A VALUATION OF **JERSEY'S MARINE HABITATS** IN PROVIDING ECOSYSTEM SERVICES

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Photo: Matt Jarvis

NEW ECONOMICS FOUNDATION

BLUE MARINE FOUNDATION

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CONTENTS

Executive Summary 3

Introduction 4

Jersey's Environment 4

Existing Designations 7

Jersey's Fishery 8

Purpose of this Report 9

Ecosystem Services 9

Ecosystem Service Valuation 10

Ecosystem Service Valuation Methodology 10

Methods 11

Stage 1: Model Scenario Selection 12

Stage 2: Calculation of Habitat and Fisheries Extent 14

Stage 3: NEF Model Execution 15

Results 16

Marine Park Designation Scenario 16

Existing MPA Scenarios 19

High-Importance Habitat Scenarios 20

Discussion 20

Biodiversity Improvement 21

Climate Change Mitigation 23

Fisheries and Commercial Activity Support 23

Community Enhancement 24

Scenario Comparison 25

Summary 26

Recommendations 26

Referenced sources 27

Annexes 28

EXECUTIVE SUMMARY

With an area 20 times that of the island itself, Jersey's marine environment is a vital resource. Incredibly diverse, with over 3,000 known animal and plant species, its range of habitats provide essential services to the Island including food, climate regulation, nutrient cycling, coastline protection, recreation and wellbeing. In 2022, the Government of Jersey committed to developing Jersey's first Marine Spatial Plan (MSP) with the aim of balancing the different uses of the marine environment. The MSP includes a commitment to extend Jersey's Marine Protected Area (MPA) network by 2025. Despite an existing network of MPAs, 93 per cent of Jersey's seabed remains unprotected and at risk from damaging activities such as bottom-towed fishing and infrastructure development.

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With global targets to protect 30 per cent of the ocean by 2030 (a target Jersey is a signatory to via the UK), the MSP provides a unique opportunity to secure significant protection of Jersey's marine environment while safeguarding and maximizing the services it provides to the Island.

This report outlines the findings of an Ecosystem Service Valuation model completed by Blue Marine Foundation (Blue Marine) and the New Economics Foundation (NEF) to establish the ecosystem services (ES) provided by Jersey's marine environment to the Island. The model uses a benefit transfer approach to estimate the ecosystem service value for ten scenarios for the extension of Jersey's MPAs through the MSP process.

The model indicates a marine park scenario as being the most effective in tackling the climate and biodiversity crisis, as well as boosting fisheries, for the balance struck by this scenario across four key themes: Firstly, it provided a high value per square kilometre, secondly, it encompassed a diverse range of habitats, thirdly it provided excellent connectivity across these habitat types; and finally it achieved global conservation targets.

The model estimated that the net ES value of the proposed marine park would be ~£8.9 million over the first five years, ~£27.7 million over the first ten years and ~£70.5 million over 20 years. After incorporating estimated lost mobile fishing value, the cumulative net benefit of the marine park over five, ten and 20 years was estimated at ~£1.2 million, ~£12.7 million and ~£42.2 million, respectively. This was an increase in the value of ES provided by Jersey's environment of ~800 per cent.

Understanding Jersey's marine resources is essential in the development of a MSP for the island. This report highlights that higher protection levels through a proposed marine park could deliver an extensive MPA network, covering habitats essential for biodiversity, carbon sequestration, sustaining fisheries and the wellbeing of Jersey's population.

INTRODUCTION

Blue Marine Foundation (Blue Marine) is advocating for a marine park in Jersey's waters to cover approximately 900 square kilometres (equating to ~30 per cent of Jersey's territorial waters) and protect 'high-value habitats' from inappropriate development and damaging activities. These include habitats essential for biodiversity, carbon sequestration, sustaining fisheries and the wellbeing of Jersey's population.

JERSEY'S ENVIRONMENT

Jersey's land area covers 120 square kilometres but is dwarfed by the surrounding 2,455 square kilometres of territorial sea. Over 70 kilometres of coastline ranging in character from dramatic cliffs and wide sandy bays through to small harbours and the port of St Helier act as the gateway to the marine environment. The character and ecology of Jersey's environment support a diverse range of wildlife, with over 3,000 known animal and plant species. Habitats range from kelp forests, seagrass and maerl beds to gravel and sand beds (Figure 1). Together these habitats support a healthy, functioning ecosystem and provide a variety of services to the Island including food provision, nutrient cycling, climate change mitigation, coastal protection and recreation and wellbeing. Jersey's marine waters are also rich with sites of cultural, archaeological and historical significance.

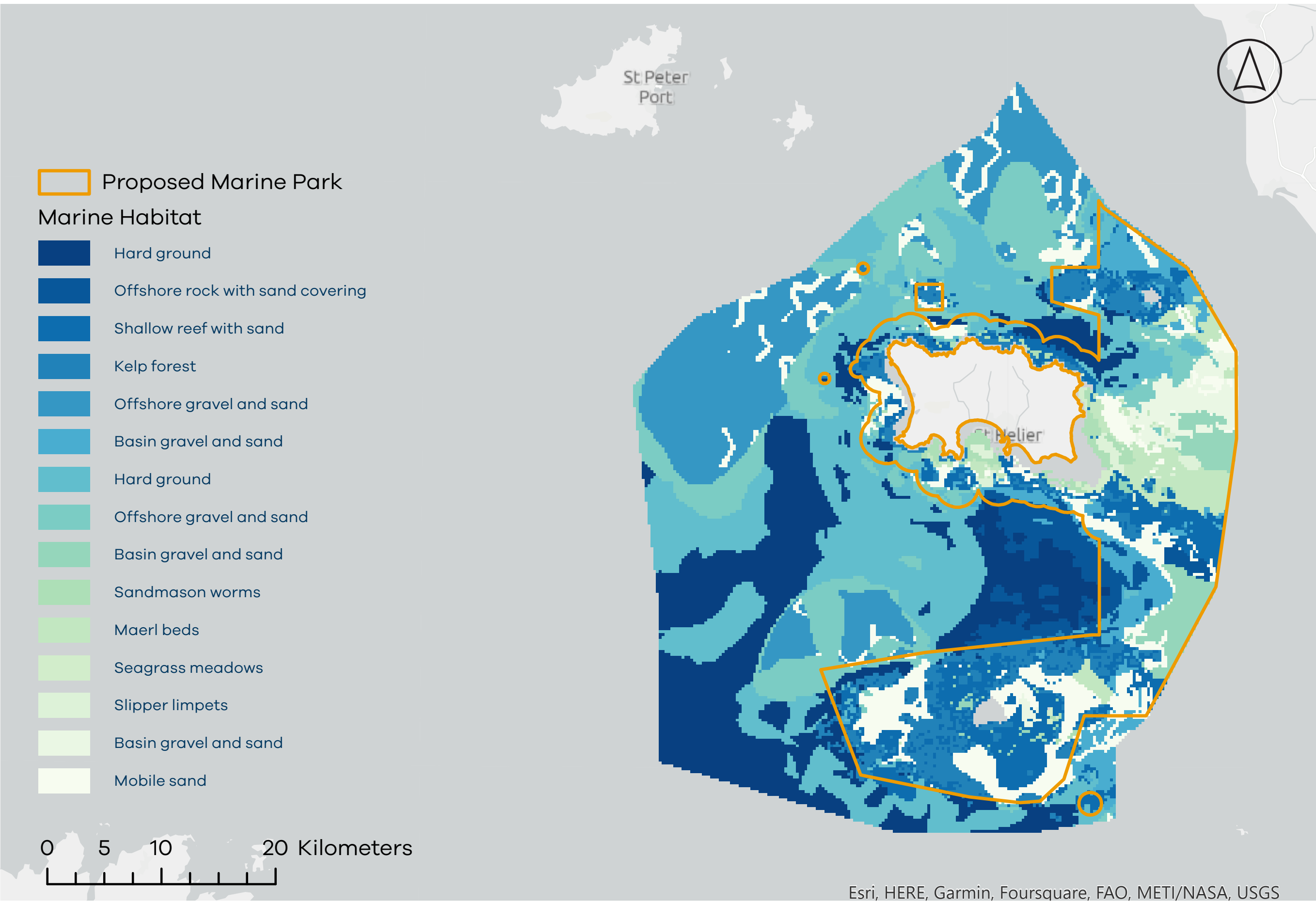


FIGURE 1 – JERSEY'S MARINE HABITATS (AND PROPOSED MARINE PARK BOUNDARY)

The south, south east and west coasts have shallow, gently sloping shore profiles, increasing the extent of the island by a quarter at low tide, as up to 30 square kilometres of intertidal area become accessible. This area holds some of the most diverse clam beds in Northern Europe[1] and the rocky intertidal zone and outlying reefs hold flooded gully and waterfall habitats known nowhere else in the region[2]. In contrast, the north and south west coasts are characterised by steep granite cliffs.

The seaweeds found on the north west coast are considered likely to be the greatest diversity of seaweed in the British Isles[3]. Kelp play important roles in nutrient cycling along with other marine wildlife and microorganisms[4]. Extensive seagrass beds, particularly along the eastern shoreline of the Island, play a fundamental role in maintaining fish populations. Acting as a foraging ground, nursery area and refuge from predation, commercial species such as bream and cuttlefish, as well as more enigmatic fish including seahorses, can be found among Jersey's seagrass beds.

Local maerl beds (of which only 13 per cent are currently under protection) have been recorded to contain up to 173 species per square metre, the highest diversity of species within Jersey's marine habitats[5]. Some of the maerl beds around Jersey's shoreline are thought to be up to 1,000 years old[6].

Maerl is also a critical nursery ground for juvenile scallops, one of the Island's fishery's most valuable species.

Several large offshore reefs sit within the boundaries of Jersey's territorial waters (Figure 2). Les Écréhous (north of the Island) and Les Minquiers (south of the island) are offshore reefs with areas permanently above the waterline, each with a small number of dwellings. Other reefs include Les Dirouilles and the Paternosters (north of the Island), as well as underwater reef systems such as Les Anquettes (east of the Island) and Les Sauvages (at the southern extent of Jersey's territorial waters). Subtidal shallow reefs interspersed with sand fringe the island and offshore reefs and host a range of species such as seaweeds, sea squirts, anemones, and tube worms. Larger cracks and crevices in these reefs host species such as lobsters and crabs (the backbone species of Jersey's fishery) as well as ormers and conger eels[7]. Kelp forests, such as those found in and around the offshore reefs, act as 'ecosystem engineers', performing important roles in creating habitat structure and coastal defence through energy mitigation (among others)[8].

Photo: Matt Jarvis

Across sandy areas, biogenic habitats, such as sandmason worms, host the same level of biodiversity as seagrass meadows[9]. Elsewhere, gravel beds form high-density communities of bivalve molluscs, burrowing crustaceans, anemones and echinoderms, as well as more mobile species like crabs, rays and demersal fish such as plaice, turbot and sole[1].

Jersey's waters also host megafauna such as porbeagles (vulnerable on the IUCN red list), blue sharks and dolphins. A plethora of seabirds are supported by Jersey's waters and shoreline. Species including terns, gulls, razorbills and puffins have important breeding sites in Jersey, although like the rest of the British Isles, their numbers are in decline.

Jersey's marine environment also has a key role to play in tackling the climate crisis. Blue carbon habitats such as seagrass (capable of capturing carbon 12 times faster than tropical rainforests), seaweed and molluscs all draw down and lock carbon in the seabed. Current estimates put the weight of carbon that Jersey's marine environment removes at ~8.6 per cent of the Island's total carbon production annually[1]. With this level of potential burial being achieved with only 6.5 per cent of Jersey's marine environment under protection, expanding protection to 30 per cent could increase the amount of carbon stored in Jersey's marine habitats.

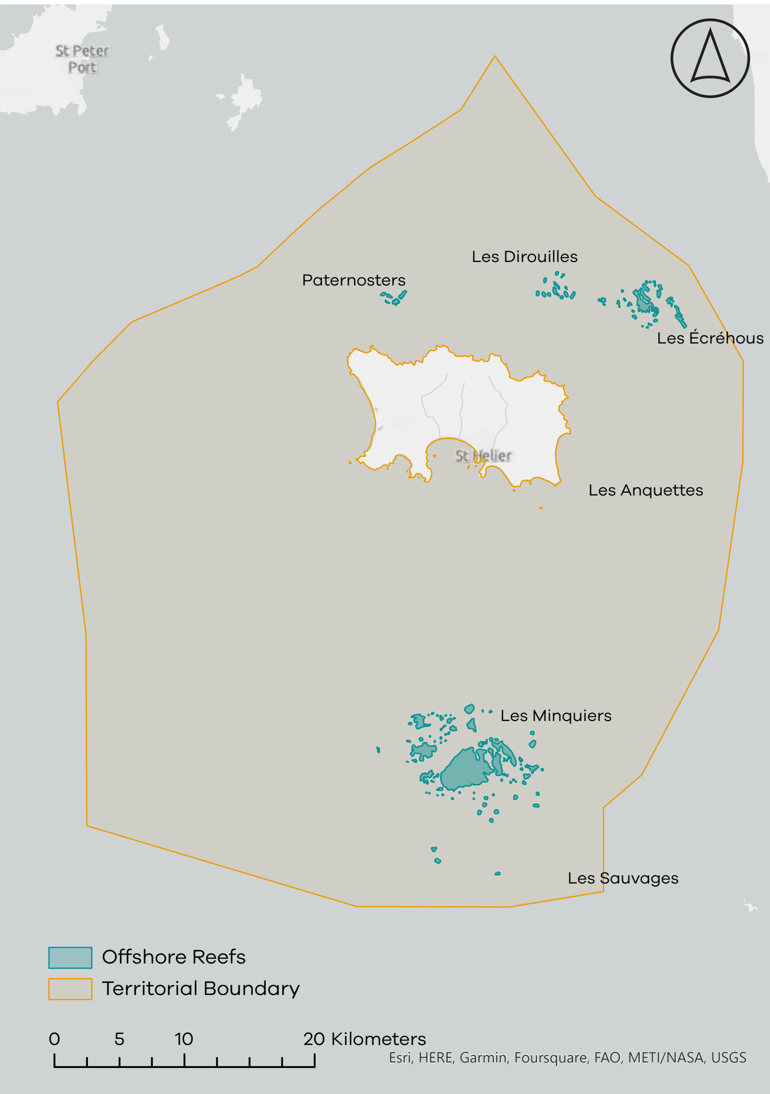


FIGURE 2 – JERSEY'S TERRITORIAL WATERS AND OFFSHORE REEFS

Current estimates put the weight of carbon that Jersey's marine environment removes at ~8.6 per cent of the Island's total carbon production annually[1].

EXISTING DESIGNATIONS

The significance of Jersey's marine ecology is recognised by the designation of almost 190 square kilometres of intertidal habitat as wetlands of international importance under the Ramsar Convention (Figure 3). However, at present in Jersey, this designation affords no material protection to the habitats within their boundaries.

Several No Mobile Gear Zones (NMGZs) and a No Take Zone (NTZ) comprise a network of Marine Protected Areas (MPAs), covering roughly 6.5 per cent of the Island's territorial waters (Figure 3). As such, over 93 per cent of Jersey's seabed remains unprotected, including sensitive habitats that play an important role in provisioning for a healthy, functioning ecosystem (including providing for commercially important species such as crab, lobster and scallops). Large areas under no form of protection exist between these MPAs, providing very little connectivity.

Jersey's NMGZ designations (hereafter referred to as MPAs) adopt a 'whole-site' approach to protection, whereby the entirety of the MPA receives protection from mobile fishing gears. This is in contrast to the 'feature-based' approach adopted in the UK, within which only individual seabed features are protected. Feature-based management is considered to be insufficient to achieve necessary biodiversity improvements[10] .

Research to date has shown that the existing MPAs are having an influence on diversity through increased numbers of taxa compared to open areas[11]. However, research globally indicates that small MPAs can be influenced by high-intensity fishing outside their borders[12]. This highlights the need for MPA coverage to be sufficiently extensive to buffer this phenomenon out.

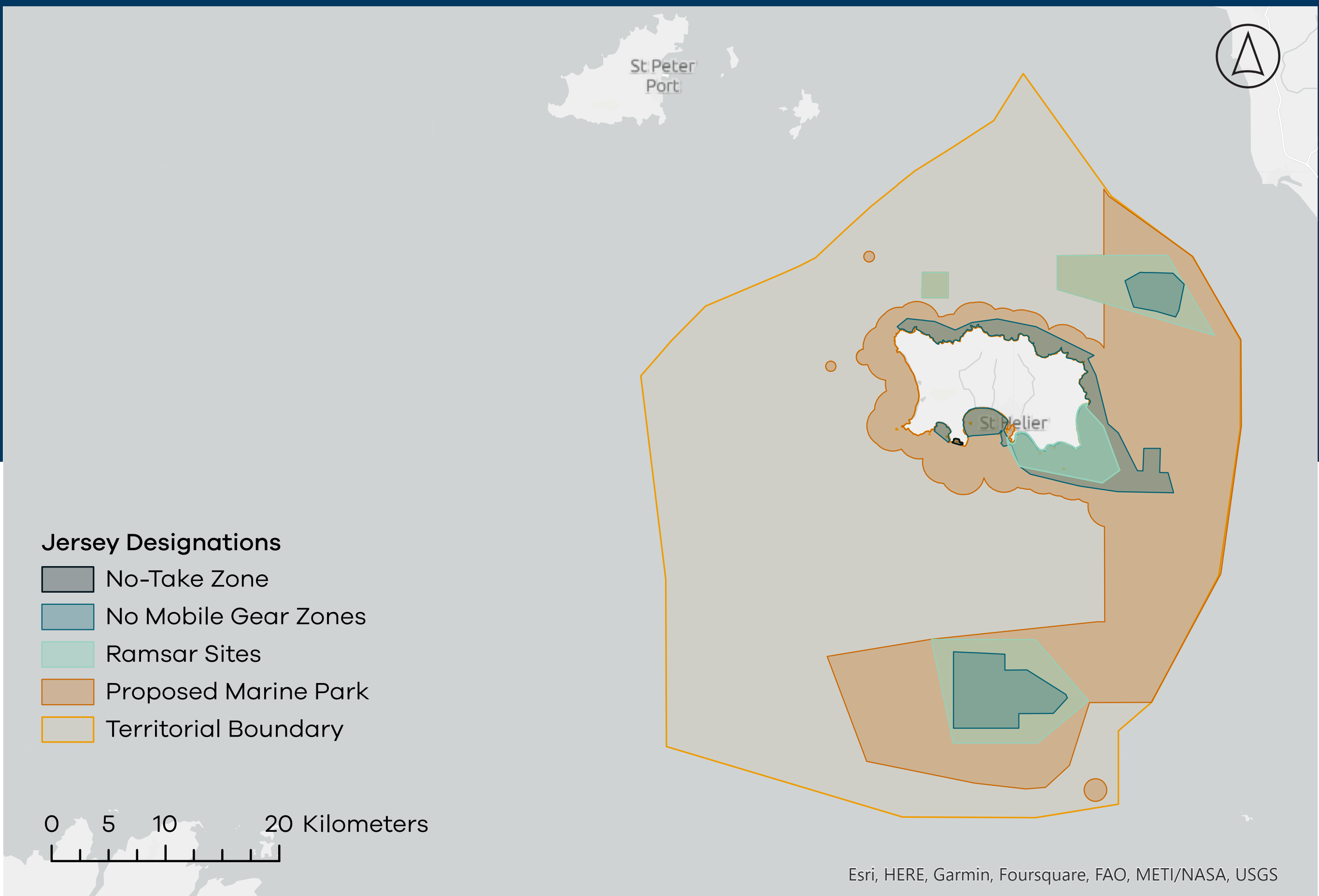


FIGURE 3 – JERSEY'S TERRITORIAL WATERS EXTENT, EXISTING DESIGNATIONS AND PROPOSED MARINE PARK DESIGNATION

Photo: James Bowden

JERSEY'S FISHERY

While Jersey has historically hosted rich fishing grounds, in recent years catches have been declining[13]: Whelk, lobster and brown crab landings per unit of effort are down 42 per cent, 43 per cent and 65 per cent respectively from their peak. As of 2021, Jersey's fishery directly supported around 180 jobs. When compared to historic highs of well over 1,000 jobs in the 19th century, the impact of the decline in Jersey's fishery on local livelihoods and the Jersey economy is clear.

In 2021, crab (both brown – or chancre – crab and spider crab) and lobster made up approximately 70 per cent of the value of Jersey's commercial landings. Both species depend on healthy habitats such as maerl to spawn, breed and feed, of which currently only 13 per cent is protected. Approximately 90 per cent of Jersey's commercial fishing boats use static gear (pots, nets, diving and hook and line) to fish for whelk, lobster, crab, scallop and wetfish.

The fisheries agreement that Jersey previously operated under, the Bay of Granville Agreement, was first concluded in 1839[14]. This agreement, and its subsequent iterations, led to the unusual situation of France granting licences for its own vessels to fish in Jersey waters. This led to difficulties in Jersey's ability to enforce restrictions on fishing vessels that did not fulfil Jersey's requirements, for example the provision of adequate catch data. Under the new UK-EU Trade and Co-Operation Agreement (TCA), the Government of Jersey (GoJ) is now the issuing authority for all licences for vessels wishing to fish in Jersey waters. This gives Jersey, for the first time since 1839, the opportunity to manage the fisheries within its own waters effectively.

