A Survey of the Feeding Activity of the Breeding Terns of Rye Bay

By Lewis Yates October 2014

Sandwich Terns

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Common Tern feeding a Perch to a large chick

ABSTRACT

Terns are a large part of the breeding and passage avian community of Rye Bay on the Sussex / Kent border in the UK. As such, the Common, Sandwich and Little Terns are listed as the Dungeness, Romney Marsh and Rye Bay SPA qualifying species under article 4.1 of the Directive (2009/147/EC). Populations of these species and their productivity have been variable and often very low and concerns have been raised over the supply of fish in the local waters. This project was designed to assess tern feeding behaviour and correlate this to local fish stock surveys. This was also analysed with respect to provisioning of local nests and the productivity of each of the three tern species.

Survey work was carried out from late March to the end of August. The location of feeding terns was recorded and assessed with respect to state of tide, time of day, season, weather conditions and small fish stocks (through surveys run by the Sussex Inshore Fisheries and Conservation Authority, Natural England, Environment Agency and Sussex Wildlife Trust).

INTRODUCTION

Rye Bay is a large shallow area of coastal water which mostly has a sand and mud bottom. It is approximately 57km^2 in size with roughly 22km between the two headlands of Fairlight in the West and Dungeness in the East. There is a relatively large tidal range and a shallow sloping foreshore which provides extensive fishing grounds for breeding terns.

Rye Bay has historically seen six species of tern breed but in recent years only three species breed. These are the Common Tern, Sandwich Tern and Little Tern (Yates, SOS 2010). All of the contemporary nesting sites are located within the 9,137ha. Dungeness, Romney Marsh and Rye Bay SSSI within sites managed by RSPB Dungeness, Rye Harbour Nature Reserve (SWT) and the Wetland Trust. These populations have in recent years seen varying and often low productivity values and a connection with fish stocks has been suggested. Through the observation of feeding birds this project aims to determine where the most important fishing grounds are. It also aims to discuss fish stocks alongside other pressures such as predation to summarise the contemporary situation for breeding terns within Rye Bay. As a comparison, Langstone Harbour is used as the nearest, relatively distinct tern colony which also holds breeding populations of Common, Sandwich and Little Tern.

Little Tern with Sandeel

LOCATION

Observations of feeding activity were made for the entire stretch of coastline between Fairlight (TQ 8786 1160) and Greatstone (TR 084 244), just north of Dungeness. In addition, occasional observations were made at the easterly end of Hastings seafront (West to TQ 8114 0912) but were not maintained over the whole survey as very few terns were seen. Inland waters were also observed including all of the larger extraction pits and ponds near the coastline and the River Rother (inland to TQ 8863 2576), River Brede (inland to TQ 8279 1739) and the Royal Military Canal (inland to TQ 9541 2871).

Observations of nests were made at three main locations: the scrapes on the westerly extent of Pett Level managed by The Wetland Trust (Common Tern at TQ 893 153), Rye Harbour Nature Reserve (Little Tern on Flat Beach TQ 946 182, Common Tern on The Quarry TQ 941 180, Sandwich Tern on Ternery Pool TQ 940 179) and RSPB Dungeness (Common Tern on rafts on New Excavations TR 058 184)

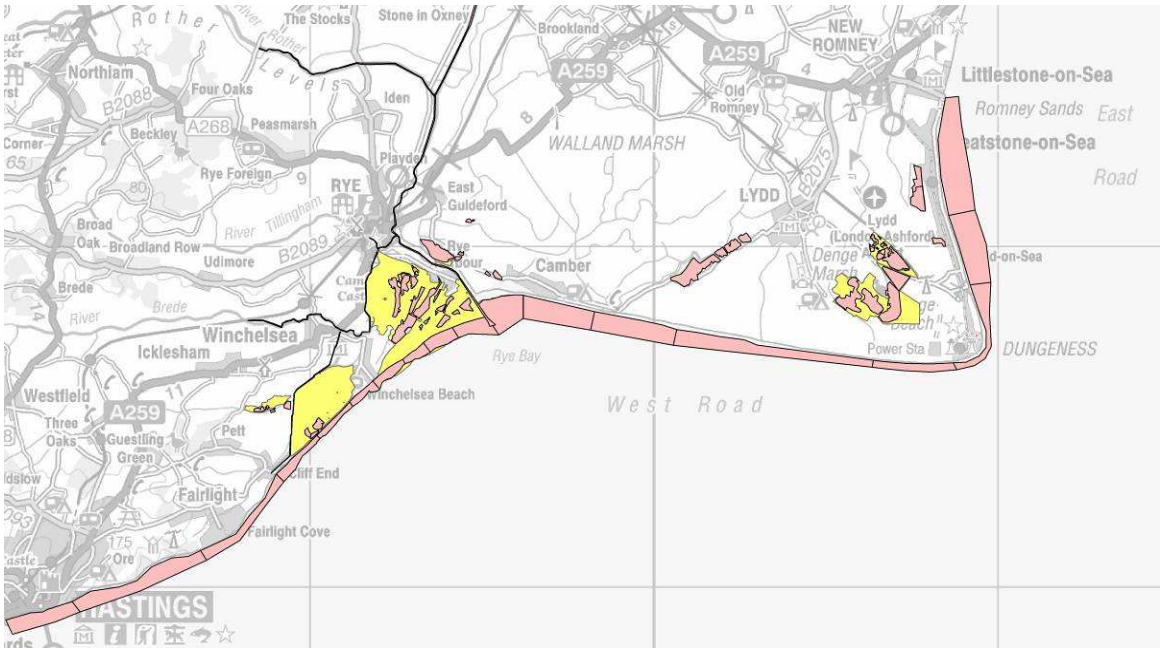

Fig 1: The Dungeness to Pett Level SPA (yellow) with the observation plots for the Tern Survey superimposed.

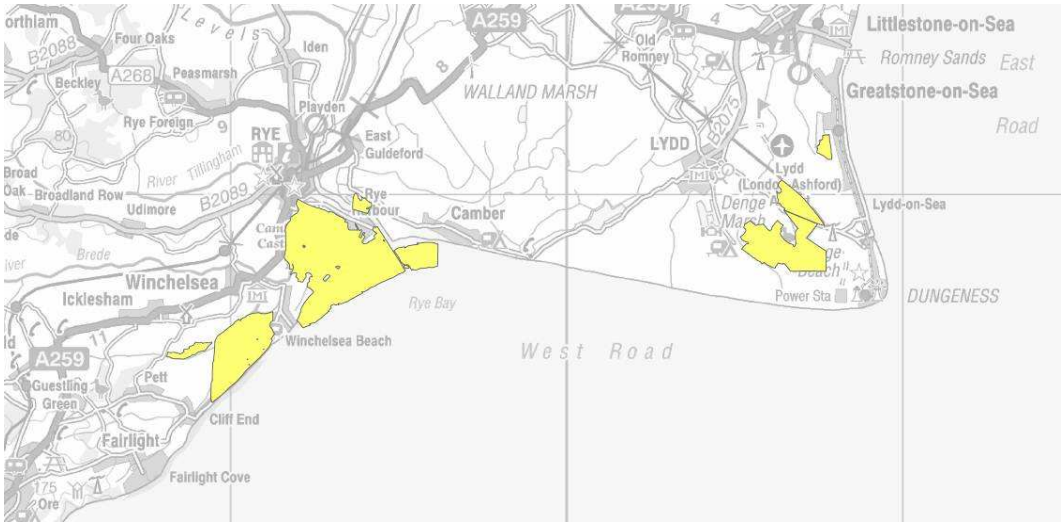

Fig 2: The Dungeness to Pett Level SPA.

