

The history, status and conservation management of Cottonweed *Achillea maritima* (*Otanthus maritimus*) (Asteraceae) at Lady's Island Lake, Co. Wexford, Ireland

Tony Murray^{1*}; Mike Wyse Jackson²

National Parks and Wildlife Service, Department of Housing, Local Government and Heritage: ¹Wexford, Ireland; ²Dublin, Ireland

***Corresponding author:** Tony Murray: tony.murray@housing.gov.ie

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Abstract

Cottonweed *Achillea maritima* (L.) Ehrend. & Y.P. Guo (*Otanthus maritimus* (L.) Hoffmans. & Link) is a distinctive, perennial member of the Asteraceae found on Mediterranean and Atlantic coasts. While formerly recorded from more than thirty coastal sites in Ireland, Great Britain and the Channel Islands it no longer persists at any of these other than at Lady's Island Lake, Co. Wexford (v.c.H12). Towards the end of the 19th century and during much of the 20th the species was recorded as occurring here in abundance; however, over the last half century this population has declined dramatically both in terms of extent and number of individuals such that as of 2021 only ten naturally-occurring plants remained at the site. This paper describes the history of recording of the species, focussing on sites in Ireland, and provides summary details of the populations recorded by the various botanists who visited and studied them. The various initiatives and conservation actions undertaken over the years in an effort to conserve the species are described and illustrated. Results are provided of recent conservation measures for the species and its habitat at Lady's Island Lake, including the management and protection of remaining plants, restoration of habitat for the species, collection of seed and cutting material for *ex situ* propagation and the return of *ex situ*-raised plants to a specially-prepared part of the site where the species formerly occurred. The population of *A. maritima* at Lady's Island Lake in 2021 comprised 10 naturally-occurring and 60 translocated individuals, as well as at least 64 young, self-seeded plants that had arisen from seed produced by translocated plants. The causes of the population decline at Lady's Island Lake are considered and discussed.

Keywords: History of recording; historic imagery; distribution; conservation status; conservation measures.

Introduction

Achillea maritima (L.) Ehrend. & Y.P. Guo is an attractive, aromatic, shrubby, woody-based, perennial herb belonging to the family Asteraceae [formerly Compositae]. It is a very distinctive species immediately recognised by its dense covering of white, cottony hairs and its rayless, yellow flower heads. Stace (2019) provides the following description [with explanatory detail for some terms provided here in square brackets]: "Plant from stems to phyllaries [bracts surrounding inflorescence] densely white-woolly; stems erect to ascending, to 30 cm; leaves oblong-ovate; capitula [flower heads], subcorymbose

[inflorescence almost flat-topped], 6-9 mm across". Additional details provided by Webb *et al.* (1996) include "leaves ... slightly crenate" [with very blunt, rounded teeth], "Florets ... all tubular" [i.e. the individual flowers in the inflorescence are rayless]. Tutin (1976), Clapham (1987) and Sell & Murrell (2006) provide additional details.

It is an iconic species whose presence in Ireland is well-known and of considerable interest, this being the last known occurrence of the species in Britain and Ireland and the northernmost remaining in Europe, and, indeed, globally. It is a species of coastal gravel shingle banks and upper beach communities found, for the most part, on Mediterranean and Atlantic coasts. It was formerly widespread (though never common) in Britain, but is now considered to be extinct there, and in Ireland it has been recorded from only a handful of sites. It occurs on the coasts of the Mediterranean Sea, predominantly along the European coast from Gibraltar east to Turkey (including a mapped location on the coast of the Black Sea), Syria and Israel and is also found at several sites on the North African coast and the Canary Islands. It is well-distributed on the Atlantic coasts of Portugal, Spain and France, extending as far north as the Cotentin Peninsula (<https://www.gbif.org/species/3120356> [accessed 24th February 2022]).

The importance of the Irish population has long been recognised and in 1980 it became legally protected under the Flora (Protection) Order, 1980. Its threat status in Ireland was assessed as Endangered in 1988 (Curtis & McGough, 1988) and Critically Endangered in 2016 (Wyse Jackson *et al.*, 2016) based on a significant decline in the size of the population and on the very small number of individuals remaining. The last remaining site for the species in Ireland is at Lady's Island Lake, Co. Wexford, where it occurs on the shingle barrier separating the lake from the sea. The conservation importance of the site for the species is recognised by its inclusion in the Lady's Island Lake Special Area of Conservation (<https://www.irishstatutebook.ie/eli/2018/si/292/made/en>) under the E.U. Habitats Directive and the listing of its habitat, the E.U. Habitats Directive Annex I habitat "1220 perennial vegetation of stony banks" [i.e. shingle banks], as a qualifying interest for this designated site.

Nomenclature and taxonomy

The species was first described by Carl Linnaeus in his *Species Plantarum* (Linnaeus, 1753), the accepted starting point for binomial botanical nomenclature, where it was treated as a species of the genus *Filago*, *Filago maritima* L. He provided a short description/diagnostic note ("*Filago tomentosa*, *corymbo subramoso*, *foliis oblongis*, *obtusis crenatis*") and stated that the species occurred in southern Europe on the shores of the Mediterranean Sea. Prior to 1753 the species had been known under various other binomial and polynomial names, the earliest cited by Linnaeus being that of Caspar Bauhin, "*Gnaphalium maritimum*" (Bauhin, 1623). Bauhin, himself, cited several even earlier references to this distinctive species.

Since 1753 several different names for the species have been employed, arising from uncertainties regarding its taxonomic affinities – *Athanasia maritima* (L.) L. in 1763, *Diotis candidissimus* Desf. in 1799, *Diotis maritima* (L.) Desf. ex Cass. in 1819 and, when placed as the sole member of the new genus *Otanthus* (Mabberly, 1987), *Otanthus maritimus* (L.) Hoffmanns. & Link in 1834, the most familiar and widely-used name. In 2005 the genus *Otanthus* was merged with *Achillea* and the species received the new and currently accepted name, *Achillea maritima* (L.) Ehrend. & Y.P. Guo (Ehrendorfer & Guo, 2005). Two subspecies have been described: *Achillea maritima* subsp. *atlantica* (Chrtek & B. Slavík)

Ehrend. & Y.P. Guo, to which plants from Ireland, Britain and Atlantic coasts of France are referred, and the type, subsp. *maritima* (Greuter, 2011+).

History of recording in Britain and Ireland

The first record of *A. maritima* in Britain was from near Colchester in 1597 (see Pearman, 2017) since which time it has been reported, generally as a temporary colonist, from sites along southern coasts from Suffolk to Cornwall and the Isles of Scilly, and on the west coast from Devon north to Anglesey in North Wales (Killick, 2002). Over the years it has been recorded from sites in thirty hectads in Great Britain and the Channel Islands (<https://bsbi.org/maps> [accessed 6th April 2022]), but has not persisted at any; it is assessed as Extinct in Great Britain (Cheffings & Farrell, 2005), England (Stroh *et al.*, 2014) and Wales (Dines, 2008). Its appearances and disappearances in Great Britain and the Channel Islands are well set-out by Marren (1999).