PURPOSE OF THIS REPORT

To establish the role that Jersey's marine habitats play in providing ecosystem services (ES) to the Island, this report outlines the findings of an Ecosystem Services Valuation (ESV) completed by Blue Marine and the New Economics Foundation (NEF).

ECOSYSTEM SERVICES

ES are defined simply as the direct and indirect benefits people obtain from their surrounding ecosystems (Millennium Ecosystem Assessment; MEA)[15]. There are two ways of classifying ES: ecological values which dictate how the ES benefit the surrounding ecosystem, and socioeconomic values which provide monetary and economic benefits directly to people.

These services can be further categorised into four main types of ES:

- **regulating (i.e. gas and climate regulation)**
- **supporting (nutrient recycling)**
- **provisioning (i.e. food provision)**
- **cultural (i.e. cultural heritage and identity).**

The MEA is widely considered as the baseline for all ES definitions and differentiations. Within the model used for this report, the MEA ES categories have been used with the ES outlined in The Marine Bill - Marine Nature Conservation Proposal: Valuing the Benefits (MNCP), a 2007 Defra-commissioned report[16]and the Ecosystem Services Valuation Database (ESVD)[17] .

Of the ES available, nine were quantified within the model (Table 1). These were selected for inclusion by searching the ESVD for all the ES relevant to ecosystems categorised as 'Open oceans and/or Open seas' (one of the ten biomes covered by the ESVD) and located within Europe. These were then matched to the ES used in the Marine Bill Report[17] to prevent double-counting. Brief definitions of these ES are provided below, from a 2007 report outlining and defining the goods and services provided by marine ecosystems specifically[18]. Table 1 outlines the primary benefits associated with each of these ES, although it should be noted that within a functioning ecosystem, no process operates in isolation. As such, to some extent, each ES provides value for all of the benefits listed.

<table>
<tr><th>ECOSYSTEM SERVICE CATEGORY</th><th>ECOSYSTEM SERVICE QUANTIFIED</th><th>ASSOCIATED BENEFIT</th></tr>
<tr><td rowspan="3">Regulating</td><td>Gas and climate regulation</td><td>Climate change mitigation</td></tr>
<tr><td>Resilience and resistance</td><td rowspan="4">Biodiversity improvement</td></tr>
<tr><td>Biodiversity improvement</td></tr>
<tr><td rowspan="2">Supporting</td><td>Nutrient recycling</td></tr>
<tr><td>Bioremediation of waste</td></tr>
<tr><td rowspan="3">Provisioning</td><td>Food provision</td><td rowspan="2">Fisheries and commercial activity support</td></tr>
<tr><td>Raw materials</td></tr>
<tr><td>Leisure and recreation</td><td rowspan="2">Community enhancement</td></tr>
<tr><td>Cultural</td><td>Cultural heritage and identity</td></tr>
</table>

TABLE 1 – ECOSYSTEM SERVICES QUANTIFIED IN THE MODEL AND THEIR ASSOCIATED BENEFITS

ECOSYSTEM SERVICE VALUATION

With importance often being assigned to economically viable policies and plans, being able to quantify the value of ecosystems allows scientists and economists to try and encourage the inclusion of environmental protection in decision making. ESV is used to both incentivise protection and to help highlight and integrate non-market values into decision making.

ESV has grown in popularity over the last three decades, increasing its relevance and impact in policymaking. It is a step towards more inclusive decision-making that incorporates nature, but it should be recognised that some of nature's benefits simply cannot be measured in monetary terms and therefore values should be considered approximate.

Ecosystem Services Valuation is a step towards more inclusive decision-making that incorporates nature

ECOSYSTEM SERVICE VALUATION METHODOLOGY

Differentiation among ES values can often be attributed to the valuation method used in the study. ESV methods are chosen due to a variety of reasons, the most dominant being that of the purpose of the study and the ES that are going to be observed. Other reasonings include ease of communication, participation of available stakeholders, and other practical reasons, such as access to data and expertise, are also notable. These methodologies have two main distinctions: questionnaire-based methods and data-based methods.

The methodologies in Table 2 are categorised and defined using the System of Environmental-Economic Accounting (SEEA) Ecosystem Accounting (EA) framework (SEEA EA). Stated preference methods are used when there is no existing market for the good, allowing the participant of the questionnaire to determine what value they attach to a specific service. If a market does exist, then a revealed preference method can determine how these ES appear in market goods. Cost-based methods are based on the estimated costs of damages if these ES did not exist, or the cost of replacing ES with man-made equivalents, and the cost restoring existing ecosystems. Price-based methods measure the price of the ES directly observable in the markets. Production-based methods are the value of the revenue from the sale of the ecosystem-related goods including the cost of all other inputs. Finally, benefit transfer methods use information from existing sites to estimate the value of ES at the study sight. Benefit transfer methods have not been officially categorised by the SEEA EA but they are defined as "the use of research results from pre-existing primary studies at one or more sites (often called study sites) to predict welfare estimates, such as willingness to pay, for other, typically unstudied sites (often called policy sites)"[19].

APPROACH	VALUATION METHOD
Stated preference	- Contingent valuation - Deliberative group valuation
Revealed preference	- Hedonic pricing - Travel cost
Cost based	- Avoided damage cost - Replacement cost - Production function approach - Restoration cost
Price based	- Market price
Production based	- Net factor income approach
Other	- Benefit transfer

TABLE 2 – VALUATION METHOD CLASSIFICATION INTO GENERAL APPROACH METHODS

METHODS

Data analysis involved several stages, completed by Blue Marine and NEF. Firstly, the scenarios to be modelled were defined (Stage 1); following this, the extents of habitat type and mobile fishing were estimated for each scenario (Stage 2). Finally, the habitat and fishing extents were run through the model to generate the outputs (Stage 3). Stages 1 and 2 were completed by Blue Marine, while Stage 3 was completed by NEF.

Throughout analysis, two key software programmes were used, ArcGIS Pro (Version 3.0.2), a Geographic Information System (GIS) software, and Microsoft Excel. The datasets used for analysis were:

- Modelled Jersey habitat data covering the extent of Jersey's territorial waters (excluding the intertidal zone) at 500m x 500m (0.25km^2) resolution, cropped to Jersey's territorial waters and excluding area landward of Jersey's shoreline.
- Modelled fishing activity data averaged from years 2015–2019 at 1km x 1km (1km^2) resolution, cropped to Jersey's territorial waters and excluding area landward of Jersey's shoreline. Data included the metier and modelled landing values from each 1km^2 in GBP.
- Shapefiles (spatial datasets) of Jersey's territorial waters, Jersey coastline, and existing MPAs (including the NMGZs and NTZ).

STAGE 1: MODEL SCENARIO SELECTION

Ten scenarios were examined to compare the ES provided by various designation extents. These can broadly be split into two groups; five scenarios based on existing designations and the proposed marine park, and four scenarios based on the extent of certain habitat types, referred to as 'high-importance habitats'. A final scenario assessing the entirety of Jersey's territorial extent was included for reference, but was not of key importance to the model as this extent of protection is not being proposed.

Jersey's existing MPAs are relatively small, covering a total of 6.5 per cent of Jersey's territorial waters. While research shows they are having a positive impact on recovery of stocks, their boundaries are tightly constrained to the habitats they were designated to protect. To assess benefits provided by the existing MPAs that cover a greater variety of habitats, three buffer sizes were added to each MPA (0.5nm, 1nm and 2nm) and those extents used as scenarios for the model run (Figure 4).

Jersey's existing MPAs are relatively small, covering a total of 6.5 per cent of Jersey's territorial waters

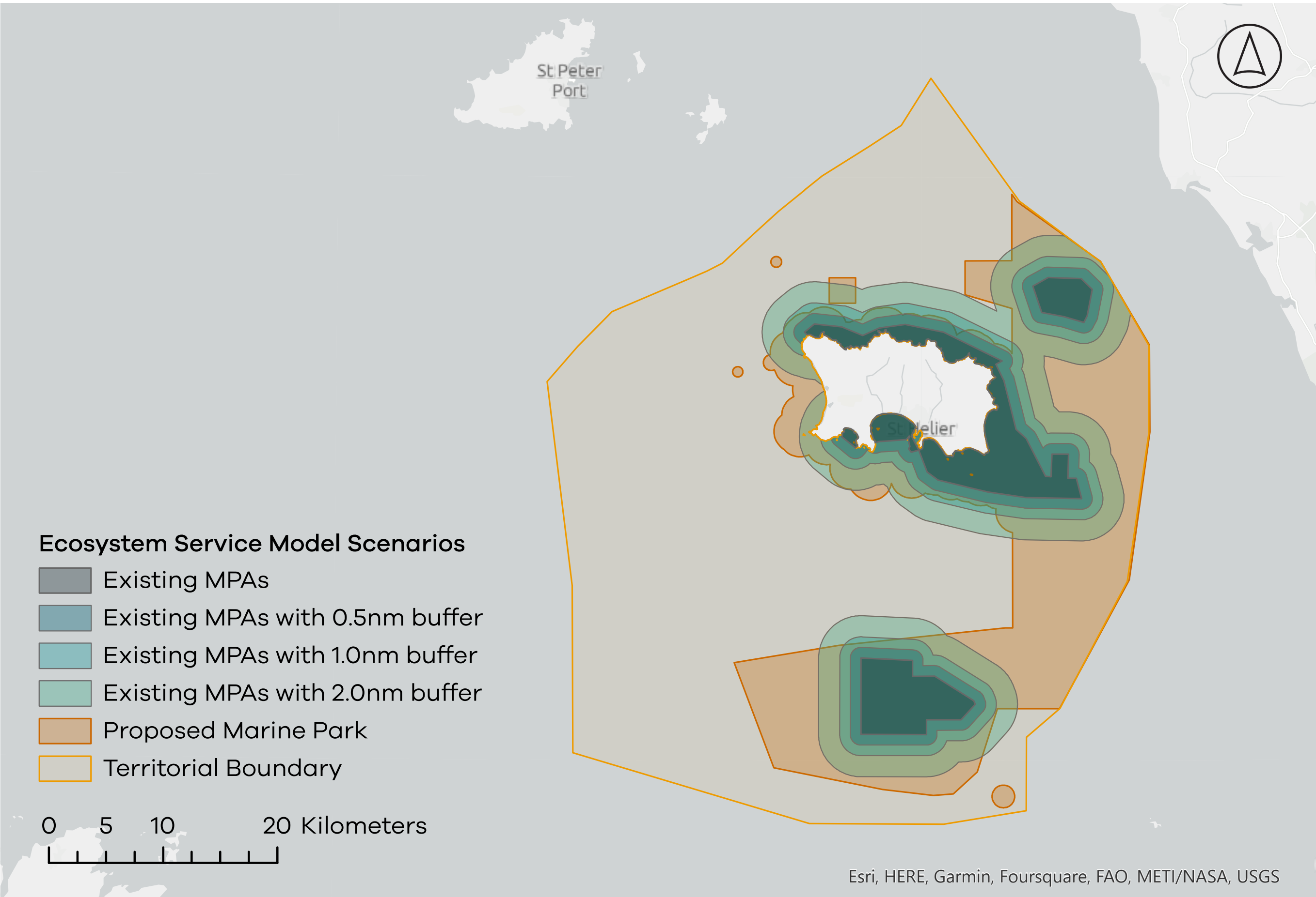


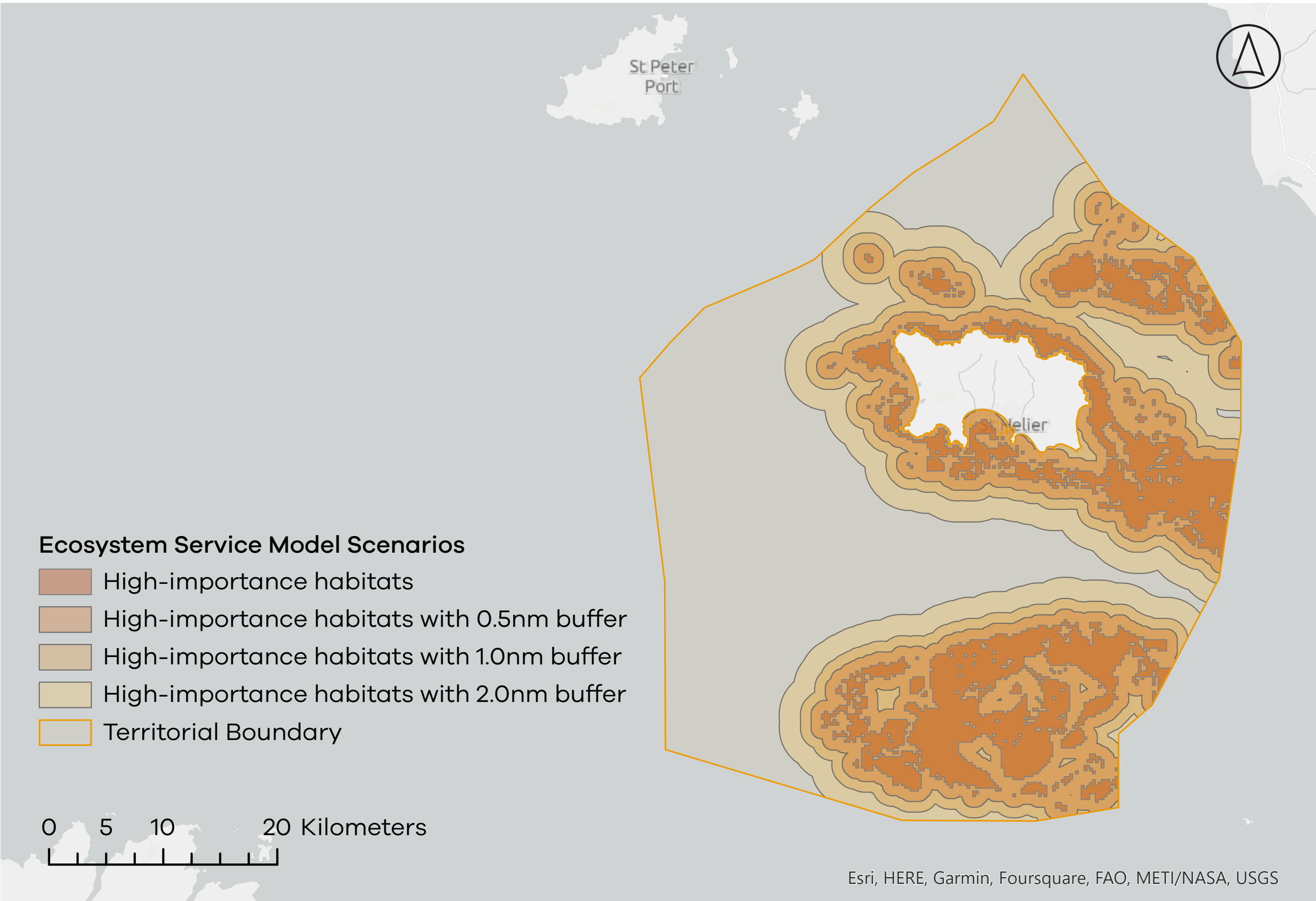
FIGURE 4 – MODELLED SCENARIOS BASED ON EXISTING MPAS AND THE PROPOSED MARINE PARK

For the habitat-based scenarios, five habitat types were selected based on their importance in biological process such as supporting biodiversity and fisheries as well as their sensitivity to damaging activities such as construction or development and bottom-towed mobile fishing. It should be noted that the selection of these habitats did not focus on habitats important for biogeochemical processes such as nutrient recycling or carbon burial. The five habitat types selected were:

- **Maerl beds**
- **Seagrass beds**
- **Shallow reef with sand**
- **Kelp forest**
- **Sandmason worms.**

The extents of these habitat types were chosen as a scenario. Following this, three buffer sizes were added to their spatial extent (0.5nm, 1nm and 2nm) to provide three more scenarios (Figure 5). Finally, to gain an understanding of the total ES provided by the extent of Jersey's territorial waters, a scenario covering the entirety of the area was also used. A summary of the scenarios used in the model is provided in Table 3.

FIGURE 5 – MODELLED SCENARIOS BASED ON HABITATS OF HIGH IMPORTANCE AND THE ENTIRETY OF JERSEY'S TERRITORIAL WATERS



SCENARIO NUMBER	SCENARIO DESCRIPTION	TOTAL AREA (KM^2)
1	Proposed marine park boundary	887
2	Existing MPAs	167
3	Existing MPAs and 0.5nm buffer	261
4	Existing MPAs and 1nm buffer	382
5	Existing MPAs and 2nm buffer	662
6	High-importance habitats	389
7	High-importance habitats and 0.5nm buffer	859
8	High-importance habitats and 1nm buffer	1,090
9	High-importance habitats and 2nm buffer	1,428
10	Jersey's territorial extent (reference scenario)	2,455

TABLE 3 – SCENARIOS USED FOR THE ECOSYSTEMS SERVICES VALUATION

STAGE 2: CALCULATION OF HABITAT AND FISHERIES EXTENT

Following creation of a shapefile of the scenarios listed in Table 3, for each scenario the habitat data was clipped to the outline of the shapefile, and the extent of each habitat type was calculated.

Modelled fisheries data of mobile fishing metiers were clipped to each scenario shapefile. The metiers included in the dataset are outlined in Table 4. It should be noted that some metiers were not completed by Jersey vessels (such as pair trawling and clam dredging), and as such are only recorded by French vessels. Within each clipped fishing scenario dataset, the modelled landing values were summed to estimate the total displacement cost for each scenario.

It should be noted that mobile fishing was recorded as having occurred within the existing MPAs. There are several possible causes for this, one of which is that the offshore reef designations did not come into force until 2017, partway through the modelled dataset time period (2015–2019). Given the designations in place, there should be no mobile gear fishing happening in these areas presently, so fishing data from within the MPA boundaries were not included.

METIER	JERSEY VESSELS	FRENCH VESSELS
Trawling	X	X
Scallop dredging	X	X
Pair trawling		X
Clam dredging		X

TABLE 4 – MOBILE METIERS INCLUDED IN FISHING DISPLACEMENT COST CALCULATIONS

STAGE 3: NEF MODEL EXECUTION

The model used by NEF for this project was first used in a 2021 ESV of a closure of EU MPAs to bottom-towed fishing gear[20]. The model is based on a benefit transfer approach, using extent and type of seabed habitats that each scenario is comprised of. The model also considers the extent of mobile gear activity. For all scenarios, an ESV of the first 20 years of designation has been included.

A full description of the model sources and assumptions for both impact and financial proxies is provided in Annex 1. Within this report, individual ES values and the cumulative net gain value are referred to. Where individual ES values are listed, these are provided prior to accounting for fisheries displacement, while the cumulative net gain incorporates this figure. As such, the sum of the individual ES values listed are greater than the cumulative net gain value. For the detailed methodology, refer to Annex 1. For the full dataset with all values for all scenarios pre- and post-fishing displacement, refer to Annex 2.

DISPLACEMENT CALCULATIONS

The model provided both gross and net ES values. For each scenario, the total value of individual ES was calculated, providing gross values. However, to get the net impact, the model was adjusted for displacement. In this context, displacement of fishing effort means some of the ES benefits in the protected areas are offset by reduced ES elsewhere, as fishing effort moves in response to the protections.

To calculate displacement, it was assumed that, of the fishing effort that would have occurred in the proposed scenarios, 75 per cent would still occur outside of the proposed area (i.e. 75 per cent of the fishing effort is displaced and 25 per cent does not continue). Additionally, the model assumed that the areas outside the scenario boundaries would be of slightly lower ecosystem quality than the proposed area and would provide only 90 per cent of their potential ES.

The model then assumed that an area 75 per cent the size of the protected area, and of an ecosystem quality 10 per cent lower than the protected area would be subject to displaced fishing effort. Multiplying 75 per cent by 90 per cent gives 67.5 per cent, forming an assumption on the displaced negative impact on ES that would not have otherwise taken place but is now occurring due to the protection of the given scenario area. Consequently, of the total improvement in ES for each scenario, 67.5 per cent of this was offset by the effect of the displaced activity in other areas.

To calculate the net ecosystem service benefit, only the remaining 32.5 per cent of the gross improvement fed through to the net improvement. This was then subject to the subtraction of 25 per cent of the fishing activity assumed to no longer continue. These figures were used for displacement calculations to ensure that net values were conservative in their estimates.

The model used by NEF for this project was first used in a 2021 ecosystem services valuation of a closure of EU MPAs to bottom-towed fishing gear

RESULTS

As the scenario outlining the ecosystem benefits for protection of the entirety of Jersey's territorial waters is purely for reference, the values associated with that scenario are not discussed within the body of this report.

MARINE PARK DESIGNATION SCENARIO

The model estimated that the ES value of the proposed marine park would be ~£8.9 million over the first five years, ~£27.7 million over the first ten years and ~£70.5 million over 20 years (Table 5). After incorporating estimated lost fishing value, the cumulative net benefit of the marine park over five, ten and 20 years was estimated at ~£1.2 million, ~£12.7 million and ~£42.2 million, respectively (Table 5, Figure 6). As some ES in the model had a time lag for benefits to arise following a hypothetical designation, the marine park scenario became a net benefit five years after designation (Figure 6).