Fig 3: The Dungeness, Romney Marsh and Rye Bay SSSI

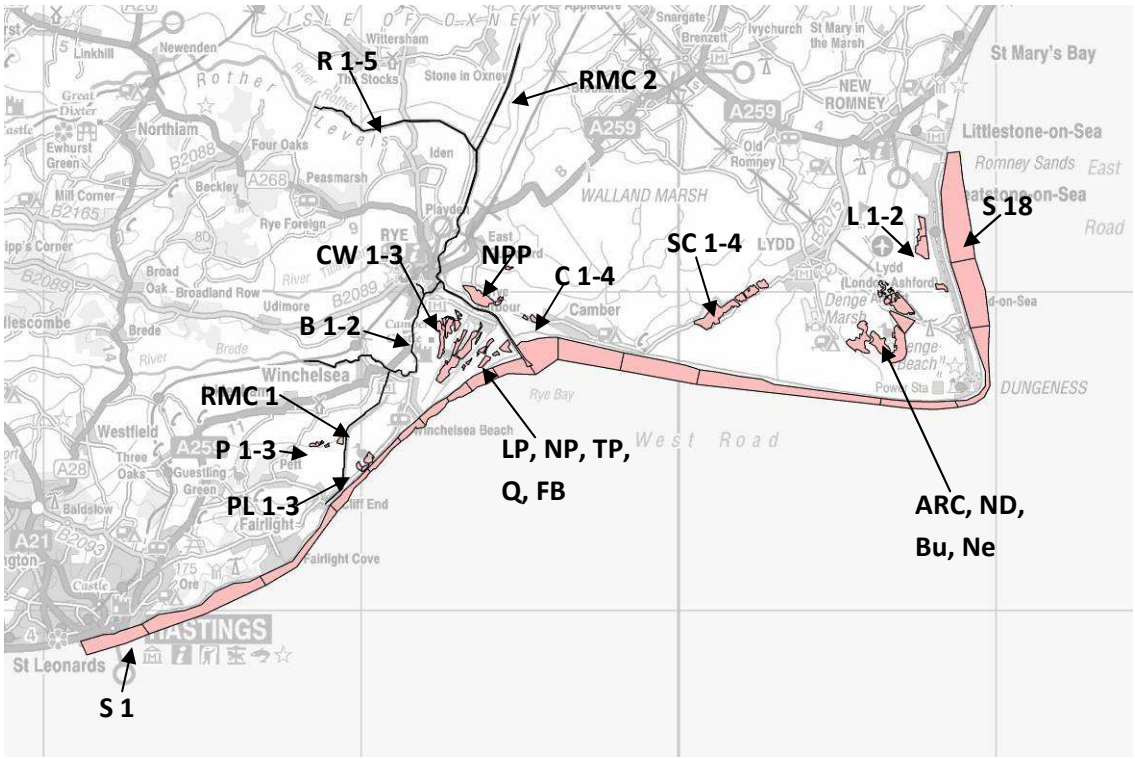

Fig 4: A map of the observational plots for the survey.

Survey Plot Labels:

S1 - S18 The marine plots are labelled sequentially from West to East. The River Rother enters the sea between S10 and S11.
P 1-3 The freshwater pools in Pannel Valley managed by The Wetland Trust, a significant number of Common Tern usually nest on the eastern pool.
PL 1-3 The slightly brackish pools of Pett Level.
RMC 1-2 The Royal Military Canal with one section running very close to the sea through Pett Level and the second section running to the North East of Rye town.
B 1-2 The Brede River.
CW 1-3 The main pools of Castle Water, managed by Rye Harbour Nature Reserve for The Sussex Wildlife Trust.
LP Long Pit is a freshwater pool formed from a gravel extraction pit.
NP Narrow Pit is a freshwater pool formed from a gravel extraction pit.
TP Ternery Pool is the contemporary nesting site of Sandwich Tern within Rye Bay, within Rye Harbour Nature Reserve.
Q The Quarry is the main nesting area for Common Tern within Rye Harbour Nature Reserve.
FB Flat Beach was the nesting site of Little Tern during 2014.
R 1-5 The River Rother was split into five sections, with ascending numbers indicating increased difference from the sea.
NPP North Point Pit is a large gravel extraction pit filled with freshwater.
C 1-4 A series of small freshwater pools.
SC 1-4 A series of small freshwater pools.
ARC A gravel extraction pit managed by the RSPB.
ND A gravel extraction pit
Bu A gravel extraction pit
Ne New excavations which host the tern rafts which held the Dungeness population of breeding Common Tern in 2014.
L 1-2 Gravel extraction pits, the southern L2 pit is still an active quarry.

HISTORY OF TERN POPULATIONS WITHIN RYE BAY

Little Tern

The Little Tern is the species of tern most at risk within Rye Bay due to its very small breeding population size, its great distance to adjacent colonies, its choice of habitat and pressures from disturbance and predation leading to very low productivity. Since 1978 nesting has occurred almost entirely at Rye Harbour with the exceptions of 2000 when the colony moved to The Midrips, and 2008 and 2009 when none were known to have nested in Rye Bay. This single location now means that relatively long lived predators, such as Kestrel, can become specialist predators of these terns. It is in only 16 out of 38 years that the colony has produced the 0.65 fledged chicks per pair that is considered the level of productivity necessary to maintain the population (Ratcliffe 2000). Most egg predation is thought to be by fox and badger and most loss of chicks during the last 25 years has been due to Kestrels preying on chicks.

However, management at Rye Harbour has become more active with decoys and sound recordings prompting the re-colonisation in 2010 after two years of no activity. This promoted colony formation within permanent electric fences, away from the foreshore which is exposed to

high tides, the full force of sea winds, predation (by fox and badger) and disturbance by the public and dogs.

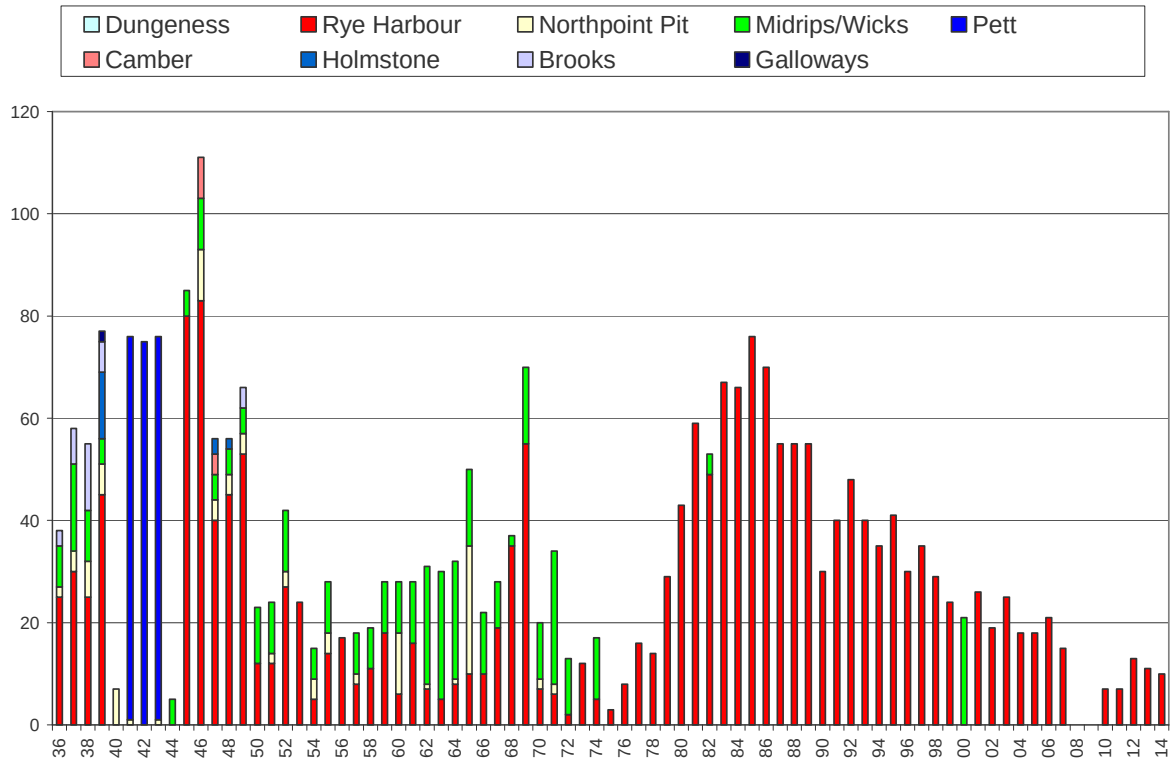

Fig 5: Number of active pairs of Little Tern within Rye Bay since 1936.

Common Tern

Common Tern have generally bred successfully in Rye Bay but have declined in numbers, with 1000 pairs being reported on the west beach at Dungeness alone in 1915 and 1933 but just 183 apparently occupied nests (AONs) being recorded in 2014. In the 1940s and 1950s egg collection and predation were reported to put pressure on the population but the Rye Bay population has survived and breeds widely. Their flexible diet and feeding habits are thought to have helped them perform better than other specialist species. Individuals have been seen feeding up to 8km inland and freshwater fish can make up an important component of their diet as discussed below.

