



Wylfa Newydd

Horizon Nuclear Power

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1. Introduction

1.1 Report aims and objectives

The aim of this report is to present additional baseline information on the foraging activities of Sandwich tern (*Sterna sandvicensis*), common tern (*Sterna hirundo*) and Arctic tern (*Sterna paradisaea*) breeding at the Cemlyn Lagoon colony adjacent to the Wylfa Newydd Development Area during the 2018 breeding season. This information is supplementary to existing information on tern foraging presented in the Environmental Statement (ES Volume D – WNDA Development App D13-07 – Seabirds Baseline Report), and is intended to provide additional support to the environmental assessment of the Project.

During the 2017 tern breeding season, studies concluded early due to the abandonment of the Cemlyn Lagoon colony due to predation and as such further study is provided. The objective of the report is, therefore, to:

- provide an additional season's worth of detailed data on the foraging distribution of the three tern species breeding at the Cemlyn Lagoon colony; and
- provide comparison to previous years of tern tracking study¹.

1.2 Cemlyn Lagoon colony 2018

Sandwich terns returned to Cemlyn Lagoon in 2018 later and in smaller numbers, at least initially, compared to numbers typical of recent years. In the previous year, 2017, the tern colony was abandoned by late June following successive predation events of eggs and chicks, resulting in zero productivity. The slow return to the colony in 2018 is likely to be related to the 2017 events, as was the case previously in 2008 following colony abandonment due to predation in 2007. There were, for example, less than 100 adult Sandwich terns present at the colony on 16 May 2018 (with a small number of eggs laid), a date by which numbers in recent years would normally be in the thousands with many pairs laying eggs. This initial small influx of birds marked the first 'wave' of Sandwich terns at the colony, which subsequently built to approx. 500 adults present by 15 June – again, a much lower number than is typical of recent years. The first Sandwich tern chick from this wave of birds was recorded on 9 June; a date slightly later than typical first chick sightings in recent years.

On 18 June a second wave of approx. 1300 Sandwich terns arrived at the Cemlyn colony. Sandwich terns are known to continue to arrive into June years at Cemlyn, but the normal arrival pattern is for the large majority of birds to arrive in May with only stragglers arriving in June (NWWT annual reports). The 2018 second influx of such a large number of birds is therefore a very unusual occurrence. These birds were considered likely to have come from another colony at Hodbarrow, Cumbria (Cemlyn Wardens, *pers comm*), based upon Hodbarrow colony counts concurrently declining in similar numbers. Further, Hodbarrow is the colony to which displaced Sandwich terns relocated from Cemlyn in 2017, following the colony abandonment – as was also the case in 2007 following the Cemlyn colony abandonment that year (due to repeated predation by grey heron). New birds continued to arrive at Cemlyn until the number of adults increased to an overall peak of approx. 2300 by 2 July. The first chick considered likely to be from the second wave of Sandwich terns was noted on 15 July, five days later than the typical fledging date (10 July) for Sandwich tern as described in Perrow *et al.* (2011), again illustrating the very late, and two-stage nature of the 2018 tern breeding season at Cemlyn.

Due to the two separate waves of arrivals of Sandwich terns at Cemlyn in 2018 the tracking study was extended into early August (see Section 2.3) to account for both waves of breeding activity. Common and Arctic terns returned within typical breeding cycle timescales and were primarily tracked in between the two waves of Sandwich terns.

¹ Joint Nature Conservation Committee (JNCC) (2009),
ECON Ecology Consultancy Ltd. (2009),
Horizon Nuclear Power (HNP) (2016),
HNP (2017).

