

A summary of Seabird Monitoring on Sceilg Mhichíl 2020 – 2023



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Summary

The Sceilg Mhichíl World Heritage Property Management Plan 2020–30 as prepared by Department of Housing, Local Government and Heritage provides the framework for the sustainable management of the UNESCO World Heritage Property of this island which, together with Little Skellig and surrounding waters, constitutes the Skelligs Special Protection Area (SPA). Both Little Skellig and Sceilg Mhichíl are statutory Nature Reserves.

The National Parks and Wildlife Service instigated a seabird monitoring programme on Sceilg Mhichíl in the early 1990s. After a brief pause in the early 2000s this work resumed and developed further. This report summarises the seabird monitoring programme thus far with particular emphasis on the 2020–2023 period. Population estimates of each of the island’s eleven breeding seabird populations are presented here. The majority of Sceilg Mhichíl’s are assessed as stable or increasing including Puffin, Guillemot and Fulmar. With varying levels of certainty three species are considered to be in decline namely Kittiwake, Manx Shearwater and Storm Petrel.

The scope of the monitoring programme developed significantly during this period with greater insights gained into the year to year changes in the species’ population sizes as well as quantifying some species’ productivity rates and other aspects of their breeding ecology.

Acknowledgments

Sincere thanks to the Office of Public Works (OPW) for facilitating this survey and to the other members of the Sceilg Mhichíl Implementation Group (SMIG) for the Sceilg Mhichíl World Heritage Property Management Plan 2020–30, namely the National Monuments Service (NMS), part of the Department of Housing, Local Government and Heritage. Oscar Merne alongside one of the authors (AW) initiated the NPWS seabird monitoring programme on Sceilg Mhichíl in 1990. A second phase of this monitoring started in the 2000s and the following people played significant roles in the field work that produced the survey data over the last 18 years: Anthony McGeehan, Brendan O’Connor, Christen Ghlader, Eoin McGreal, Gavin Arneill, Irene O’Brien, John Murphy, John Wilson, Killian Mullarney, Magnus Robb, Steve Newton, Tony Murray and Sineád Cummins.

Introduction

Sceilg Mhichíl, Skellig Michael or Great Skellig is one of Ireland's most important multi-species seabird colonies. Skellig Michael and Little Skellig along with the surrounding waters are classified as a Special Protection Area (SPA) under the EU Birds Directive. These highly exposed and isolated islands, which are separated by a distance of 3 km, are located in the Atlantic over 10 km off the County Kerry mainland. The following breeding seabird species are listed under the SPA citation: Fulmar, Manx Shearwater, Storm Petrel, Gannet, Kittiwake, Guillemot and Puffin. The SPA's Gannet colony is sited on Little Skellig. Skellig Michael holds at least the majority of all the remaining listed seabird species populations. Both Skellig Michael and Little Skellig are statutory nature reserves.

Skellig Michael is also an important early medieval monastic site. The monastic complex is associated with the arrival and spread of Christianity and emerging literacy of lands so remote that they were beyond the frontiers of the Roman Empire and the reach of organised monasticism which spread from Egypt to Ireland in the 5th and 6th centuries. The date of the foundation of the monastery on this island is not known. It was dedicated to St Michael somewhere between 950 and 1050.

Sceilg Mhichíl is listed as a UNESCO World Heritage site under two criteria, namely:

- Criterion (iii): Sceilg Mhichíl illustrates, as no other property can, the extremes of a Christian monasticism characterizing much of North Africa, the Near East and Europe.
- Criterion (iv): Sceilg Mhichíl is an outstanding and in many respects a unique example of an early religious settlement deliberately sited on a pyramidal rock in the ocean, preserved because of a remarkable environment.

The Sceilg Mhichíl World Heritage Property Management Plan 2020–30 as prepared by Department of Housing, Local Government and Heritage provides the framework for the sustainable management of the UNESCO World Heritage Property of this island. The plan aims to ensure that the island's unique qualities and global significance are well understood and that its cultural and historical features and significance can be conserved and safeguarded alongside its biodiversity and natural heritage.

Key to the conservation management and safeguarding of the island's biodiversity and natural heritage is the continuation, and further strengthening, of NPWS's programme of seabird monitoring and research which was initiated in the early 1990s. To this end various actions are specifically listed in the Management Plan 2020–30 with regard to seabird monitoring. This report sets out contemporary population estimates for all of the island's breeding seabirds collected during the period 2020-2023 and contextualises these over a circa 30-year period. Additionally, other important demographic and phenological data is presented here for several of these breeding seabirds.

Seabird Population Estimates & Trends

There is significant variation across Skellig Michael's seabird species in terms of their breeding behaviour including nest site selection and the timing of breeding activities. Due to this variation differing monitoring strategies needs to be devised for particular species and/or species groups. Core to the seabird monitoring programme are various strands of monitoring, which can be broadly categorised as follows: 1) estimating the sizes of a significant subset of the island breeding species on an annual basis; 2) the production of annual indices of population sizes of those species that are logistically challenging to census fully; and 3) estimating the breeding productivity of some target species. The first category is dominated by the 'cliff nesting seabird' species (see below) where an annual census produces estimates of breeding population sizes and trends. Also whole island surveys of Manx Shearwater, Puffin and Storm Petrel all occurred during the period 2020-2023. Storm Petrel is currently the sole species where a population index is estimated on an annual basis. At this moment productivity monitoring effort is focussed on Kittiwake and Fulmar with increasing attention being brought to bear on Manx Shearwater, Puffin and Storm Petrel. Additional phenological data (e.g. dates of egg laying and chick fledging) is also gathered as part of this work strand.

Cliff nesting seabirds

Over the years the 'cliff nesting seabird survey' have received the most survey attention largely on account of the fact that a single survey, usually conducted over 2 – 3 days in mid- to late June can provide estimates of breeding population size for eight out of the eleven seabirds that regularly breed on the island. Some of the surveys visits (i.e. 2006, 2008 – 2011) were undertaken in early July, which is outside of the ideal surveying period as several species may begin to leave their nest sites and even the colony around this time.

Arranging visits to the island can be difficult due to availability of accommodation, poor weather and other events (e.g. in 2022 the survey was cancelled due to a rock fall incident). Nevertheless, a concerted effort is made to undertake the survey during the third week in June which usually occurs during the weekend period when accommodation availability is less pressured. Table 1 sets out the dates of the cliff nesters survey for the period 2006-2023.

Results of recent monitoring are presented here along with data from the period circa 1990-2002 as reported in detail by Merne & Walsh (2005). The survey methods employed to derive these estimates presented here conform to those set out in with Walsh et al (1995).

Table 1 Dates of the cliff nesting seabird survey on Skellig Michael 2006-2023

2006	02 July	2012	22 – 25 June	2018	22 – 25 June
2007	22 – 24 June	2013	28 – 30 June	2019	21 – 24 June
2008	04 – 05 June	2014	18 – 23 June	2020	19 – 23 June
2009	03 – 04 July	2015	19 – 22 June	2021	19 – 21 June
2010	09 – 12 July	2016	24 – 27 June	2022	Partial survey*
2011	01 – 03 July	2017	23 – 26 June	2023	16 – 19 June

*unlike all the other cliff nesting seabird species a 2022 population estimate was derived for Kittiwake which was based on a series of counts undertaken BP.

Fulmar *Fulmarus glacialis*

With the exception of 2022 the number of Apparently Occupied Sites (AOS) of Fulmar have been recorded annually for the period 2006-2023. Merne & Walsh (2005) provides annual estimates for the period 1991-2002. At 781 AOS, the calculated mean for the period 1991-2002 is significantly higher than the most recent mean of 678 AOS for the period 2006-2023 (unpaired t-test, $P < 0.01$) and equates to a decline of some 13%. However, an increasing trend during the period 2006-2023 is noted with the mean of 763 AOS reported for the 2020-2023 period (Figure 1). This equates to a 4% decrease from the mean of 795 AOS calculated for the period 1991-1994.