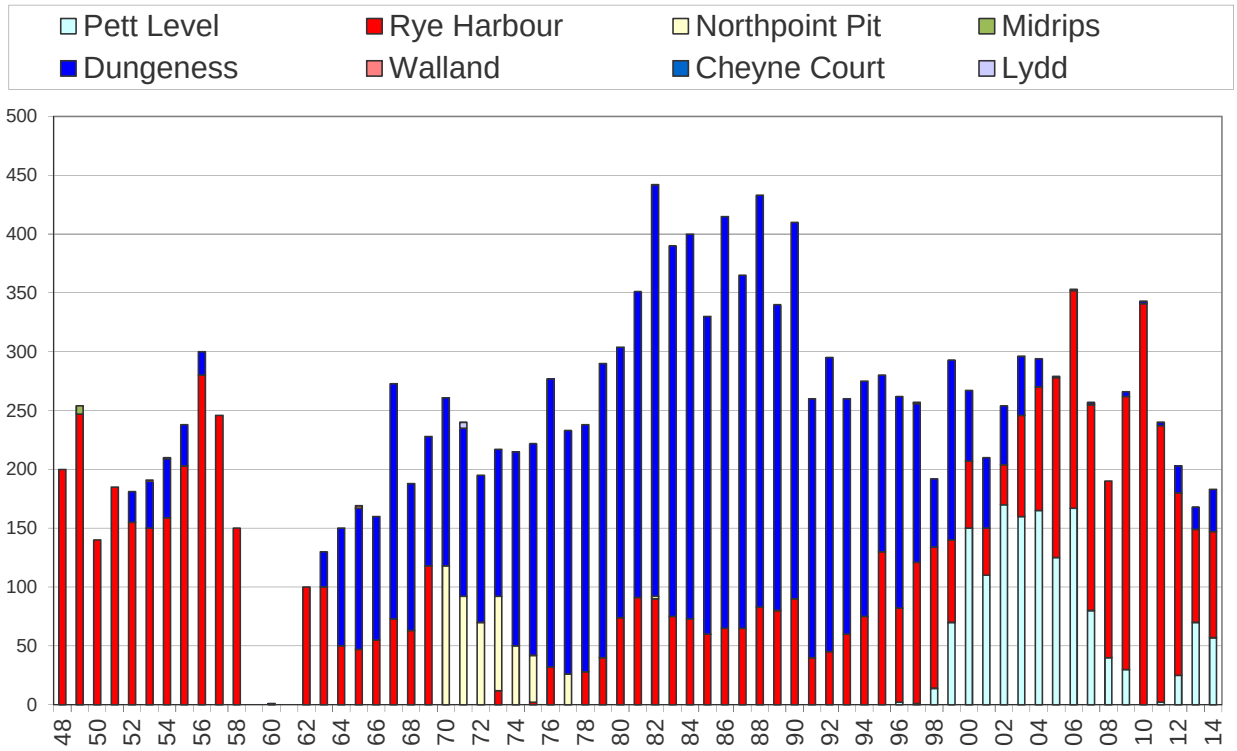

Fig 6: Number of active pairs of Common Tern within Rye Bay since 1948.

Sandwich Tern

The Sandwich Tern is the largest of the breeding terns in Rye Bay and similarly has the largest feeding range, but only fishes at sea. Individuals have been seen carrying fish more than 30km to their breeding colonies and, in Rye Bay, Sandwich Terns have been seen fishing East of Dungeness point and taking prey to the Rye Harbour nesting grounds 15km away. This range shows that they are not restricted geographically within Rye Bay due to prey locations.

Sandwich Terns have historically nested at Dungeness but not since 1997, probably due to the impact of rising fox, badger and Herring Gull populations. There was a lull in local populations during 1996-2001 when birds may have relocated to nearby French coastal sites (Since 1996 over 200 pairs have nested at La Reserve Naturelle du Platier d'Oye, 80km East of Dungeness). Since 2001 the population has increased at Rye Harbour with a peak of 750 pairs in 2010 (then representing 7% of the UK population) correlating with the improvement of electric fencing to reduce fox and badger predation as well as controlling of breeding Herring Gulls (under license). In the last four years success has been very low for Sandwich Terns in Rye Bay and in 2014 there were just 280 AONs, all located at Rye Harbour.

In recent years high water levels at Dungeness have limited tern nesting opportunities with island area being greatly reduced.

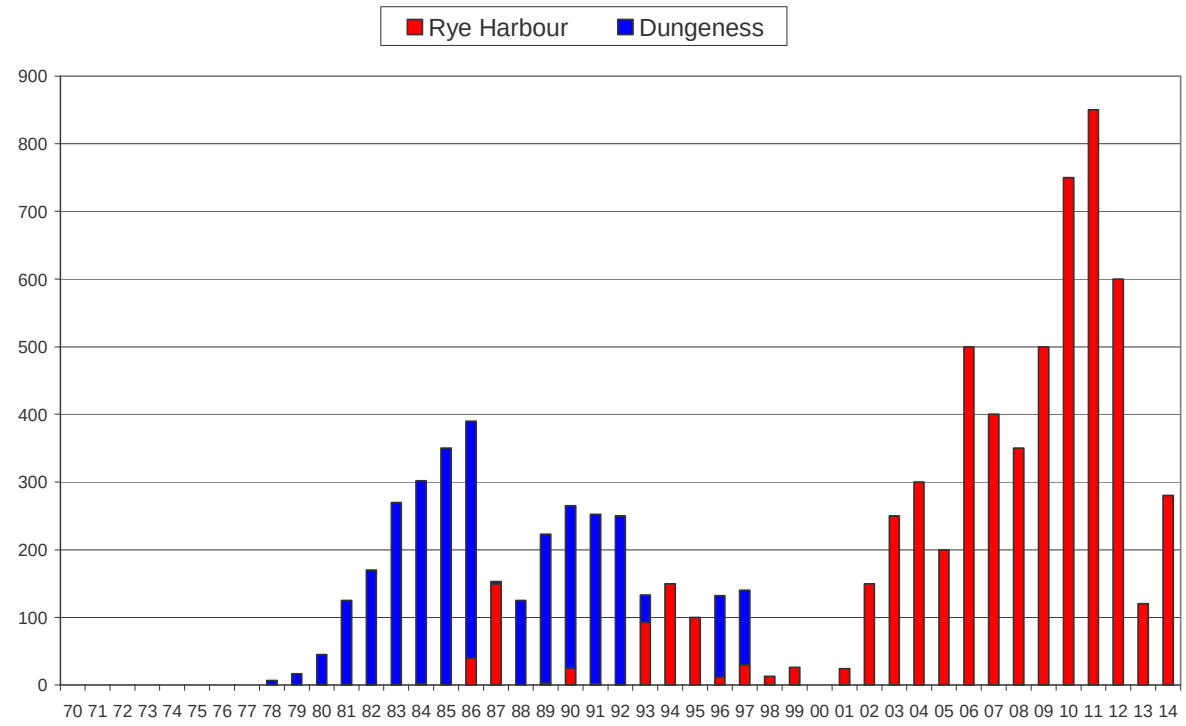

Fig 7: Number of active pairs of Sandwich Tern within Rye Bay since 1970.

CONTEXT OF TERNS IN SOUTH EAST AND REST OF UK

Common Terns are the most ubiquitous of the three species considered in this report, with a UK population of 11,838 given by the Seafarer 2000 census. They breed over much of the UK and are not restricted to the coast, nesting and feeding on inshore waters and frequently making use of man-made habitats. As such, few colonies are isolated and combined with the broader diet of this species these birds are most able to adapt to future changes.

Conversely, Little Tern are the most threatened of the breeding terns present in Rye Bay and restricted to quite specific breeding habitats. Their preference for exposed shingle or sandy locations and their short feeding range is quite restrictive and has contributed to their decline. There is one breeding location remaining in Kent, on the South Swale SSSI just north of Faversham, where productivity has been nil in recent years. To the West there are breeding Little Terns at Langstone Harbour, managed by the RSPB with more success (discussed in a later section), but this is 120km away and movement of birds between these colonies is possible but unproven. There are also breeding pairs at Pagham Harbour (110km to the West) with 12 fledged in 2014.