The first record of the species from Ireland is in Smith (1756), who listed it in his chapter entitled "Of the Rare and Useful Plants growing in Kerry" as follows: "42. *Gnaphalium maritimum*, C. B. Sea cudweed, or cotton weed, on the shores of the strand at Ballyheigh." The record is treated as unconfirmed in Colgan & Scully (1898), dubious in Praeger (1901) and unconfirmed in Scully (1916). Scully (1916) did, however, state that, although there had been no confirmation of the species in Kerry since, it "is quite possible, however, that the *Diotis* really grew at Ballyheige and has been exterminated since Dr. Smith's time by the severe Atlantic storms to which this locality is much exposed". Given that the species is distinctive and not easily mis-identified, and that it was reported from suitable habitat it is considered that, on balance, Smith's record is more likely correct than not. Recent surveys at Ballyheigue have failed to record the species and, if it was present in Co. Kerry in Smith's day, it now considered to be extinct there.

The next record for the species from Ireland was from Co. Waterford where George J. Allman observed it "during the latter part of the summer of 1845, in the sand-hills in the neighbourhood of Dungarvan" (Allman, 1846). This record is supported by a specimen in the herbarium of Trinity College Dublin (**TCD**). Then in August 1850, it turned up in Tramore, Co. Waterford, where Isaac Carroll recorded it from "Amongst boulders on the strand" (Carroll, 1854), "growing sparingly among loose stones with *Eryngium*" (specimens in the herbarium of the National Botanic Gardens (**DBN**) and in **TCD**). It was since reported from here by Alexander Goodman More in 1878 and E. Malone in 1883, the last time the species was recorded from the county (Green, 2008). The next Irish county in which the species was recorded was Wexford, where it was first reported in 1866, see details below. Almost a century later it made a fleeting appearance in Co. Wicklow (Scannell & Synnott, 1987, 1989), where it was recorded from the beach at Buckrone, south of Mizen Head by Howard Hudson in or around 1964 (Curtis & Wilson, 2008); despite regular searches no further sightings of the species have been made here or elsewhere in the county.

Records from Co. Wexford

The first report of the occurrence of *A. maritima* in Co. Wexford (v.c.H12) is by Syme (1866), who had received specimens collected by John Waddy from near Carnsore Point. In 1876 the species was recorded from near Tacumshin Lake by George Kinahan (Colgan & Scully, 1898) and in 1882 Henry Hart, whilst on an extended ramble along the coasts of Wexford and Waterford, encountered it near the eastern end of Lady's Island Lake and recorded it as occurring for about a mile westwards to Tacumshin Lake, growing on "the

barest sandy shores" of the narrow bank that separates these waterbodies from the sea (Hart, 1883).

As part of his review of the range of species in Britain and Ireland Cecil Hurst undertook a detailed survey of the population at the turn of the 20th century (Hurst, 1901). He recorded it as extending eastwards from "close to Carnsore Point, near the spot where the granite crops out and renders the coast untenable" as far west as the eastern extremity of the barrier which separates Tacumshin Lake ("just south of Little Sigginstown Island"), a distance of "about three and a half miles". He provided useful details of its distribution and status between these points, which bear repeating here: "For a little over a quarter of a mile at the eastern extremity of the bar which separates Lake Tacumshin from the sea it grew sparingly, and the plants were below the average size. They also appeared to flower earlier and more sparsely than the plants of the Lady's Island Lake, as their flower heads were ripe while the lake plants were still in luxuriant bloom. It grows on the bar at Lake Tacumshin among *Ammophila arundinacea*, and chiefly on the landward side, as is also the case at Lady's Island Lake. I did not meet with any *Diotis* on the small strip of coast which separates the two lakes. But on the bar which separates Lady's Island Lake from the sea it grows in the greatest profusion for about a mile, save for a tract of about 250 yards where the plant is absent; it is somewhat unevenly distributed on the bar, but it occurs in the greatest luxuriance and abundance at the two extremities, to the exclusion of other vegetation. There are patches of a hundred square yards or more, growing so thickly together as to make their white foliage visible a long way off; many plants are bushy, quite small undershrubs, spreading at the base, and densely covered with flowers." "In the mile and a half between Lady's Island Lake and Carnsore Point, I saw only twenty plants scattered singly, or in twos and threes at irregular intervals, three of them being close to Carnsore Point itself. At this point its distribution ceased". Hurst illustrated his paper with two plates showing part of the Lady's Island Lake population (Plate 2 of which was reproduced by Praeger (1922; 1934; 1937)) and these show the abundance of the species at the site and provide useful information on the vegetation community in which it occurred at the time (Fig. 1).

In 1906 Nathaniel Colgan and the Dublin Naturalists' Field Club recorded the species at Lady's Island, growing in great abundance over a distance of about 400 paces on the shingle barrier between the lake and the sea (Anonymous, 1906). The site was described as "perhaps, its only remaining station in the British Isles" and it was noted that "every care was taken to prevent needless injury" to the population. In the same year, George Claridge Druce described the species as occurring "In great abundance and flowering freely... A sight worth going to Ireland to see" (Druce, 1907). When Arthur Stelfox recorded the species in 1922 he noted that there was "nearly an acre of it" between Lady's Island Lake and the sea (Stelfox, 1922). Druce revisited the Lady's Island Lake population in 1928 and described it as "Still existing in considerable quantity" (Druce, 1929). In June 1931 a group of botanists visiting from Britain took a diversion on their way to the ferry home to pay their respects to the population at Lady's Island Lake: "we sought the shingly shores of Lady Island Lake, where the acres of *Diotis* with its white flannelly leaves made an unforgettable sight, though the flowers were only in early bud" (Foggitt, 1932).