2. Methods

2.1 Survey approach

Tern tracking surveys were undertaken following methods described in Perrow *et al.* (2011). Surveys were conducted from a high-speed Humber Interceptor RIB, sufficiently fast and manoeuvrable to enable visual tracking of terns during their foraging flights at sea. The skipper, a lead surveyor and a scribe were on the RIB on every survey. The lead surveyor selected a target bird as it flew from the Cemlyn Lagoon colony and concentrated on the selected bird throughout its foraging flight. The lead surveyor called out observations made of the bird's behaviour throughout the flight, which were recorded by the scribe and each observation assigned a waypoint using a handheld GPS unit to enable subsequent geo-referencing.

2.2 Survey area

Terns of all three species from the colony in Cemlyn Lagoon were tracked. Individual birds were typically followed to the full extent of their foraging range, including their return flights back to the colony (normally carrying fish). Due to logistical constraints (e.g. deteriorating sea state or occasionally very high flight speeds) some individuals could not be followed throughout the whole flight; in such instances an incomplete track was recorded. As such, the study area was effectively defined by the movements of the three tern species within the Irish Sea whilst being tracked.

2.3 Survey timing

Tern tracking surveys were undertaken on 19 separate dates between 12 June and 5 August (inclusive) as detailed in Table 1. The first period of Sandwich tern tracking was between 12 June and 28 June and the second period was between 24 July and 5 August, targeting the respective chick provisioning periods of the two waves of arrivals. The arrival date of the late, second wave of Sandwich terns was 18 June, therefore terns tracked in the first 'early' period would have initially (12 June and 13 June) been early arrival birds, but from 19 June onwards, could have been either early or late arrival birds. Terns tracked during the second tracking period are likely to have been late arrival birds.

Small terns (common and Arctic) were the primary focus between 4 July and 14 July, again targeting the chick provisioning period for these species. The outlying tracking dates for small terns correspond to tracks which were undertaken on days when conditions became unsuitable for tracking the faster/further-flying Sandwich terns, but remained conducive to tracking the smaller species.

Table 1: Distribution of tern tracking dates and species tracked

Species	12-Jun	13-Jun	19-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	04-Jul	05-Jul	06-Jul	09-Jul	11-Jul	12-Jul	14-Jul	24-Jul	25-Jul	26-Jul	05-Aug
Sandwich tern																			
Common tern																			
Arctic tern																			

2.4 Recording tern foraging behaviour

All behaviour observations associated with foraging activity were recorded in the following three categories:

- 'wet' dives – recorded as successful (prey item caught), unsuccessful or of unknown outcome:
 - dive (diving from a height, resulting in full submersion into the sea);
 - surface-dip (shallow dive close to sea surface resulting in partial submersion); and
 - surface-skim (only the bill of the bird touched the sea surface).

- 'dry' dives – which are aborted 'wet' dives (incomplete dives during which the bird does not touch the sea).
- other behaviours associated with foraging activity:
 - changes in flight action (wing flicks, hovers and glides);
 - significant changes of direction to left/right; and
 - interactions with other bird species or marine mammals.

Tracking surveys were carried out in generally calm conditions with sea states of up to and including 3, due to the often high speeds necessary to pursue birds in flight and accurately record foraging behaviours.

2.5 Data analysis

For all three species of tern, tracking data consisted of GPS tracks with locations of foraging activity marked along each track. These are presented in map form. The data mapped show the locations of 'wet' and 'dry' dives, behaviours which were considered to either prove or strongly indicate presence of prey items.

The data describe the movements and foraging behaviour of individual Cemlyn colony terns, indicating routes taken to and from areas of foraging activity and the extent of foraging range. If the bird was tracked until returning to the colony the track was considered complete; if not, the track was considered incomplete. Further breakdown of the results discusses the data, for each species, within the following metrics:

- total number of dives;
- total number of observational records associated with foraging;
- maximum number of dives on a single track;
- mean number of dives on a single track;
- maximum track length - the longest distance travelled on a single track;
- mean track length – the average distance travelled on a single track;
- furthest dive from the colony – the maximum direct distance from the colony of the furthest dive on a single track;
- mean furthest dive from the colony – the average direct distance from the colony of the furthest dive on a single track; and
- furthest dive from shore – the maximum direct distance from the nearest shoreline of the furthest dive on a single track.