During the breeding season, British Sandwich Tern are found in relatively few aggregations, with 72% of the 14,000 pairs of breeding birds being located within 16 SPAs. In the South East the nearest locations are at Langstone Harbour to the West and Foulness to the East/North. These terns are more mobile, however, and movement between colonies is well known- it is thought that there is significant interchange between birds in the South East and the colonies in North Western France. This mobility should allow them to avoid local influences such as poor food supply or particular disturbance or predation pressures.

METHOD

This project was carried out mostly by a single field worker (LY) with occasional sightings submitted by volunteers, and guidance from nature reserve staff. Observation methods were based on previous studies, significantly using the PhD dissertation of V Booth and E Dunn. Because the work was designed with volunteer contributions in mind the method was kept quite simple to remain robust, and repeatable if suitable in the future. To enable a larger sample size each observation was kept short at just ten minutes, allowing a much higher number of observations per day of field work. Each observation comprised of the following:

Once at the location a number of things were recorded before observations began:

- Date
- Location
- Cloud cover
- Wind strength on the Beaufort Scale
- Precipitation (None/Light/Heavy/Shower/Persistent)
- Start time

A single species of tern was then observed for ten minutes, counting the peak number of birds feeding at one time and the total number that flew through without fishing in that time. The peak number was used for feeding as birds would circle around or pass back and forth whilst feeding, whereas birds passing through very rarely passed twice so a cumulative number was more accurate. During the ten minutes if possible, but if not then immediately afterwards, a small sample of birds were timed to record the frequency of their dives and the identification of any prey if it could be seen. This process was then repeated for the second and then the third species of tern- this was necessary as the contrast in fishing habits and size of Little and Sandwich terns made counting both simultaneously unreliable.

This method was practiced and developed during March to ensure that it was workable and that any measures were repeatable. This time was also used to assess the suitability of the equipment used (30x magnification telescope and tripod combined with a pair of 10x binoculars). Observations used in the final results commenced on 20th March and continued until 22nd August. At this point there was still a small number of Common Terns at Rye Harbour but activity had significantly tailed off and these late pairs were likely to be young, inexperienced birds which would skew any results. Also birds passing South from colonies to the North, especially Sandwich Tern, were starting to appear on passage and affect numbers locally.

In addition to this, two trail cameras were placed within the two fencing units which enclose the majority of breeding terns at Rye Harbour Nature Reserve. These were placed where predator presence was suspected and checked at regular intervals to determine predator activity. This informed immediate management measures as well as giving a rough indicator of activity levels.

RESULTS

Between 20th March 2014 and 22nd August 2014, over 52 separate days of observations, a total of 1056 observations of tern numbers were made. This was split between 373 Sandwich Tern observations, 575 Common Tern observations and 121 Little Tern observations. These observations

included a total of 6179 Sandwich Terns (non-unique individuals) where 247 were recorded as fishing and 1127 were recorded as passing through (the remainder being at roost or at the nest). Similarly, 4332 Common Terns were recorded, with 1295 fishing and 1004 passing through. And 436 Little Terns were recorded with 124 fishing and 143 passing through. With a maximum of 38 Little Terns being seen in a day this shows the likely number of repeat counts of individuals over the three species that took place.

Feeding activity was generally very dispersed over space and time so many observations were of no birds seen. For Sandwich Tern, 147 observations were of no birds, which makes up 39.4% of the observations for this species. This figure was 42 (34.7%) for Little Tern and 279 (48.5%) for Common Tern. This figure was higher for Common Tern, presumably because of the wider range of feeding habitat and the inclusion of several groups of small, freshwater pools which were very rarely fished. Due to this, all average or cumulative figures stated in this report appear very low. All figures should be taken as relative to each other otherwise they will be misleading.

FEEDING

Terns mainly feed by flying over an area of water and dropping down to catch individual fish in the water. This can be through a plunge dive where the bird drops at speed and dives head first into the water, sometimes completely submerging, before flapping hard to regain height. This technique is usually used to catch fish, but terns can feed by surface dipping where insects or fragments of food are present on the water's surface. Here birds swoop down more gently and take items from the surface without penetrating the surface with more than the tip of their bill. And finally, Common Terns occasionally feed on flying insects with a hawking method, plucking flying invertebrates straight out of the air.

During this survey no hawking behaviour was seen. Most fishing was carried out through plunge diving, but there was occasional surface dipping seen on a small subset of the study plots. This is important as surface dips were always carried out at a significantly higher rate but due to the mixture of methods at each location could not easily be filtered out of results without discarding valuable data. To highlight this in results shown below, sites were surface dipping was observed are labelled **(sd)**. These values should not be taken at face value as they will be higher than other sites where only plunge dives were recorded.

Another factor that would distort values would be the presence of feeding frenzies. Concentrations of fish near the surface (often herded by submarine predators) can attract large numbers of feeding terns, which in turn attracts more fishing birds (Gochfield et al.). These situations can be very focussed in space and time so birds can dive at much higher rates than normal to exploit them to the fullest extent possible. A group of Common Tern and Black-headed Gull were observed feeding at a slightly higher density on 1st June as the tide receded over a sand bar at Rye Harbour. This could not be classed as feeding frenzy, though, due to the generally low number of birds involved. In other years, feeding frenzies have been much more common and have drawn in Gannets from further offshore.

Although no traditional feeding frenzies were observed during the survey, an upwelling of cooling water from the Dungeness power station can be regarded as an artificial feeding frenzy. It is continual but still has the concentration of food items needed to attract feeding terns. The cooling

water itself contains fragments of food and the warm water, and current kicking up any sediments, is thought to attract more fish and invertebrates. However most food items seen to be caught here were either very small, and impossible to identify at distance, fragments of food items or shrimps. This means that "*The Patch*", as it is known locally, may provide significant calories to adult birds but is a refuelling station at best as no higher quality food items suitable for feeding to offspring were observed (i.e. Herring, Sprat, Sandeel).

FEEDING AREAS

Tern feeding usually takes place at inshore, coastal waters within a few kilometres of the colony. Therefore the highest numbers of feeding terns are expected to be near the colony but they may travel surprisingly long distances to find food- up to 70km in the case of the Sandwich Tern (Cramp et al., 1974).

The figures below show the number of terns present at each observational plot. Graphs show the mean number of birds observed fishing and passing through, adjusted for plot size, with each species being shown separately:

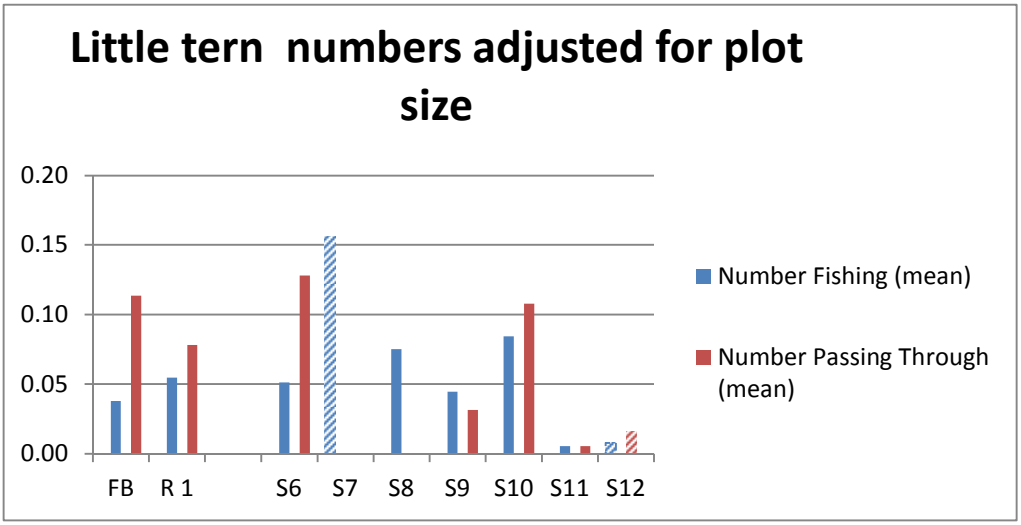

Figure 8: Little Tern numbers adjusted for plot size- showing the mean number of Little Terns fishing and passing through each observation plot (birds per hectare per observation). Plots S7 and S12 had a small number of observations so these averages are unreliable and given for illustrative purposes only (hatched columns).

