosting. In some recent years, nationally important numbers of pintail have been recorded, such as in 2018/19 when 346 birds were recorded. Other abundant waterfowl species include wigeon and teal (Woodward et al., 2024).

Non-wading and waterfowl species are also observed here, including little egret (WeBS 5-year mean peak of 60 birds), grey heron, moorhens and coots.

Many seabirds breed in Pagham Harbour, and there has been concerted conservation action leading to population increases for most species over the last decade. Over the summer, several tern species breed in Pagham Harbour, notably on the aptly named Tern Island, though numbers have fluctuated over the years, albeit in a general upward pattern. For example, since 1995, Little tern numbers have fluctuated between 0 and 23 breeding pairs, with 18 observed in 2023. Common tern pair numbers have ranged between 1 and 35 since 1995, with only two seen in 2023. Sandwich tern pair numbers have fluctuated dramatically over the past 30 years, with no pairs breeding in the 1990s or early 2000s, before numbers started to increase to a maximum of 335 in 2022; however, no pairs have bred here in the two years since. Other seabirds and shorebirds also breed at Pagham Harbour, including ringed plover and black-headed gulls. Numbers of the latter species have also seen a dramatic decline over the past two years, from an unprecedented maximum of 1,400 breeding pairs in 2022 to only 18 and then 8 pairs observed in 2023 and 2024 respectively (BTO, 2024b). These recent declines are mainly due to bird flu, which devastated the Pagham colony (along with many others around the UK) in 2022, though relocation and predation have also played a role[47]. Many common terns for example are believed to have relocated to the colonies which have rapidly grown on the rafts at Thorney Deeps and the West Hayling LNR (in

[47] RSPB (2024) note that after the '*major die off seen in the 2022 breeding season with over 900 gull and tern bodies recovered from Tern Island at the end of summer, the birds continued to suffer at their wintering grounds in Europe with large numbers of deaths reported. The impact quickly became evident in spring 2023, with numbers initially returning to the harbour far lower than usual. The birds that did arrive seemed agitated, and despite early efforts to build nests and lay eggs, the entire colony abandoned the harbour over the space of a weekend in early May. Survey figures suggest they relocated to Langstone Harbour, showing the importance of treating the Solent sea bird population as a wider meta-colony rather than distinct groups, as well as the importance of having multiple suitable sites available in any given year*'.

Chichester and Langston Harbours). Actions are currently taking place to regrow the seabird colony at Pagham Harbour (RSBP, pers. comm.).

There is furthermore a heronry at Pagham Harbour (at Owl Copse), where little egret and cattle egret breed alongside grey heron. The cattle egret breeding numbers here accounted for 63% of the UK total in 2023 (RSPB, 2024); noting that cattle egret are a colonising species.

5.7.3 Other wildlife

Many fish species typical of estuarine settings are known to be present in the Harbour. For example, 16 fish species were caught over the course of two Sussex IFCA fish surveys in 2007 and 2015, with sandsmelt being the most abundant fish by far. Bass, sand goby and herring were also observed in relatively high numbers (Sussex IFCA, 2015). Sea trout and eel may be migrating through the Harbour, as they are key migratory species which are believed to frequent most of the Solent region's rivers (see Section 2.4.4); Atlantic salmon are not encountered here. Lagoon invertebrate species are notably found in the Harbour (and its coastal lagoons), with two of the three MCZ features being made up of such species (Defolin's lagoon snail and lagoon sand shrimp).

5.7.4 Human activities

Pagham Harbour is situated in a rural location, with several villages and hamlets surrounding the Harbour, and the town of Selsey situated near its western shores. A caravan park can be found along the eastern shore, near the village of Pagham. Vessel access to the Harbour is discouraged, and has in the past decade or so been near impossible at times due to the shifting nature of the Church Norton Spit. Watersport activity is instead focussed on Pagham Beach, where numerous such sports are pursued, and some small watercraft, notably paddle boards, can occasionally be observed venturing into Pagham Harbour, though this appears to be quite rare. Numerous footpaths, including some cycle path connections, circle most of the Harbour, and are well used. Bait digging has in the past been recorded in the Harbour (Watson et al., 2016).