	CUMULATIVE ECOSYSTEM BENEFIT	CUMULATIVE TOTAL COSTS	CUMULATIVE NET IMPACT
Year 1	£568,741	£1,565,862	***-£997,121***
Year 2	£1,720,501	£3,125,673	***-£1,405,172***
Year 3	£3,464,164	£4,658,357	***-£1,194,193***
Year 4	£5,833,975	£6,174,751	***-£340,776***
Year 5	£8,858,207	£7,675,029	£1,183,178
Year 6	£12,364,592	£9,159,362	£3,205,230
Year 7	£15,995,710	£10,627,919	£5,367,791
Year 8	£19,755,190	£12,080,869	£7,674,321
Year 9	£23,646,775	£13,518,376	£10,128,399
Year 10	£27,674,325	£14,940,606	£12,733,719
Year 11	£31,841,820	£16,347,720	£15,494,100
Year 12	£36,153,362	£17,739,880	£18,413,482
Year 13	£40,613,182	£19,117,243	£21,495,939
Year 14	£45,025,604	£20,479,968	£24,545,636
Year 15	£49,391,130	£21,828,210	£27,562,920
Year 16	£53,710,259	£23,162,123	£30,548,137
Year 17	£57,983,485	£24,481,858	£33,501,626
Year 18	£62,211,294	£25,787,568	£36,423,726
Year 19	£66,394,170	£27,079,400	£39,314,770
Year 20	£70,532,591	£28,357,503	£42,175,088

TABLE 5 – ECOSYSTEM SERVICE VALUATION OF A PROPOSED MARINE PARK DESIGNATION 20 YEARS FOLLOWING DESIGNATION

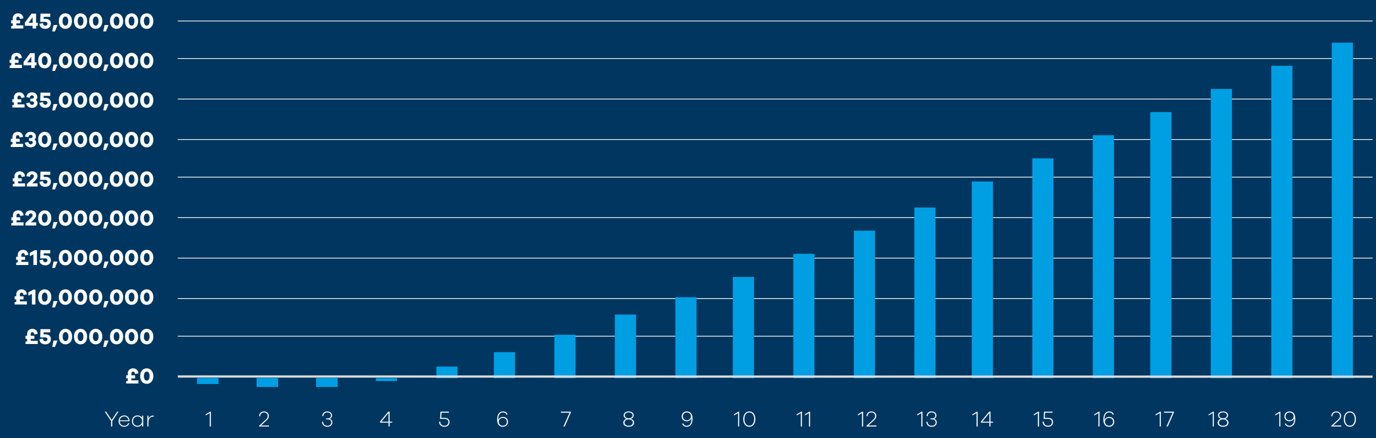


FIGURE 6 – CUMULATIVE NET IMPACT OF THE DESIGNATION OF A PROPOSED MARINE PARK 20 YEARS AFTER DESIGNATION

Of the ES values calculated, the greatest value ES after a 20-year period was bioremediation of waste (~£92.1 million), followed by nutrient recycling (~£80.4 million; Table 6). Gas and climate regulation contributed ~£23.4 million, an increase in value of ES provided of ~1,500 per cent from current designations (~£1.5 million). The ES providing the smallest contribution to the marine park scenario was cultural heritage and identity, which was estimated at £11,000 after a 20-year period (Table 6), however, this was still an increase in value of ~1,500 per cent compared to current designations. Of the ES relevant to fisheries and the fishing industry, food provision and raw materials under a proposed marine park designation were estimated to increase to ~£312,000 and ~£40,000 from ~£20,000 and ~£2,000 under current designations, respectively.

It should be noted that across all scenarios, food provision showed substantially lower values than those which can be realistically expected. For example, the fisheries data showed that in the existing MPAs, mobile fishing had average annual landings of ~£92,000, but the ESV model indicated a fisheries value in the existing MPAs scenario of ~£20,000. The fisheries data was not only an average from a period of time whereby mobile gear closures came into effect (so the areas only experienced mobile fishing for part of this averaged time), but also does not include static fishing gear landings, which form a substantial part (roughly 70 per cent)[13] of Jersey's fishery. To maintain consistency across all ES calculation methods, the food provision value was taken from the same ESVD as all other ES, however, it should be viewed with the caveat that the food provision is very likely to be significantly greater than the values provided in this report.

It should be noted that across all scenarios, food provision showed substantially lower values than those which can be realistically expected

ECOSYSTEM SERVICE TYPE	ECOSYSTEM SERVICE	20-YEAR IMPACT	
		EXISTING MPAS	PROPOSED MARINE PARK
Regulating	Gas and climate regulation	£1,502,429	£23,426,920
	Resilience and resistance	£60,588	£944,731
	Biologically mediated habitat	£237,006	£3,695,560
Supporting	Nutrient recycling	£5,155,210	£80,383,657
	Bioremediation of waste	£5,907,375	£92,111,940
Provisioning	Food provision	£19,966	£312,028
	Raw materials	£2,393	£40,462
	Leisure and recreation	£1,615,982	£16,097,055
Cultural	Cultural heritage and identity	£668	£11,003
Total Increase			**£202,521,739**

TABLE 6 – INDIVIDUAL ECOSYSTEM SERVICES VALUES FOR CURRENT MPA EXTENTS AND THE PROPOSED MARINE PARK

The total increase in value across the individual ES provided by the proposed marine park compared to current designations was ~£202.5 million (an increase of ~1,400 per cent). Following application of the fishing displacement cost in the proposed marine park boundaries, the total increase in the ES provided by a marine park compared to current designations was ~800 per cent.

To assess the highest value designation scenarios without the extent influencing overall values, the value per km^2 protected was calculated for all scenarios (Table 7). Of these, the marine park had the second greatest cumulative net gain per square kilometre, at ~£48,000/km^2, with the high-importance habitats having the greatest value at ~£57,000/km^2.

SCENARIO NUMBER	SCENARIO NAME	AREA (KM^2)	CUMULATIVE NET GAIN AT YEAR 20	CUMULATIVE GAIN PER KM^2 (£/KM^2)
1	Proposed marine park boundary	887	£42,175,088	£47,569
2	Existing MPAs	167	£4,713,026	£28,222
3	Existing MPAs with 0.5nm buffer	261	£11,332,593	£43,420
4	Existing MPAs with 1nm buffer	382	£17,174,064	£44,958
5	Existing MPAs with 2nm buffer	662	£29,683,293	£44,839
6	High-importance habitats	389	£22,170,441	£56,993
7	High-importance habitats with 0.5nm buffer	859	£38,242,556	£44,520
8	High-importance habitats with 1nm buffer	1,090	£47,900,848	£43,946
9	High-importance habitats with 2nm buffer	1,428	£64,853,203	£45,415
10	Jersey's territorial extent (reference scenario)	2,455	£98,810,560	£40,249

TABLE 7 – CUMULATIVE NET GAIN AND VALUE PER KM^2 AT YEAR 20 FOR ALL MODELLED SCENARIOS

EXISTING MPA SCENARIOS

The scenario assessing existing MPAs indicated that the cumulative net impact of their designation was positive from Year 1, one of only two modelled scenarios to demonstrate net gain immediately (the other being Existing MPAs with a 0.5nm buffer). This is due to no mobile gear fishing activity data being included within the MPAs.

The model estimated that 20 years after designation of the MPAs, the cumulative net gain of the existing MPAs was ~£4.7 million. This scenario also had the lowest cumulative net gain per km² at ~£28,000/km² (Table 7).

This is likely due to large areas of missing habitat data, typically above the waterline, or intertidal habitat which had not been classified within the modelled seabed habitat dataset.

Unsurprisingly, the scenario with the greatest extent (MPAs with 2.0nm buffer) provided the greatest net gain over the 20-year period at ~£29.7 million. The scenarios assessing the MPAs with 0.5nm and 1nm buffers provided cumulative net gains of ~£11.3 million and ~£17.2 million, respectively.

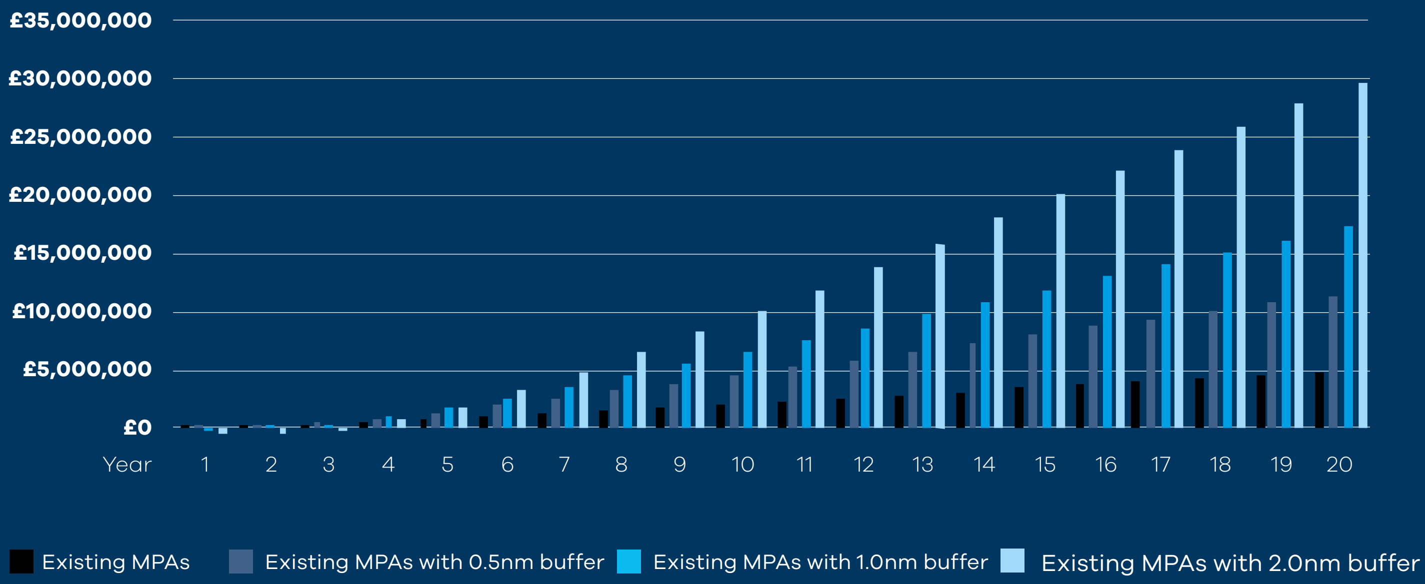


FIGURE 7 – CUMULATIVE NET IMPACT OF JERSEY'S EXISTING MPAS AND BUFFER SCENARIOS

The model estimated that 20 years after designation of the MPAs, the cumulative net gain of the existing MPAs was ~£4.7 million

HIGH-IMPORTANCE HABITAT SCENARIOS

The four scenarios based on extent of high-importance habitats followed a similar pattern to that seen in the existing MPAs scenarios. As size increased, so too did the value of cumulative net gain, with the total values at ~£22.2 million, ~£381.2 million, ~£47.9 million and ~£64.9 million (for high-importance habitats only and high-importance habitats with 0.5nm, 1nm and 2nm buffers, respectively).

Of all scenarios modelled, the high-importance habitat extent demonstrated the highest net cumulative gain per square kilometre at ~£57,000/km² (Table 7). This is to be expected, as the scenario was designed around those habitats known to play an important role in promoting essential functions for marine species.

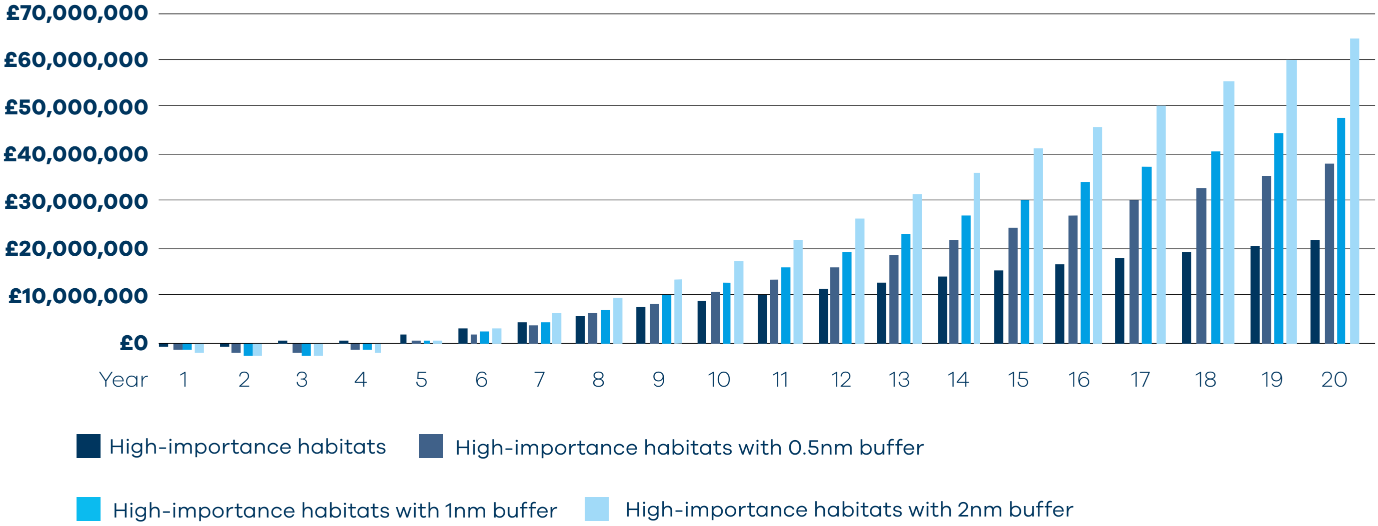


FIGURE 8 – CUMULATIVE NET IMPACT OF JERSEY'S FIVE IDENTIFIED 'HIGH-IMPORTANCE' HABITATS AND BUFFER SCENARIOS

DISCUSSION

Blue Marine is advocating for a marine park in Jersey's waters, closed to mobile fishing gear but open to low-impact, static fishing gear. This report aims to better understand and quantify the potential benefits associated with further protection designations. In 2022, Jersey's Bridging Island Plan (BIP) was released, detailing the requirement for a Marine Spatial Plan (MSP) to be developed before 2025. The BIP stated that the MSP should 'in particular… develop a network of marine protected areas'. This project was completed to inform the MSP and ensure further MPA designations maximise the ES provided, while accommodating for a variety of marine uses.

There were two scenarios that demonstrated the greatest values of ES per square kilometre within the ESV model: the marine park and high-importance habitats scenarios. Given this, the discussion within this report compares these two scenarios to determine which provides the greatest benefit to Jersey's marine environment.

Within this discussion, unless specified otherwise, values referenced are those of ES prior to the subtraction of displacement costs.

BIODIVERSITY IMPROVEMENT

The model indicated that the ES of a marine park would generate a net value (after factoring in conservative displacement costs) of ~£42.2 million, an increase of ~£37.5 million from current designations. The high-importance habitats scenario indicated provision of ~£22.2 million, a ~£17.5 million increase. Of the ES relevant to biodiversity (resistance and resilience, biologically mediated habitat, nutrient recycling and bioremediation of waste), this comprised a total of ~£177.1 million in the marine park scenario (an increase of ~£165.7 million from current designations), in comparison to ~£82.4 million in the high-importance habitats scenario (an increase of ~£71 million).

Resilience and resistance is defined as the extent to which an ecosystem can absorb recurrent perturbations (both natural and human) and continue to regenerate without degrading or abruptly losing the ability to function as intended in its natural state[19]. High-biodiversity, healthy ecosystems typically have greater resilience to natural or anthropogenic impacts, as a variety of species will have differing responses to these impacts (as opposed to species which collectively exhibit the same response). This has been demonstrated in studies examining the impacts of storms on areas closed to bottom-towed fishing, where habitats within protected areas recover faster following storm events than open areas[21]. The proposed marine park boundaries cover a variety of habitats (Figure 1), optimising the diversity of responses that species within the proposed designation can provide.

Biologically mediated habitat is habitat generated or provided by living organisms. This includes 'ecosystem engineers' (such as sandmason worms[22] or Ross worm reefs), as well as seagrass bed meadows, maerl beds and kelp forests.

These habitats play an important role in the provisioning of breeding and nursery grounds within an ecosystem. Not only do they typically encourage greater biodiversity per square metre than homogenous habitats, they are particularly important for the continued recruitment of commercial species.

Biologically mediated habitat has been described as 'a pre-requisite for the provision of many goods and services'[18]. Habitats such as sandmason worm, seagrass and maerl beds are particularly susceptible to destruction from damaging activities, and recovery can take centuries. Upon loss of these habitats, not only is the species in question lost, but the ability to support other species through provisioning of spawning, nursery and foraging habitat is also removed.

Under current designations, substantial proportions of these habitats are not afforded any protection in Jersey's waters. Of the maerl, sandmason worm and kelp beds, only 13 per cent, 64 per cent and 15 per cent are protected, respectively. Under the marine park scenario, the proportion of these habitats protected from damaging activities would increase to 98 per cent, 100 per cent and 93 per cent, respectively. This was reflected in the ~£3.5 million increase in biologically mediated habitat value for the marine park scenario compared to current designations. The high-importance habitat scenario demonstrated an increase of ~£1.5 million.

Habitats such as sandmason worm, seagrass and maerl beds are particularly susceptible to destruction from damaging activities, and recovery can take centuries

Nutrient recycling is defined as the storage, cycling and maintenance of nutrients by living marine organisms. This is a fundamental process in the functioning of a healthy ecosystem[23], distributing elements necessary for life throughout the food chain.

Nutrient recycling promotes productivity, including that required for productive fisheries, by making necessary nutrients available to all levels of the food chains and webs. It takes place across multiple components of the marine environment, particularly within seabed sediments, so it is specifically important that protection designations incorporate these habitats (Figure 1). Studies have demonstrated that bottom-towed fishing gears alter local nutrient recycling[24]. Effects of bottom-towed fishing gears include direct release of nutrients from sediments into the water column (including contaminants if present), reduced oxygen concentration, and increased concentrations of dissolved inorganic carbon, ammonium and silicate. Bioremediation of waste is the removal of waste (including anthropogenic) from an ecosystem through storage, burial and recycling[25]. It results in cleaner, clearer water, playing an important role in ensuring marine fauna have adequate light conditions and water quality remains at habitable levels. Anthropogenic waste can be organic (such as oil and sewage), or inorganic (such as chemicals used in industry).

Multiple marine organisms are involved in bioremediation of waste, including burrowing shrimps and polychaetes that draw waste deep into sediments, removing it from the water column through burial. Filter feeders (such as molluscs) also actively filter large volumes of water, removing suspended particles from the water column.

For such functions to be provided, the benthic habitats that support them require protection from disturbance. Studies have shown that the impact of bottom-towed mobile gear passes through mollusc reefs extend to the populations of surrounding polychaetes. Abundance is reduced and polychaete exposure to scavenging species is increased[26], impacting upon wider ecosystem function and community structure far beyond the target species.

Nutrient recycling and bioremediation of waste, in particular, require undisturbed sedimentary habitat for epifauna such as bivalve molluscs, and burying organisms such as polychaetes. The ESV of the marine park scenario reflected this in the provision of ~£80.4 million and ~£92.1 million in nutrient recycling and bioremediation of waste, respectively (compared to ~£5.2 million and ~£5.9 million under current designations). In comparison, the high-importance habitats scenario indicated a provision of ~£37.4 million and ~£42.8 million, respectively.

Photo: Matt Jarvis

CLIMATE CHANGE MITIGATION

In 2019, Jersey's States Assembly outlined a commitment to reach carbon neutrality by 2030. In 2022, Jersey's Carbon Neutral Strategy[27] was released, outlining a roadmap to achieve Jersey's carbon neutrality goals. Within the strategy, a number of ambitious targets were outlined, including doubling Jersey's seagrass bed extent and using nature-based solutions that also address the biodiversity crisis. Both of these targets are intrinsically linked to the level of marine protection afforded to Jersey's waters, through the removal of disturbance that prevents establishment of high-carbon habitats, and through the cessation of agitation (and subsequent release into the water column) of carbon in sediments through damaging activities.

The modelled marine park scenario outlined an increase in gas and climate regulation of ~£22 million from current designations. In comparison, the high-importance marine habitats scenario indicated an increase of ~£9.4 million. Gas and climate regulation can be described as the balance and maintenance of the chemical composition of the atmosphere and oceans by marine living organisms. To maintain this balance for a healthy, habitable planet, regulation of volatile and dangerous gases is necessary, as well as the exchange and regulation of carbon by marine living organisms, particularly calcifying organisms such as molluscs.