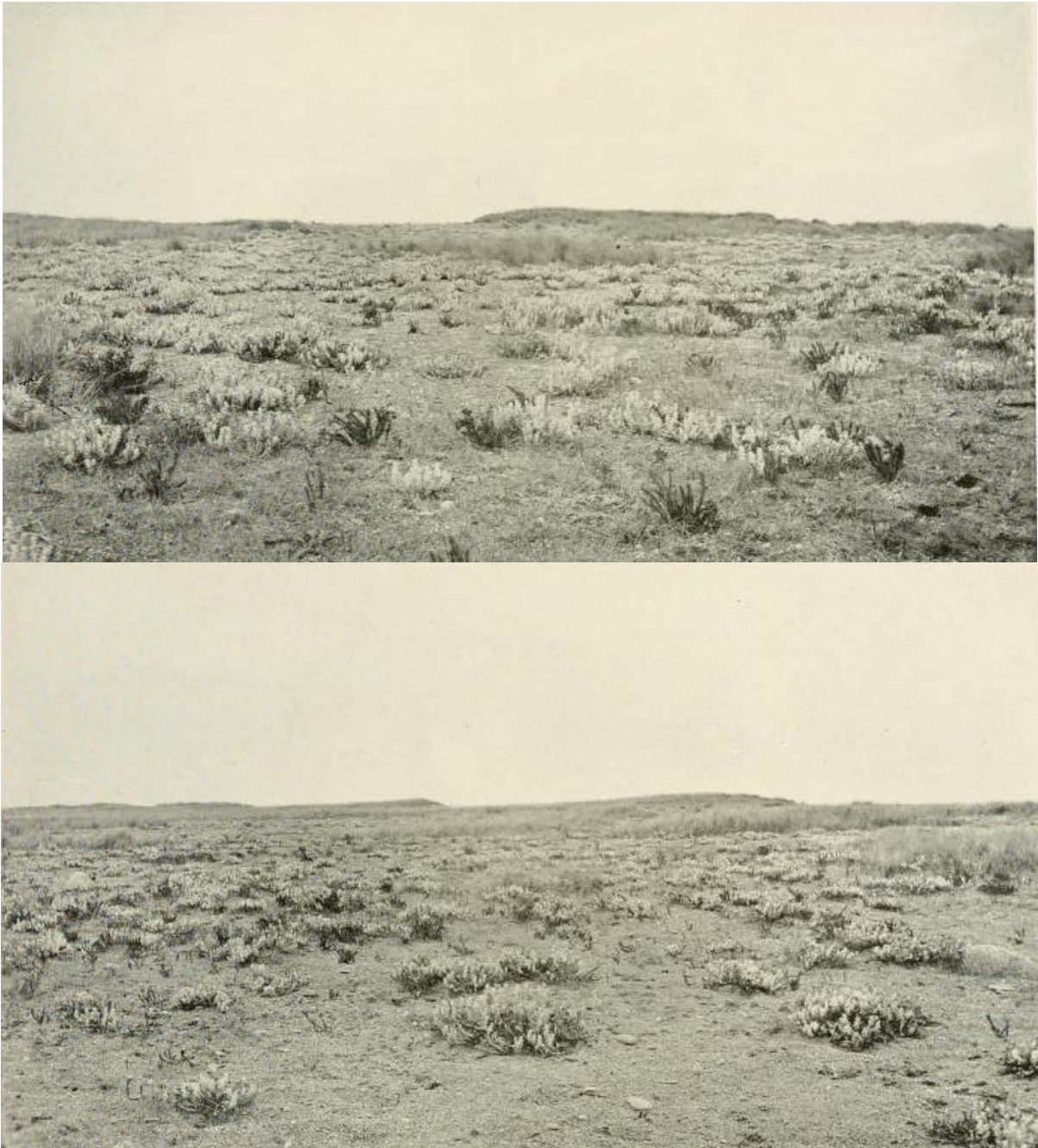


Figure 1. *Achillea maritima* on the barrier at Lady's Island Lake, Co. Wexford, 1901, the upper image (Plate 1) looking southward, the lower image (Plate 2) westward. Image: W. Andrews and Son (Hurst, 1901, Plates 1 & 2)

David Webb provided some interesting observations on the population, noted during a visit he made in 1948: It "still flourishes on the bar of Lady's Island Lake, but is abundant and luxuriant only at the east end. At the S.W. corner of the lake the vegetation is apparently becoming too densely clothed with vegetation for it. I could not find it at the S.E. corner of Tacumshin Lake. It would seem, therefore, that its range has somewhat contracted since Hurst's survey..., but that it is in no immediate danger of extinction. It is now over half a century since this plant has been seen in any other station in the British Isles" (Webb, 1948). Webb brought the Ninth International Phytogeographical Excursion to Lady's Island Lake the following year and there was much interest from the eminent vegetation scientists attending: "The morning was spent agreeably on the shingle bar of

Lady's Island Lake and in the adjoining area. *Diotis*, just coming into flower, provided a spectacle that astonished even those that had seen it in the Mediterranean" (Webb, 1950). He provides further detail in Webb (1952), "Here the chief interest was provided by *Otanthus maritimus*, a Mediterranean species which has become extinct in Great Britain and now is found nowhere else in the British Isles than at this station. Over a limited area of bare, sandy shingle it is very abundant." During this excursion Reinhold Tüxen recorded three relevés containing the species at Lady's Island Lake, referring them to two vegetation associations, the *Euphorbio-Agropyretum juncei* and the *Euphorbio-Ammophiletum arenariae*; these and a photograph of the species at Lady's Island Lake (Fig. 2) are included in the landmark *Irische Pflanzengesellschaften* (Braun-Blanquet & Tüxen, 1952).