Foraging distribution was compared to previous years' data by simple visual comparison of mapped results. The 2018 dataset is also compared with previous years of tracking, where possible, across the above metrics.

3. Results

A total of 98 tern tracks were recorded in 2018 of which 73 were complete tracks of birds returning to the Cemlyn colony after foraging. Sandwich tern was tracked most frequently (59 tracks), with 40 tracks recorded within the first tracking period (12 June to 28 June) and 19 tracks recorded within the second tracking period. A total of 27 common tern and 12 Arctic tern tracks were recorded. A breakdown of the tracking effort is provided in Table 2.

Table 2: Number of complete/incomplete tern tracks 2018

Species	Tracks			
	Total	Complete	Incomplete	% Complete
Sandwich tern	59	44	15	75%
Sandwich tern - wave one	40	33	7	83%
Sandwich tern - wave two	19	11	8	58%
Common tern	27	21	6	78%
Arctic tern	12	8	4	67%
Overall	98	73	25	73%

A total of 7,023 behavioural observations were recorded during the tracking surveys across the three species of tern. Of these, 2,906 (41%) represent dives; a total of 1,464 wet dives and 1,442 dry (aborted) dives. A further breakdown of the tracking results is provided in Table 3.

Table 3: Numbers of dives, track lengths and distances during tern tracking 2018

Species	Total records	All tracks			Single tracks			Track lengths (km)		Diving activity (km)		
		Total dives	Wet dives	Dry dives	Max dives	Max wet dives	Mean dives	Max length	Mean length	Max from colony	Mean from colony	Max from shore*
Sandwich tern	4638	2059	1133	926	146	109	34.90	91.81	27.08	34.05	12.41	14.75
Wave one	3449	1411	851	560	146	109	35.28	91.81	27.60	34.05	11.46	10.25
Wave two	1189	648	282	366	115	75	34.11	72.07	25.99	33.58	14.48	14.75
Common tern	1631	581	243	338	73	53	21.52	66.18	24.19	33.61	8.75	24.81
Arctic tern	754	266	88	178	58	26	22.17	55.99	22.63	19.23	8.84	15.94

*Note – distances from shore are measured perpendicularly to the nearest coastal point

Sandwich terns travelled the furthest overall, an average distance of 27.08 km per track, including the longest individual track (91.81 km). The second wave of Sandwich terns travelled 1.61 km less on average per track although the longest track was 19.74 km shorter than the longest of the first wave of breeders. Common terns ranged further than Arctic terns in both maximum track length and mean track length, indicating a larger foraging range for common tern. Sandwich tern diving activity ranged out to a maximum of 34.05km from the colony (12.41km mean distance), and 14.75km from shore. Common tern diving activity ranged out to a maximum of 33.58km from the colony, similar to Sandwich tern, but with a lower mean distance of 8.75km, and a maximum distance of 24.81km from shore. Arctic tern diving activity ranged out to a maximum of 19.23km from the colony (mean distance 8.84km, similar to common tern), and a maximum distance of 15.94km from shore.

3.1 Distribution of foraging behaviour

The distribution of tern foraging behaviour is presented in Figures 1.1 to 3.2 for the three species of tern. A map of each of the two Sandwich tern breeding waves is also provided in Figures 1.3 and 1.4 for comparison purposes.