Fig 9: Map of mean number of Little Terns fishing (birds per hectare per observation). (Grey= no fishing observed, Blue=fishing seen but no reliable dive rate, Yellow/Green= dive rate as shown on scale)

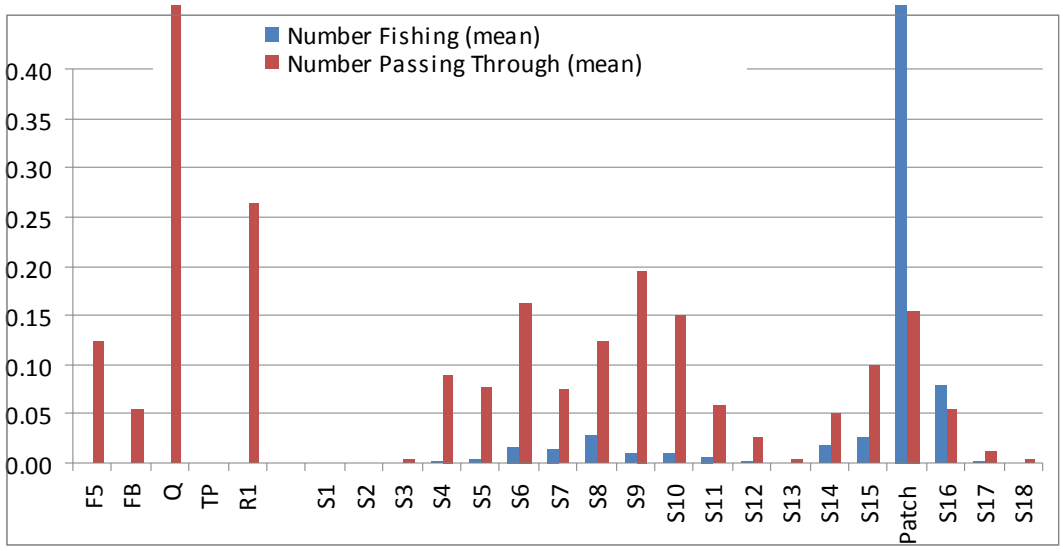

Figure 10: Numbers of Sandwich Terns adjusted for plot size, showing numbers of Sandwich terns fishing and passing through each observation plot (birds per hectare per observation). Quarry (1.08) and Patch (2.77) bars are cut off to show the lower values more clearly. These two plots had much higher values due to their small size and regular presence of Sandwich Terns.

Fig 11: Map of the mean number of Sandwich Tern at each plot (birds per hectare per observation). The Patch had a mean value of 2.77

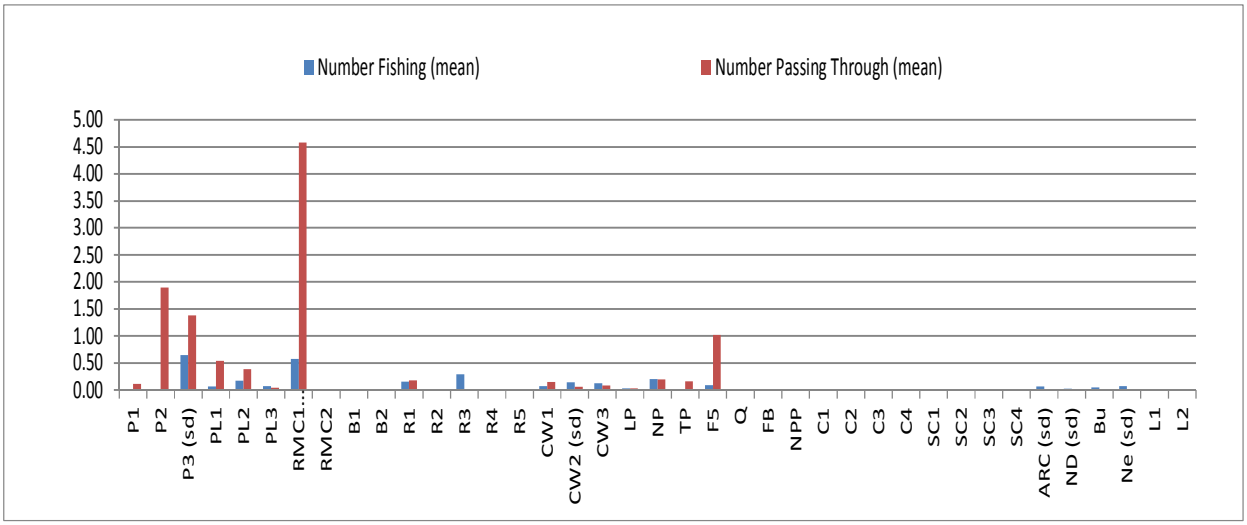

Figure 12: Number of Common Terns adjusted for plot size, showing the number of birds fishing and passing through each **freshwater** observation plot (birds per hectare per observation). (sd) indicates feeding action was primarily surface dipping which indicated prey was mostly invertebrates. RMC1 was placed between the breeding area on the Pett Levels and the popular fishing stretch of coast.

Fig 13: Map of the mean number of Common Tern fishing at each **freshwater** plot (birds per hectare per observation), split into three areas- the Rye Harbour area, the Pett Level area and the Dungeness area. Pink shaded areas are marine locations shown separately in fig 14.

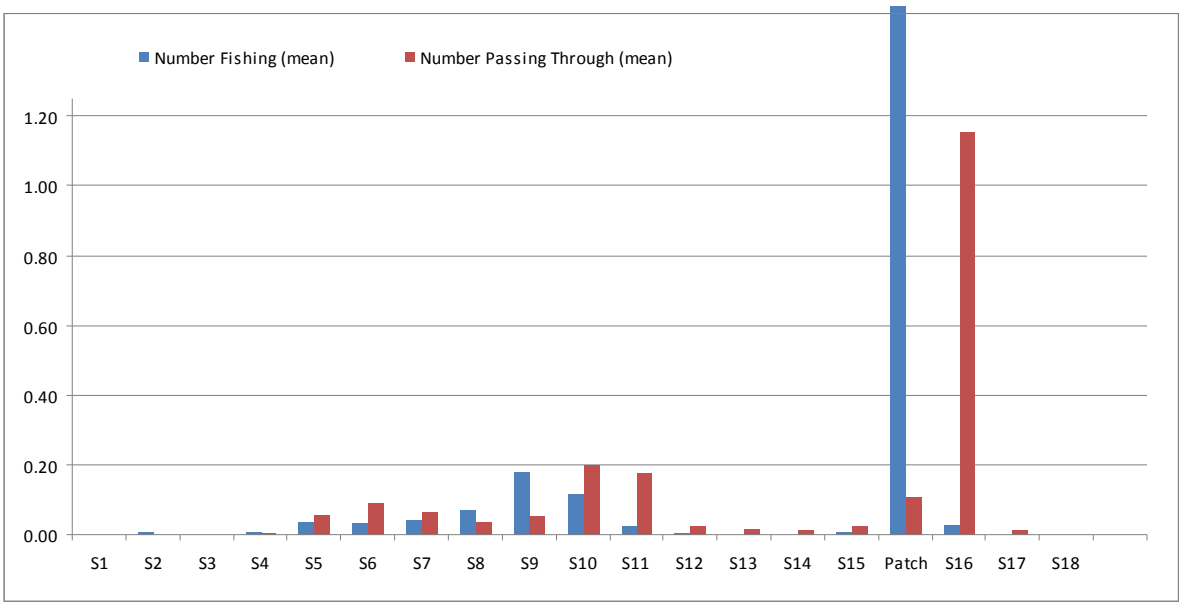

Figure 14: Number of Common Terns adjusted for plot size, showing number of birds fishing and passing through each **marine** observational plot (birds per hectare per observation). The Patch (44.5) has a high value due to its small size and regular presence of feeding birds, it is cut off to give a better view of the smaller values.