These organisms play a significant role in climate control through their regulation of carbon fluxes, by acting as a reserve or sink for CO_2 in living tissue and by facilitating burial of carbon in seabed sediments. Disturbance of these sediments (through damaging activities such as bottom-towed fishing gear) releases carbon into the water column, increasing the acidity of the ocean and reducing its ability to absorb the atmosphere's anthropogenically elevated levels of carbon dioxide[28].

Disturbance of seabed sediments releases carbon into the water column, increasing the acidity of the ocean and reducing its ability to absorb the atmosphere's anthropogenically elevated levels of carbon dioxide

FISHERIES AND COMMERCIAL ACTIVITY SUPPORT

Annual reports from GoJ's Marine Resources department outline the current state of Jersey's fishery. Compared to historic peaks, catches are down for species that play a crucial role in the fishery (such as crab and lobster)[14].

Within the model, the estimated value of the food provision in the marine park and high-importance habitats scenario was ~£312,000 and ~£110,000, respectively. As noted previously, the food provision values provided by the ESV model are expected to be a substantial underrepresentation of the actual increase in this ES. The calculations of all ES were calculated consistently using the same data source (the ESVD). However, a comparison of the food provision value under existing designations in the ESV model and the fisheries data indicate a significant disparity in values and should be viewed as an underestimate of the true value. Food provision is defined as the extraction of marine organisms for human consumption. Both animals and plants taken from the marine environment contribute significantly towards human diet. Fisheries and the associated employment that they provide contribute substantially towards this function.

The closure of areas to damaging activities such as bottom-towed fishing (but left open to static gear fishing methods such as potting and rod and line) have been demonstrated to improve commercial species populations. In the example of Lyme Bay Reserve on the south coast of the UK, monitoring since designation has detected a steady increase in abundance of species. Eleven years after designation, exploited fish species showed increases in number of taxa by 430 per cent and total abundance by 370 per cent inside the Reserve compared to open areas[29].

Designation of a marine park would afford protection from damaging activities to further enhance habitats that play a supporting role for species of commercial importance for static gear fishing (such as crab and lobster).

The model predicted provision of ~£40,000 of the service raw materials upon designation of a marine park, and ~£16,000 upon protection of high-importance habitats (an increase of ~1,600 per cent and ~600 per cent, respectively, from current designations). The ES 'raw materials' is defined as the extraction of marine organisms for all purposes with the exception of human consumption. It also does not include dredge materials, oil or aggregates, as they are not supported by living marine organisms. The materials in question range from seaweed (for use in fertiliser), fishmeal (for use in agriculture), baitfish (such as sandeels), pharmaceuticals and ornamental goods. Provision of these raw materials can result in significant employment opportunities.

COMMUNITY ENHANCEMENT

ES relating to enhancement of the community (leisure and recreation and cultural heritage and identity) provided a total contribution of ~£16.1 million in the marine park scenario and ~£10.3 million in the high-importance habitats scenario. The contribution of cultural heritage and identity was relatively small for both the marine park and high-importance habitats scenarios (which were valued at ~£11,000 and ~£4,000, respectively) but still represented significant (~1,500 per cent and 600 per cent, respectively) increases from the value provided by current designations.

Leisure and recreation is defined as the refreshment and stimulation of the human body and mind through the perusal and study of, and engagement with, living marine organisms in their natural environment. Marine biodiversity provides the basis for a wide range of recreational activities including seabird watching, rock pooling, beachcombing, sport fishing, recreational diving and snorkelling. The provision of this service has been known to result in significant employment opportunities.

A local example of this service has been demonstrated in the launch of a snorkel trail and associated education programme on the Island in 2022 by Blue Marine with a local dive centre. The programme reached nearly 200 school children between the ages of nine and eleven in the first six weeks alone. Positive outcomes reported included greater engagement with, and awareness of, the marine environment, investment into local business and an increased sense of belonging by pupils.

Cultural heritage is defined as the benefit of biodiversity that is of founding significance or demonstrates multiple cultural identities of a community. Marine biodiversity may have beneficial community ties linked to folk lore, religion, painting, cultural and spiritual traditions. Communities living by and off the sea, such as Jersey's, often attach particular importance to marine ecosystems that have played a founding or significant role in the community's economic or cultural founding. This service is separate from leisure and recreation, which outlines the economic importance of commercialised and modernised cultural heritage.

Jersey's cultural identity is intrinsically linked to its marine environment through the small size of the Island and the huge tides that change its shoreline from day to day. Several shipwrecks exist within Jersey's waters, many of which now serve as popular diving and free-diving sites 9. Similarly, offshore reefs (including reefs that peak both above and below sea-level) are frequented by divers, boat users and recreational fishers. To preserve (and enhance) both the cultural and recreational elements of these sites, further protection is necessary.

Jersey's cultural identity is intrinsically linked to its marine environment through its small size and huge tides that change its shoreline from day to day

SCENARIO COMPARISON

From the results of the ESV, it was determined that the marine park was the optimal scenario modelled for several reasons:

- **It had a high value per km² (~£48,000/km²). This was the second highest value of all scenarios after high-importance habitats (~£57,000/km²), but provided a greater overall ES value (£42.2 million, in comparison to the high-importance habitats scenario which indicated a net gain of £22.2 million).**
- **It covered off on a greater diversity of habitats than the high-importance habitats scenario (which was selected on the extent of five habitats chosen specifically for their contribution towards biological processes, but not biogeochemical processes such as nutrient recycling or carbon burial).**
- **It provides the greatest level of connectivity through its spatial extent. Maximising connectivity in marine spatial design is essential for the greatest potential exchange of genes, organisms, nutrients and energy.**
- **It achieves global conservation targets by protecting a minimum of 30 per cent of Jersey's territorial waters.**

SUMMARY

Jersey is facing a unique opportunity. In the wake of Brexit, the GoJ gained greater fisheries management powers over Jersey's territorial waters with the formation of the UK-EU TCA. Further to this, the development of the Kunming-Montreal Global Biodiversity Framework at COP15 in December 2022 (of which Jersey is a signatory to via the UK), set an ambition of 30 per cent protection of the ocean by 2030.

In 2023, the GoJ is developing Jersey's first MSP, which will set out how the marine environment can best be used and protected. The MSP arrives after several years of Marine Resources annual reports indicating that catches are well below historical levels.

The model used for this report outlined the ES provided by Jersey's current marine designations and compared these against several other scenarios (the proposed marine park, buffer zones to existing MPAs and high-importance habitats for biodiversity and fisheries plus buffer zones). Results indicated that an increase in the level of protection afforded to Jersey's marine environment could result in substantial increases in the ES provided.

RECOMMENDATIONS

From the findings of this report, Blue Marine recommends that the scenario taken forward to increase biodiversity, meet carbon neutrality goals and boost Jersey's fishery is the proposed marine park. This recommendation is due to the balance it provided across four general themes: 1) it provided a high value per square kilometre while also providing a high value overall, 2) it encompassed a wide range of habitat types, 3) it provided excellent connectivity between habitats, and 4) it achieves global conservation targets.

Protection must be afforded to those habitats which support biodiversity and fisheries (such as those used in the high-importance habitats scenario), as well as sedimentary habitats important for biogeochemical processes (such as nutrient recycling and climate regulation). Designations for further protection of these habitats are crucial for making progress on Jersey's commitment to tackle the climate and biodiversity crises. The world is at a pivotal point in safeguarding our natural environment for future generations and protection of these crucial ecosystems cannot wait.

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ECOSYSTEM SERVICES VALUATION OF A MOBILE GEAR CLOSURE IN JERSEY'S WATERS

Photo: Matt Jarvis

ANNEX 1

NEF METHODOLOGY NOTE

NEF CONSULTING

NEW ECONOMICS FOUNDATION

NEF CONSULTING

NEW ECONOMICS FOUNDATION

ECOSYSTEM SERVICES VALUATION OF A MOBILE GEAR CLOSURE IN JERSEY'S WATERS

Methodology Note

April 2023

This document outlines the methodology used to estimate the value of ecosystem services associated with a closure to mobile gears in certain areas of Jersey's territorial waters.

The model is based on a benefit transfer approach, defined by researchers[1] as "the use of research results from pre-existing primary studies at one or more sites (often called study sites) to predict welfare estimates, such as willingness to pay (WTP), for other, typically unstudied sites (often called policy sites)". As with all benefit transfer studies, there are limitations around measurement and generalisation error.[2] Acknowledging these limitations, we transparently present all our sources and modelling assumptions for both impact and financial proxies. Given the diversity of habitats/ecosystems, different fishing practices, and gear types, it is not possible for the model to capture the complexity of impact and value. Instead, the model represents indicative estimates, using the best data available within the project's scope and resources.

Central to this model is information on the extent and type of seabed habitats that would make up the newly protected area in each scenario, and the extent to which fishing activity currently occurs in these different habitats. This study presents ten scenarios, each proposing a different area where a closure would be implemented with the exception of Scenario 10 - the entirety of Jersey's territorial waters, which was included for reference purposes (see Table 1). Understanding different seabed habitats is important as they experience varying levels of fishing activity and intensity and as such impacts as a result of bottom-contact fishing also vary. Understanding the habitats where fishing currently takes place is important as this provides insights on the type and extent of the seabed habitats that will benefit if an area becomes protected under each scenario. For this study, Blue Marine Foundation provided:

- A summary extent of each habitat type covered by the modelled scenarios. This was calculated from modelled seabed habitat data covering the entirety of Jersey's territorial waters, excluding intertidal habitat data (which is purely marked as 'Intertidal'), originally in JNCC habitat code format, converted to EUNIS classifications using a conversion table; and
- Summarised mobile fishing intensity data for each modelled scenario. This was calculated from modelled spatial fishing activity data, using mobile fishing intensity for both French and Jersey vessels, as an annual value averaged across the years 2015–2019.

This data was provided for Jersey waters under all proposed protected area scenarios, with seabed habitats categorised using the EUNIS classification. Table 1 presents the seabed habitats fished under each scenario.

Table 1. Type and extent of seabed habitat fished under each scenario

Scenario		EUNIS broad categories (km^2)												
		A3.1	A3.21	A4.1	A5.1	A5.13	A5.137	A5.141	A5.2	A5.431	A5.451	A5.51	A5.53	Intertidal
1	Proposed Marine Park	117.1	52.5	16.6	56.1	75.1	8.3	30.5	93.6	8.3	37.9	51.1	0.2	1.1
2	Existing MPAs	13.2	4.4	0.3	1.2	1.0	1.6	0.6	2.5	2.1	0.8	5.7	0.1	1.1
3	Existing MPAs with 0.5nm buffer	30.6	10.6	2.7	6.6	5.6	6.5	3.6	12.9	3.9	1.0	14.4	0.2	1.1
4	Existing MPAs with 1nm buffer	44.3	15.4	6.4	12.5	12.9	7.9	7.6	28.5	4.7	2.7	23.8	0.2	1.1
5	Existing MPAs with 2nm buffer	78.5	32.6	15.4	27.4	29.6	8.3	31.2	54.7	8.3	9.5	39.2	0.2	1.1
6	High-Importance Habitats	103.9	59.2	0.0	0.0	0.0	8.3	0.0	0.0	0.1	0.0	50.9	0.2	0.0
7	High-Importance Habitats with 0.5nm buffer	120.5	59.2	41.6	47.4	31.7	8.3	49.2	88.3	8.3	14.7	50.9	0.2	1.1
8	High-Importance Habitats with 1nm buffer	131.7	59.2	62.5	64.4	70.8	8.3	95.8	105.0	8.3	22.8	50.9	0.2	1.1
9	High-Importance Habitats with 2nm buffer	151.6	59.2	97.2	99.6	141.0	8.3	162.5	118.5	8.3	37.0	50.9	0.2	1.1
10	Jersey's Territorial Extent	162.2	59.2	325.6	350.5	276.5	8.3	328.4	145.6	8.3	38.1	51.6	0.2	1.1

For the model, it was necessary to outline a set of ecosystem services that were both broad enough in scope to capture the key impacts of mobile gear use but also had sufficient data available for (a) the extent to which the ecosystem service was impacted and (b) monetary values per annual unit of change (eg £/ha/year). Two sources were used as the basis for the ecosystem services selected in the model: *the Ecosystem Services Valuation Database (ESVD)*[3] and *The Marine Bill - Marine Nature Conservation Proposal: Valuing the Benefits (MNCP)*, prepared on behalf of Defra by researchers from SAC Ltd and the University of Liverpool.[4] The MNCP presents in detail the type/extent of impact estimated from a scenario that includes "restriction of bottom fishing gears either spatially or temporally and technical conservation measures" across UK waters.[5] Table 2 presents the type/extent of impact categorised by ecosystem services and seabed habitats relevant to Jersey waters. For each ecosystem service and seabed type, a code ranging from Very Low to Very High is provided in terms of the % impact of these fishing restrictions, estimated over the 20 years. Specifically, it states the increase (or, in fact, lack of decrease) in ecosystem services relative to the baseline status quo scenario (i.e. a continuation of fishing activity without new restrictions, which is likely to lead to a deterioration in ecosystems services). The report provides a range for these categories, here we use an average of that range. Hence, the impact coding was adopted as follows: Very High (VH), 95%; High (H), 70%; Medium (M), 30%; Low (L), 5%; and Very Low (VL), 0.5%.

Table 2. Impact estimates of conservation measures including restrictions on mobile gears

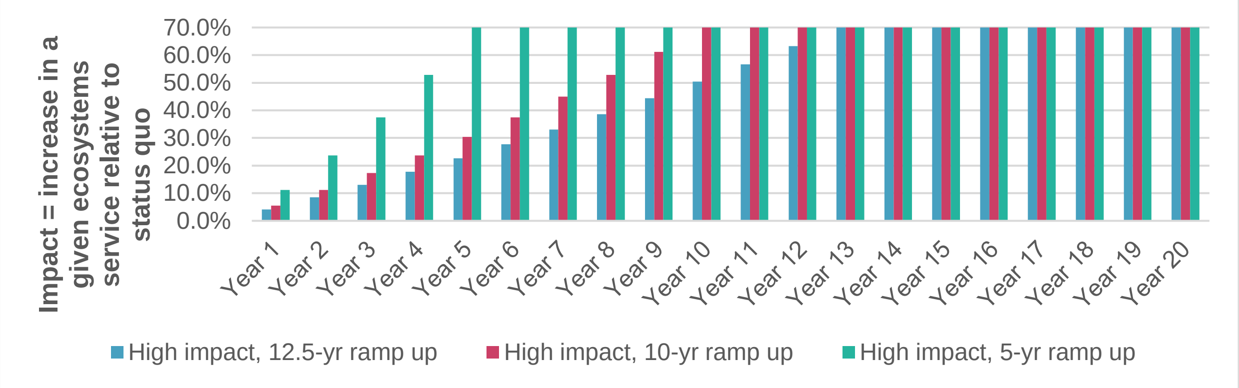
Ecosystem Service	Aphotic reef	Oceanic cold water coarse sediment	Oceanic cold water mixed sediment	Oceanic cold water mud	Oceanic cold water sand	Oceanic warm water mud	Oceanic warm water sand	Photic reef	Shallow moderately tide stress coarse	Shallow weak tide stress coarse sediment	Shallow strong tide stress mixed sediment	Shallow moderately tide stressed mixed	Shallow weal tide stress mixed sediment	Shallow mud	Shallow sand	Shelf strong tide stress coarse sediment	Shelf moderately tide stress coarse sediment	Shelf weak tide stress coarse sediment	Shelf strong tide stress mixed sediment	Shelf moderately tide stress mixed sediment	Shelf weak tide stress mixed sediment	Shelf mud	Shelf sand
Resilience and resistance	H	H	H	H	H	H	H	H	M	H	M	M	M	M	M	M	M	VH	H	H	H	H	H
Biologically mediated habitat	H	H	H	H	H	H	H	H	M	H	M	M	M	M	M	M	M	VH	H	H	H	H	H
Nutrient recycling	H	H	H	H	H	H	H	H	M	H	M	M	M	M	M	M	M	VH	H	H	H	H	H
Gas and climate regulation	H	H	H	H	H	H	H	H	M	H	M	M	M	M	M	M	M	VH	H	H	H	H	H
Bioremediation of waste	H	H	H	H	H	H	H	H	M	H	M	M	M	M	M	M	M	VH	H	H	H	H	H
Option use values	H	H	H	H	H	H	H	H	M	H	M	M	M	M	M	M	M	VH	H	H	H	H	H
Non-use / bequest values	H	H	H	H	H	H	H	H	M	H	M	M	M	M	M	M	M	VH	H	H	H	H	H
Leisure and recreation	H	VL	VL	VL	VL	VL	VL	H	L	H	M	M	M	L	L	L	L	L	L	L	L	VL	VL
Food provision	M	VL	VL	VL	VL	VL	VL	VL	L	L	L	L	L	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL
Raw materials	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL
Disturbance prevention and alleviation	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL
Cultural heritage and identity	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL
Cognitive values	H	H	H	H	H	H	H	H	M	H	M	M	M	M	M	M	M	VH	H	H	H	H	H

We make several assumptions by using the impact coding described by Moran et al.[6] First, that the impacts described here are broadly similar for the context of Jersey waters. Secondly, that the status described by Moran et al. is similar to a mobile gear closure and is also similar to the Jersey context. Third, that the baseline used is the expected deterioration in UK waters during the 20 years following ca. 2008, with the assumption that the same deterioration would apply in Jersey waters over the period approx. 2023–2043 in the absence of a mobile gear closure.

The time profile of the impact is applied using the same approach as in the source paper,[7] with the ecosystem services impact of a closure building up gradually for some habitats and ecosystem services as these habitats recover (eg rising at a constant growth rate over a period of 5 / 6 / 12.5 years, depending on the habitat and ecosystems service in question) and occurring instantaneously for others. After this initial build-up period, the level of ecosystem services sits at its maximum for every remaining year until the end of the 20-year period covered by the model. The ecosystem services expected to improve immediately upon protection in some habitats include leisure and recreation, food provision, raw materials, and cultural heritage and identity, albeit in all cases the magnitude of this immediate impact is very low.[8]

For example, a given ecosystem service for a given habitat may eventually increase by 70% ('High' impact coding in Table 1) but have a build-up period of 5 years. In this case, it will grow by 11.2% per annum from the status quo to achieve a level 70% higher than the status quo by year 5. From year 6 to year 20, the same high level (70% above the status quo) will be achieved each year. The profile of increased ecosystem services per year relative to the status quo is shown in Figure 1, using the example of a 'High' impact (70% increase) over ramp-up periods of 5, 10 and 12.5 years.

Figure 1. Ecosystem services increase by year, relative to status quo, under three different time profiles.



The aforementioned ESVD consists of hundreds of studies and thousands of value records distributed across all biomes, services, and geographic regions for the economic benefits of ecosystems and biodiversity, as well as the costs of their loss using valuation approaches such as the contingent valuation and replacement-cost methods. As well as consisting of up-to-date financial proxies for a wide range of ecosystem services (mostly from academic peer-reviewed literature) the database standardises proxies for each ecosystem service in easily comparable units: International $/ha/year. Here, the assumption is that one ha/year/$ is for the perfect hectare of ecosystem service quality. We assume in the estimation of impact in the cost-benefit model, that a % of this increases in quality when mobile gears are excluded. For this study, the database was queried for the following: ecosystems categorised under 'Open oceans and/or Open seas' (one of the ten biomes covered by the ESVD), and location within Europe. The ecosystem services returned (that possessed monetary values) are presented in Table 3.[9,10,11,12,13,14] The valuation methods used for these financial proxies include Contingent Valuation, Damage Cost Avoided, Market Prices, Net Factor Income, Production Function, Replacement Cost, Travel Cost, and Value Transfer. The financial proxies were converted into £ using the annual average exchange rate for 2020[15] and uprated to 2022 Jersey prices by applying the uplift in the Jersey RPI between December 2020 and December 2022.[16] For the purposes of the model, these ecosystem services needed to align with the ecosystem services outlined in the MNCP. These alignments are also presented in Table 3.[17]

Table 3. Financial proxies for ecosystem services related to 'Open Oceans/Seas' biome (as categorised by the ESVD) within Europe[18] (Aligned with MNCP ecosystem services).

Ecosystem service type (MNCP)	Ecosystem service (MNCP)	Ecosystem service (ESVD - Open Ocean/Sea EU)	Economic value per ha per year (£)* *2022 prices
Regulating	Resilience and resistance	Prevention of extreme events	£2.23
Regulating	Biologically mediated habitat	Biodiversity protection	£8.74
Supporting	Nutrient recycling	Nutrient cycling	£150.00[19]
Regulating	Gas and climate regulation	Climate regulation	£55.38
Supporting	Bioremediation of waste	Waste remediation	£217.76
Provisioning	Leisure and recreation	Marine leisure and recreation	£433.68[20]
Provisioning	Food provision	Fish	£23.51
Provisioning	Raw materials	Raw materials (the extraction of marine organisms for all purposes, except human consumption)	£8.82
Cultural	Cultural heritage and identity	Cultural values	£2.30

Similarly, the seabed habitat data provided by Blue Marine Foundation in EUNIS classification had to be aligned with the habitat types described in the aforementioned MNCP study. This first required conversion to the Marine Strategy Framework Directive's (MSFD) classified benthic habitats using a crosswalk guide.[21] Table 4 presents this alignment.