Sandwich tern

Sandwich tern foraging distribution is presented in Figures 1.1 to 1.4. The tracking data for Sandwich tern show a large foraging range, primarily radiating eastwards from the Cemlyn Lagoon colony, along the north Anglesey coastline. Describing from west to east, a relatively small proportion of tracks were recorded between Carmel Head and the Skerries. The majority of tracks and associated data were then recorded in an area extending from West Mouse to Amlwch, out to a distance of approx. 4 km from shore. Within this area a 'hotspot' at the overfall areas north of Cemaes bay near Middle Mouse is notable and small numbers of birds were tracked further northeast from this location up to 30 km from the colony. Other than occasionally in Cemlyn Bay, tracked birds did not feed within the inshore bays in the Wylfa Head area. Further east along the north Anglesey coast some tracks extended past Port Lynas, as far as Puffin Island and the Menai Strait (approximately 50 km from the colony). Close-to-shore feeding was only observed in the shallow sandy bays of Dulas and Red Wharf Bays, greater than 20 km from the colony.

A comparison of tracking data between the first and second wave of Sandwich terns is presented in Figures 1.3 and 1.4. The datasets both show the eastward foraging trend of Sandwich terns breeding at Cemlyn. Whilst bearing in mind the difference in number of tracks, there are some differences between the datasets. Describing from west to east, the second wave of Sandwich tern were not tracked directly west towards West Mouse, or the Skerries, unlike a small number of tracks during the first wave. Closer to Cemlyn, the second wave of birds were recorded in a known reef area 2 km north northwest of Cemlyn Bay which was notably used by small terns, particularly common tern. Unlike a large number of first wave tracks the later breeders were not tracked foraging around the overfalls near Middle Mouse. The general trend of foraging between Cemlyn and Port Lynas remains similar across the two datasets. However, a small number of tracks in the second wave extended further offshore in this area, in a northeast direction up to 30 km from Cemlyn the colony. Tracking during both the first and second waves extended past Port Lynas as far as Puffin Island. A small number of tracks in the second wave, however, ended when birds landed on beaches in Dulas Bay, within a loafing group of terns. It is possible these were non-breeders, including post-breeders from the first wave of birds, due to the extended tracking surveys focussing on the late breeders.

Common tern

Common tern foraging distribution is presented in Figures 2.1 and 2.2. The tracking data show a foraging range reaching offshore up to approx. 6 km north from Cemlyn, extending west to the Skerries and east to Port Lynas, with very few exceptions. Describing from west to east, one individual foraged directly south of the Skerries, prior to returning to Cemlyn with food. Two individuals flew into the Skerries and were lost to view, presumed landing within the offshore small tern colony. The majority of foraging activity then spreads eastwards between West Mouse and Middle Mouse. No wet dives were recorded within Cemlyn Bay, Porth-y-pistyll or Cemaes Bay. Two 'hotspots' coinciding with the known reef area north northwest of Cemlyn and the overfalls near Middle Mouse, discussed above for Sandwich tern, are notable. A smaller number of individuals were tracked further northeast from these locations, ranging up to 18 km from shore. Further east, and northeast a small number of tracks extended further from the colony, with only one individual recorded further east than Port Lynas. This individual was lost to view 34 km northeast from Cemlyn.

Arctic tern

Arctic tern foraging distribution is presented in Figures 3.1 and 3.2. The tracking data indicate foraging trips regularly started by heading directly north from Cemlyn up to 4 km from the colony. Thereafter multiple tracks extended further, up to 16 km from shore, in various directions in no discernible pattern. The furthest west track was recorded 1 km west of the Skerries and the furthest east offshore from Bull Bay. Arctic terns notably foraged more on their return trips to the colony than Sandwich and common terns. This created a number of foraging 'round-trips' with less direct flights whilst returning to the colony.