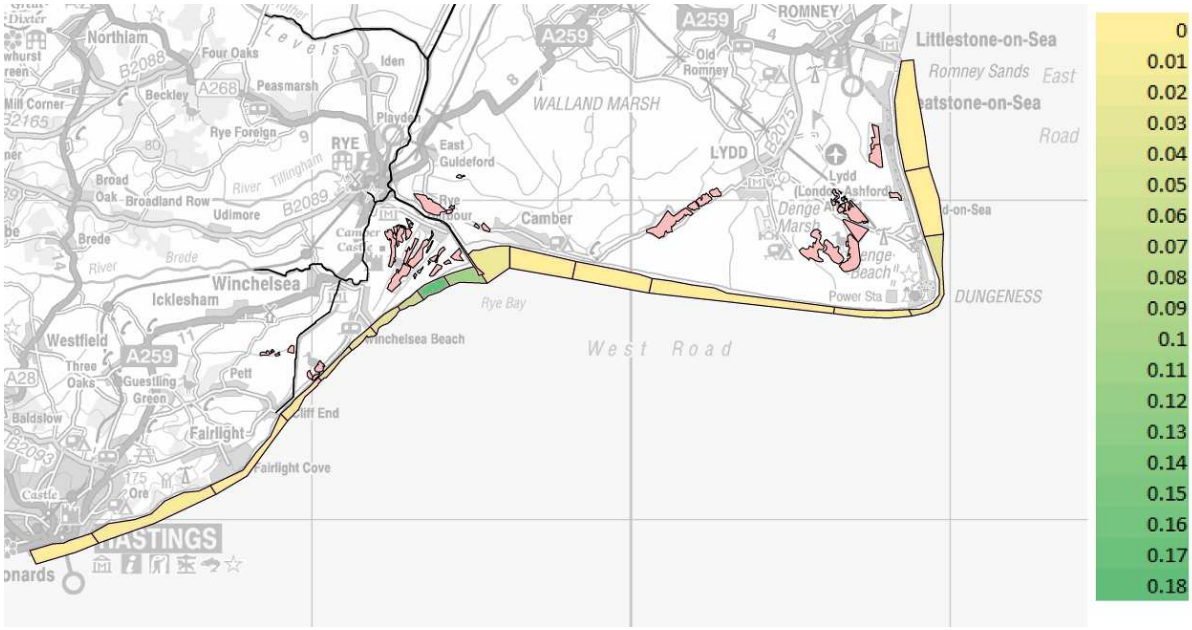

Fig 15: Map showing the mean number (birds per hectare per observation) of Common Terns fishing at each **marine** observation site (pink shaded areas are freshwater locations shown separately in fig 16).

MAP OF DIVE RATES

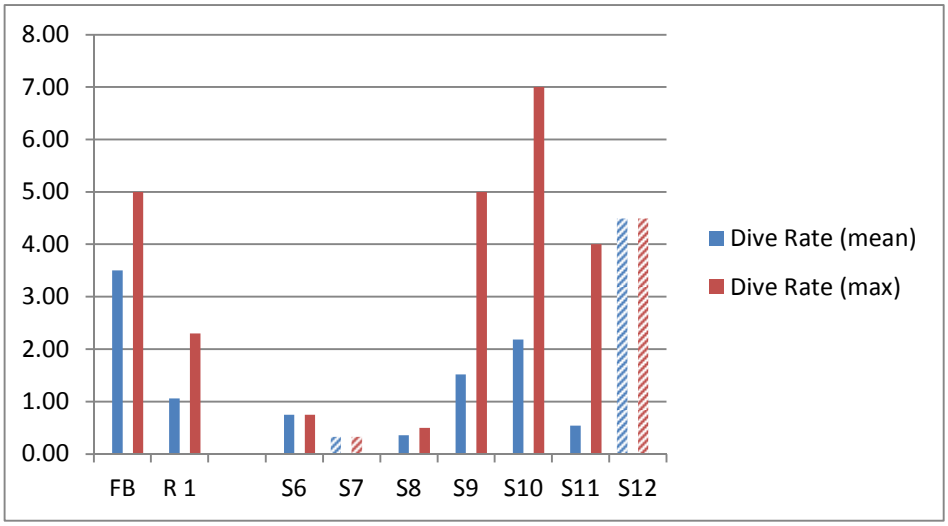

Figure 16: Dive rates of Little Tern in Rye Bay, showing mean and maximum dive rates (dive per minute). S7 and S12 had small sample sizes so values are shown for illustrative purposes only.

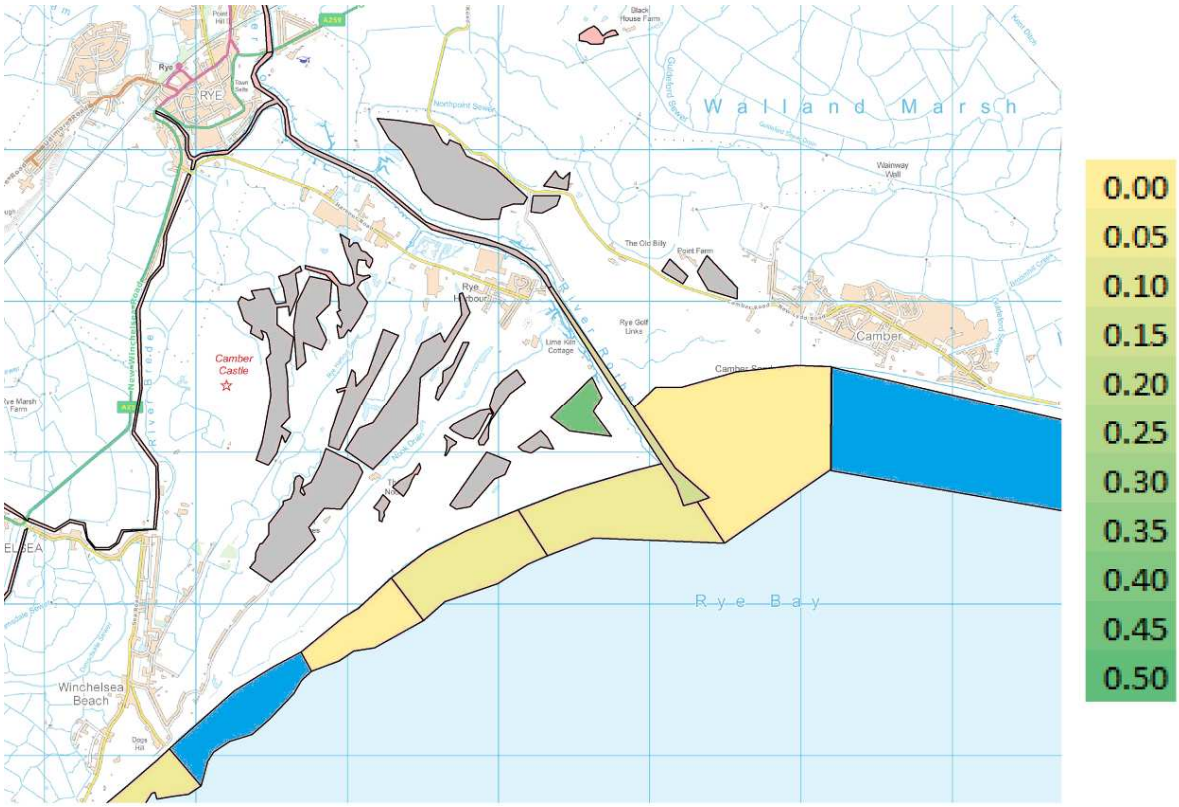

Fig 17: Map of mean dive rates (dives per minute) of Little Tern. (Grey= no fishing observed, Blue=fishing seen but no reliable dive rate, Yellow/Green= dive rate as shown on scale)