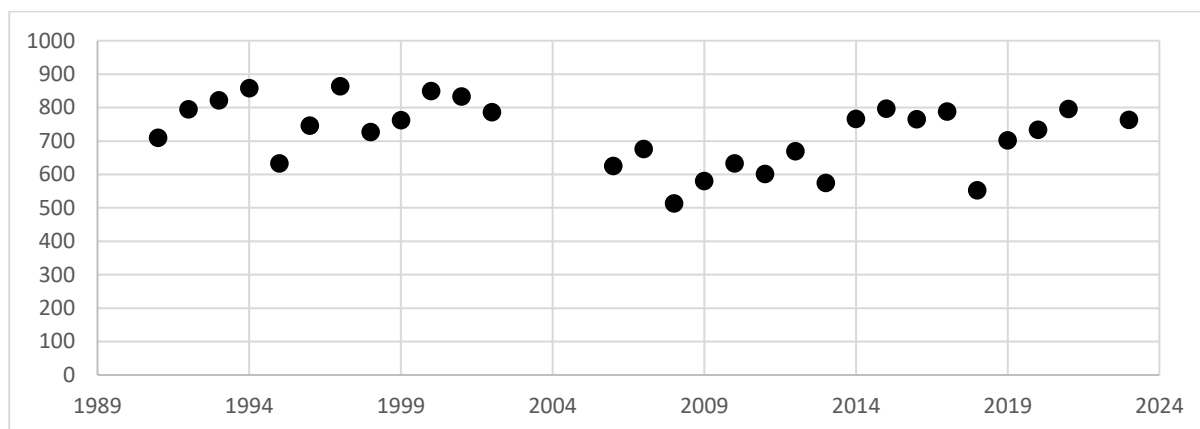


Figure 1 Numbers of Fulmar Apparently Occupied Sites on Skellig Michael 1991-2023. Note data based on this study and Merne & Walsh (2005)

Shag *Gulosus aristotelis*

Shag breed on Skellig Michael in relatively low numbers. Due to the later timing of the survey visits during the period 1990-2002 population estimates were not reported out in Merne and Walsh (2005) as the breeding birds had begun to leave their nest sites. During the period 2007-2019 number of Shag ranged from 0 to 3 Apparently Occupied Nests (AONs). Numbers have begun to rise with four AON recorded in 2020 and 2021 and six AON in 2023. This results in a mean estimate of four AON for the 2020-2023 period.

Lesser Black-backed Gull *Larus fuscus*

Merne & Walsh (2005) recorded Lesser Black-backed Gull breeding on the island every year but because the visits were made at the end of June and mid-July when a portion of the chicks were fledged or nearly fledged it was not always possible to quantify pairs of this gull by way of standard census units i.e. Apparently Occupied Nests and/or Apparently Occupied Territories (AOTs) and so the population was described by way of the total number of adult birds recorded at or near used nests or broods, which ranged from 30 to 78 individuals for the period 1990-2001. From 2014 onwards an estimate for the number of AOTs was produced and as per Figure 2 a strong increasing trend is noted. An estimated mean of 57 AOT for the 2020-2023 period is reported here.

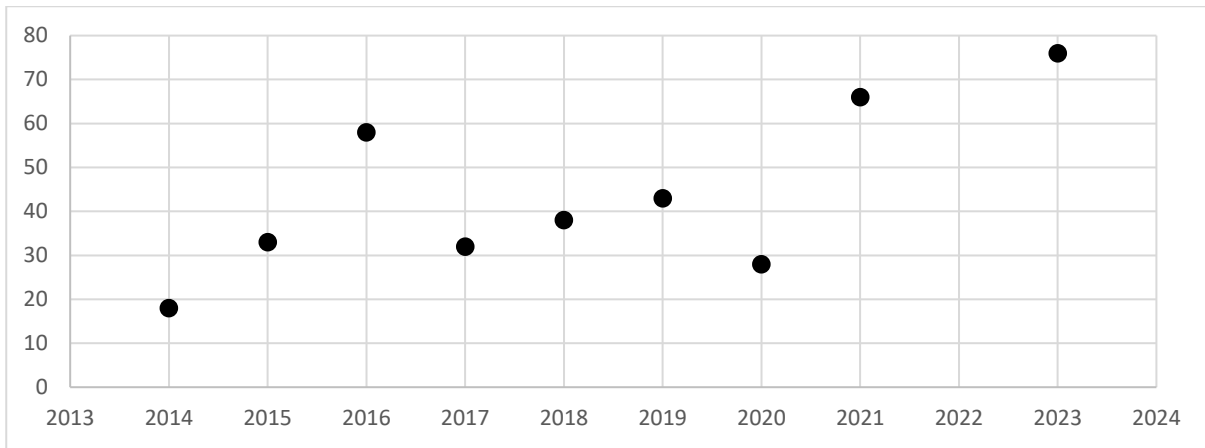


Figure 2 Numbers of Lesser Black-backed Gull Apparently Occupied Territories on Skellig Michael 2014-2023.

Herring Gull *Larus argentatus*

Similar to the Lesser Black-backed Gull counts over the decades Merne and Walsh (2005) reported the numbers of adults at or near nests or broods ranged from a low of four (in mid-July 1990) to peaks of 43 individuals in 1997 and 2002. The estimated breeding population of Herring Gull has also increased during the period 2014-2023 (Figure 3). An estimated mean of 38 AOT for the 2020-2023 period is calculated for Herring Gull.

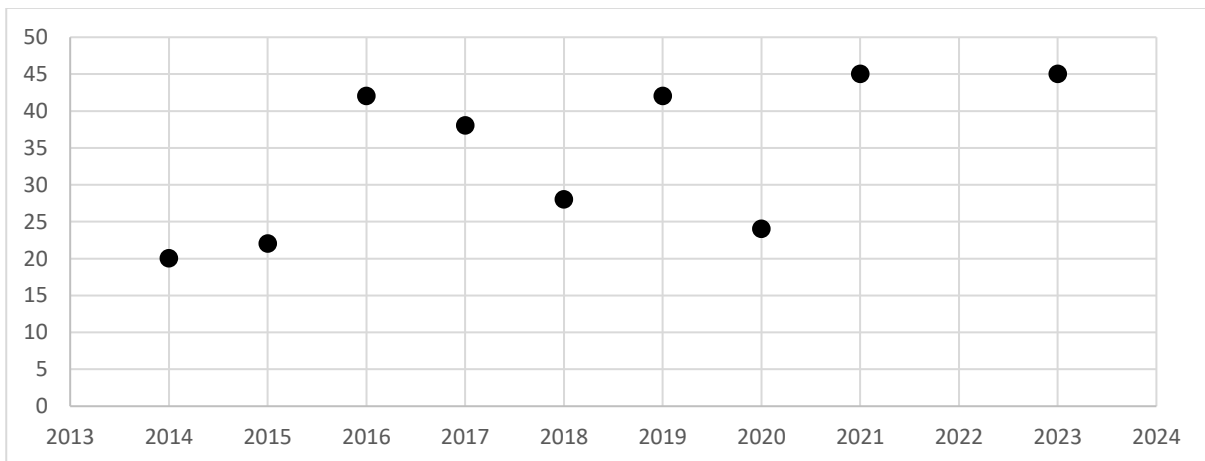


Figure 3 Numbers of Herring Gull Apparently Occupied Territories on Skellig Michael 2014-2023.

Great Black-backed Gull *Larus marinus*

Merne and Walsh (2005) recorded Great Black-backed Gull nesting every year ranging from four to 12 individual adult birds. Unlike the previous two gull species it was usually possible to identify most of the birds as breeding pairs, giving a range of two to six pairs. The mean estimate of this breeding population for the period 2020-2023 is five pairs which is within Merne and Wlash's (2005) reported range, indicating long term stability of this population on Skellig Michael but notable peaks in the estimated numbers of Great Black-backed Gull AOTs were noted in 2017 and 2019 (Figure 4).

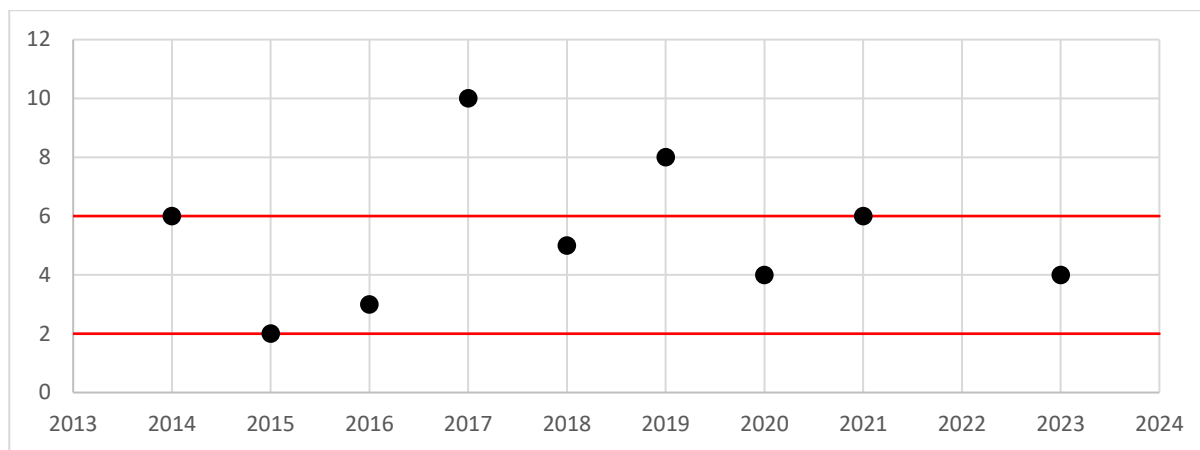


Figure 4 Numbers of Great Black-backed Gull Apparently Occupied Territories on Skellig Michael 2014-2023. Note the red lines indicate the minimum and maximum number of AOTs recorded by Merne and Walsh (2005) during the period 1990-2002.