5.7.5 Restoration and management effort

Disturbance management is undertaken by the RSPB in this Harbour, who manage the reserve; many volunteer rangers contribute to this effort around Pagham Harbour. The RSPB has furthermore installed fencing around a summer 'exclusion zone' along a section of Church Norton Spit, to protect beach nesting birds from human disturbance. Predator exclusion fencing is also in place at the three bird nesting islands in the harbour (Tern Island, New Island and Breach Island).

There have been various restoration measures undertaken in this Harbour, focused mainly on improving conditions for nesting birds. This has included various improvement measures at Tern and New Island, and, more recently, the creation of Breach Island in 2021, as part of the harbour mouth realignment works (when a channel was cut through Church Norton spit in November 2021). This shingle island was created within the harbour as compensatory habitat for the little terns, using the materials cut from the breach (RSPB, 2024). Going forward, there are plans for habitat restoration in the Ferry Pool area of the reserve, with the aim of improving the lowland wet grassland habitat for breeding and wintering waders. This will be through the introduction of new / restored water level control structures, the creation / restoration of a number of scrapes and in field ditches, and the installation of new fences to prevent predator access and reduce disturbance by dogs and walkers (RSPB, 2024).

6 Next Steps / The Future

This report has summarised the state of the (coastal and marine) nature in the Solent. It has found that many habitats and species in the Solent are struggling, and will continue to do so especially due to ongoing pressures, especially human disturbance, sea level rise and sub-optimal water quality. Whilst there are many ongoing management, enhancement and restoration measures aimed at helping the marine nature of the Solent recover, more are still likely to be needed to further this cause.

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There are substantial evidence gaps remaining, some of which are being filled by ongoing projects (including the Solent Seascape Project). For example, more information on habitat condition and the distribution of key habitats such as seagrass is needed.

In addition, often, monitoring data is collected, but data is either not analysed at all, or only partially; and where analysis is undertaken then this is frequently not made public. Locations where human activities cause particular issues to nature are also often not properly identified, although there is a relatively good level of understanding of this in the Solent. Efforts have been made in relation to this State of Nature work to collate the knowledge of the different Solent Seascape partner organisations for example. However, more detailed mapping would still be beneficial for most pressures.

With regard to management and restoration, there is frequently not enough information on the individual measures, and in particular lessons learned from them, or consistent approaches for defining success. Again, both within the Solent, and nationally, there are various endeavours to improve this, though more can still be done by all the organisations involved in such measures, to facilitate consistent and efficient exchange of knowledge and evidence. There are also broader knowledge gaps around coastal and marine habitat connectivity, ecosystem services and the impacts of climate change.

This State of Nature report, and accompanying data viewer and summary report, will now be used by the partners of the Solent Seascape Project and other relevant stakeholders to develop a Recovery Plan for the Solent as part of the Solent Seascape Project.