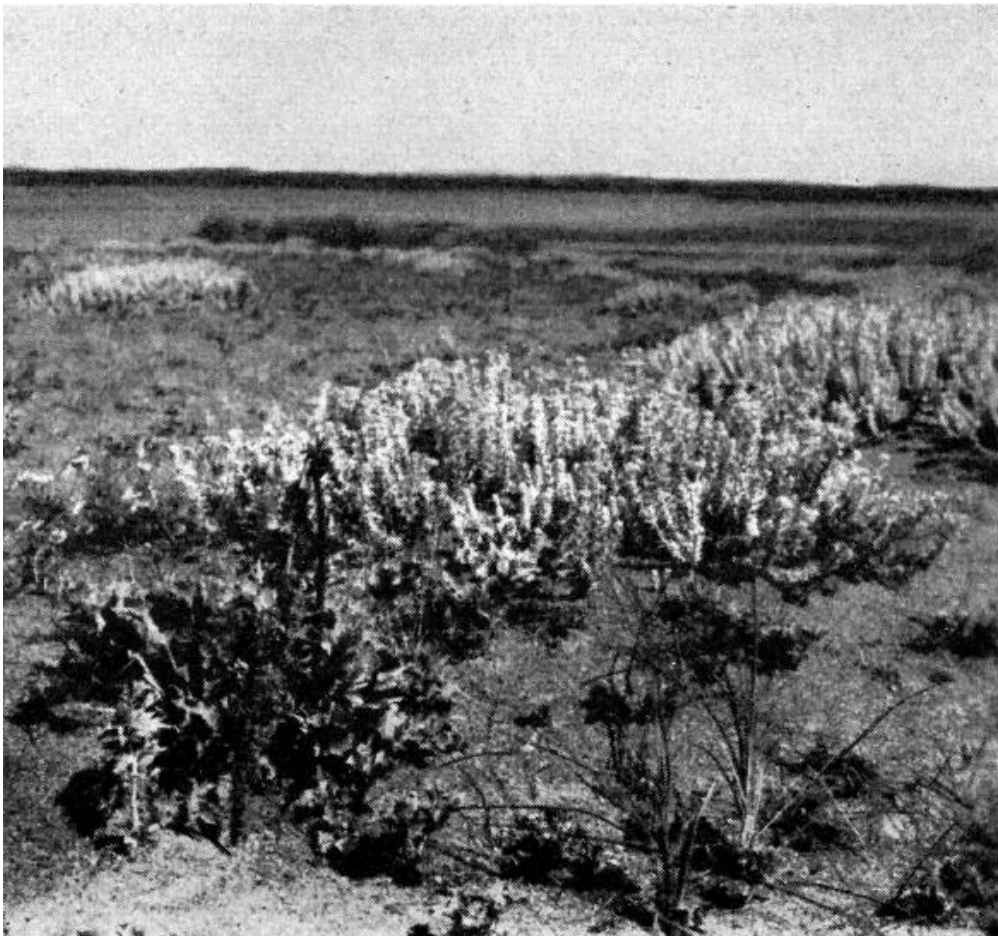


Figure 2. *Achillea maritima* in *Euphorbio-Agropyretum juncei* vegetation on the barrier at Lady's Island Lake, Co. Wexford, 1949.

Image: Reinhold Tüxen (Braun-Blanquet & Tüxen, 1952, Tafel I, Abb. 1)

In the late 1960s, when Jim Hurley first went to see the species, there was a large stand on the barrier at Lady's Island Lake and the "habitat was much more open with little or no Marram" (Jim Hurley pers. comm. to Mike Wyse Jackson, 28th March 2017). In 1972 Austin O'Sullivan surveyed the Lady's Island Lake population east of the channel between the lake and the seas and recorded "1000+" individuals of the species occurring over an acre on "Open, sandy gravel with about 20% vegetation cover" (copy of site survey card in National Parks and Wildlife Service [NPWS] files). Figs 3-6 are photographs taken by Austin O'Sullivan showing the habitats and abundance of the population at Lady's Island Lake in 1968, 1970, 1971 and 1973.



**Figure 3. *Achillea maritima* at Lady's Island Lake, Co. Wexford, 1968.
Image: Austin O'Sullivan**



**Figure 4. *Achillea maritima* at Lady's Island Lake, Co. Wexford, 1970.
Image: Austin O'Sullivan**



**Figure 5. *Achillea maritima* at Lady's Island Lake, Co. Wexford, 1971.
Image: Austin O'Sullivan**



**Figure 6. *Achillea maritima* at Lady's Island Lake, Co. Wexford, 1973.
Image: Austin O'Sullivan**

In 1973 Monika Nooren & Matthijs Schouten carried out detailed surveys of the flora and vegetation of the Lady's Island Lake and Tacumshin Lake barriers, and classified and mapped the vegetation communities present Nooren & Schouten (1976). They mapped the *A. maritima* population at Lady's Island Lake (where they described it to be "very abundant") and also noted it in scattered locations on the Tacumshin Lake barrier, where it was described as occurring "frequently".

Roger Goodwillie (Goodwillie, 1979) described the Lady's Island Lake population thus: "The shingle is the site of a famous colony of cottonweed (*Otanthus maritimus*), a plant very sensitive to human disturbance and rare outside the Mediterranean shores. It grows here with sea spurge (*Euphorbia paralias*), sea bindweed (*Calystegia soldanella*) and sea

couch (*Elvmus junceiforme*) avoiding the sandier tracts dominated by marram *Ammophila arenaria*)."

In 1980 Carter *et al.* (1981) noted *A. maritima* to "grow in well-spaced profusion over an area of 30,000-40,000 m² just east of the artificial lake cut at Lady's Island". The authors also recorded a few isolated plants on the west side of this cut and a single specimen from Tacumshin, 7 km further west, and noted that "Although this distribution is broadly the same as that described by Hurst (1901), it would appear that the total population has declined since his survey". The species was again recorded from Tacumshin in 1983 (record in NPWS files). Information kindly provided by Jim Hurley indicates that the 1973–1983 Tacumshin records were based on material that had been planted there in the early 1970s by a local individual who, in the interests of conservation and on his own initiative, collected plants or stems that had become uprooted or broken at the Lady's Island Lake population and planted them to various locations along the Tacumshin Lake barrier. In 1997 the status of the last six of these known transplants was reviewed by Jim Hurley and the late Roy Watson as follows: "One plant died in the period 1973-76, cause of death unknown (survived about 4 years). Another was eaten by sheep (1986) and rabbits (1987) (survived up to 17 years). A third was bulldozed when the horse gallop was created in 1992 (survived about 22 years). The fourth died during 1994, cause of death unknown (survived about 24 years). The fifth was smothered in 1996 by an excessive depth of washover sediment (survived about 26 years) and the sixth was still alive at T0494405517 on Grogan Burrow. The age of that last-surviving plant was certainly 18+ years (from 1979), probably 24 years (from 1973) and possibly up to 27 years (from 1970). Roy and I found it to be still alive on 13 January 2013 but failed to find any trace of it on 28 September 2014 or since, so we assume it no longer survives" (Jim Hurley pers. comm. to Mike Wyse Jackson, 28th March 2017). Targeted surveys for the species at the locations recorded by Nooren & Schouten (1976) were carried out under contract to NPWS in 2019 but no sign of the species was recorded, lending weight to the view that the species no longer survives at Tacumshin.

In June 1983 a population census and survey of the distribution of the population at Lady's Island Lake was conducted by members of the Dublin Naturalists' Field Club and the results of these were included in Goodwillie (1983). Over 600 plants were recorded, the majority growing to the east of the Lady's Island Lake outflow channel (the "Cut"), but with a small number of plants also found on the west side of this. The species occurred over a length of shoreline of about 500 m (Goodwillie, 1986).

Surveys of the Lady's Island Lake population conducted by Forest and Wildlife Service staff in 1983 and 1984 recorded over 800 individuals (NPWS files).

In 1985 the population was significantly impacted when the channel cut in the barrier that year remained open for longer than usual and "erosion widened it by about 200 m", resulting in the loss of "about one quarter of the colony" (Goodwillie, 1986), including the few individuals known from the western side of the Cut.

In 1993 when Jim Hurley visited the population he recorded plants to be growing well by the Cut on its eastern side (Fig. 7) and nearby (Fig. 8) (Jim Hurley pers. comm. to Mike Wyse Jackson, 30th March 2017). Jim Hurley's photograph of c.1996 (Fig. 9) shows a significant stand of the species surrounded by dense stands of encroaching *Ammophila arenaria*.