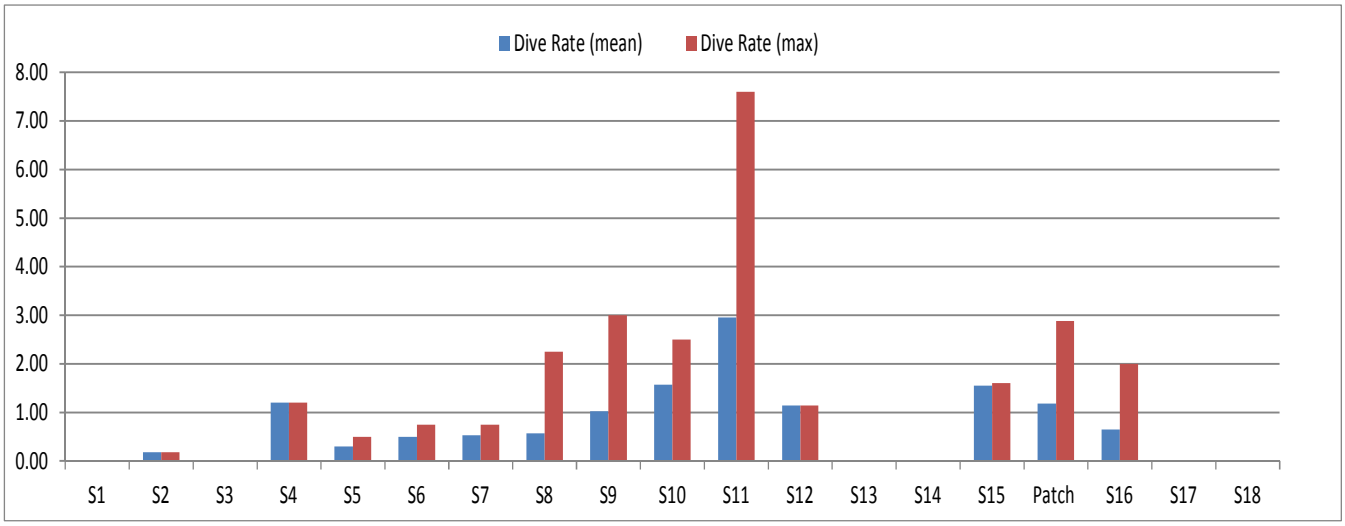

Figure 18: Dive rates of Common Terns on marine plots, showing mean and maximum dive rates (dives per minute).

Fig 19: Map of mean Common Tern dive rates (dives per minute) for marine plots (pink shaded areas are **freshwater** and shown separately in fig 20). The Patch has a value of 1.18

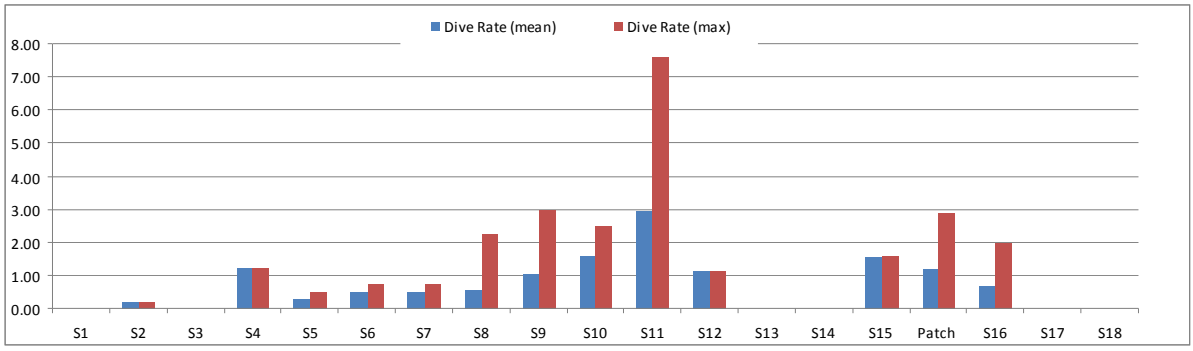

Figure 20: Dive rates for Common Terns on **freshwater** locations, showing mean and maximum dive rates (dives per minute).

Fig 21: Map of dive rates (dives per minute) of Common Terns on freshwater locations. Shown for the Rye Harbour area, the Pett Level area and the Dungeness area. Note that surface dipping actions greatly increased values for some locations (denoted by ***sd*** on the chart above), in particular the ARC site at Dungeness scored 13.75 but has been coloured as approximately 4.5 so as to not skew the colour scale of the rest of the maps.

GRAPH OF ACTIVITY OVER DAY

Below are charts showing the totals of birds seen at plots with respect to the time of day, including birds fishing, passing through and roosting or washing. There is a weak downward trend over the day, mainly due to the presence of a small number of high values during the late morning period. Seabirds usually have an early morning fishing trip and these values could be reflecting returning birds. Seabirds also adjust their fishing activity in response to the success of the morning's fishing, with particularly successful birds resting more in the afternoon once they have hit their daily calorie requirements. This could explain this weak trend but averaging over sites weakens the correlation whilst individual sites lack the sample size to show this- future work on a more restricted area could determine if this is a true effect in the local setting.

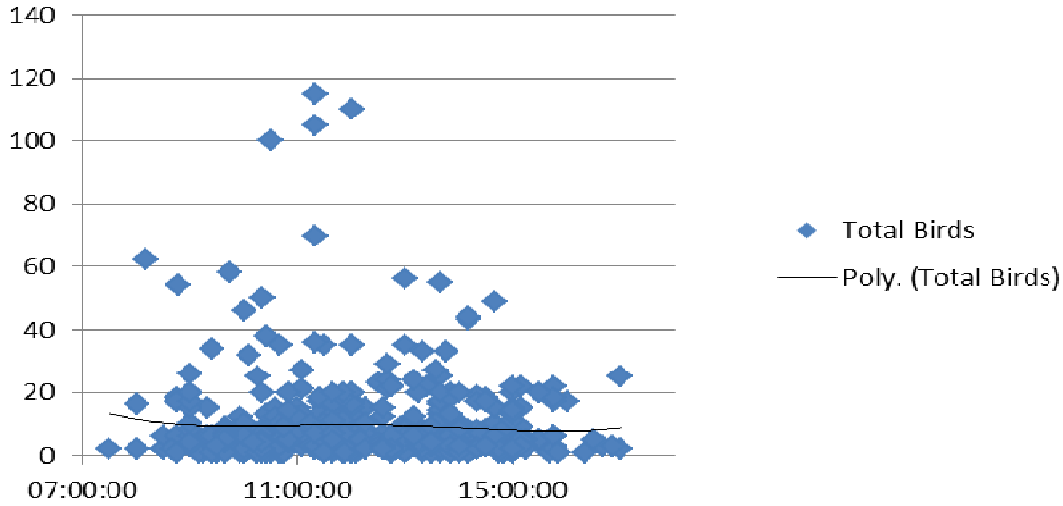

Figure 22: Totals of all three species combined across all sites with a polynomial trendline (4th order)

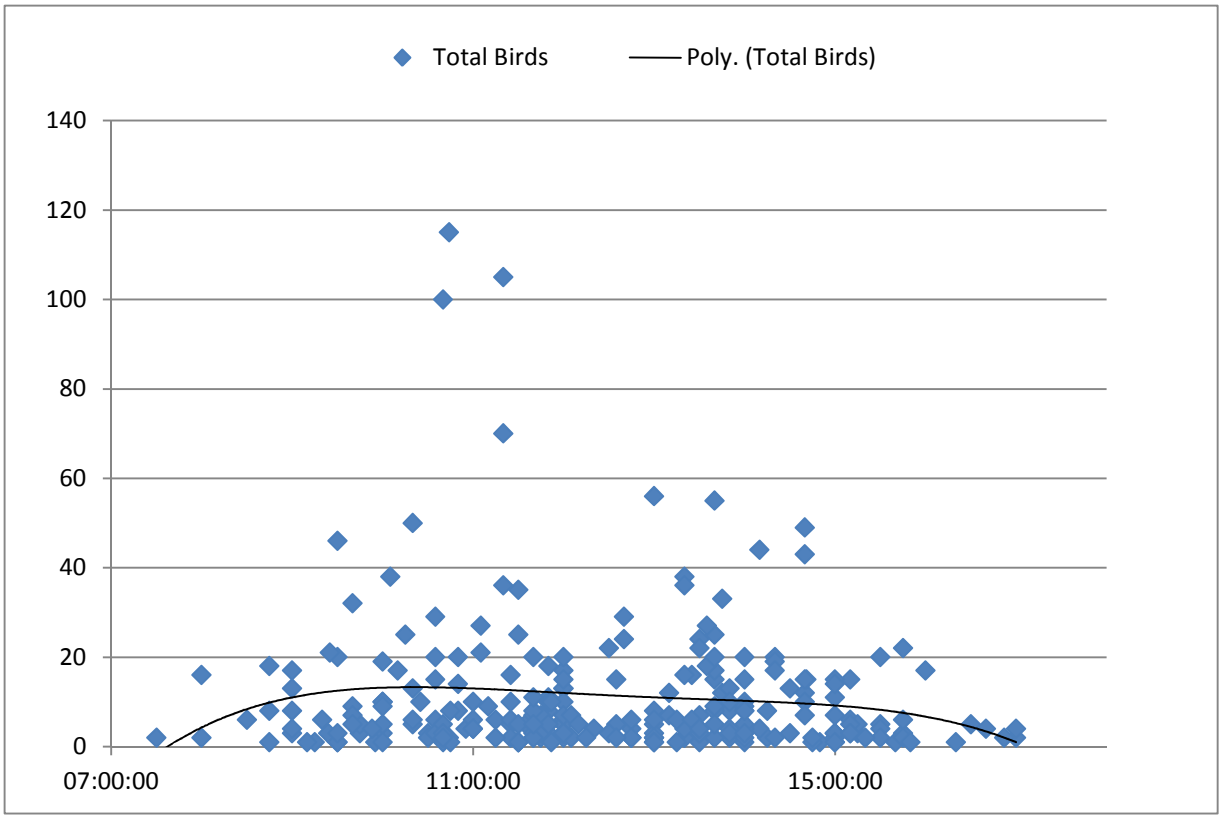

Figure 23: Totals of Common Terns across all sites ith a polynomial trendline (4th order)