4. Results summary and comparison with previous data

All three species of tern successfully bred at Cemlyn Lagoon in 2018. Across 19 days of tracking a total of 73 complete tracks were logged, of 98 tracks attempted. This represents an overall completion rate of 73%. The breeding season was extended at Cemlyn due to the slow, and late, arrival of Sandwich terns followed by an influx of an additional second wave of breeders around 18 July. As such, tern tracking was extended later than previous years to study the foraging activity of the late breeders. The overall results indicated that Sandwich tern ranged the furthest from Cemlyn, primarily east of the colony along the north Anglesey coast. A comparison of results between the two breeding waves showed some differences in terms of overall track length and dive activity. Although the second wave of breeders travelled less distance per track, and aborted more dives, the average number of attempted dives on a single foraging trip remained comparable (35.28 first wave, 34.11 second wave). Overall the distribution between the two waves of Sandwich tern is also comparable, showing the consistent trend of foraging of Sandwich tern primarily east of Cemlyn, along the north Anglesey coast.

Small terns largely bred within expected timeframes for the Cemlyn colony and were tracked in between the two Sandwich tern breeding waves. Common terns travelled further than Arctic terns to forage. Foraging distribution was comparable between the two species in that both species headed north of the colony before actively foraging further offshore, primarily between the Skerries and Amlwch. Overall, however, Arctic terns generally remained more contained in terms of distance from shore and distance east and west of Cemlyn Bay.

4.1 Comparison with previous years of tern tracking study

The 2018 tern tracking information is presented in comparison to previous years of study below. The 2018 track completion rate (73%) is very high and comparable with the short study in 2017 (74%) during which only 23 tracks were initiated. The highest number of complete Sandwich and common tern tracks were also recorded in 2018, in part due to the calm prevailing conditions. An overview of the results of each year of tracking study is provided in Table 4, with a more detailed breakdown provided in Table 5.

Table 4: Overall comparison with previous years of tern tracking study

Study / Year	Date range	Sandwich tern			Common tern			Arctic tern			Overall	
		Total	Complete	Incomplete	Total	Complete	Incomplete	Total	Complete	Incomplete	Total	% Complete
JNCC 2009	09 June to 06 July	111	25	86	29	9	20	2	1	1	142	25%
ECON 2009	28 May to 10 July	149	16	133	2	0	2	1	0	1	152	11%
HNP 2016	22 June to 28 July	84	35	49	9	4	5	17	9	8	110	44%
HNP 2017	14 June to 22 June	-	-	-	17	13	4	6	4	2	23	74%
HNP 2018	12 June to 05 Aug	59	44	15	27	21	6	12	8	4	98	73%

Table 5: Further breakdown comparison with previous years of tern tracking study

Study year	Tracks		Dives (wet and dry)		Track lengths (km)		Diving activity (km)	
	Total	% Complete	Total	Mean (per track)	Max length	Mean length	Max from colony	Max from shore
Sandwich tern								
JNCC 2009	111	23	1255	11.31	77.15	8.75	34.89	19.38
ECON 2009	149	11	1127	7.56	39.21	4.89	27.77	7.41
HNP 2016	84	42	2081	24.77	74.15	16.11	41.20	16.28
HNP 2017 ¹	-	-	-	-	-	-	-	-
HNP 2018	59	75	2059	34.90	91.81	27.08	34.05	14.75
Common tern								
JNCC 2009	30	30	548	18.27	31.20	7.08	12.17	8.85
ECON 2009	2	0	19	9.50	14.15	12.48	18.72	13.87
HNP 2016	9	44	324	36.00	35.61	12.14	16.88	8.92
HNP 2017	17	76	665	39.12	93.37	30.53	33.06	27.03
HNP 2018	27	78	581	21.52	66.18	24.19	33.61	24.81
Arctic tern								
JNCC 2009	2	50	144	72.00	10.65	6.76	2.56	1.70
ECON 2009	1	0	0	0	-	-	-	-
HNP 2016	17	53	255	15.00	23.92	7.89	6.03	3.67
HNP 2017	6	67	113	18.83	41.96	19.90	33.29	29.91
HNP 2018	12	67	266	22.17	55.99	22.63	19.23	15.94

¹ Sandwich terns were not tracked by HNP in 2017.