**Figure 7. *Achillea maritima* at Lady's Island Lake, Co. Wexford, east of the Cut.
Image: Jim Hurley, September 1993**



**Figure 8. *Achillea maritima* at Lady's Island Lake, Co. Wexford.
Image: Jim Hurley, 1993**



**Figure 9. *Achillea maritima* at Lady's Island Lake, Co. Wexford, surrounded by encroaching *Ammophila arenaria*.
Image: Jim Hurley, c.1996**

In 1998 Éimear O'Neill mapped the population at Lady's Island Lake, in connection with her genetic study of the species there (O'Neill, 1998). She noted the species to occur over a distance of 177 m and recognised five areas where plants were to be found (identified as A(i), A(ii), B, C and D), A(ii) being the easternmost and D the most western. A(i), B and C were obvious open areas (which Carter *et al.* (1981) had also noted) without a significant cover of *Ammophila arenaria* (Marram) whilst areas A(ii) and D were dominated by this species.

Soil conditions and vegetation communities at the Lady's Island Lake population were recorded and described by Jim Martin as part of his post-graduate research on the conservation of *A. maritima* and other threatened Irish plant species (Martin, 1998).

In 1999 David Moore and Faith Wilson recorded a "Large quantity of plants" of the species as occurring on the barrier at Lady's Island Lake during a survey of the shingle vegetation there (Moore & Wilson, 1999).

Conservation actions at Co. Wexford sites up to 2014

While a large and healthy population of the species was to be found at Lady's Island Lake in the 1970s it was also recognised at the time that it was declining, under threat and requiring protection. So, on 8th March 1971, in order to protect the species, the local authority made the *Wexford County Council (Lady's Island Shingle Bank) Conservation Order, 1971* pursuant to Section 46 of the *Local Government (Planning and Development) Act, 1963* (see Hurley, 1991). In addition, the species was listed on the first Flora (Protection) Order, in 1980; it has been included on the four subsequent Orders, in 1987, 1999, 2015 and 2022.

Carter *et al.* (1981) noted the population at Lady's Island Lake to be coming under increasing pressure from vehicular traffic and from gravel extraction, the latter resulting in shoreline erosion which could upset the delicate balance between the frequency and magnitude of deposition of gravels on the barrier, a process considered to be crucial to the

needs of the species. In 1984 measures were taken to protect the population from gravel extraction and from vehicular traffic, when NPWS (Forest and Wildlife Service at the time) organised for a line of boulders restricting vehicular access to be placed around the main area for the species (see Hurley, 1997 for further details).

In 1997 trial translocation of the species to two experimental plots at Ballyteige National Nature Reserve (one at the eastern end of the dunes near to the lagoon dam and the other further west towards the spit) were established by Jim Martin of Trinity College Dublin, under licence and in association with NPWS. The ninety-two plants translocated were raised from seed and cuttings originating from the Lady's Island population. While the species had not been recorded at this site before, it was chosen primarily for the fact that it was in state ownership and thus the integrity of the translocation experiment could be guaranteed (Martin, 1998). However, survival of the translocated plants at Ballyteige was poor, with the western plot being destroyed by a storm in 1999 and only three plants remaining in the eastern site by September 2003 (Waldren, 2003; Waldren & Lynn, 2003). In 2005, only two plants were found at the eastern plot and continued survival was considered unlikely (Waldren, 2005). NPWS contract surveys in 2019 at the locations of the experimental plots failed to find any plants of the species and confirmed that the species no longer persists at Ballyteige.

Given the poor success of the Ballyteige translocation, alternative sites were investigated by Trinity College, Dublin and NPWS, following which it was decided to attempt translocations of plants to the Tacumshin barrier. This site was chosen on account of it being a former site for the species and because, like Lady's Island, it also experiences overwash by sea water and deposition of the gravels favoured by the species (Waldren, 2003). Two plots were identified, one near the lake outflow (plot 1) and one further to the west (plot 2). In 2003, using plants raised from seeds from Lady's Island, 76 plants were planted to plot 1 and 67 to plot 2 (Waldren, 2003); in 2004 plot 1 still held 69 plants and in 2005 there were 54, however, in plot 2 only a single plant remained in both 2004 and 2005 (Waldren, 2004, 2005). In 2008 the Tacumshin translocation site was surveyed by Tony Murray – at plot 1 near the outflow only five of the original 76 plants remained (two of which were under a canopy of Marram, in contrast to an earlier survey here (Murray, 2005) when the area was largely free of Marram) while none were recorded at plot 2 to the west (Murray, 2008). Four plants persisted at plot 1 in 2010, but by June 2013, when visited by Tony Murray and Mike Wyse Jackson, only one remained. A succession of storms in January/February 2014 deposited significant amount of sand at the location where this plant grew, and it was not seen thereafter. By 2014 the only Irish site at which *A. maritima* was known to survive was at Lady's Island Lake.

In 2012 Tony Murray surveyed the population of the species at Lady's Island Lake and recorded a significant decline in the number of plants present, with only a single plant in area A (the easternmost area [A(i/ii)] of O'Neill, 1998), three plants in area B to the west of this and about 35 clumps in area C still further to the west; no plants were seen in area D (Murray, 2012). His resurvey the following year again recorded the single plant in area A and the three plants in area B, but only 30 plants in area C. The succession of storms in January/February 2014 that wiped out the last remaining Tacumshin plant, deposited significant amount of sand onto area C at Lady's Island Lake (Murray, 2014a, Fig. 10) and there were concerns for the survival of the remaining plants of the species at Lady's Island. Thankfully, however, when the population was surveyed later in the year, other than the loss of one plant in area B, all plants recorded in 2013 were still present, i.e. 1 in area A, 2 in area B and 30 in area C (Murray, 2014b). During subsequent NPWS surveys of the Lady's

Island population no plants were seen in area A after 2014 nor in area B after 2018, and numbers continued to drop in area C to 16 in 2016, 13 in 2018 and 10 in 2021, this despite regular manual removal of Marram by NPWS staff.



Figure 10. *Achillea maritima* at Lady's Island Lake, Co. Wexford (area C), following a major storm during which a significant quantity of sand was deposited [note also scrambler bike track].

Image: Tony Murray, 8th January 2014

Fig. 11 shows seven of the ten plants remaining in area C in 2021, the last naturally-occurring individuals in the Irish population. Note the dense stand of Marram in close proximity to the plants; it is clear that, had work to remove encroaching plants of this species not taken place, *A. maritima* plants in area B would not have persisted as long as they did and that there was a strong possibility that the plants in area C would also have been lost.



Figure 11. Seven of the ten naturally-occurring plants of *Achillea maritima* remaining at Lady's Island Lake, Co. Wexford in 2021, surrounded by dense Marram-dominated vegetation.

Image: Mike Wyse Jackson, 23rd September 2021

Conservation Management at Lady's Island Lake from 2014

With the alarming reduction in the number of plants of the species remaining and the translocations consigned to history it was evident that immediate alternative conservation measures to bring the species back from the brink of extinction would be required.