Kittiwake *Rissa tridactyla*

During the tenure of Merne & Walsh's (2005) monitoring a decline in the breeding population of Kittiwake was noted with a peak of 1,143 AONs recorded in 1993 to a low of 625 AON (Figure 5). The continuing decline was noted in the early years of this study which reached a low of 365 AON in 2010. For the next seven years the population recovered to almost it's early 1990's size but this was not maintained as numbers have now reached their lowest since annual monitoring began in 1990 and the second lowest on record – in 1966 the population had declined to 305 pairs (Evans & Lovegrove 1974). Comparing the means of the first four years of Merne & Walsh's (2005) study with the most recent four-year period the population has declined by 39% (1,1082 AON, 1990-1993; and 665 AON, 2020-2023).

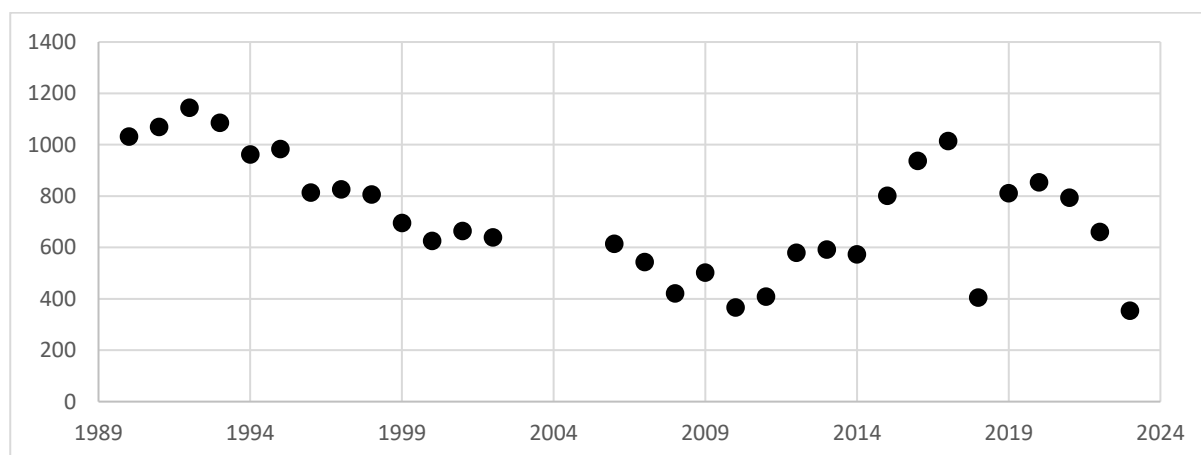


Figure 5 Numbers of Kittiwake Apparently Occupied Nests on Skellig Michael 1990 – 2023. Note data based on this study and Merne & Walsh (2005)

Guillemot *Uria aalgae*

Figure 6 show a relatively strong increase in the numbers of individual Guillemot recorded in recent (2014 onwards) years. Merne and Walsh (2005) reported mean of 1,070 individual Guillemot recorded during the period 1991-2002 is significantly smaller than the recorded mean of 1,926 individuals for this study's findings (2010-2023). The estimated contemporary size of Sceilig Mhili's Guillemot population, based on the mean of data from the period 2020-2023 is 2,287 individuals, which equates to an 124% increase from the calculated mean (at 1,023 individuals) for the period 1991-1994. Merne & Walsh (2005) cautioned that seabird species such as Guillemot begin to desert their colonies in July and therefore it is possible that the timings of the two sets of monitoring periods (i.e. 1991-2002 and 2010-2023) may account for some of the calculated increasing trend since the early 1990s.

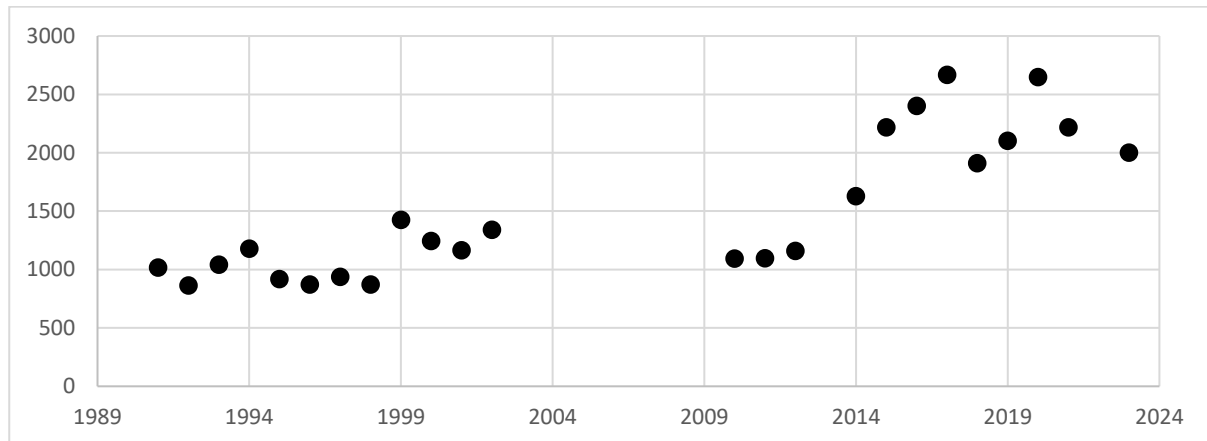


Figure 6 Numbers of Guillemot individuals on Skellig Michael 1991-2023. Note data based on this study and Merne & Walsh (2005)

Razorbill *Alca torda*

Merne and Walsh (2005) report a mean of 315 individual Razorbill recorded during the period 1991-2002. As per Figure 7 the reported range (149-528) is wider than that of this study which reports a mean of 291 individuals for the period 2010-2023, which is not statistically different from the earlier mean (t-test $P = 0.43$). The estimated contemporary size of Skellig Michael's Razorbill population, based on the mean of data from the period 2020-2023 is 310 individuals.

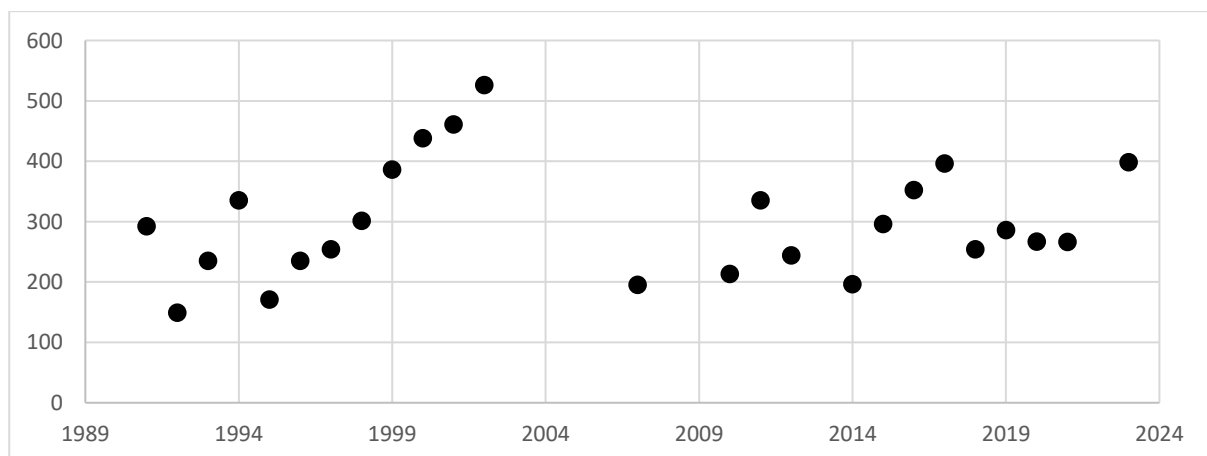


Figure 7 Numbers of Razorbill individuals on Skellig Michael 1991-2023. Note data based on this study and Merne & Walsh (2005)

Storm Petrel *Hydrobates pelagicus*

Listed on Annex I to the European Birds Directive, the European Storm Petrel (hereafter Storm Petrel), is Europe's smallest seabird with a population size of an estimated 459,000 - 551,000 breeding pairs in Europe, of which approximately 21% are believed to breed in Ireland (Burnell et al., 2023). The Storm Petrel only visits land, and only under the cover of darkness, to breed, laying a single egg in rock crevices (e.g. scree, stone walls) or burrows (Figure 8)

Work estimating the size and trend of Storm Petrel breeding population consisted of two strands namely: a full survey of the Storm Petrel population of Great Skellig focussing primarily on the built heritage structures but also including work on estimating numbers across the island's natural habitats; and annual monitoring of Storm Petrel abundances along the island's three sets of stone steps.