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8 Abbreviations/Acronyms

ABP	Associated British Ports
AL1	Action Level 1
AL2	Action Level 2
ALs	Action Levels
AMS	Advanced Mooring Systems
AON	Apparently Occupied Nest
AONB	Area of Outstanding Natural Beauty
APEM	APEM Ltd
BBC	British Broadcasting Corporation
BEIS	Department for Business, Energy and Industrial Strategy
BNG	Biodiversity Net Gain
BP	The British Petroleum Company p.l.c
BTO	British Trust for Ornithology
BUDS	Beneficial Use of Dredge Sediment in the Solent
CCO	Channel Coastal Observatory
CCTV	Closed Circuit Television
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEH	Centre for Ecology and Hydrology
CHA	Competent Harbour Authorities
CHaMP	Coastal Habitat Management Plan
CHaPRoN	Chichester Harbour Protection and Recovery of Nature
COVID-19	Coronavirus disease
dB	Decibels
DBT	Dibutyltin
Defra	Department for Environment, Food and Rural Affairs
DETR	Department of the Environment, Transport and the Regions
DfT	Department for Transport
EC	Escherichia (E.) coli
EMFF	European Maritime Fisheries Fund
EMS	European Marine Site
EPS	European Protected Species
EQS	Environmental Quality Standard
ESCP	Eastern Solent Coastal Partnership
EstSim	Estuary Simulations
Fav	Favourable
GPS	Global Positioning System
ha	Hectare
HAT	Highest Astronomical Tide
HCRP	Habitat Compensation and Restoration Programme
HIWWT	Hampshire and Isle of Wight Wildlife Trust
HVDC	High Voltage Direct Current
IAS	Invasive Alien Species
ICES	International Council for the Exploration of the Sea
IFA2	Interconnexion France-Angleterre 2
IFCA	Inshore Fisheries and Conservation Authority
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide

LiDAR	Light Detection and Ranging
LIFE	Programme for the Environment and Climate Action
LNR	Local Nature Reserve
LNRS	Local Nature Recovery Strategies
LOTE	LIFE on the Edge
µPa	Micropascal
MaRePo	Marine Restoration Potential
MCCIP	Marine Climate Change Impacts Partnership
MCZ	Marine Conservation Zone
MDP	Maintenance Dredge Protocol
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MOD	Ministry of Defence
MP	Mean Peaks
MPA	Marine Protected Area
MW	Megawatt(s)
NBN	National Biodiversity Network
nc	No Suggestive Change
NERC	Natural Environment and Rural Communities Act
NFDC	New Forest District Council
NGO	Non-Governmental Organisations
NIS	Non-Indigenous Species
NMS	Nutrient Mitigation Scheme
NNR	National Nature Reserve
NRW	Natural Resources Wales
NTS	Non-Technical Summary
NVZs	Nitrate Vulnerable Zones
OD	Ordnance Datum
OMReg	Online Marine Registry
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PSPO	Public Spaces Protection Order
QR	Quick Response Code
Ramsar	The Ramsar Convention on Wetlands of International Importance
RDB	Red Data Book
REACH	Registration, Evaluation, Authorisation [of chemicals]
ReMEDIES	Reducing and Mitigating Erosion and Disturbance Impacts affecting the Seabed
ReMeMaRe	Restoring Meadow, Marsh and Reef
RHCP	Regional Habitat Compensation Programme
RSPB	Royal Society for the Protection of Birds
RTE	Regulated Tidal Exchange
RYA	Royal Yachting Association
S41	Section 41 of the Natural Environment and Rural Communities (NECR) Act
SAC	Special Area of Conservation
SANG	Suitable Alternative Natural Greenspace
SCOPAC	Standing Conference on Problems Associated with the Coastline
SD	Standard Deviation
SEMS	Solent Marine Sites
SEMS MG	Solent Marine Sites Management Group
SIFCA	Southern Inshore Fisheries and Conservation Authority

SMP	Shoreline Management Plan
SNCB	Statutory Nature Conservation Body
SNCO	Special Nature Conservation Order
SPA	Special Protected Area
SSSI	Site of Special Scientific Interest
STW	Sewage Treatment Works
SWEEP	South West Partnership for Environment and Economic Prosperity
Swimfo	Environment Agency's online 'Find a bathing water' tool
TBT	Tributyltin
TEMITH	Total Ecosystem Management of the InterTidal Habitat
TraC	Transitional and Coastal [waterbodies]
UK	United Kingdom
Unfav Decl	Unfavourable Declining
Unfav DK	Unfavourable Unknown
Unfav NC	Unfavourable No Change
Unfav Rec	Unfavourable Recovering
WACA	Wildlife and Countryside Act 1981
WeBS	Wetland Bird Survey
WEIF	Water Environment Improvement Fund
WFD	Water Framework Directive
WWF	World Wide Fund for Nature
WWT	Wildfowl and Wetlands Trust

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

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