The main reason for the decline of the population is competition with Marram which, in recent years, has spread throughout the area of the population and effectively out-competed it – this increase is not restricted to Lady's Island but is also occurring elsewhere along the south Co. Wexford coast. The underlying reasons for the increase in Marram are not fully understood, but are likely due to a combination of factors, including changes in the type of sediment deposited and in the frequency of deposition. Currently, the sediments of the upper layers of the barrier at the site contain a high percentage of sand and are more fine-grained (and thus more suitable for Marram) than the coarser sandy-gravels that occurred heretofore and which favoured *A. maritima*. Whatever the reasons, it was clear that if action was not taken *A. maritima* would shortly be extinct both at the site and in Ireland. In 2016 in an attempt to prevent the imminent loss of the species here, NPWS Regional Management and Scientific Unit staff formulated a draft Conservation Plan for the species and its habitat. This included plans to trial various methods to control/remove Marram that may have application for habitat restoration at the site, and to restore and maintain areas of suitable habitat where specific conservation measures for the protected species could be applied.

The first method trialled for the removal of Marram was excavation, taking the opportunity to avail of the excavator that was on-site carrying out the annual cut in the barrier to manage the water level in Lady's Island Lake. A trial excavation was carried out in 2014, in which a 10 m x 10 m test plot was excavated to a depth of c.0.75 m. It quickly became clear that in order to remove the Marram deeper excavation to below the root zone of the species would be required, as within six months Marram had appeared across the whole of the test plot. Site investigations to establish the rooting depth of Marram at the site and to check the suitability of the sediments there for *A. maritima* were needed.

The site was visited in January 2016 by Mike Wyse Jackson and Tony Murray and a grid of eight 11 m x 11 m trial plots was laid out in an area situated between sub-populations B and C that formerly supported *A. maritima* (but where it no longer occurs). Each of the four corners of the eight trial plots (a-h) was marked with a numbered wooden post (15 in total) and grid references for these were recorded by GPS.

During the site visit a soil auger was employed to sample the sediment at the centre of each trial plot (a-h) and the sediment type and rooting depth of Marram was recorded. Sampling was to as deep as the length of the auger handle and the compactness of the sediment would allow. The positions where samples were taken were also recorded by GPS. Results of the soil sampling are provided in Table 1 – in summary, it was found that in the uppermost 60-115 cm layer of sediment there was no appreciable difference in sediment size between the eight trial plots. In all of these the sediment comprised fine to coarse sand, with very little coarse gravel material present. Roots of Marram were noted to occur to at least 70 cm in some plots (Table 1); while it was not possible to categorically establish the greatest depth to which roots of this species occurred it was clear that most of the roots occurred in the top 1 m of sediment. This agrees well with the Biological Flora for the species (Huiskes, 1979) where it is noted that "The majority of the roots of *Ammophila arenaria* extend to a depth of c.1 m ..., but roots can regularly be found at depths of 2 m ... and even at 5 m".

With this information gathered and, given the urgency of the situation with regard to the survival of the remaining plants of the species at the site, it was decided to press ahead with preparing several of the trial plots as "translocation plots" where plants raised *ex situ* might find conditions more suitable to their requirements and which would serve as an *in situ* nursery and reservoir for the species from which it might spread. Allowing the natural spread of species of the perennial vegetation of stony banks community to the plot and, at the same time preventing incursions of Marram through regular weeding/hand-pulling, would bring added benefits in advancing the restoration of this habitat in the plot.

It was proposed that plants would be raised from seeds and cuttings collected from the remaining naturally-occurring plants and that these would be returned to the site in the translocation plot, where it was hoped that conditions would be suitable to allow them to thrive and reproduce. At the same time it was hoped that the translocation plot would also provide suitable conditions for natural spread of the species from the remaining naturally-occurring plants situated close by to the west.

Table 1. Trial plot sediment sampling, January 2016

Trial Plot	Sediment Sampling Depth / Sediments Present	Depth of Marram Roots
a	0-110 cm. Fine/coarse sand throughout, with some pea-sized gravel pieces appearing at 110 cm	Present to at least 60 cm
b	0-80 cm. Fine/coarse sand throughout. No sign of coarser material	Present at 70 cm, not noted at 80 cm
c	0-70 cm. Fine/coarse sand throughout, with some pea-sized gravel pieces appearing at 70 cm	Present at 55 cm, not noted at 70 cm
d	0-60 cm, Fine/coarse sand throughout. No sign of coarser material	Present to at least 60 cm
e	0-115 cm. Fine/coarse sand throughout, with some pea-sized gravel pieces appearing at 115 cm	Present at 60 cm, not noted at 75 cm
f	0-115 cm. Fine/coarse sand throughout. No sign of coarser material	Present at 60 cm, not noted at 90 cm
g	0-80 cm. Fine/coarse sand throughout. No sign of coarser material	Present at 70 cm, not noted at 80 cm
h	0-75 cm. Fine/coarse sand throughout, except thin layer of coarser material at 60 cm	Present at 65 cm, not noted at 70 cm

Water level management at Lady’s Island Lake, involves cutting a channel through the shingle barrier to allow water to flow out of the lake into the sea; the flow rate depends on height of water at the time of opening of the channel and other factors such as tides and weather at the time of the works. These works are undertaken for the management of the E.U. Birds Directive designated site Lady’s Island Lake Special Protection Area (<https://www.irishstatutebook.ie/2010/en/si/0069.html>) and its Special Conservation Interests, principally terns. As part of this work excavated material is stockpiled adjacent to the channel, from where it is generally washed away as the channel widens. It was considered that the sandy gravels excavated from the channel would be very suitable substrate for the species and it was decided to utilise these materials to back-fill the excavated *Achillea maritima* translocation plot. Appropriate Assessment screening of the proposed works, as required under Article 6(3) and (4) of the E.U. Habitats Directive, provided an assessment of no significant adverse or negative in-combination effects on the qualifying interests of any Special Area of Conservation or Special Protection Area.

A suitable redeployment site for materials to be excavated from the translocation plot was identified and a traffic management plan for the works was drawn-up and marked out for machinery.

Works to lower lake water levels commenced on 11th March 2017, and an area approximately 10 m wide and 30 m long (Table 1, trial plots a, b and most of c) was excavated to an average depth of 2 m, and back-filled with material excavated from the Lady’s Island Lake outflow channel. In 2020, in tandem with works to lower water levels, the translocation plot was extended eastwards by c.20 m contiguous to the original plot on its eastern end.

In 2013 seeds were collected by Mike Wyse Jackson, under licence [Wildlife Act, Section 21 – all subsequent conservation works on the species were similarly licensed] from plants in sub-populations B and C and these were passed on to the National Botanic Gardens, Glasnevin. The seeds were sown in 2014 and 2015 and resulted in an *ex situ* population comprising seven adult plants, of which one originated from sub-population B and six from sub-population C. In 2016 and 2017 Mike Wyse Jackson took cuttings from plants in sub-population B and C and these were rooted and grown-on under glass in Dublin. At the same time any stems that became detached naturally were collected by Tony Murray and rooted/grown-on in Wexford. In both cases rooting hormone was used to encourage striking of roots. Cuttings and seeds were collected on several occasions by Noeleen Smyth and Edel McDonald Maher and cultivated in the National Botanic Gardens, Glasnevin where they form part of the *ex situ* population of the species established there. This population serves as back-up insurance for the species and as a resource from which new plants can be propagated and ultimately returned to Lady's Island Lake.