Table 4. Alignment of MSFD benthic habitats with MNCP habitat types

Code	EUNIS Broad	Marine Strategy Framework Directive 2017	MNCP habitat type*
A3.1	Atlantic and Mediterranean high energy infralittoral rock	Infralittoral rock and biogenic reef	Photic Reef
A3.21	Kelp and red seaweeds (moderate energy infralittoral rock)	Infralittoral rock and biogenic reef	Photic Reef
A4.1	Atlantic and Mediterranean high energy circalittoral rock	Circalittoral rock and biogenic reef	Aphotic Reef

Code	EUNIS Broad	Marine Strategy Framework Directive 2017	MNCP habitat type*
A5.1	Sublittoral coarse sediment	Infralittoral / circalittoral / offshore circalittoral coarse sediment	Oceanic coarse sediment
A5.13	Infralittoral coarse sediment	Infralittoral coarse sediment	Shallow moderately tide stress coarse sediment
A5.137	Dense [Lanice conchilega] and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand	Infralittoral coarse sediment	Shallow moderately tide stress coarse sediment
A5.141	[Pomatoceros triqueter] with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles	Circalittoral coarse sediment	Oceanic coarse sediment
A5.2	Sublittoral sand	Infralittoral / circalittoral / offshore circalittoral sand	Oceanic Mud / Oceanic Sand
A5.431	[Crepidula fornicata] with ascidians and anemones on infralittoral coarse mixed sediment	Infralittoral mixed sediments	Shallow moderately tide stressed mixed sediment
A5.451	Polychaete-rich deep [Venus] community in offshore mixed sediments	Offshore circalittoral mixed sediments	Oceanic mixed sediment
A5.51	Maerl beds	Infralittoral coarse sediment / mud / mixed sediment	Shallow moderately tide stress coarse sediment / Shallow Mud / Shallow moderately tide stressed mixed sediment
A5.53	Sublittoral seagrass beds	Infralittoral mud / sand	Shallow Mud / Shallow Sand

** Where more than one MNCP habitat aligns with MSFD, it is split evenly across habitats.*

The final stage of the model involves incorporating costs and fishing displacement in order to estimate the net impact of a mobile gear closure. Such a closure will result in lost economic benefit (private costs) for fishers when they are prevented from fishing using mobile gears in these prohibited, but often very productive fishing grounds. In reality, fishing activity is often displaced to other areas outside marine protected areas (MPAs). It is necessary to consider the amount of fishing activity displaced and the ecosystem quality of the areas it is displaced into, compared to the reduction in fishing activity in the protected areas. These factors are incorporated into the model to provide the net benefit value, presented in monetary terms, of a mobile gear closure. It should be noted that it is possible that benefits to the commercial fishery could accrue over time outside the MPAs through MPA spill-over benefits (eg if the fish stocks whose numbers recover in the protected areas also move through unprotected areas where they can still be caught).

To estimate the costs of lost fishing activity, data was provided by Blue Marine Foundation that presented the average annual value of the catch from mobile gear fishing activity within the areas proposed for protection under each scenario during 2015-2019. These values are presented in Table 5.

Table 5. Mobile gear fishing activity value (£, 2019 prices) under each proposed scenario

#	Scenario	Fishing activity value (£)
1	Proposed Marine Park	£4,884,628
2	Existing MPAs	£0
3	Existing MPAs with 0.5nm buffer	£331,880
4	Existing MPAs with 1nm buffer	£803,870
5	Existing MPAs with 2nm buffer	£2,407,968
6	High-Importance Habitats	£1,988,436
7	High-Importance Habitats with 0.5nm buffer	£5,190,578
8	High-Importance Habitats with 1nm buffer	£6,592,434
9	High-Importance Habitats with 2nm buffer	£8,503,330
10	Jersey's Territorial Extent	£17,566,876

We assume that displaced activity will be approximately 75% of the previous catch before protection began (we have chosen a high estimate based on impact assessments for MPAs in the UK[22]) as some of the forgone landings will be recovered from fishing other grounds. Furthermore, the displaced mobile gear activity will instead be undertaken on seabed habitat that is of lower ecosystem services quality in terms of biodiversity and biomass, which in relation to fishing reflects the catch per unit effort (CPUE) of the ground inside an MPA versus the area displaced to, which is assumed as less productive in terms of catch. The assumption is that MPA-designated areas are likely to have higher ecosystem service value as a starting point (hence the need to protect them) but are also more likely to be targeted by higher fishing effort due to the likely higher CPUE. We have conservatively estimated that ecosystems services quality in areas affected by displacement is 90% of the quality occurring in newly protected areas.

References and Notes

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[17] Where more than one ecosystem service value from ESVD was put under an ecosystem service from Defra MNCP, an average was taken.
[18] ESVD. (n.d.). ESVD. Retrieved from https://www.esvd.net/ [accessed March 2023].
[19] Nutrient cycling has a large variation in values per hectare. In ESVD, it is $28,084.39. However the MNCP paper citing the same source put it at $118 (1994 price). In the spirit of conservative estimations, we have used the lower value, here £157.44 in 2022 values.
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ECOSYSTEM SERVICES VALUATION OF A MOBILE GEAR CLOSURE IN JERSEY'S WATERS

Photo: Matt Jarvis

ANNEX 2

NEF MODEL RESULTS

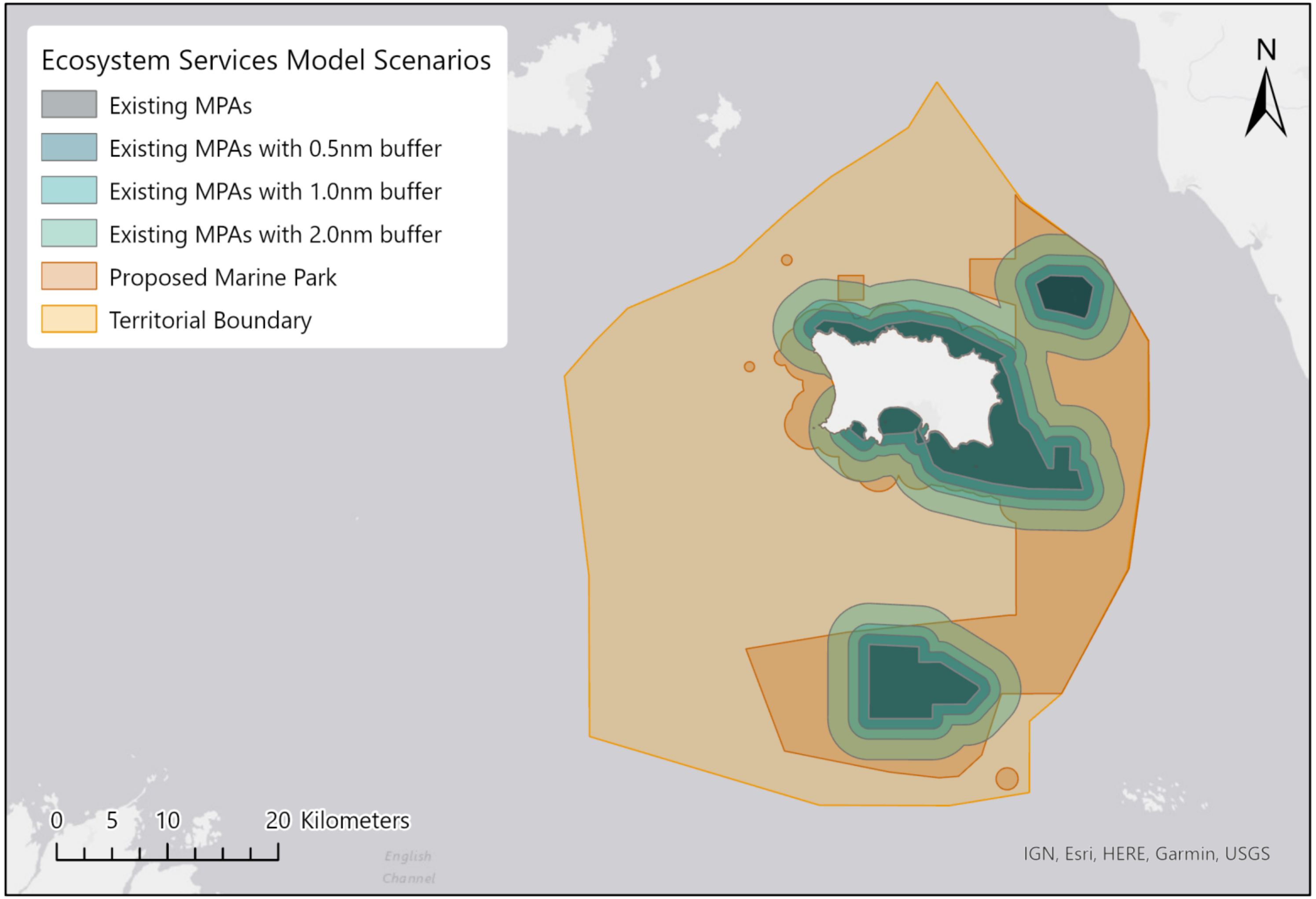
Mobile fishing gear ban in Jersey waters

Ecosystem services valuation case-study

Scenario estimates

March 2023

Ecosystem Services Model Scenarios: MPAs



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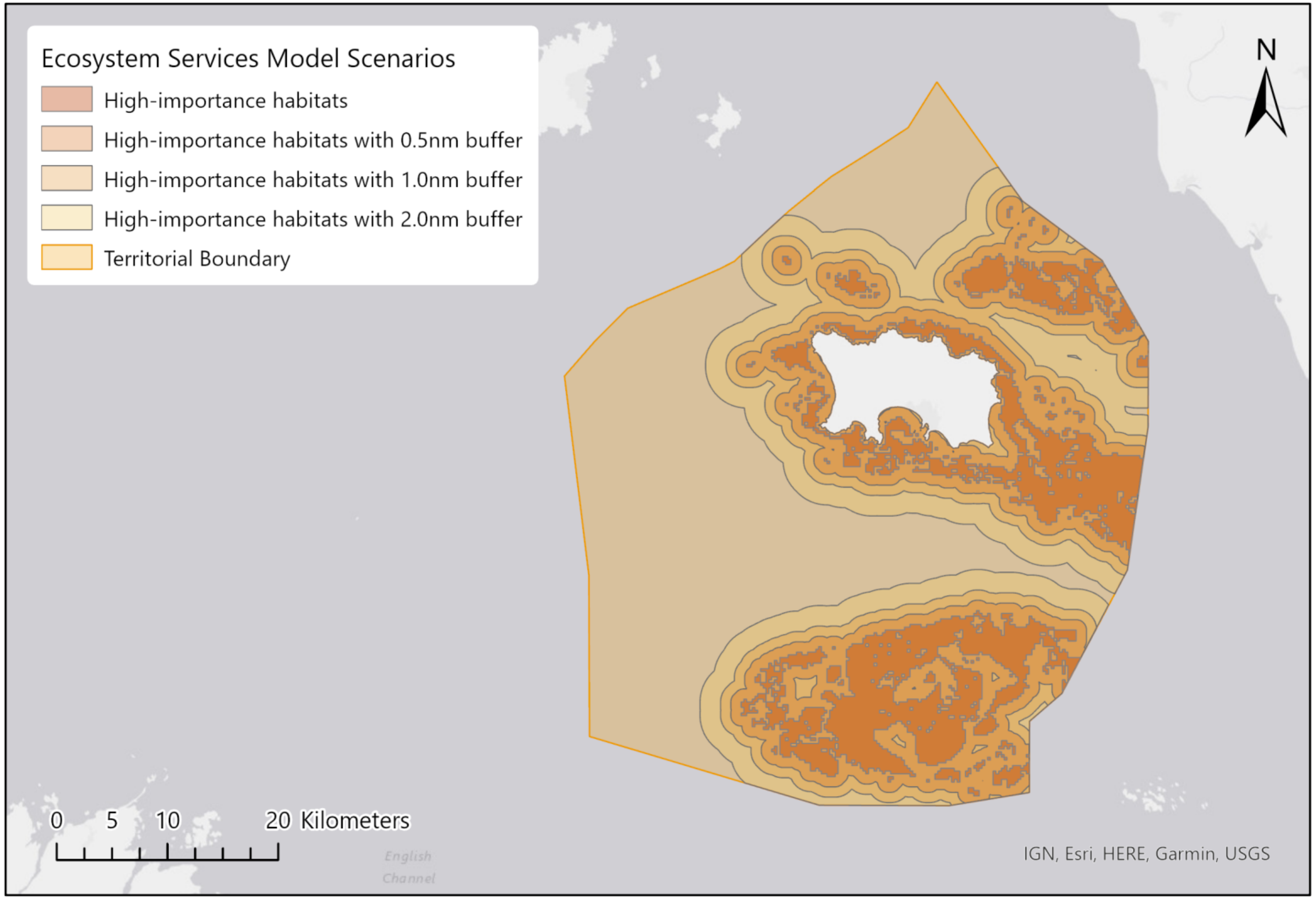
Ecosystem Services Model Scenarios: Habitats



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Summary insights

- The net ecosystem services impact of the proposed marine park where mobile gear fishing is banned is estimated at ~£9 million over the first 5-year period, ~£28 million over a 10-year period and ~£71million over a 20-year period.

- When factoring the lost fishing value from these time periods, the cumulative net benefit of the marine park proposal over five, ten and twenty years is estimated as ~£1.2 million, ~£13 million and ~£42 million, respectively.

- Due to the time lag for certain ecosystem service benefits to arise following a ban on mobile gear fishing, the proposed marine park is estimated to constitute a net cost during the first two years when considering lost fishing activity (Year 1: -£997,121; Year 2: -£408,050). However, as the ecosystems services benefits rise steadily over time the proposed marine park is estimated to become a cumulative net benefit from its fifth year onward.

- If all Jersey's territorial waters were to implement a ban on mobile fishing gear, there would be a net cost for the first six years of implementation, however from year seven it becomes a cumulative net benefit of ~£4 million, with a cumulative net impact of ~£99 million over a 20-year period.

Scenario 1: Proposed Marine Park

Net annual impact value

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
-£997,121	-£408,050	£210,979	£853,417	£1,523,953	£2,022,053	£2,162,560	£2,306,530	£2,454,078	£2,605,320
Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
£2,760,380	£2,919,383	£3,082,457	£3,049,697	£3,017,284	£2,985,217	£2,953,490	£2,922,100	£2,891,044	£2,860,318

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cumulative ecosystem benefit	£568,741	£1,720,501	£3,464,164	£5,833,975	£8,858,207	£12,364,592	£15,995,710	£19,755,190	£23,646,775	£27,674,325
Cumulative total costs	£1,565,862	£3,125,673	£4,658,357	£6,174,751	£7,675,029	£9,159,362	£10,627,919	£12,080,869	£13,518,376	£14,940,606
Cumulative net impact	-£997,121	-£1,405,172	-£1,194,193	-£340,776	£1,183,178	£3,205,230	£5,367,791	£7,674,321	£10,128,399	£12,733,719
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Cumulative ecosystem benefit	£31,841,820	£36,153,362	£40,613,182	£45,025,604	£49,391,130	£53,710,259	£57,983,485	£62,211,294	£66,394,170	£70,532,591
Cumulative total costs	£16,347,720	£17,739,880	£19,117,243	£20,479,968	£21,828,210	£23,162,123	£24,481,858	£25,787,568	£27,079,400	£28,357,503
Cumulative net impact	£15,494,100	£18,413,482	£21,495,939	£24,545,636	£27,562,920	£30,548,137	£33,501,626	£36,423,726	£39,314,770	£42,175,088

Ecosystem service type	Ecosystem service	1-year impact	5-year impact	10-year impact	20-year impact
Regulating	Resilience and resistance	£7,137	£114,142	£364,620	£944,731
Regulating	Biologically mediated habitat	£27,919	£446,496	£1,426,308	£3,695,560
Supporting	Nutrient recycling	£607,271	£9,711,921	£31,024,210	£80,383,657
Regulating	Gas and climate regulation	£176,982	£2,830,431	£9,041,660	£23,426,920
Supporting	Bioremediation of waste	£695,875	£11,128,927	£35,550,760	£92,111,940
Provisioning	Leisure and recreation	£226,807	£2,951,165	£7,569,204	£16,097,055
Provisioning	Food provision	£5,737	£60,262	£148,705	£312,028
Provisioning	Raw materials	£1,636	£9,698	£20,505	£40,462
Cultural	Cultural heritage and identity	£608	£2,978	£5,797	£11,003

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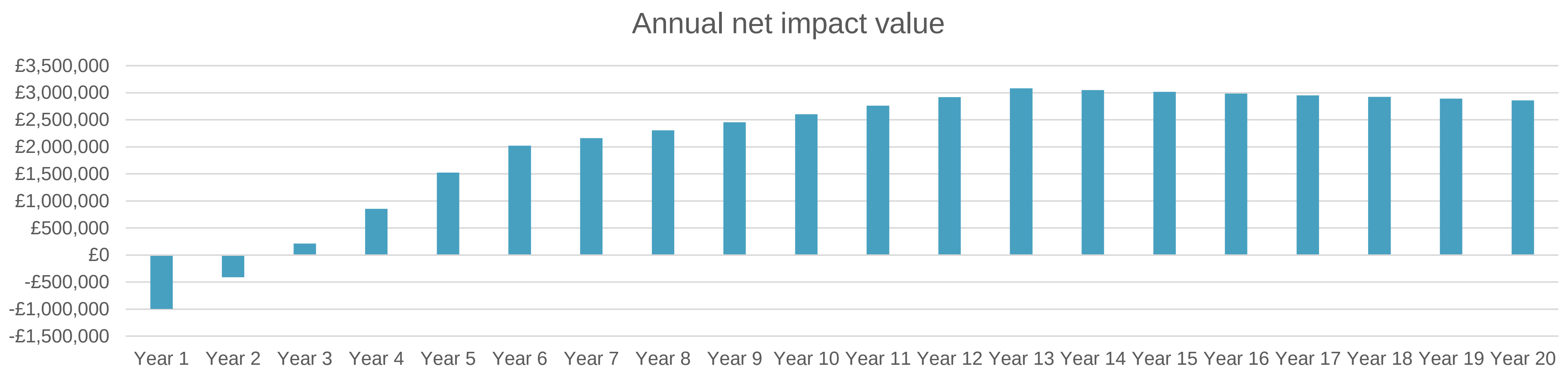
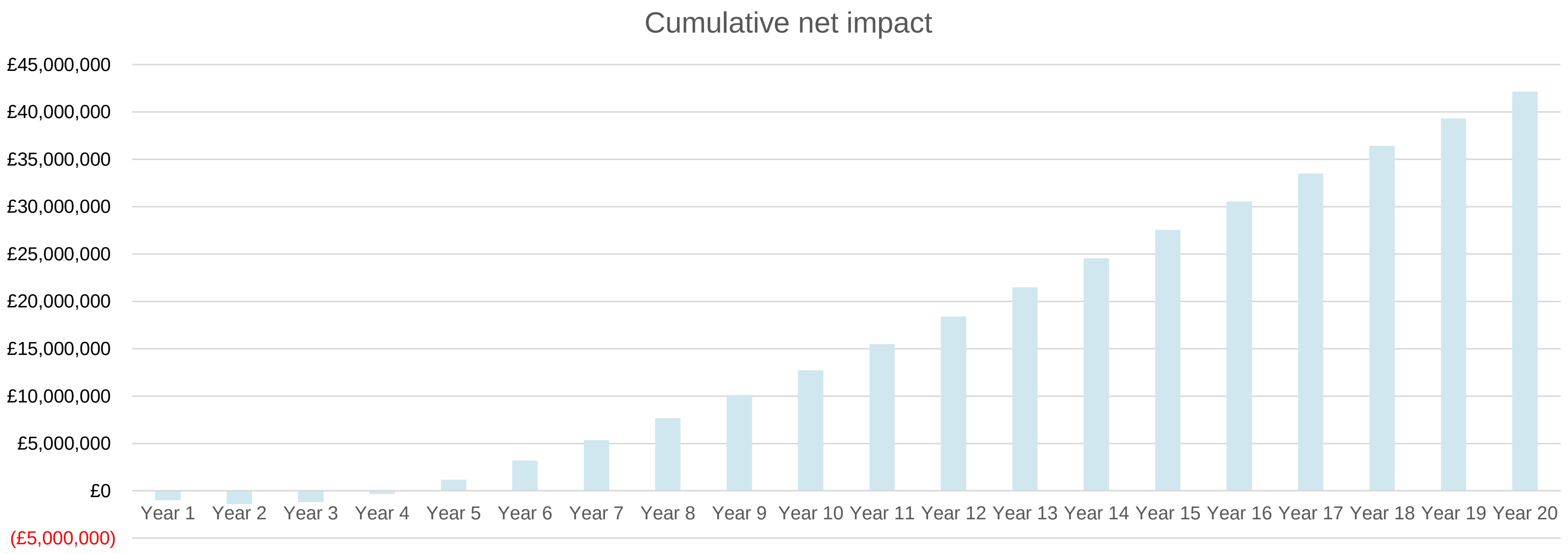
Scenario 1: Proposed Marine Park





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Scenario 2: Existing MPAs

Net annual impact value

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
£42,178	£86,614	£132,094	£180,563	£231,610	£268,604	£269,506	£270,514	£271,630	£272,856
Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
£274,195	£275,650	£277,222	£274,276	£271,361	£268,477	£265,623	£262,800	£260,007	£257,244