Figure 8 Storm Petrel chick in front of nest site cavity

2020-2021 Island wide survey

The fieldwork that led to the derivation of an estimate for the island's entire breeding population of Storm Petrel took place on 18-24th July, 2020 and 17-21st July, 2021. The primary focus of the work was to survey all of the potentially suitable nesting habitat that was situated across the island's built heritage along with some work to estimate the density of birds breeding in scree, cracks, crevices, burrows and in dense vegetation away from the built structures.

Surveying for breeding Storm Petrel can be quite challenging due to the fact that they are largely nocturnal when flying close to the island and because they nest in burrows or crevices often in areas only accessible by way of ropes e.g. the walls along the path to the lighthouses (Figure 9).

The survey works builds upon the previous survey work of the island as described by Mitchell et al 2004, Money et al 2009 and Newton & Lynch 2015. The methodology employed was adapted from Arneill (2018)

and is elaborated further in NPWS (2020). The work involved the playing of Storm Petrel calls across transects to elicit a response from adult birds present at the nest site. After estimating response rates these records were extrapolated to produce overall population estimates. The unit of population measurement is the Apparently Occupied Site or AOS which is analogous to the number of breeding pairs.

Over the course of the two field seasons of 2020 and 2021 all the main built heritage structures that were considered to be potential Storm Petrel nesting habitat was surveyed. A small number of isolated walls



situated away from the main complex in difficult to access areas such as the lower NW facing slopes of Christ's Saddle and at the slopes north of the upper Lighthouse complex were not surveyed.

The majority of the archaeological structures, all of the three main sets of steps and the walls stretching from the lower lighthouse towards the harbour were surveyed in 2020 (Figure 9). To aid survey planning and execution as well as making the survey data as comparable as possible to future surveys the areas of built heritage were divided up into sections and with each section comprised of a number of transects. Details of these transects are held in NPWS archives. In 2021 the walls between the upper and lower longhouses were surveyed in addition to other archaeological structures that were not covered sufficiently in the previous year.

Response rates were derived for both years: 2020, 0.334 (SE 0.29-0.38); and 2021, 0.534 (SE 0.50-0.57). Combining both years' data a built heritage Storm Peter population estimate of 2,617 (2,341-2,973) is produced.

Figure 9 Surveying the wall between the lower lighthouse and the harbour for Storm Petrel, July 2020

The total area of Storm Petrel open nesting habitat (as opposed to the nest sites associated with built heritage e.g. walls, beehive huts, steps) was estimated based on a three dimensional LiDAR derived model. Outside of the built heritage areas, broad areas of the island were identified as containing potential nesting Storm Petrel habitat and this was calculated to extend to some 235,285m² of open ground (Figure 10). A total of 16 transects ranging in lengths of 20 to 100m and covering approximately 2,728m² were surveyed across these areas in July 2021. Factoring in the 2021 response rate an open ground breeding population of 5,040 (4,730-5,395) AOS is derived.

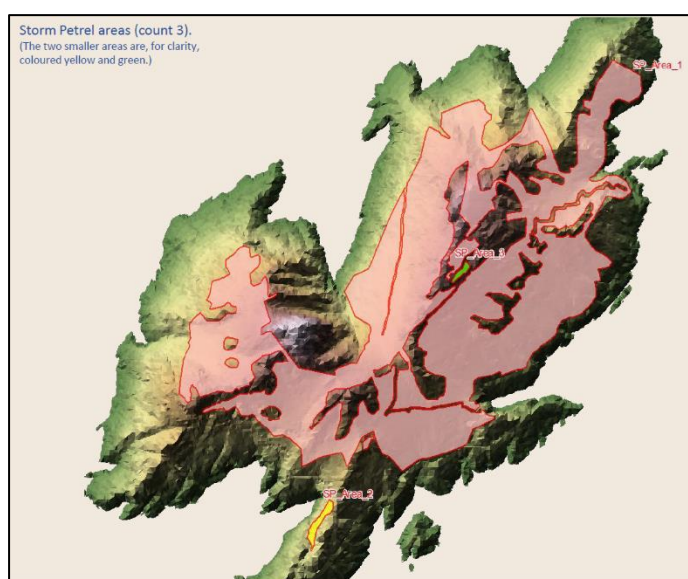


Figure 10 Estimated areas of natural Storm Petrel habitat

Note the proportion of the open ground survey only equates to 1.2% of the estimate total habitat is relatively small. Also the choice of transects were not strictly random as accessibility issues were relevant. Therefore, our population estimate for this portion of the island's breeding Storm Petrel population needs to be viewed in that context.

When one combines the population estimates of the portions of the Storm Petrel population siting their nests within the built heritage structures with that of the natural nesters an overall estimate of 7,657 AOS (7,071–8,368) is arrived at. This is 23% lower than the island's previous population estimate as reported in Mitchell et al (2004) of 9,994 (8,135–13,454). This calculated decrease must be treated with caution as the ranges of the two population estimates overlap and also it is likely that the methods used in the 2000 survey were not precisely similar to those of the 2020-2021 survey.

Monitoring of Skellig Michael's three sets of steps

Island wide breeding surveys of Storm Petrel are logistically complex and require significant amounts of effort. When combined with the scarcity of accommodation on the island it is unsurprising that such surveys are only successfully carried out every 20 or so years. In order to meet the need to acquire more frequent insights into the status of the island's breeding population a programme of work to monitor a portion of the island's population was developed. Skellig Michael has three sets of steps i.e. South Steps, East Steps and the North Steps, which account for circa 21% of the entire island's built heritage portion of the breeding population (or circa 11% of the entire island Storm Petrel population) are now monitored on an annual basis (Figure 11).

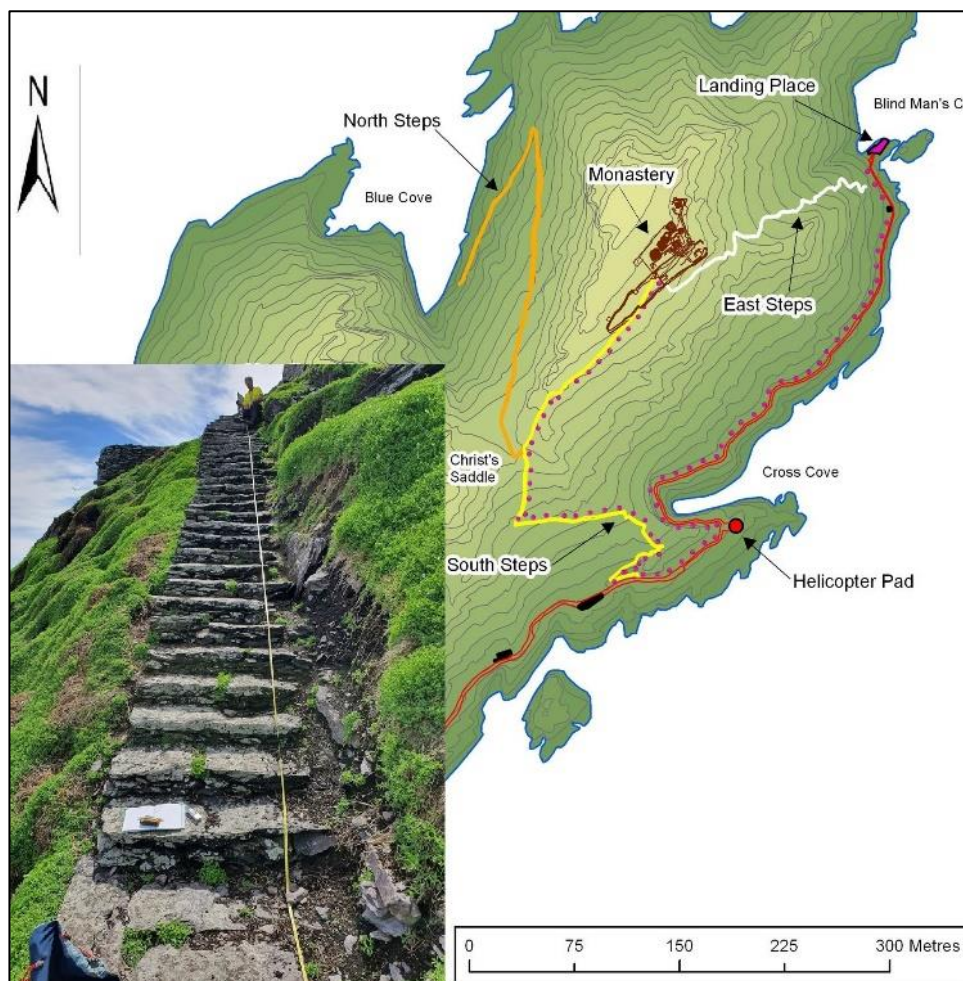


Figure 11 Storm Petrel monitoring across Skellig Michael's three sets of steps.