Results

The first plantings to the translocation plot of *ex situ*-raised *A. maritima* was on 14th August 2017 when nine plants raised from cuttings taken by Mike Wyse Jackson were planted out. Unfortunately, however, within two years eight of these had died (including one being trampled on by a horse, which resulted in the plot being fenced by post and rail). The ninth plant though did persist and, encouragingly, the seed it produced in 2020 resulted in a flush of seedlings appearing close to it in 2021. An additional seven plants cultivated by Mike Wyse Jackson, Edel McDonald Maher and Noeleen Smyth were planted to the plot on 10th September 2018. Fig. 12 shows the translocation plot in September 2021.

In 2019, 41 plants, raised from cuttings (27) and seeds (14), for the most part by staff at the National Botanic Gardens, were planted into the translocation plot. These comprised 32 plants originating from sub-population C and nine plants originating from the no longer extant sub-population B. Only two of the nine plants raised from seed survived till the following year and it was considered that a higher survival rate would be attained if plants raised from seed were a bit older (perhaps at least a year) before planting out. In 2020 an additional 18 plants were planted to the plot and in 2021 a further 25, giving a total of 100 *ex situ*-raised plants planted into the plot between 2017 and 2021 (Table 2, numbers in green). In 2021, four well-grown self-sown plants and *c.*60 small seedlings were recorded in the plot (Murray *et al.*, 2021); it remains to be seen how many of these seedlings will develop to adulthood.

An inventory of plants in the translocation plot is shown in Table 2 and many of these are to be seen stretching into the distance in Fig. 12. This inventory includes all individuals that were raised *ex situ* plus the four well-grown self-sown plants; it does not include the *c.*60 seedlings recorded in 2021.



Figure 12. *Achillea maritima* translocation plot (looking east), Lady's Island Lake, Co. Wexford, showing post and rail fencing, translocated *Achillea maritima* plants, recolonization by *Euphorbio-Agropyretum juncei* vegetation, and surrounding Marram-dominated vegetation. The 2020 extension to the plot is at the top of the image. Image: Mike Wyse Jackson, 23rd September 2021

With some exceptions, survival rates of the cohorts of translocated plants have been generally quite high. Of the 100 individuals planted into the translocation plot between 2017 and 2021, 60 [given as 62 in Murray *et al.* (2021)] were still alive on 20th September 2021. Of the 40 that did not survive it was considered that 12 of these that had been raised from seed had probably been too young when planted out, while others likely succumbed to the vicissitudes of our current weather patterns. With any translocations there is generally a high initial failure rate and, in this light, the 60% success rate after four years is encouraging. Fig. 13 shows a well-grown, flowering and fruiting translocated plant in the translocation plot.

Discussion

The Lady's Island Lake barrier forms part of what Orford & Carter (1982) described as the "most impressive barrier coast in Ireland". Carter *et al.* (1981) noted it to be "geomorphologically unusual in that it shows many facets of recent crestral overwashing and overtopping sedimentation" in which "the upper beach and ridge crest comprises coarse/fine stratified gravels which merge landward into distinctive fan splays." These features, which are well-illustrated in Orford (2021, Fig. 11.17 – examples from the Tacumshin Lake barrier), are deposited usually once every two or three years when astronomical storm conditions and high tides coincide, and provide substrate that is ideally suited to the growth of *A. maritima*. It would appear that the unusual combination of

sedimentological, geomorphological and human factors at Lady's Island Lake has facilitated the continued presence of *A. maritima* here over many years (Carter *et al.*, 1981).

Table 2. Inventory of plants in the *Achillea maritima* translocation plot. Oldest plantings are on the left, the most recent on the right. Numbers in bold on the bottom show the number of plants alive in the plot at each census/planting date. Numbers in green indicate the number of plants planted at each planting date, the survival of which at each census date is shown by the black numbers. The table is arranged such that the easternmost plantings are at the top and the westernmost at the bottom. The table does not include the c.60 seedlings recorded on 20th September 2021

Census Date (columns) Planting Date (rows)	14/08/17	08/02/18	12/07/18	10/09/18	04/06/19	12/07/19	20/08/19	04/03/20	15/06/20	17/06/20	16/07/20	22/09/20	08/06/21	19/07/21	19/07/21	20/09/21
08/06/2021													12	12	12	13
17/06/2020										12	12	4	4	4	4	4
13/07/2021														6	1	1
08/06/2021													7	7	7	7
16/07/2021											6	4	4	4	4	5
04/06/2019					9	9	7	7	7	7	7	7	7	7	7	7
Self-seeded 2021																3
10/09/2018				3	3	3	3	3	3	3	3	3	3	3	3	3
Self-seeded 2021																1
14/08/2017	9	5	2	2	1	1	1	1	1	1	1	1	1	1	1	1
04/06/2019					3	3	3	2	2	2	2	2	2	2	2	2
10/09/2018				4	4	4	4	4	4	4	4	4	4	4	4	4
04/06/2019					12	10	10	10	10	10	10	10	10	10	10	9
04/06/2019					3	3	3	3	3	3	3	3	2	2	2	2
04/06/2019					14	8	4	3	2	2	2	2	2	2	2	2
	9	5	2	9	49	41	35	33	32	44	50	40	58	64	59	64

Currently, however, that part of the barrier at Lady's Island Lake where much of the *Achillea maritima* population formerly occurred is Marram-dominated (vegetation surrounding the translocation plot in Fig. 12) and quite different in appearance to that depicted in the photographs of 1901, 1949, 1968, 1970, 1971 and 1973 (Figs. 1–6), and it clear that significant changes in the habitat have taken place. Braun-Blanquet & Tüxen (1952), Carter *et al.* (1981) and Martin (1998) all noted the occurrence of the species at Lady's Island Lake in two different vegetation communities, i.e. areas of open *Euphorbio-Agropyretum juncei* vegetation without significant Marram and areas of *Euphorbio-Ammophiletum arenariae* vegetation dominated by Marram. These vegetation types reflect the "surface mosaic of coarse marine (overtop and overwash) and fine terrestrial (dune) sediment" at the Lady's Island barrier, the open areas occurring on the gravels and the "semi-closed *Ammophila* community on the sand" (Carter *et al.*, 1981). These authors also note that "Between these two communities there is sometimes a transitional area, where thin veneers of blown sand have covered the gravel and are encouraging the *Ammophila* to invade the *Otanthus*." While *A. maritima* can survive amongst Marram for a time, in the long term it does not do well, being out-competed (Carter *et al.*, 1981) and, ultimately, extirpated. Surveys of the *A. maritima* population at Lady's Island Lake since the 1970s have shown the progressive replacement of the more open areas by vegetation dominated

by Marram and it is clear that the spread of this species has had a direct negative impact on the *A. maritima* population here.