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cumulative ecosystem benefit	£42,178	£128,792	£260,887	£441,449	£673,059	£941,663	£1,211,169	£1,481,684	£1,753,314	£2,026,170
Cumulative total costs	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
Cumulative net impact	£42,178	£128,792	£260,887	£441,449	£673,059	£941,663	£1,211,169	£1,481,684	£1,753,314	£2,026,170
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Cumulative ecosystem benefit	£2,300,366	£2,576,015	£2,853,237	£3,127,513	£3,398,874	£3,667,351	£3,932,974	£4,195,774	£4,455,782	£4,713,026
Cumulative total costs	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
Cumulative net impact	£2,300,366	£2,576,015	£2,853,237	£3,127,513	£3,398,874	£3,667,351	£3,932,974	£4,195,774	£4,455,782	£4,713,026

Ecosystem service type	Ecosystem service	1-year impact	5-year impact	10-year impact	20-year impact
Regulating	Resilience and resistance	£516	£8,372	£25,757	£60,588
Regulating	Biologically mediated habitat	£2,020	£32,747	£100,754	£237,006
Supporting	Nutrient recycling	£43,935	£712,300	£2,191,548	£5,155,210
Regulating	Gas and climate regulation	£12,804	£207,592	£638,702	£1,502,429
Supporting	Bioremediation of waste	£50,345	£816,228	£2,511,304	£5,907,375
Provisioning	Leisure and recreation	£19,759	£289,316	£755,362	£1,615,982
Provisioning	Food provision	£289	£3,691	£9,409	£19,966
Provisioning	Raw materials	£74	£526	£1,182	£2,393
Cultural	Cultural heritage and identity	£37	£181	£352	£668

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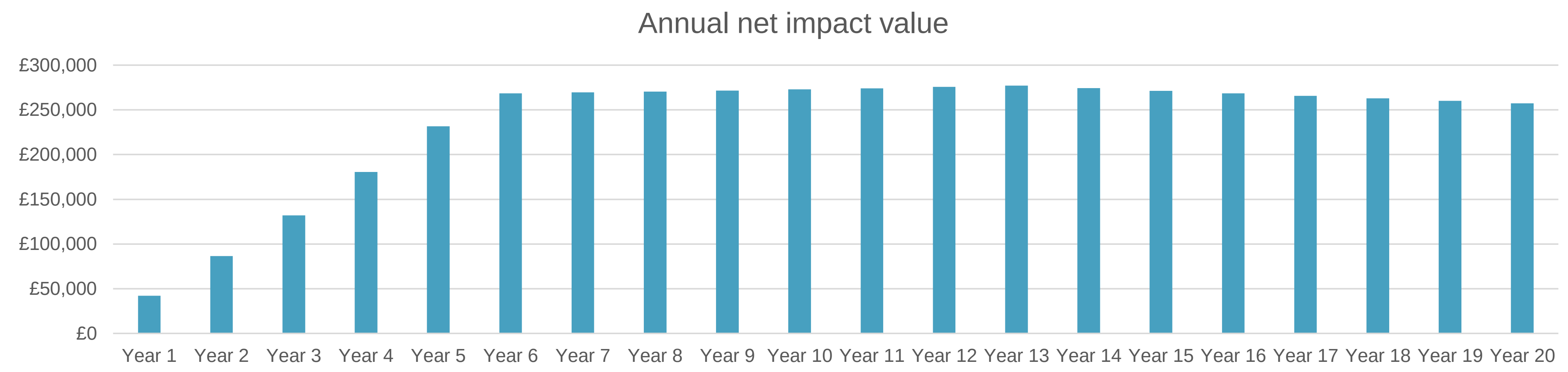
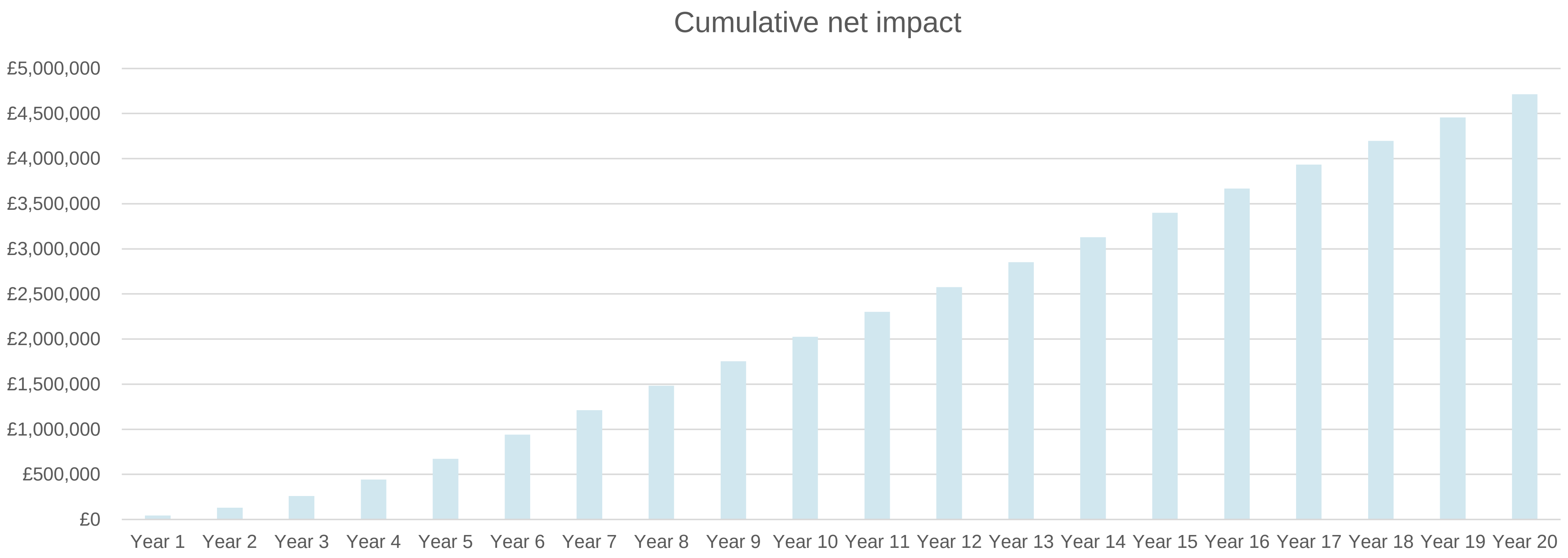
Scenario 2: Existing MPAs





NEF CONSULTING

Scenario 3: Existing MPAs with 0.5nm buffer

Net annual impact value

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
£8,505	£128,725	£252,734	£383,588	£520,850	£618,567	£629,930	£641,721	£653,953	£666,637
Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
£679,787	£693,417	£707,539	£700,020	£692,580	£685,219	£677,937	£670,731	£663,603	£656,550

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cumulative ecosystem benefit	£114,896	£349,600	£706,470	£1,193,087	£1,815,872	£2,535,289	£3,264,999	£4,005,439	£4,757,061	£5,520,330
Cumulative total costs	£106,391	£212,370	£316,506	£419,536	£521,470	£622,321	£722,100	£820,819	£918,489	£1,015,120
Cumulative net impact	£8,505	£137,230	£389,964	£773,551	£1,294,402	£1,912,968	£2,542,898	£3,184,620	£3,838,572	£4,505,209
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Cumulative ecosystem benefit	£6,295,722	£7,083,727	£7,884,850	£8,677,458	£9,461,642	£10,237,493	£11,005,097	£11,764,543	£12,515,918	£13,259,307
Cumulative total costs	£1,110,725	£1,205,313	£1,298,897	£1,391,485	£1,483,090	£1,573,721	£1,663,389	£1,752,103	£1,839,875	£1,926,714
Cumulative net impact	£5,184,997	£5,878,414	£6,585,953	£7,285,973	£7,978,553	£8,663,772	£9,341,708	£10,012,440	£10,676,043	£11,332,593

Ecosystem service type	Ecosystem service	1-year impact	5-year impact	10-year impact	20-year impact
Regulating	Resilience and resistance	£1,416	£22,823	£70,937	£172,804
Regulating	Biologically mediated habitat	£5,541	£89,276	£277,488	£675,970
Supporting	Nutrient recycling	£120,516	£1,941,888	£6,035,757	£14,703,294
Regulating	Gas and climate regulation	£35,123	£565,942	£1,759,054	£4,285,111
Supporting	Bioremediation of waste	£138,099	£2,225,217	£6,916,397	£16,848,560
Provisioning	Leisure and recreation	£51,511	£728,563	£1,892,591	£4,042,129
Provisioning	Food provision	£956	£11,405	£28,764	£60,819
Provisioning	Raw materials	£254	£1,646	£3,596	£7,197
Cultural	Cultural heritage and identity	£110	£537	£1,046	£1,985

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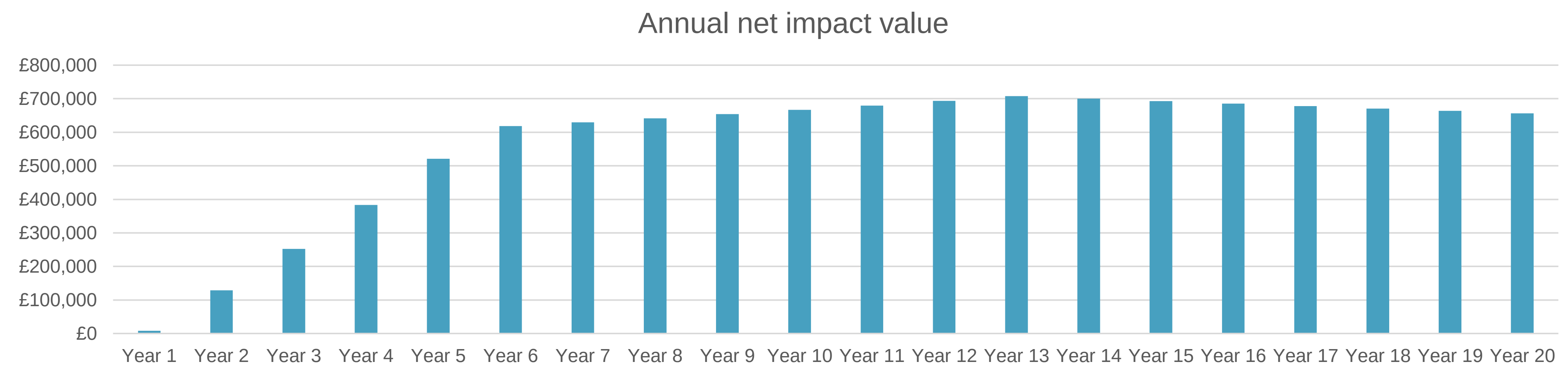
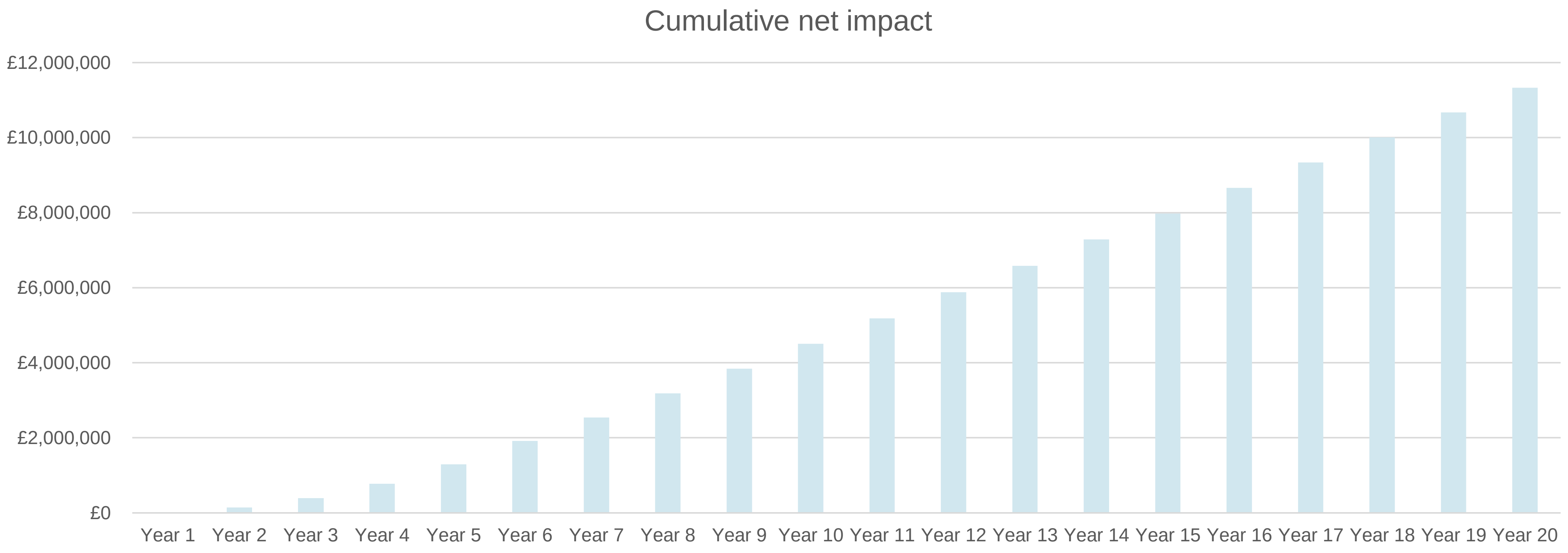
Scenario 3: Existing MPAs with 0.5nm buffer





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Scenario 4: Existing MPAs with 1nm buffer

Net annual impact value

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
-£73,274	£118,635	£317,310	£525,803	£743,964	£899,239	£927,749	£957,120	£987,379	£1,018,554
Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
£1,050,671	£1,083,762	£1,117,854	£1,105,973	£1,094,219	£1,082,590	£1,071,084	£1,059,700	£1,048,438	£1,037,295

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cumulative ecosystem benefit	£184,422	£559,757	£1,129,303	£1,904,661	£2,895,528	£4,039,046	£5,208,478	£6,404,712	£7,628,664	£8,881,276
Cumulative total costs	£257,696	£514,397	£766,633	£1,016,188	£1,263,091	£1,507,370	£1,749,052	£1,988,166	£2,224,739	£2,458,798
Cumulative net impact	-£73,274	£45,361	£362,670	£888,473	£1,632,437	£2,531,676	£3,459,425	£4,416,545	£5,403,924	£6,422,478
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Cumulative ecosystem benefit	£10,163,518	£11,476,389	£12,820,918	£14,151,157	£15,467,258	£16,769,372	£18,057,647	£19,332,230	£20,593,266	£21,840,901
Cumulative total costs	£2,690,368	£2,919,478	£3,146,153	£3,370,419	£3,592,301	£3,811,825	£4,029,016	£4,243,898	£4,456,497	£4,666,836
Cumulative net impact	£7,473,150	£8,556,911	£9,674,765	£10,780,738	£11,874,958	£12,957,547	£14,028,631	£15,088,331	£16,136,769	£17,174,064

Ecosystem service type	Ecosystem service	1-year impact	5-year impact	10-year impact	20-year impact
Regulating	Resilience and resistance	£2,280	£36,590	£114,823	£286,917
Regulating	Biologically mediated habitat	£8,918	£143,132	£449,160	£1,122,351
Supporting	Nutrient recycling	£193,970	£3,113,326	£9,769,870	£24,412,723
Regulating	Gas and climate regulation	£56,530	£907,344	£2,847,320	£7,114,816
Supporting	Bioremediation of waste	£222,271	£3,567,572	£11,195,332	£27,974,633
Provisioning	Leisure and recreation	£81,173	£1,118,669	£2,895,260	£6,175,984
Provisioning	Food provision	£1,671	£18,923	£47,320	£99,759
Provisioning	Raw materials	£457	£2,854	£6,149	£12,234
Cultural	Cultural heritage and identity	£185	£908	£1,767	£3,355

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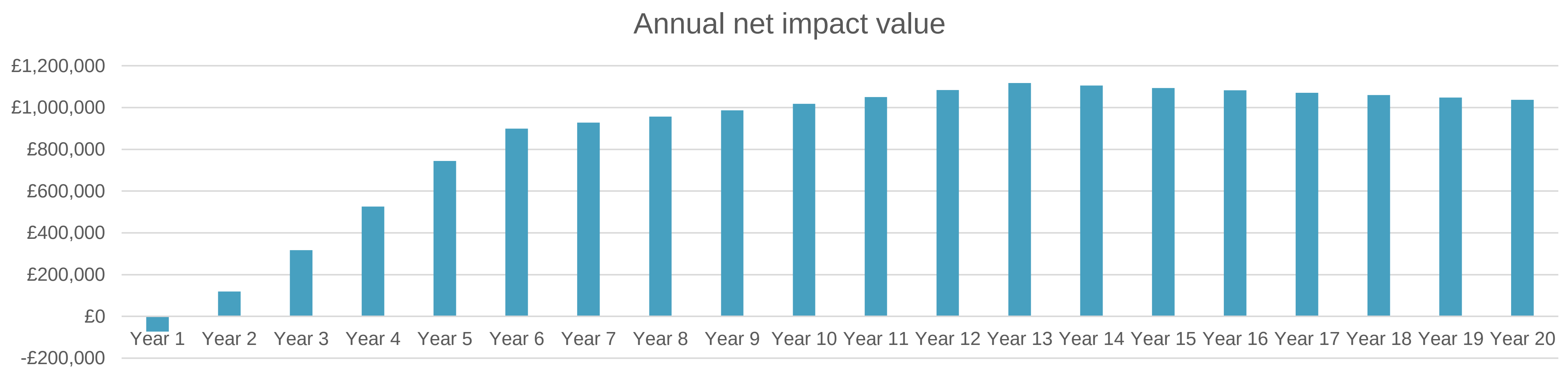
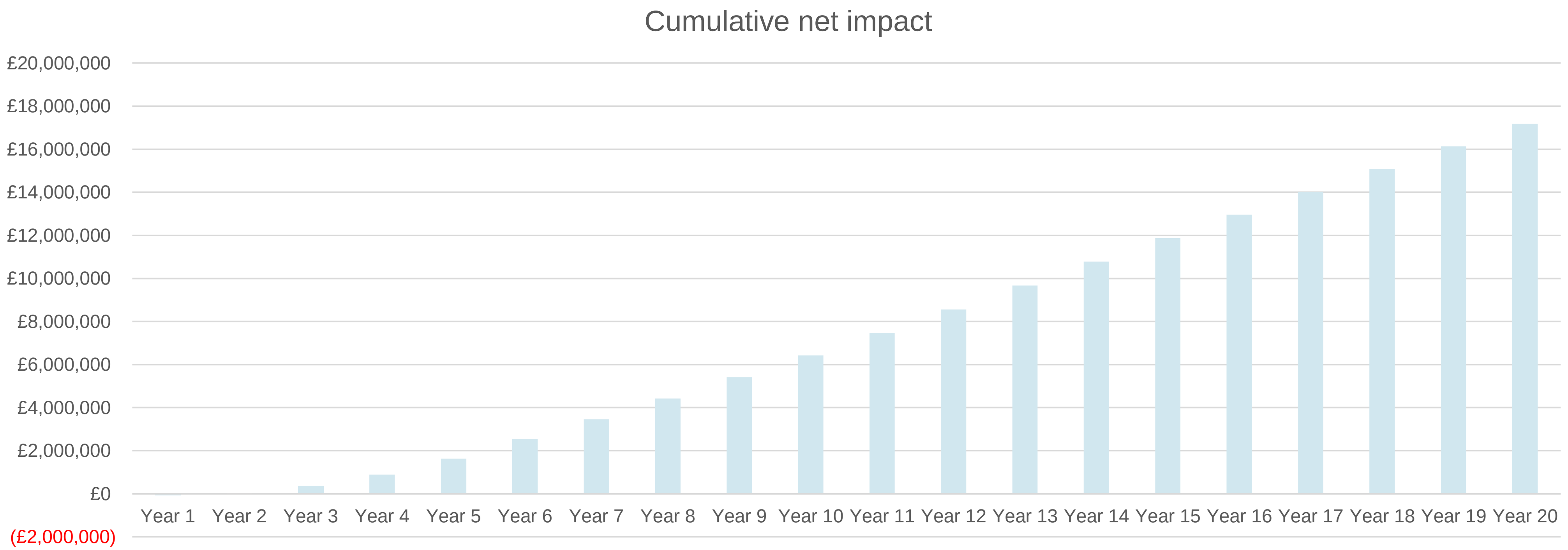
Scenario 4: Existing MPAs with 1nm buffer





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Scenario 5: Existing MPAs with 2nm buffer

Net annual impact value

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
-£414,418	-£43,520	£343,718	£747,571	£1,169,573	£1,483,208	£1,558,619	£1,636,019	£1,715,470	£1,797,039
Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
£1,880,794	£1,966,806	£2,055,146	£2,033,304	£2,011,694	£1,990,313	£1,969,160	£1,948,232	£1,927,526	£1,907,040