This annual monitoring is underpinned by a baseline survey of the steps carried out in 2018 (see Arneill and Quinn, 2018). Note that the lower sections of the East Steps are difficult to access in poor weather and therefore do not form part of the annual monitoring regime. To date annual monitoring has taken place from 2020 onwards and results show that the South Steps holds the majority of ‘steps population’ and that the trends differ between the three sets of steps (Figure 12).

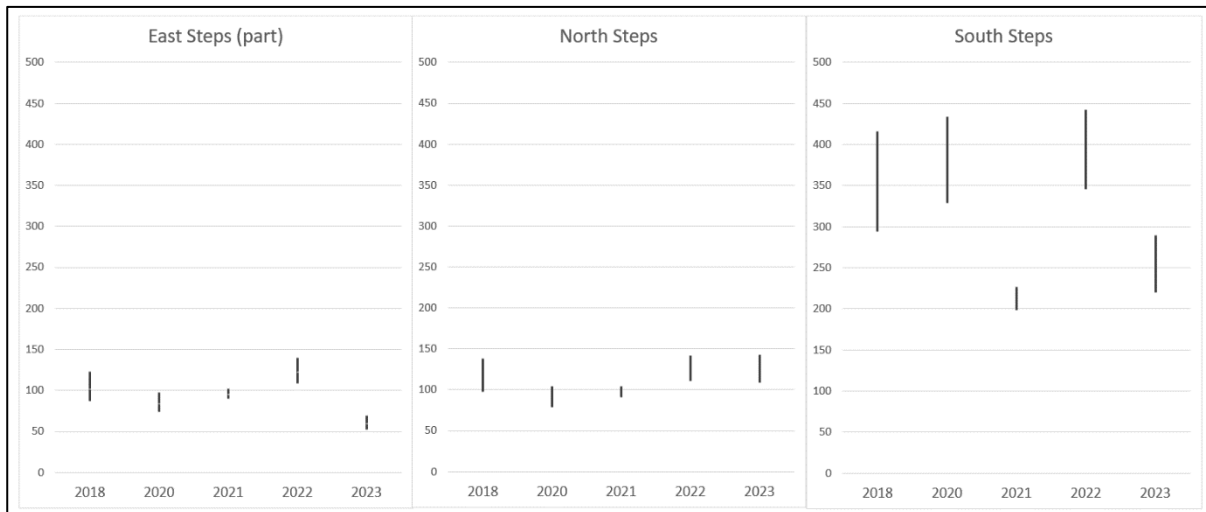


Figure 12 Storm Petrel population estimates across Skellig Michael’s three sets of steps 2018 and 2020-2023.

The relatively large decline for the South Steps is noteworthy: 1) due to the fact that the South Steps holds an important portion of the overall built heritage element of the island’s Storm Petrel breeding population; and 2) unlike the East and North Steps, the South Steps are the main access route for tourists visiting the monastic complex. The interaction between potential recreational disturbance and the island’s Storm Petrel population requires increased focus (see Watson et al 2014).

However, the dataset is still small and taking inferences from the limited time series is still somewhat premature but the available data indicate that this index is signalling a stable population at best and possibly a decline (Figure 13).

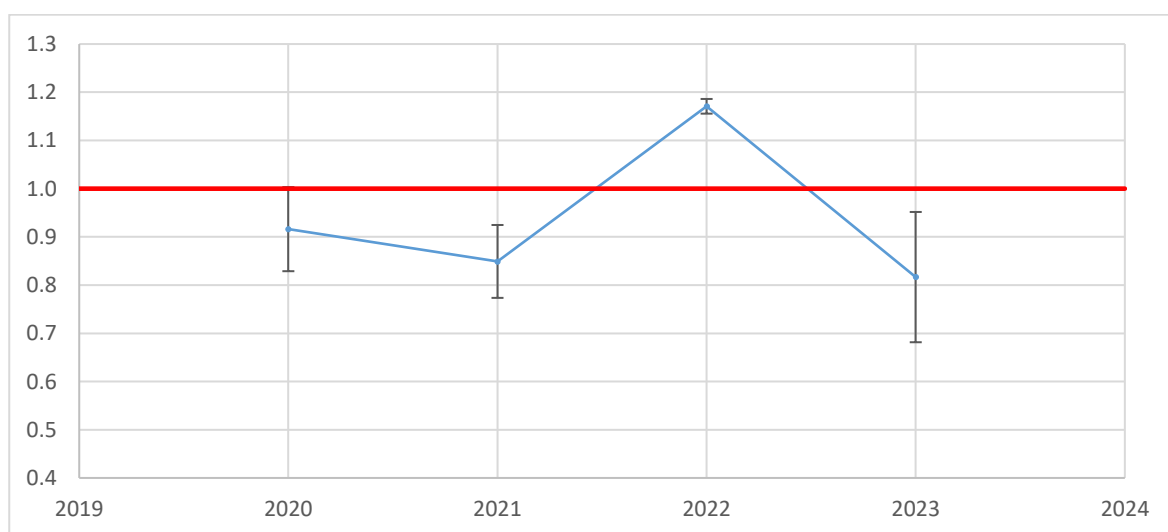


Figure 13 Index of Storm Petrel breeding abundance across Skellig Michael’s three sets of steps 2020-2023. Note red line indicates the 2018 baseline index of 1.0

Manx Shearwater *Puffinus puffinus*

Skellig Michael's breeding Manx Shearwater population was surveyed during the breeding season of 2021 and this summary is based upon the Power et al (2021) survey report. This species predominately nests



in burrows on small plateaus or on sloping ground across the island – although small numbers breed successfully in some of the island's beehive huts. Manx Shearwater enters and leaves the breeding burrow in darkness (to avoid predatory birds) making the surveying of this species a challenge. Furthermore, a large proportion of the Manx Shearwater habitat are sited on slopes that require the use of ropes to access the safely (Figure 14).

Figure 14 Surveying for Manx Shearwater on sloping ground off the South Steps

The survey was conducted during the period 19/05/21 – 12/06/20 using a tape playback approach informed by Arneill (2019). The unit of measurement is the Apparently Occupied Burrow (AOB) which is analogous to the breeding pairs. The response rate fieldwork was carried out over the period 1-3 June inclusive and produced a rate of 0.44 (CI 0.27-0.61).

Similar to the Storm Petrel approach outlined above the majority of total area of Manx Shearwater nesting habitat estimated based on a three dimensional LiDAR derived model whilst smaller more accessible areas were measured on site. In total Power et al (2021) estimates a population of 573 (412-936) AOB distributed over 37,254m² of nesting habitat. The majority of the population is estimated to occur across areas 1 – 3 (Figure 15). However, a significant proportion (circa 30%) of the overall estimated population is concentrated in the relatively smaller areas of MX21 – MX23 including Christ's Saddle and areas associated with the monastery complex (see Figure 16 and Power et al 2021 for more details).

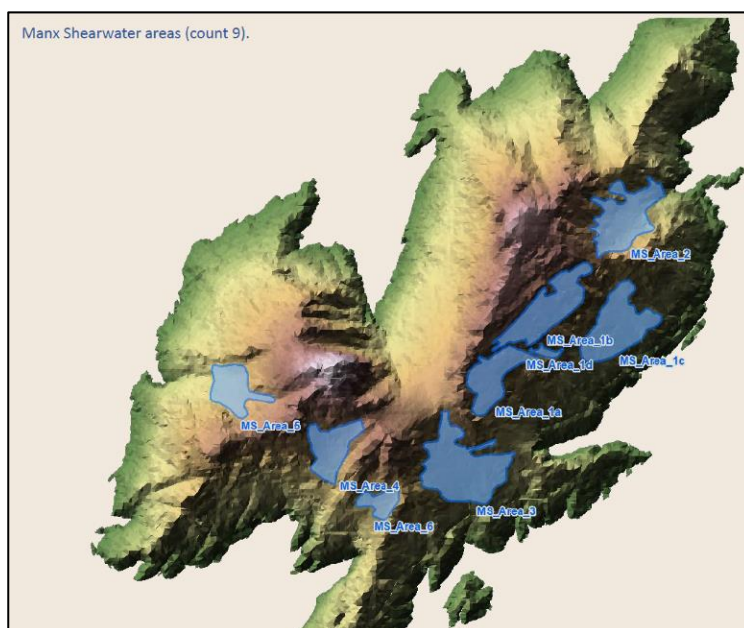


Figure 15 Estimated areas of Manx Shearwater habitat

The 2021 population estimate of 573 (412-936) AOB is smaller than the 2001 population estimated as reported by Mitchell et al (2004) of 738 (561-1,077) by 22%. This calculated decrease must be treated with caution as the ranges of the two population estimates overlap and also it is likely that the methods used in the 2001 survey were not precisely similar to those of the 2020-2021 survey.