Sandwich tern tracks in 2018 were generally longer than in previous years of study at Cemlyn. The mean track length of 27.08 km is longer than the previous highest average of 16.11 km recorded by HNP in 2016, although the extent of the envelope of diving activity (shown in Figure 4.1 and indicated by maximum distances of diving activity from colony and from shore) has remained similar across the years. The longest Sandwich tern track in the dataset, 91.81 km, was recorded in 2018. The increase in mean track length is at least in part due to the increase in percentage of complete tracks achieved in 2018 during spells of good weather. The 2018 maps of Sandwich tern tracks and distribution of foraging activity show a high level of correlation with previous years (Figure 4.1).

Common tern tracks in 2018 were shorter in length, 24.19 km, on average than in 2017 (30.53 km) although were longer than the preceding years of study in 2009 and 2016. The increase in mean track length (over years 2009 and 2016) is again likely to be at least in part due to the increase in percentage of complete tracks achieved in 2018. The envelope of diving activity is similar in extent across years 2016, 2017 and 2018, and greater in extent than in 2009, indicating an expansion in foraging range since then (Figure 4.2).

Arctic tern tracks in 2018 were longer on average (22.63 km) than recent years - in 2016 (7.89km) and 2017 (19.90 km), again at least in part due to the higher percentage of complete tracks achieved in 2018. The envelope of diving activity for Arctic tern has increased in size across the study years. The 2018 maps of Arctic tern tracks and distribution of foraging activity extend further north than in 2016 and in 2017, which in turn show an expansion of foraging range from 2009 (Figure 4.3).

5. References

ECON Ecology Consultancy Ltd., 2009. *Tern tracking survey results – Cemlyn Bay*.

Joint Nature Conservation Committee, 2009. *Tern tracking survey results – Cemlyn Bay*.

Perrow, M.R., Skeate, E.R. and Gilroy, J.J., 2011. Visual tracking from a rigid - hulled inflatable boat to determine foraging movements of breeding terns. *Journal of Field Ornithology*, 82(1), pp.68-79.

Appendix A. Tracking dates and survey details

Tracking Date	Start Time	End Time	Surveyors	Boat Provider	Sea State	No. of tracks
12/06/2018	09:00	14:30	PC & CC	SBS Rib Charter	1-5	3
13/06/2018	05:45	12:45	PC, CC & DH	SBS Rib Charter	1-4	4
19/06/2018	07:15	15:30	PC & CC	SBS Rib Charter	1-2	7
24/06/2018	05:00	12:30	PC & CC	SBS Rib Charter	0-1	7
25/06/2018	08:15	17:00	PC & CC	SBS Rib Charter	1	7
26/06/2018	09:30	15:45	PC & CC	SBS Rib Charter	0	7
27/06/2018	07:30	15:00	PC & CC	SBS Rib Charter	0	4
28/06/2018	07:15	12:30	PC & CC	SBS Rib Charter	2-3	3
04/07/2018	08:30	16:15	PC & CC	SBS Rib Charter	1-3	7
05/07/2018	05:00	09:00	PC & CC	SBS Rib Charter	1-5	2
06/07/2018	05:00	11:30	PC & CC	SBS Rib Charter	0-1	5
09/07/2018	06:00	12:45	PC & CC	SBS Rib Charter	2-4	7
11/07/2018	07:30	14:00	PC & CC	SBS Rib Charter	1-3	4
12/07/2018	09:00	14:00	PC & CC	SBS Rib Charter	1-4	4
14/07/2018	07:15	12:30	PC & CC	SBS Rib Charter	1-2	6
24/07/2018	11:00	17:00	PC & CC	SBS Rib Charter	1-2	5
25/07/2018	08:00	15:00	PC & PS	SBS Rib Charter	2	4
26/07/2018	08:30	16:00	PC & CC	SBS Rib Charter	0-1	6
05/08/2018	08:30	15:30	PC & CC	SBS Rib Charter	0-1	6

Appendix B. Transect surveys 2018

