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cumulative ecosystem benefit	£357,503	£1,082,921	£2,182,203	£3,677,309	£5,586,473	£7,801,410	£10,083,982	£12,436,259	£14,860,374	£17,358,528
Cumulative total costs	£771,921	£1,540,859	£2,296,423	£3,043,958	£3,783,548	£4,515,277	£5,239,230	£5,955,488	£6,664,134	£7,365,249
Cumulative net impact	-£414,418	-£457,938	-£114,220	£633,351	£1,802,925	£3,286,132	£4,844,752	£6,480,770	£8,196,240	£9,993,279
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Cumulative ecosystem benefit	£19,932,985	£22,586,081	£25,320,224	£28,025,308	£30,701,643	£33,349,533	£35,969,281	£38,561,187	£41,125,546	£43,662,651
Cumulative total costs	£8,058,912	£8,745,203	£9,424,200	£10,095,980	£10,760,621	£11,418,198	£12,068,786	£12,712,460	£13,349,293	£13,979,357
Cumulative net impact	£11,874,073	£13,840,878	£15,896,024	£17,929,328	£19,941,021	£21,931,335	£23,900,495	£25,848,727	£27,776,253	£29,683,293

Ecosystem service type	Ecosystem service	1-year impact	5-year impact	10-year impact	20-year impact
Regulating	Resilience and resistance	£4,446	£71,222	£226,507	£579,432
Regulating	Biologically mediated habitat	£17,393	£278,603	£886,042	£2,266,597
Supporting	Nutrient recycling	£378,325	£6,060,013	£19,272,664	£49,301,702
Regulating	Gas and climate regulation	£110,259	£1,766,123	£5,616,803	£14,368,431
Supporting	Bioremediation of waste	£433,524	£6,944,192	£22,084,619	£56,495,009
Provisioning	Leisure and recreation	£151,423	£2,026,118	£5,221,103	£11,121,088
Provisioning	Food provision	£3,319	£35,250	£87,154	£183,002
Provisioning	Raw materials	£949	£5,804	£12,416	£24,626
Cultural	Cultural heritage and identity	£372	£1,822	£3,547	£6,732

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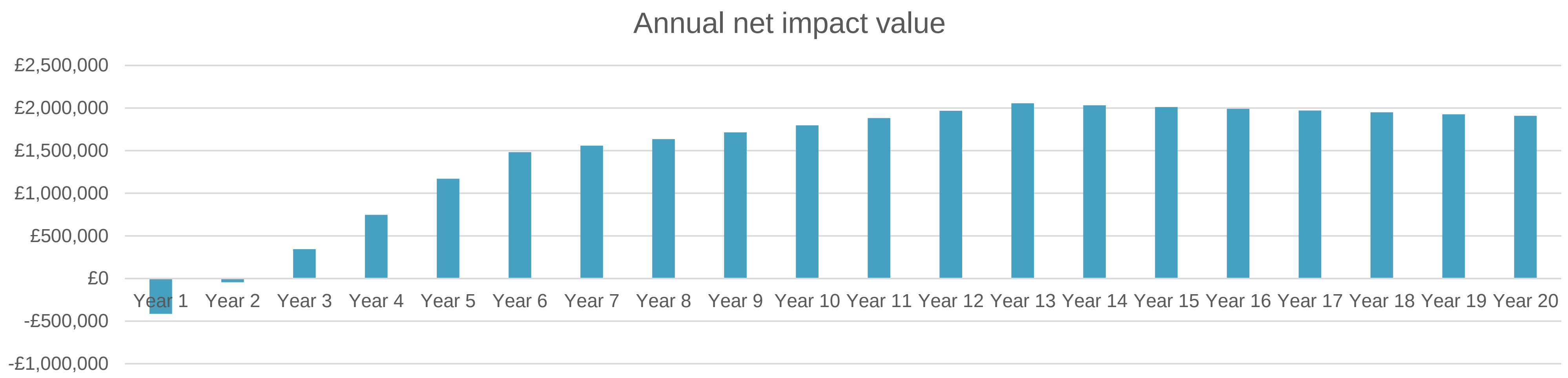
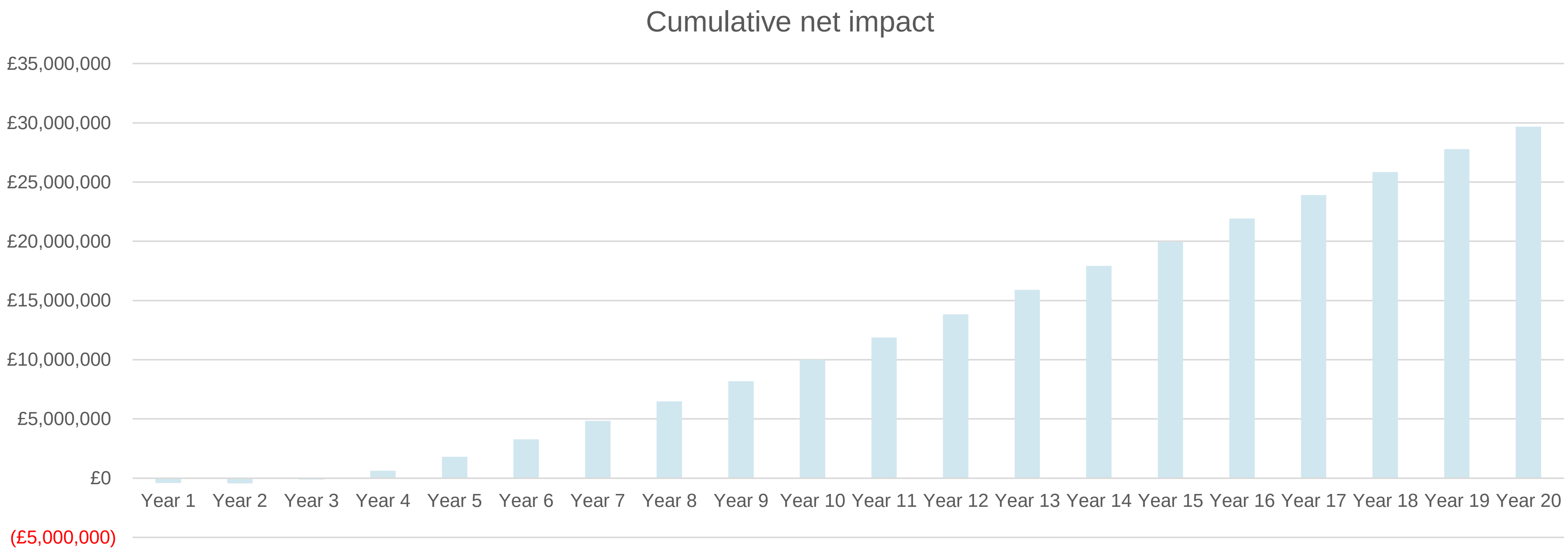
Scenario 5: Existing MPAs with 2nm buffer





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Scenario 6: High-Importance Habitats

Net annual impact value

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
-£325,722	£9,973	£364,114	£738,415	£1,134,421	£1,453,241	£1,437,796	£1,422,515	£1,407,396	£1,392,438
Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
£1,377,639	£1,362,998	£1,348,512	£1,334,180	£1,320,000	£1,305,971	£1,292,091	£1,278,359	£1,264,773	£1,251,331

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cumulative ecosystem benefit	£311,710	£956,652	£1,944,691	£3,300,400	£5,045,555	£7,103,038	£9,138,654	£11,152,636	£13,145,213	£15,116,613
Cumulative total costs	£637,432	£1,272,400	£1,896,325	£2,513,619	£3,124,353	£3,728,595	£4,326,416	£4,917,883	£5,503,064	£6,082,026
Cumulative net impact	-£325,722	-£315,748	£48,365	£786,780	£1,921,202	£3,374,442	£4,812,238	£6,234,753	£7,642,149	£9,034,587
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Cumulative ecosystem benefit	£17,067,061	£18,996,779	£20,905,989	£22,794,907	£24,663,750	£26,512,731	£28,342,060	£30,151,948	£31,942,600	£33,714,221
Cumulative total costs	£6,654,834	£7,221,555	£7,782,252	£8,336,991	£8,885,833	£9,428,843	£9,966,081	£10,497,610	£11,023,489	£11,543,780
Cumulative net impact	£10,412,227	£11,775,224	£13,123,736	£14,457,916	£15,777,916	£17,083,888	£18,375,979	£19,654,338	£20,919,110	£22,170,441

Ecosystem service type	Ecosystem service	1-year impact	5-year impact	10-year impact	20-year impact
Regulating	Resilience and resistance	£3,932	£64,336	£196,106	£439,438
Regulating	Biologically mediated habitat	£15,382	£251,666	£767,119	£1,718,975
Supporting	Nutrient recycling	£334,585	£5,474,101	£16,685,933	£37,390,137
Regulating	Gas and climate regulation	£97,511	£1,595,366	£4,862,929	£10,896,939
Supporting	Bioremediation of waste	£383,402	£6,272,794	£19,120,474	£42,845,501
Provisioning	Leisure and recreation	£122,364	£1,842,283	£4,818,515	£10,314,541
Provisioning	Food provision	£1,351	£19,906	£51,705	£110,427
Provisioning	Raw materials	£333	£3,121	£7,516	£15,632
Cultural	Cultural heritage and identity	£247	£1,211	£2,358	£4,475

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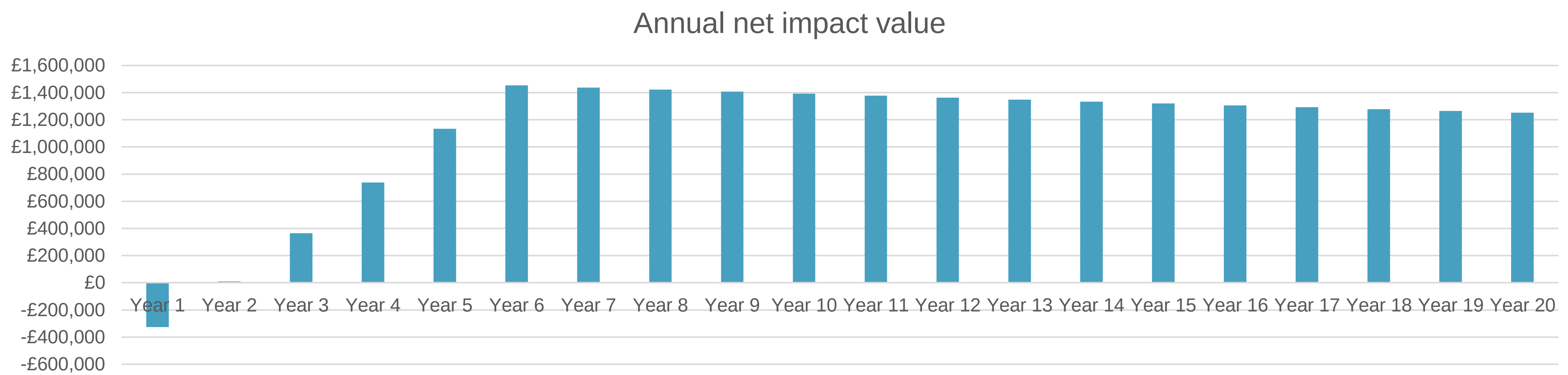
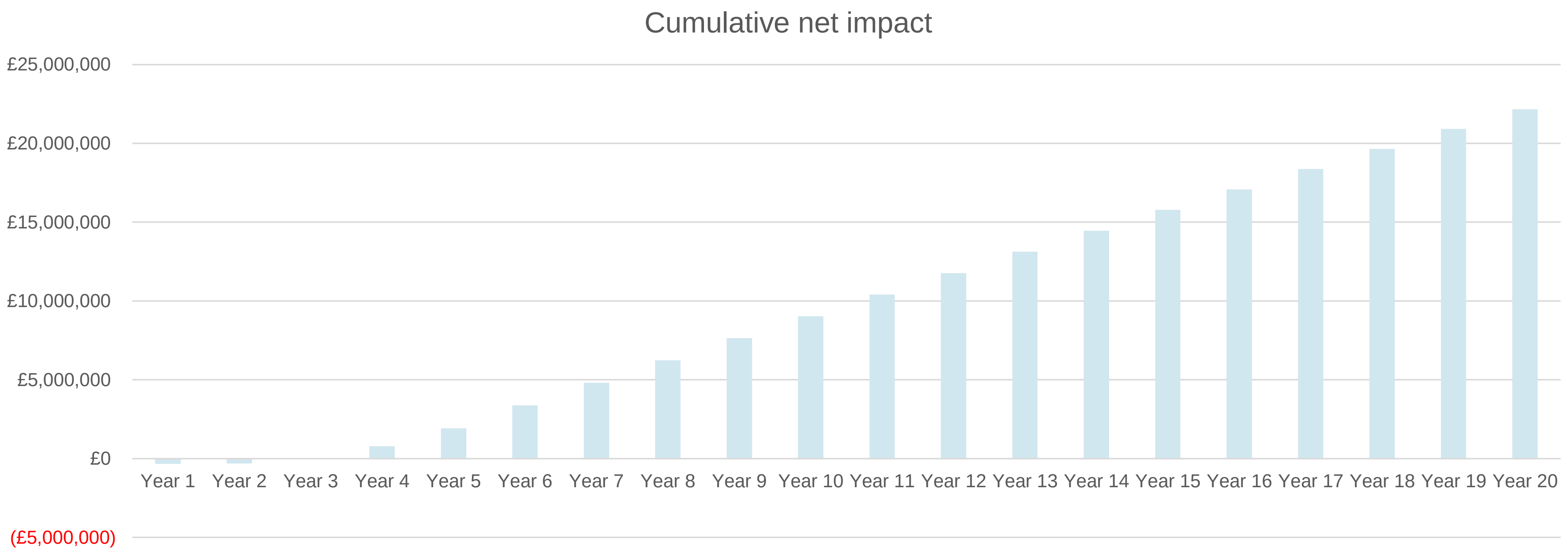
Scenario 6: High-Importance Habitats





Scenario 7: High-Importance Habitats with 0.5nm buffer

Net annual impact value

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
-£1,113,630	-£541,349	£62,794	£689,562	£1,344,606	£1,871,243	£1,999,577	£2,131,081	£2,265,861	£2,404,024
Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
£2,545,682	£2,690,949	£2,839,944	£2,809,761	£2,779,899	£2,750,354	£2,721,123	£2,692,203	£2,663,590	£2,635,282

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cumulative ecosystem benefit	£550,311	£1,666,472	£3,357,949	£5,658,885	£8,597,739	£12,046,287	£15,606,404	£19,281,441	£23,074,847	£26,990,183
Cumulative total costs	£1,663,941	£3,321,451	£4,950,134	£6,561,508	£8,155,756	£9,733,061	£11,293,602	£12,837,557	£14,365,104	£15,876,415
Cumulative net impact	-£1,113,630	-£1,654,979	-£1,592,185	-£902,623	£441,983	£2,313,226	£4,312,802	£6,443,883	£8,709,744	£11,113,768
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Cumulative ecosystem benefit	£31,031,113	£35,201,420	£39,504,999	£43,762,840	£47,975,429	£52,143,246	£56,266,767	£60,346,463	£64,382,801	£68,376,240
Cumulative total costs	£17,371,664	£18,851,022	£20,314,657	£21,762,737	£23,195,426	£24,612,889	£26,015,286	£27,402,780	£28,775,526	£30,133,684
Cumulative net impact	£13,659,449	£16,350,398	£19,190,342	£22,000,104	£24,780,003	£27,530,357	£30,251,480	£32,943,684	£35,607,274	£38,242,556

Ecosystem service type	Ecosystem service	1-year impact	5-year impact	10-year impact	20-year impact
Regulating	Resilience and resistance	£6,912	£110,791	£355,743	£915,648
Regulating	Biologically mediated habitat	£27,040	£433,388	£1,391,579	£3,581,797
Supporting	Nutrient recycling	£588,153	£9,426,801	£30,268,819	£77,909,142
Regulating	Gas and climate regulation	£171,411	£2,747,336	£8,821,510	£22,705,751
Supporting	Bioremediation of waste	£673,967	£10,802,207	£34,685,155	£89,276,384
Provisioning	Leisure and recreation	£219,166	£2,876,340	£7,386,876	£15,716,206
Provisioning	Food provision	£4,636	£46,052	£112,417	£234,971
Provisioning	Raw materials	£1,402	£8,836	£19,107	£38,074
Cultural	Cultural heritage and identity	£577	£2,830	£5,509	£10,457

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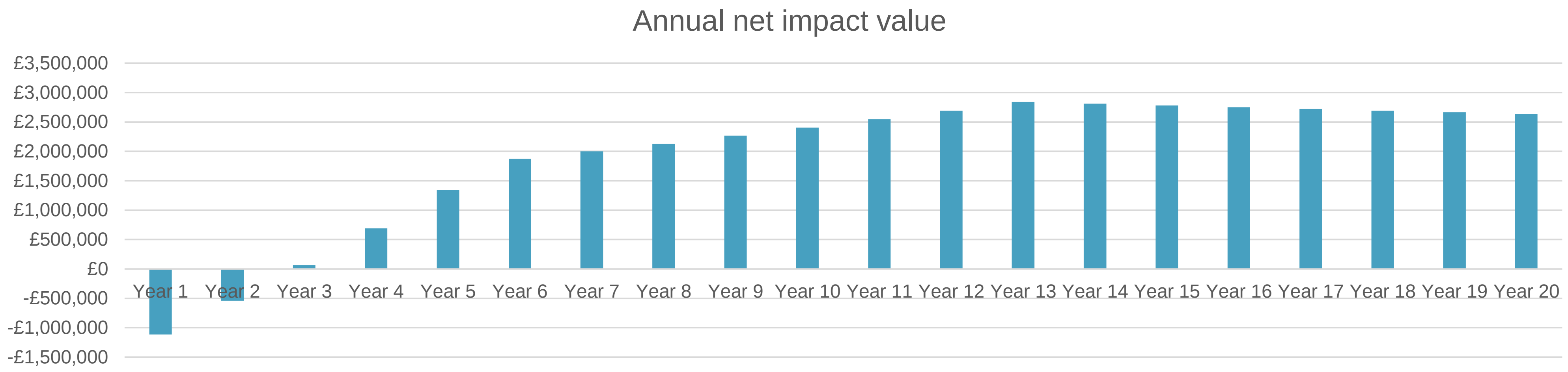
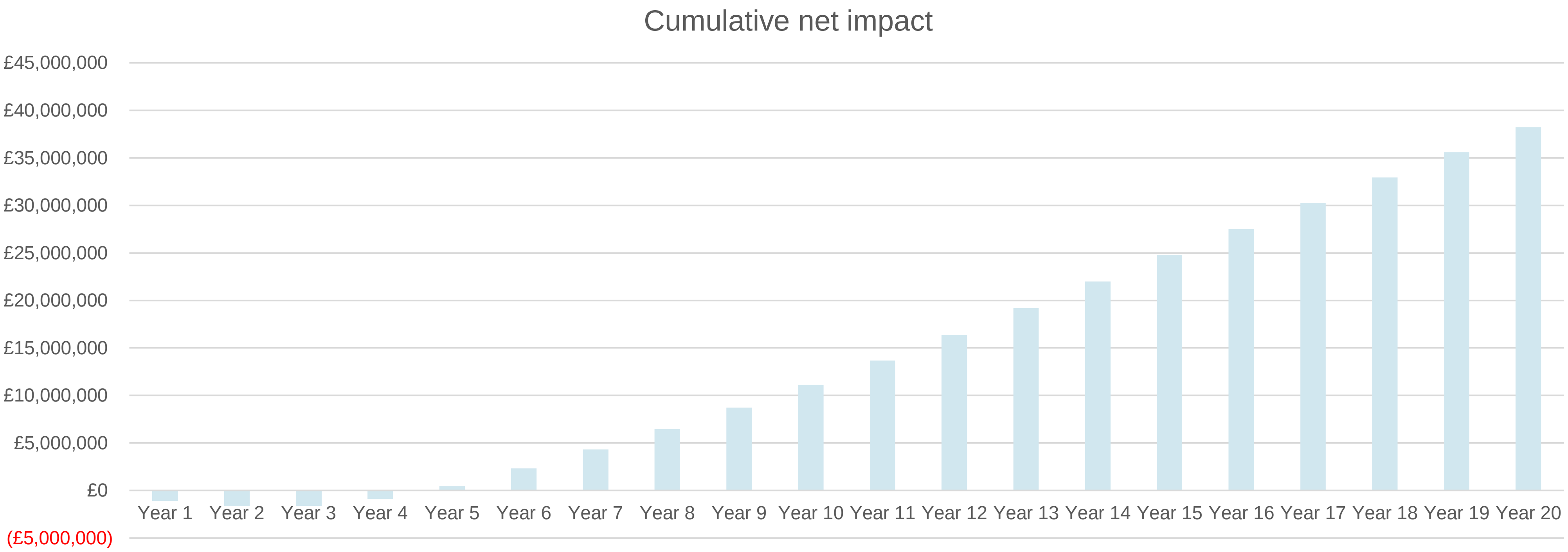
Scenario 7: High-Importance Habitats with 0.5nm buffer





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Scenario 8: High-Importance Habitats with 1nm buffer

Net annual impact value

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
-£1,431,527	-£727,546	£14,313	£781,207	£1,580,265	£2,207,284	£2,397,787	£2,592,810	£2,792,506	£2,997,032
Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
£3,206,548	£3,421,222	£3,641,224	£3,602,525	£3,564,237	£3,526,356	£3,488,878	£3,451,798	£3,415,112	£3,378,817