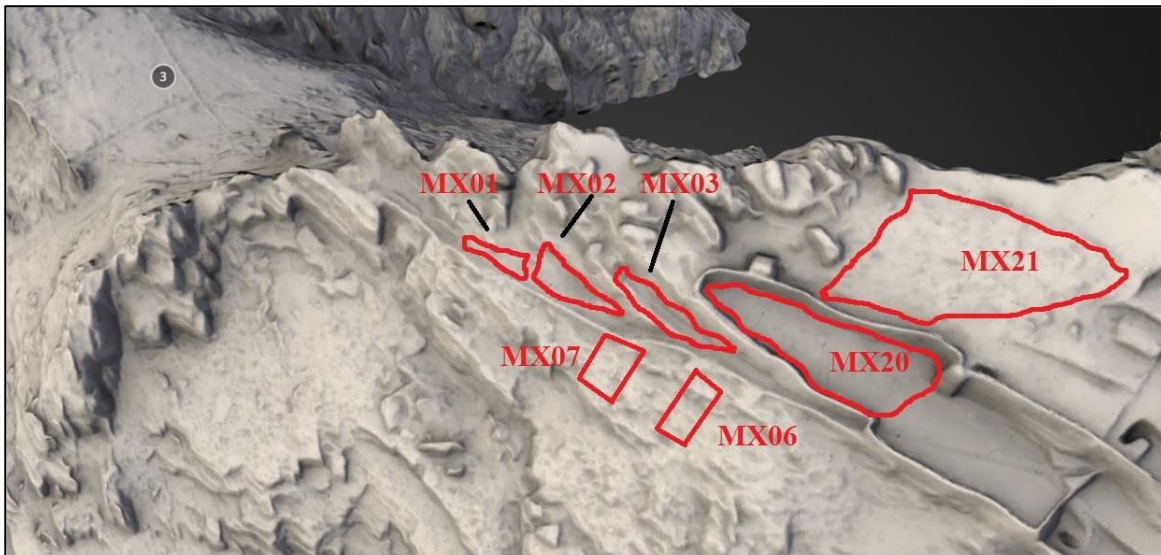


Figure 16 Further Manx Shearwater nesting areas associated with the monastery complex on the north peak

Puffin Fratercula arctica

The latest breeding Puffin survey of Skellig Michael took place in May, 2023 and this summary is based upon the NPWS (2023) survey report. Puffin spend most of the year at sea but during the breeding season, starting in April, the islands off the southwest coast of Ireland host an important component of the overall Irish and British population of this auk species (Burnell et al 2023).

Ideally the best estimate of the size a breeding bird population is often based on a quantification of the number of active nests. However, Puffin breed in burrows and/or rock crevices often sited across inaccessible areas and this presents challenges for the surveyor attempting to determine a robust estimate of the size of the breeding population. Generally, counts of individual Puffin on land, flying over the island and on the sea surrounding the island can give an indication of the numbers attempting to breed especially if the counts are completed sufficiently early in the season; ideally in April and certainly before June when substantial numbers of immatures are thought to begin to attend the colony (Arneill 2018).

The majority of the Puffin nesting habitat of Sceilg Mhichíl are located on steeply sloping ground – this constrains our survey method to counting the number of individuals observed to be in attendance at the colony. However consistent access to the island to survey in April is not possible and so a series of counts in early May forms a pragmatic compromise especially as efforts to monitor a sample of accessible nests on land continue. Two separate surveys were conducted on the evenings of the 5th and 6th of May, 2023 by three surveyors. On both survey days the environmental conditions were favourable for survey (see NPWS 2023 for more details).



Figure 17 Puffin loafing near their nesting burrows, Skellig Michael

One of the objectives of these surveys was to establish a method of approach for future surveys of the Puffin population of Sceilg Mhichíl and therefore there was a significant degree of overlap and discussions between the three surveyors during the survey with regard to the delineation of count sites and other approaches. From the outset challenges in identifying and quantifying Puffin on the water were evident. The majority of the on sea Puffin lay some distance off the island (often > 200m) with some forming mixed flocks with other auk species (i.e. Razorbill and Guillemot) and therefore the use of a telescope (20 – 60 x 65) was necessary to identify and count Puffin on the water.

On both surveys similar routes were taken with the survey commencing on the western part of the island near the Old Lighthouse and continuing along the path as far as base of the South Steps where the team split with one continuing towards the harbour to undertake the sea counts of the waters lying to the SE of the island whilst the remaining members of the team paused their survey work to climb the South Steps and resumed the survey from the Monastery Complex and worked down.

A total count of 7,380 Puffin were recorded on the first survey with the respective Land : Sea : Air counts of 785 : 6,226 : 369. The second evening's count recorded a slightly higher count of 8,236 individuals with an L:S:A breakdown of 1,954 : 5,467 : 815. The number of birds recorded on the water as a proportion of the survey total decreased notably from 84% (Survey No 1) to 66% (Survey No 2). Conversely the proportion of individuals counted on land more than doubled over the two surveys (Figure 18).

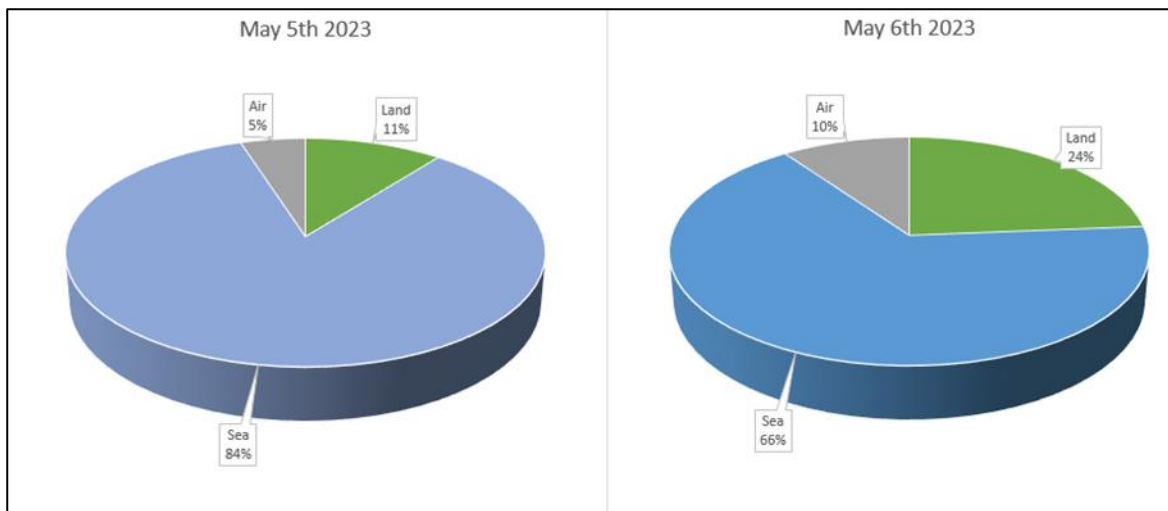


Figure 18 Proportions of Puffin counted on land, sea and air over two evenings in May 2023

Ostensibly, at approximately 8,000 individuals the findings of the May 5 – 6, 2023 surveys compare favourably with a previous count of 6,808 individuals taken on June 21, 2019 and 4,000 individuals counted on July 3, 1999. However due to the differences in timings and methodologies a precise quantitation of the changes of Skellig Michael's breeding Puffin population comes with several caveats.

The findings of the 2023 Puffin survey produced the third estimate of the size of the Puffin population associated with Skellig Michael over the last quarter of a century. More significantly, precise count areas of the breeding habitat of Skellig Michael and its adjacent waters have been defined here which will form the basis of recording future early May annual counts of the whole island as well as more regular subsampling monitoring initiatives within breeding seasons.

Summary Table of Skellig Michael's seabird population sizes and trends

Name	Population estimate	Details	Trend summary	Notes
Fulmar	763 AOS	Three-year mean (2020-2023)	Stable	< 5% calculated decline when comparing the means of 2020-2023 with 1991-1994
Manx Shearwater	573 (412 – 936) AOS	2021 survey	Possible decline	Seabird 2000 estimated 738 AOB (561-1,077) is 2001 equating to a 22% decline. Note however that the confidence intervals between surveys overlaps.
Storm Petrel	7,657 (7,071-8,368) AOS	2020-2021 Survey	Possible decline	Seabird 2000 estimated 9,994 AOB (8,135-13,454) is 2000 equating to a 23% decline. Note however that the confidence intervals between surveys overlaps.
Shag	4 AON	Three-year mean (2020-2023)	Possibly increasing	Shag are known to occur here since the 1990s. Latest results indicate an increase albeit from a low base.
Lesser Black-backed Gull	57 AOT	Three-year mean (2020-2023)	Increasing	Different count units used in the 1990s (see species account above)
Herring Gull	38 AOT	Three-year mean (2020-2023)	Increasing	Different count units used in the 1990s (see species account above)
Great Black-backed Gull	5 AOT	Three-year mean (2020-2023)	Stable	Different count units used in the 1990s (see species account above)
Kittiwake	665 AON	Four-year mean (2020-2023)	Declining	Kittiwake numbers have now reached their lowest since annual monitoring began in 1990.
Guillemot	2,287 IND	Three-year mean (2020-2023)	Increasing	Overall increasing population but it is possible that the gross timings of the two sets of monitoring periods (i.e. 1991-2002 and 2010-2023) may account for some of the calculated increase.
Razorbill	310 IND	Three-year mean (2020-2023)	Stable	A mean of 315 individuals was reported for the period 1991-2002. The estimated contemporary size, based on the mean of data from the period 2020-2023 is 310 individuals.
Puffin	7,808 IND	2023 Survey	Possibly increasing	Acknowledging differing survey methodologies the numbers of Puffin counted associated with Skellig Michael has increased from 4,000 individuals in 1999 to circa 8,000 in 2023

Productivity & phenology

This section of the report sets out the findings of additional monitoring effort focussing on a subset of breeding seabird species in order to get a better understanding on productivity rates, which is another important facet of understanding a population's demography. Work on getting a better understanding of the burrow nesting species breeding ecology specifically with regard to the timing of the various stages which is known as phenology.