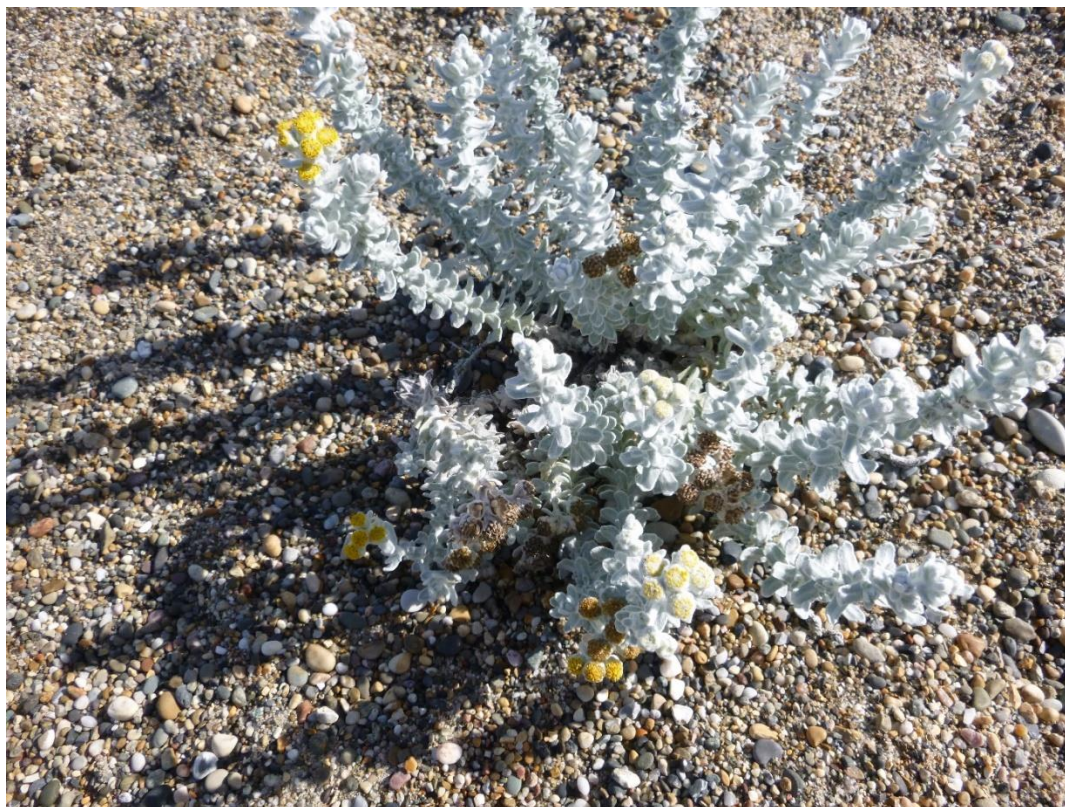


Figure 13. Translocated plant of *Achillea maritima* in flower and fruit, thriving in coarse sandy-gravels of translocation plot, Lady's Island Lake, Co. Wexford. Image: Mike Wyse Jackson, 23rd September 2021

The reasons for the change in the relative proportions of the vegetation communities on the Lady's Island Lake barrier are not fully understood. It is likely to be attributable to a combination of some or all of the following factors, to a greater or lesser degree (some sources of information on these are referenced): changes in the frequencies of winter storms and barrier overtop/washover events, (Department of Culture, Heritage and the Gaeltacht, 2019; Murray, 2014a), changes in the type of marine-derived material being deposited and in the frequency of deposition (Hurley, 1997; Orford, 2021), changes in connection with the annual lake outlet works for the management of water levels in Lady's Island Lake (Cabot, 1999; Carter *et al.*, 1981; Goodwillie, 1983; Goodwillie, 1986; Hurley, 1997; Hurley, 2021a, 2021b, 2021c), changes in the grazing regime (Nooren & Schouten, 1976 [who noted that grazing by cattle "is rather intensive in the dune area between Carnsore Point and Lady's Island Lake"]; Austin O'Sullivan, pers. comm. to Mike Wyse Jackson, 19th April 2022), changes induced by vehicular access (Goodwillie, 1983; Hurley, 1997), extraction/removal of beach gravels (Carter *et al.*, 1981; Goodwillie, 1983; Hurley, 1991; Hurley 1997; Hurley 2021b; Orford, 2021), coastal erosion (Carter *et al.*, 1981; Goodwillie, 1983), climatic changes (Department of Culture, Heritage and the Gaeltacht, 2019; Lousley, 1971 – with reference to the Scilly Isles population), amongst others.

With regard to one such factor, it is considered that the extraction and removal from the system of beach gravels for use in construction works may have played a significant part in accelerating the change in vegetation on the barrier. The comments of Orford

(2021) on the subject are of interest in this regard: "Gravel extraction from the barrier by building contractors, now forbidden by law, threatened the best gravel sections around Carnsore, and certainly reduced the overall gravel budget. As a result, some sections seem to be dominated by beach sands." Reference is also made to this by Carter *et al.* (1981) who noted that "continuing gravel removal is leading to shoreline erosion, which may in time destroy the delicate balance between frequency and magnitude of crestral deposition which appears so crucial to *Otanthus*." Goodwillie (1983) reiterated these concerns, noting that "the largescale removal of gravel from the shore east of Lady's Island should be viewed most seriously." Hurley (1997) discussed the extraction of gravel on a commercial scale from the Lady's Island Lake barrier and listed the following negative impacts arising: "It resulted in a sediment deficit in the dynamic sediment system. It steepened the beach face profile causing instability. It accelerated coast erosion."

Orford (2021) goes on to point out that though some sections of the barrier appear to be dominated by beach sands "This is an illusion, though, in that the barrier is still gravel-dominated, if lost at times under sand cover"; this observation gives some comfort in that, although buried under sand, the gravels needed by the species are still present on-site and, with ongoing conservation management efforts, provides hope for the future of *A. maritima* at Lady's Island Lake. Management to remove Marram will continue to be required around the remaining naturally-occurring plants of the species and also on the margins of the translocation plot to ensure it does not become re-established there. Along with ongoing management and monitoring, it is planned to continue re-enforcing the population in the translocation plot with *ex situ*-raised plants originating from the Lady's Island Lake population and to further encourage natural spread of the species there. It is hoped that the plot can be enlarged again in the coming years and that another plot might also be developed close by. While the decline of the species at Lady's Island Lake has been alarming the positive results of the current conservation management actions have been very encouraging and, with continued conservation efforts, give hope for the future of the species in Ireland.

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