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cumulative ecosystem benefit	£681,806	£2,059,425	£4,142,292	£6,970,067	£10,575,150	£14,785,732	£19,165,526	£23,719,279	£28,451,886	£33,368,400
Cumulative total costs	£2,113,333	£4,218,498	£6,287,051	£8,333,620	£10,358,438	£12,361,737	£14,343,744	£16,304,686	£18,244,787	£20,164,269
Cumulative net impact	-£1,431,527	-£2,159,073	-£2,144,760	-£1,363,553	£216,712	£2,423,996	£4,821,782	£7,414,592	£10,207,099	£13,204,130
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Cumulative ecosystem benefit	£38,474,030	£43,774,150	£49,274,303	£54,716,000	£60,099,863	£65,426,506	£70,696,537	£75,910,559	£81,069,165	£86,172,946
Cumulative total costs	£22,063,351	£23,942,249	£25,801,178	£27,640,351	£29,459,977	£31,260,263	£33,041,417	£34,803,640	£36,547,134	£38,272,098
Cumulative net impact	£16,410,679	£19,831,901	£23,473,125	£27,075,649	£30,639,887	£34,166,243	£37,655,121	£41,106,919	£44,522,032	£47,900,848

Ecosystem service type	Ecosystem service	1-year impact	5-year impact	10-year impact	20-year impact
Regulating	Resilience and resistance	£8,580	£136,872	£441,785	£1,160,128
Regulating	Biologically mediated habitat	£33,563	£535,410	£1,728,156	£4,538,141
Supporting	Nutrient recycling	£730,045	£11,645,919	£37,589,840	£98,710,976
Regulating	Gas and climate regulation	£212,764	£3,394,073	£10,955,140	£28,768,213
Supporting	Bioremediation of waste	£836,561	£13,345,103	£43,074,341	£113,113,284
Provisioning	Leisure and recreation	£267,039	£3,401,032	£8,691,964	£18,462,405
Provisioning	Food provision	£6,584	£64,919	£158,249	£330,597
Provisioning	Raw materials	£1,972	£11,898	£25,323	£50,115
Cultural	Cultural heritage and identity	£755	£3,699	£7,201	£13,668

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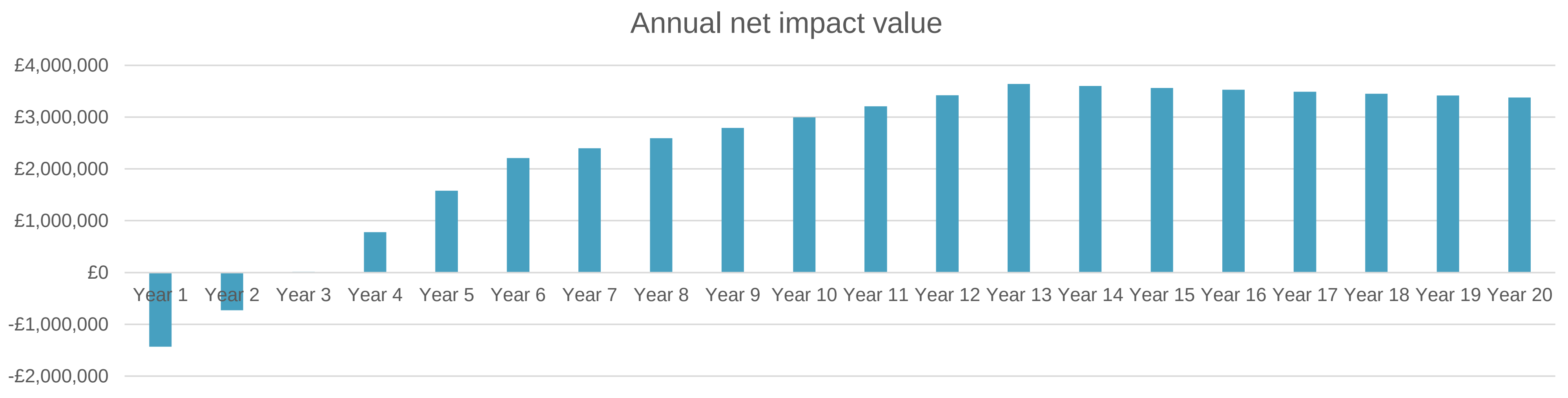
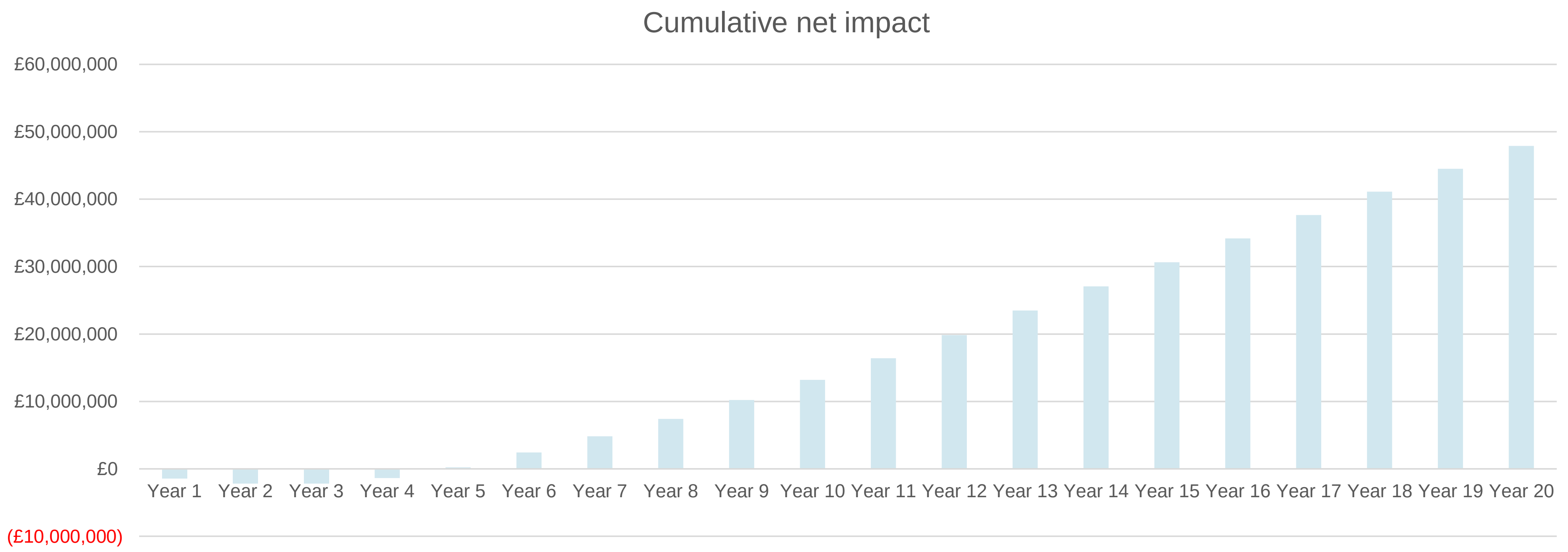
Scenario 8: High-Importance Habitats with 1nm buffer





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Scenario 9: High-Importance Habitats with 2nm buffer

Net annual impact value

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
-£1,830,902	-£912,627	£51,884	£1,046,350	£2,079,523	£2,862,367	£3,142,055	£3,428,257	£3,721,195	£4,021,095
Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
£4,328,192	£4,642,727	£4,964,948	£4,912,181	£4,859,974	£4,808,322	£4,757,219	£4,706,659	£4,656,637	£4,607,146

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cumulative ecosystem benefit	£895,005	£2,697,751	£5,417,783	£9,103,924	£13,795,182	£19,241,527	£24,940,098	£30,897,700	£37,121,358	£43,618,320
Cumulative total costs	£2,725,907	£5,441,280	£8,109,428	£10,749,220	£13,360,955	£15,944,934	£18,501,449	£21,030,794	£23,533,257	£26,009,124
Cumulative net impact	-£1,830,902	-£2,743,529	-£2,691,645	-£1,645,296	£434,227	£3,296,593	£6,438,649	£9,866,906	£13,588,101	£17,609,196
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Cumulative ecosystem benefit	£50,396,065	£57,462,311	£64,825,022	£72,109,481	£79,316,521	£86,446,965	£93,501,626	£100,481,310	£107,386,814	£114,218,925
Cumulative total costs	£28,458,677	£30,882,196	£33,279,958	£35,652,237	£37,999,302	£40,321,424	£42,618,865	£44,891,890	£47,140,757	£49,365,722
Cumulative net impact	£21,937,388	£26,580,116	£31,545,064	£36,457,245	£41,317,219	£46,125,541	£50,882,760	£55,589,420	£60,246,057	£64,853,203

Ecosystem service type	Ecosystem service	1-year impact	5-year impact	10-year impact	20-year impact
Regulating	Resilience and resistance	£11,280	£179,162	£579,402	£1,543,558
Regulating	Biologically mediated habitat	£44,126	£700,838	£2,266,482	£6,038,027
Supporting	Nutrient recycling	£959,797	£15,244,217	£49,299,191	£131,335,630
Regulating	Gas and climate regulation	£279,722	£4,442,757	£14,367,699	£38,276,305
Supporting	Bioremediation of waste	£1,099,835	£17,468,407	£56,492,131	£150,498,000
Provisioning	Leisure and recreation	£345,455	£4,292,466	£10,923,165	£23,167,671
Provisioning	Food provision	£9,741	£97,042	£237,057	£495,613
Provisioning	Raw materials	£2,869	£16,742	£35,192	£69,261
Cultural	Cultural heritage and identity	£1,037	£5,084	£9,896	£18,783

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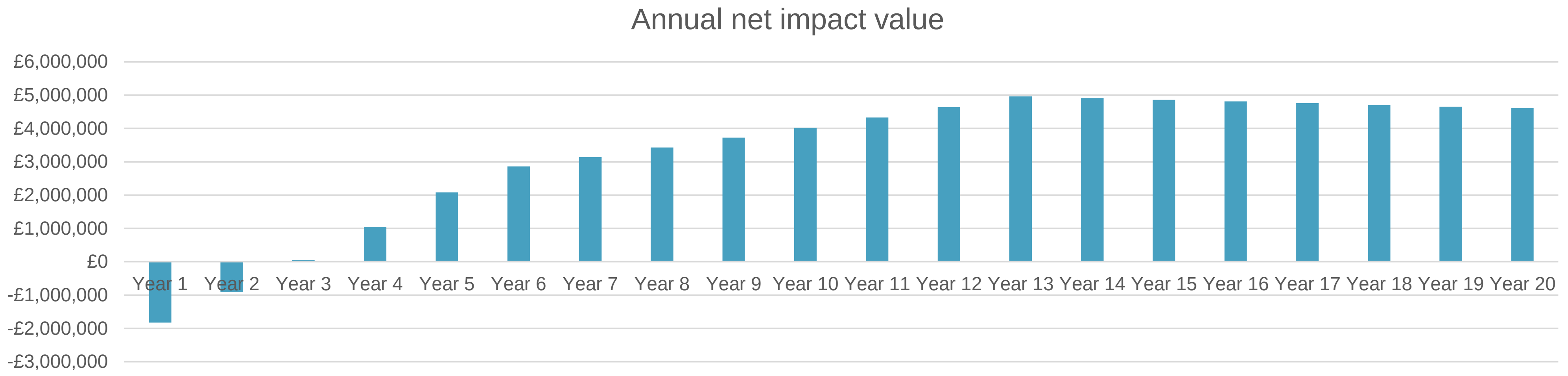
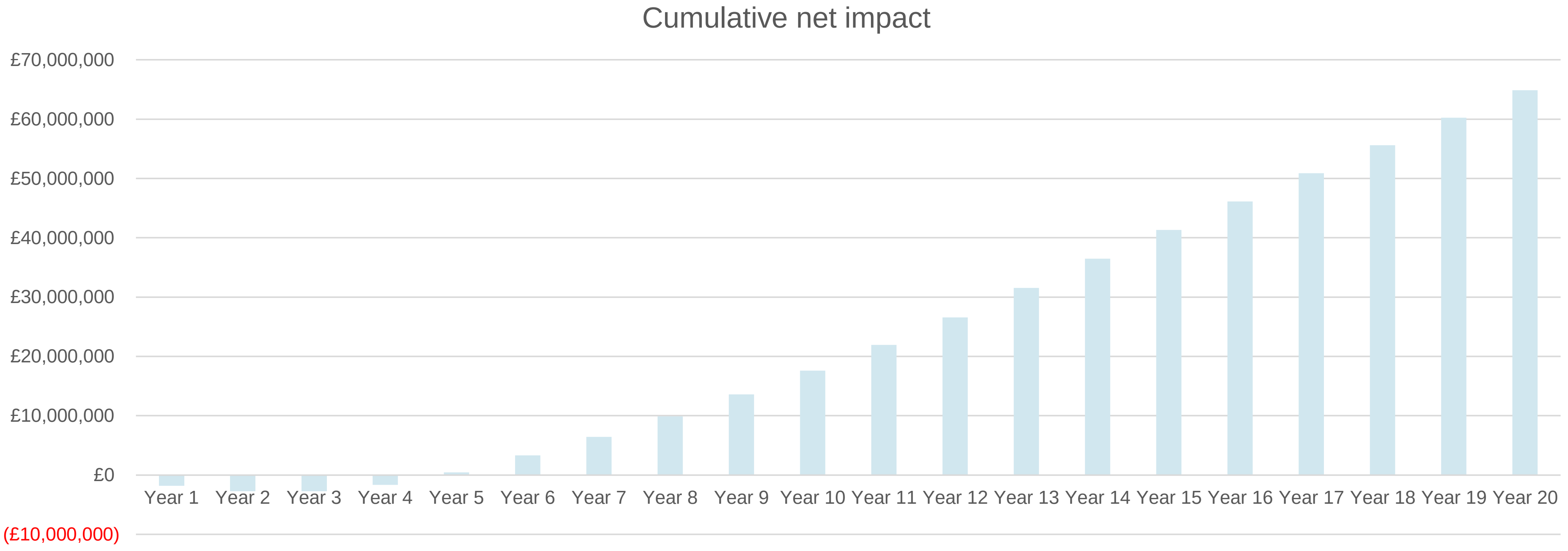
Scenario 9: High-Importance Habitats with 2nm buffer





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Scenario 10: Jersey's Territorial Extent

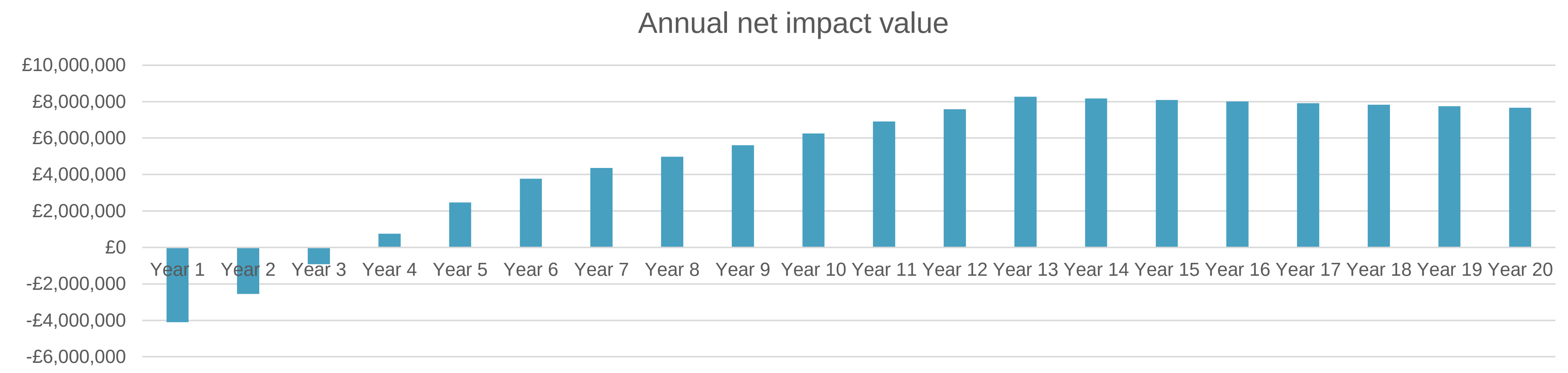
Net annual impact value

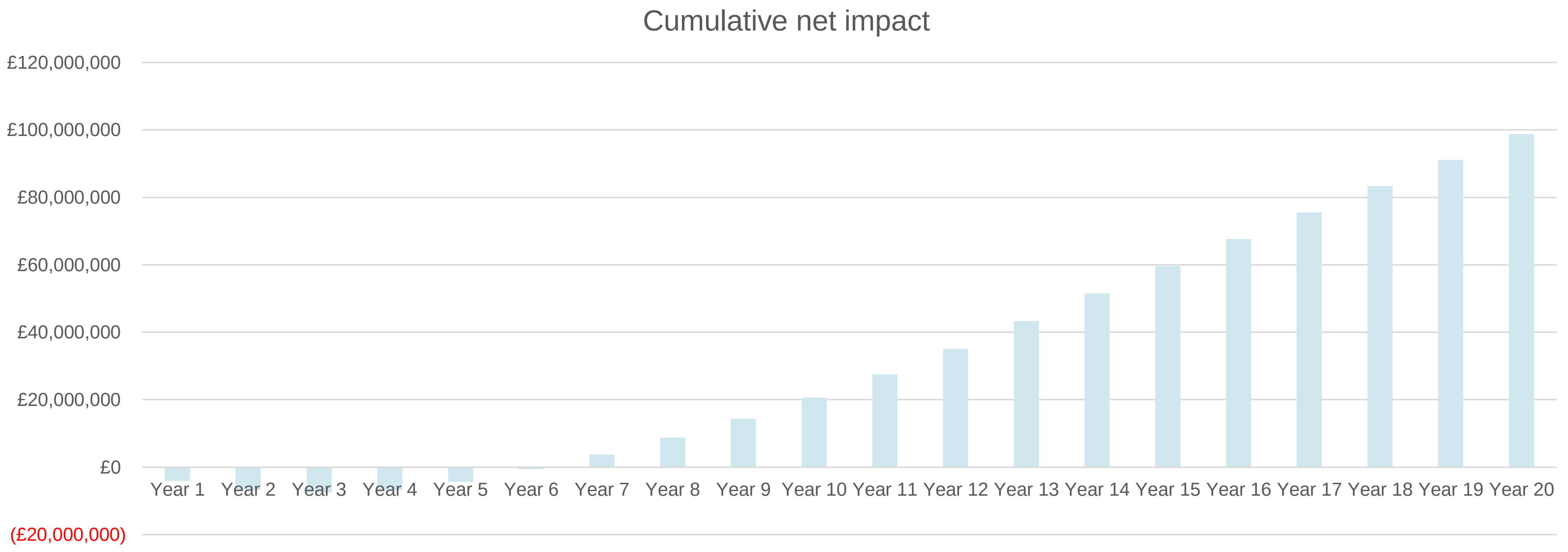
Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
-£4,102,259	-£2,550,679	-£917,539	£747,998	£2,466,509	£3,766,515	£4,367,105	£4,980,909	£5,608,387	£6,250,010
Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
£6,906,266	£7,577,655	£8,264,692	£8,176,855	£8,089,951	£8,003,971	£7,918,905	£7,834,742	£7,751,475	£7,669,092

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cumulative ecosystem benefit	£1,529,144	£4,588,104	£9,182,645	£15,384,141	£23,246,187	£32,350,896	£41,999,461	£52,205,698	£62,983,878	£74,348,737
Cumulative total costs	£5,631,403	£11,241,042	£16,753,122	£22,206,620	£27,602,158	£32,940,352	£38,221,811	£43,447,139	£48,616,932	£53,731,781
Cumulative net impact	-£4,102,259	-£6,652,939	-£7,570,477	-£6,822,479	-£4,355,971	-£589,456	£3,777,649	£8,758,559	£14,366,946	£20,616,956
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Cumulative ecosystem benefit	£86,315,491	£98,899,851	£112,118,036	£125,195,739	£138,134,451	£150,935,651	£163,600,799	£176,131,342	£188,528,710	£200,794,318
Cumulative total costs	£58,792,269	£63,798,973	£68,752,467	£73,653,315	£78,502,076	£83,299,304	£88,045,548	£92,741,348	£97,387,242	£101,983,758
Cumulative net impact	£27,523,222	£35,100,877	£43,365,569	£51,542,424	£59,632,375	£67,636,346	£75,555,251	£83,389,993	£91,141,468	£98,810,560

Ecosystem service type	Ecosystem service	1-year impact	5-year impact	10-year impact	20-year impact
Regulating	Resilience and resistance	£19,248	£302,780	£991,584	£2,728,476
Regulating	Biologically mediated habitat	£75,292	£1,184,401	£3,878,840	£10,673,143
Supporting	Nutrient recycling	£1,637,708	£25,762,398	£84,370,251	£232,155,962
Regulating	Gas and climate regulation	£477,292	£7,508,164	£24,588,769	£67,659,266
Supporting	Bioremediation of waste	£1,876,655	£29,521,231	£96,680,192	£266,028,403
Provisioning	Leisure and recreation	£593,013	£7,031,944	£17,748,599	£37,538,393
Provisioning	Food provision	£18,359	£174,439	£422,057	£879,316
Provisioning	Raw materials	£5,544	£31,828	£66,471	£130,443
Cultural	Cultural heritage and identity	£1,947	£9,546	£18,582	£35,269

Scenario 10: Jersey's Territorial Extent





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