Kittiwake

Kittiwake is one of only a few seabirds whose breeding population is in significant decline at the national level (Burnell et al 2023). Therefore, enhanced monitoring of this declining species is warranted in order to inform potential conservation actions. Annual Kittiwake productivity monitoring is ongoing at other sites across the country e.g. Wicklow Head (see Tierney 2022).

Work on establishing a suite of monitoring plots to assess the island's annual Kittiwake productivity started in 2017 (see NPWS 2017). However, as a greater on-site presence during the latter stages of the chick rearing period was needed to progress this initiative. Adequate levels of data only started to become available from 2021 onwards when the NPWS funded seabird monitoring contractor was established.

The establishment of this work coincided with a pronounced decline in the overall breeding population attempting to breed on Skellig Michael. It also coincided with a shift in the sizes and distributions of the various Kittiwake sub-colonies across the island. Productivity estimates from various plots were gathered over the years but the summary statistics presented here are based on only those plots that had 20 or more Kittiwake AONs.

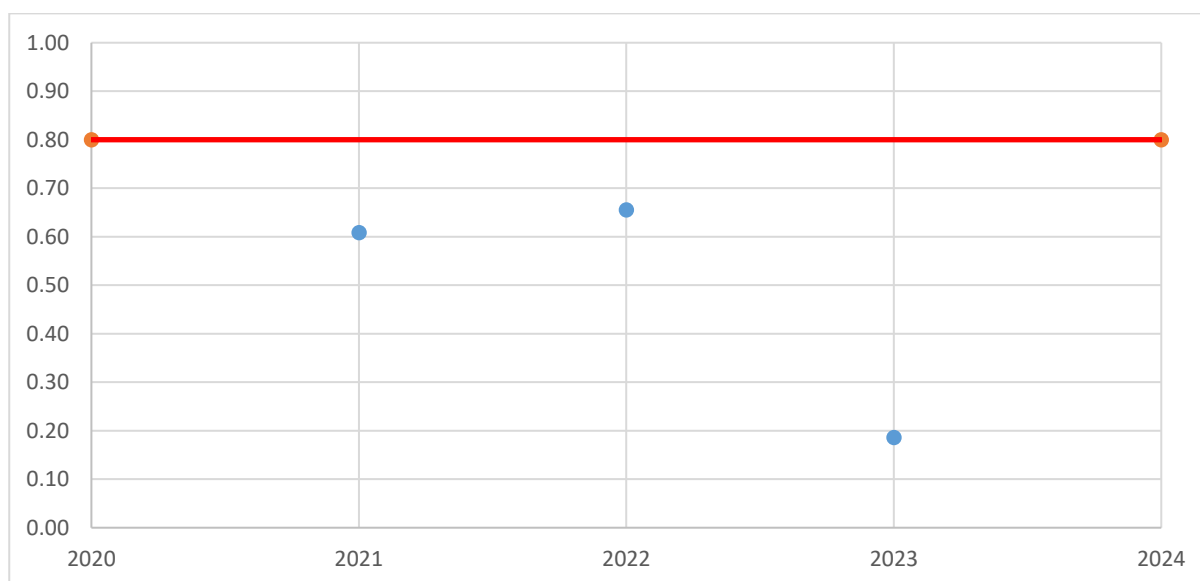


Figure 19 Estimated Kittiwake productivity (fledglings per pair) for the period 2021 – 2023 on Skellig Michael in relation to Coulson et al 2017's estimated productivity rate of 0.8 fledged chicks per pair necessary to maintain Kittiwake colonies.

The methods employed were informed by Walsh et al (1995) and the annual productivity estimates presented in Figure 19 are based on the assumption that all chicks within the age cohort Class D or older go on to fledge and that 50% of the younger chicks will not. For the period 2021 – 2023 Kittiwake productivity is estimated to be 0.49 (± 0.15 SE) fledglings per pair. Coulson et al (2017) established that based on data from UK Kittiwake colonies during the period 1985–2015, 0.8 fledglings per pair were needed to maintain the size of these colonies. Coulson (2017) also noted that this level of productivity is not a fixed value and changes if the adult mortality rate changes.

During the period 2021-2023 the breeding productivity values of Kittiwake at Skellig Michael were consistently poor and 2023 was a particularly poor year. The drivers for such poor performance could be due to marine conditions immediately prior to or during the breeding season but on island sources may also contribute (e.g. excessive predation at one or more of the sub-colonies). On June 19th, 2023 the waters off Ireland's southwest coast was estimated to be 17.4 °C, almost 4°C higher than the average June temperature (Met Eireann, 2023).

Fulmar

Data collection to inform the assessment of Fulmar productivity and to record fledging dates began in 2021. Monitoring plots are established on an annual basis and the fates of individuals pairs are tracked in each of the plots. Additionally, nesting attempts outside of these plots are also tracked to increase our power of analysis to describe annual peak fledging dates. This programme of work will expand and



Figure 20 Fulmar chick with adult in attendance

become more formalised in the years ahead – see Power (2023a) for further information. In 2023 presumed fledging activity was first observed on the 16th August within the monitoring areas, peaking between the 23rd-29th August and completed by the 1st of September. This closely resembles the pattern encountered in 2021 and 2022.

Over the period 2021-2023 inclusive the number of chicks presumed fledged per pair is estimated to be 0.56 (± 0.04 SE). As per Figure 21 it is evident that there is some variation between plots and between years. There is a dearth of long term data series from Irish colonies in relation to Fulmar productivity but contemporary data for the Cliffs of Moher exists (see Kavanagh 2020) and their estimates are broadly on a par with our Skellig Michael estimates (i.e. 0.52 ± 0.07 in 2020 and 0.67 ± 0.04 in 2017). Both of these sites' productivity estimates compare favourably against those data series from UK colonies as set out in JNCC (2021).

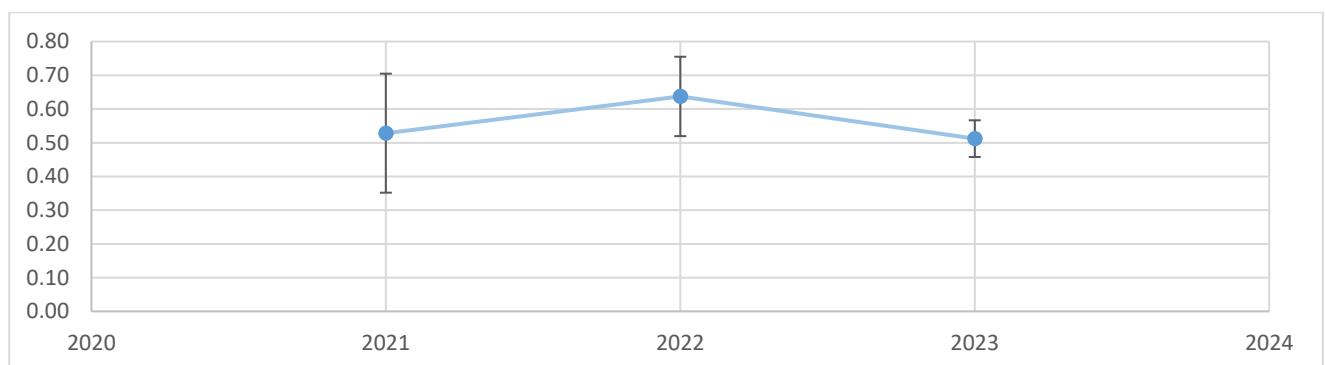


Figure 21 Trend in breeding productivity (no. of chicks fledged per pair) of Fulmar 2021-2023

Puffin

The monitoring of Puffin breeding activity on Skellig Michael continues to develop in the face of various constraints including: accessing the island during the early stages of breeding cycle, Puffin is one of the earliest breeding seabirds on Skellig Michael; nest site selection, the majority of nest sites are in burrows often located in friable soil and on steeply sloping ground; and biosecurity issues; Highly Pathogenic Avian Influenza has been active in some Irish seabird colonies in recent years, Puffin nests are not monitored remotely and often require the inspection of each burrow using a burrowscope. Nevertheless, data on hatching rates, fledging success and phenology is building (Power 2023b).



Figure 22 Near fledged Puffling at the entrance of its burrow with an adult in attendance

Initial results of the estimated fledging rates from Skellig Michael is 63% and 73% for the breeding seasons of 2021 and 2023 respectively compare reasonably well with long term studies from Scotland (JNCC 2021). However, these values need to be put in the context that Puffin populations are in decline in Scotland and elsewhere and that this seabird is one of only a few of Europe's Endangered bird species that breed in Ireland (See Burnell et al 2023, BirdLife International 2021)

Anecdotal reports based on the numbers of adult Puffin visible on the island during daylight hours indicated that Skellig Michael's Puffin breeding season in 2023 was completed earlier than usual. The Puffin burrow monitoring work, albeit which is still at an early stage of its development, supports this contention. In 2023, fledging was completed within all active monitoring nests by the 24th of July compared to 27% of those nests monitored in 2021 were found to still hold unfledged young by this date. In 2021 fledging continued into the first week of August.

Manx Shearwater

Several of the issues that are relevant to the development of the Puffin nest monitoring raised above also apply to Skellig Michael's Manx Shearwater breeding population. Twenty-six burrows were monitored in 2021 and 33 in 2023. The estimated productivity rate for both years are quite similar (0.61 and 0.62 chicks per breeding pair) and falls marginally below the long-term (1986 – 2019) UK productivity rate of 0.65 chicks per breeding pair (JNCC 2022).

Five of Skellig Michael's beehive huts hosted breeding pairs of Manx Shearwater during the period 2021-2023. In each the year the majority of these nesting attempts were presumed to have produced fledged young.

Storm Petrel

Despite the fact that the overall size of Storm Petrel population breeding on Skellig Michael is estimated at over 7,000 pairs finding suitable study nest sites is a significant challenge. This is in part due to the small rocky crevices that these birds nest in thereby limiting the opportunity to readily observe the actual site and any associated chick. Tracking the breeding cycle at each of the study nest sites is further exacerbated by this species relatively protracted breeding season with a proportion of the monitored nests each year remaining active after the OPW retreat from Skellig Michael for the year. Of the 18 nest sites monitored in 2023 twelve of these were known to be active in previous years of monitoring indicating a degree of site fidelity (Figure 23, Power 2023c).

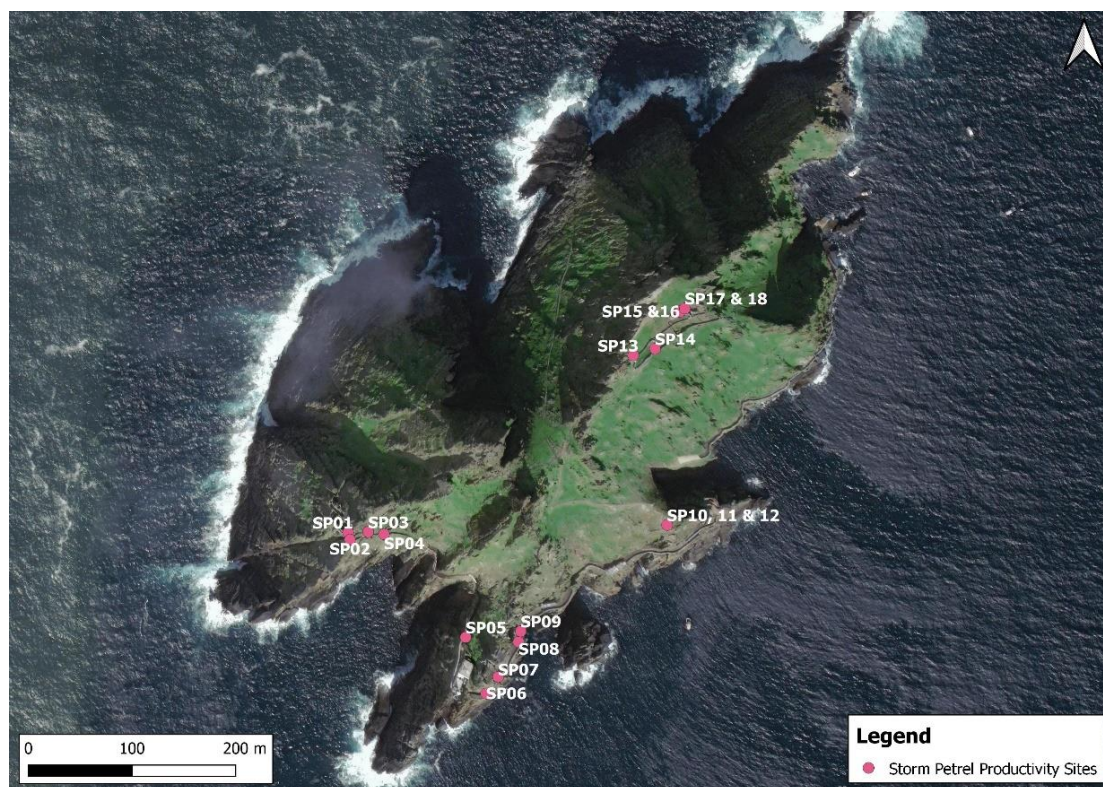


Figure 23 Storm Petrel nest sites monitored in 2023

Conclusion

Targeted monitoring of Skellig Michael's seabird populations is integral to the effective biological conservation management of this site whose unique archaeological and built heritage features also needs to be preserved. This island attracts 1,000s of tourists each year and it is important that the seabird monitoring is of a sufficient standard so that it can effectively inform the management of this World Heritage Site that such recreational pressures does not significantly impact upon the island's seabird populations.

The period 2020-2023 saw a significant step forward in our understanding of the breeding seabird populations of Skellig Michael. Over the breeding seasons of 2020 and 2021 fieldwork was carried out to produce updated population estimates of the island's nocturnal burrow nesting seabirds which are extremely challenging to survey i.e. Manx Shearwater and Storm Petrel. In early May of 2023 a survey of those adult Puffin associated with Skellig Michael was successfully carried out.

NPWS established a seabird monitoring initiative on Skellig Michael in the early 1990s. The cliff nesting seabird surveys carried out in June 2023 continues this work; annual population trend data now exists for up to 31 years over a 34-year time frame making this one of the most important time-series seabird population datasets for this period in Ireland.

More focussed monitoring on the breeding productivity rates of a subset of the island's seabirds continue to develop. Results thus far are mixed with Fulmar productivity rates at levels that are apparently maintaining its long term stable population trend. This is in stark contrast to the corresponding metrics for Kittiwake, a population in decline both at Skellig Michael and nationally indicating that a large scale driver such as climate change may, in part, be responsible for such chronically low levels of productivity. Although sample sizes and time series data are small the initial productivity rates for Puffin and Manx Shearwaters are at levels broadly on a par with study colonies in the UK that receive intense monitoring effort.

The annual monitoring of the numbers of Storm Petrel attempting to breed in the interstitial crevices of the island's three sets of steps continues. The results show that the south steps, which is the main thoroughfare for tourists accessing the monastery complex, hosts a significant portion of the overall population and that the most recent numbers attempting to breed at these steps are down. This is a cause for concern cognisant of the calculated 23% decline of the island's estimated population from the previous survey from the early 2000s. Further and more intensive study on this species is warranted. Such increased study effort could include closer examination of the potential impact of recreational disturbance on productivity rates as well as gaining insights into the feeding ecology of diet of the island's house mouse population to see if Storm Petrel eggs or chicks form a significant element (see Watson et al 2014 and Bicknell et al 2009).

Looking towards 2024 it is suggested that the NPWS seabird monitoring programme continues to be a key driver in implementing the objectives of Sceilg Mhichíl World Heritage Property Management Plan 2020–30. To achieve this the following ambitions are relevant:

- the annual securing of the services of an on-island seabird surveyor to support the survey and monitoring work of NPWS Birds Unit continues;
- on island facilities are available to the support surveyor to spend extended periods at key times of the year including early in the season (April and early May) to establish Puffin monitoring sites as well as late September and early October to continue the tracking of Storm Petrel nesting attempts;
- the rate of the roll out of artificial nest sites is increased substantially in order to increase the levels of monitoring of species such as Storm Petrel and Manx Shearwater;

- on island facilities are available for NPWS staff to undertake surveys throughout the season including Puffin survey (early May), cliff nesters survey (mid-June) and Storm Petrel monitoring along the three sets of Steps (mid-July);
- initiate a study on the house mouse population and its interaction with the Storm Petrel population; and
- trial a study to characterise the nocturnal flying activity of Storm Petrel along the lighthouse walls throughout the breeding season.

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