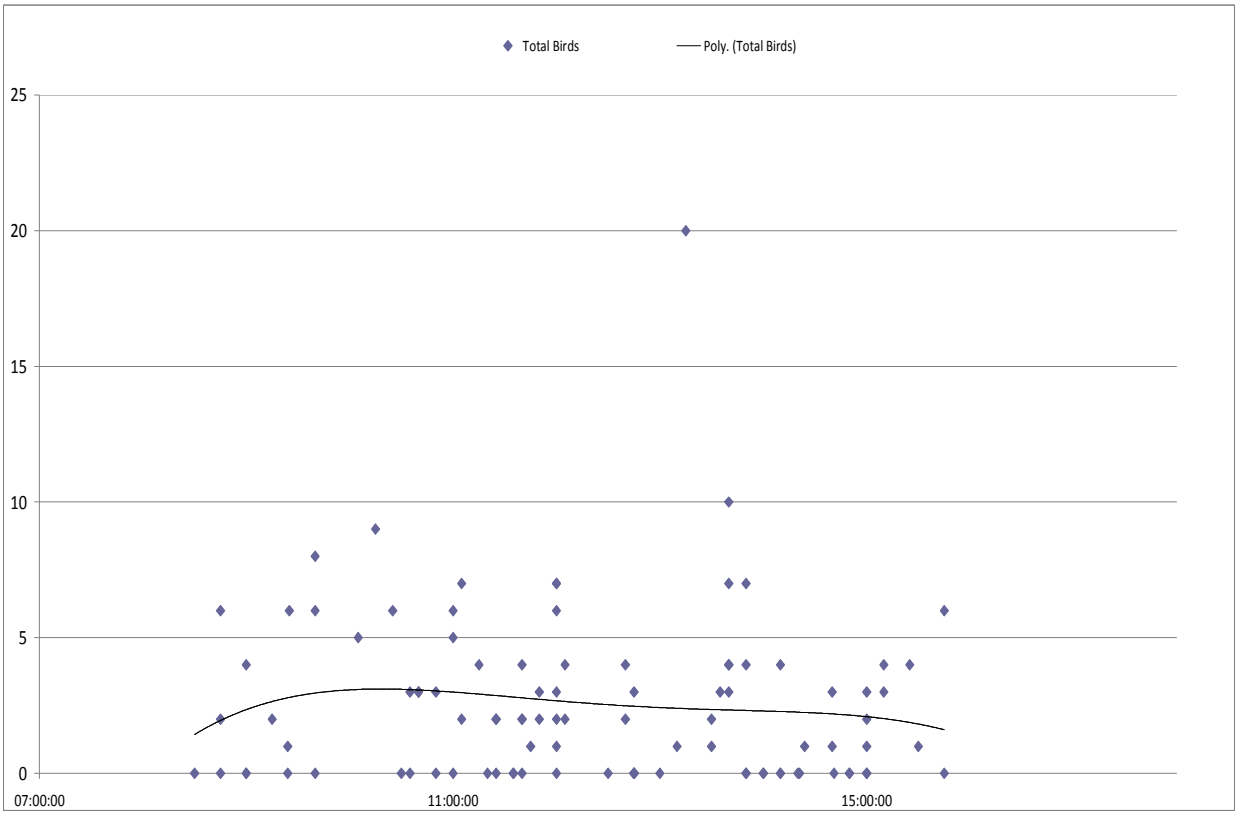

Figure 24: Totals of Little Tern across all sites with a polynomial trendline (4th order). One outlier excluded

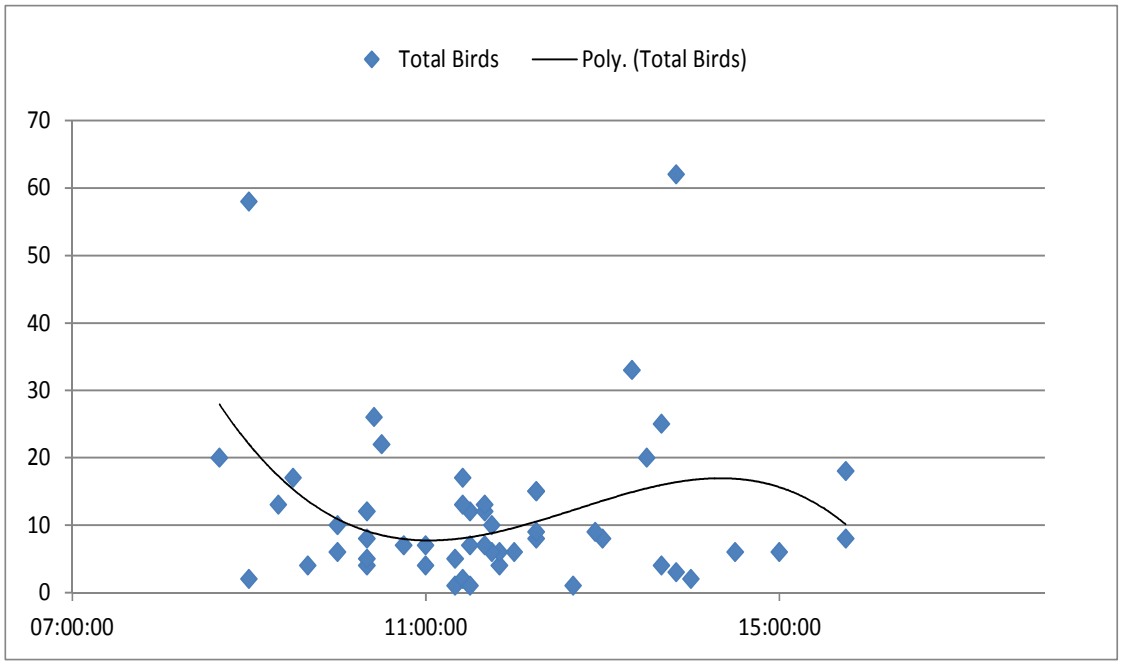

Figure 25: Totals of Sandwich Tern across all sites with a polynomial trendline (4th order). Two outliers excluded.

GRAPH OF ACTIVITY OVER TIDE

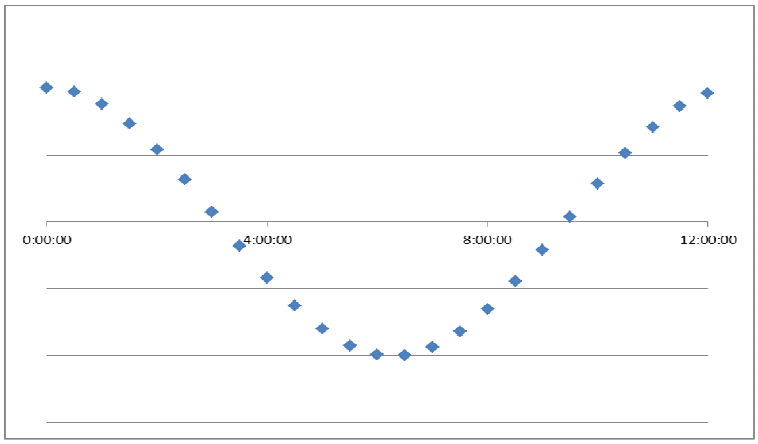

Figure 26: A simplified tidal chart showing the height of the tide over a tidal cycle for reference with the following charts. The x-axis runs from immediately after a high tide until roughly 12 hours 35 mins (i.e. one whole tidal cycle).

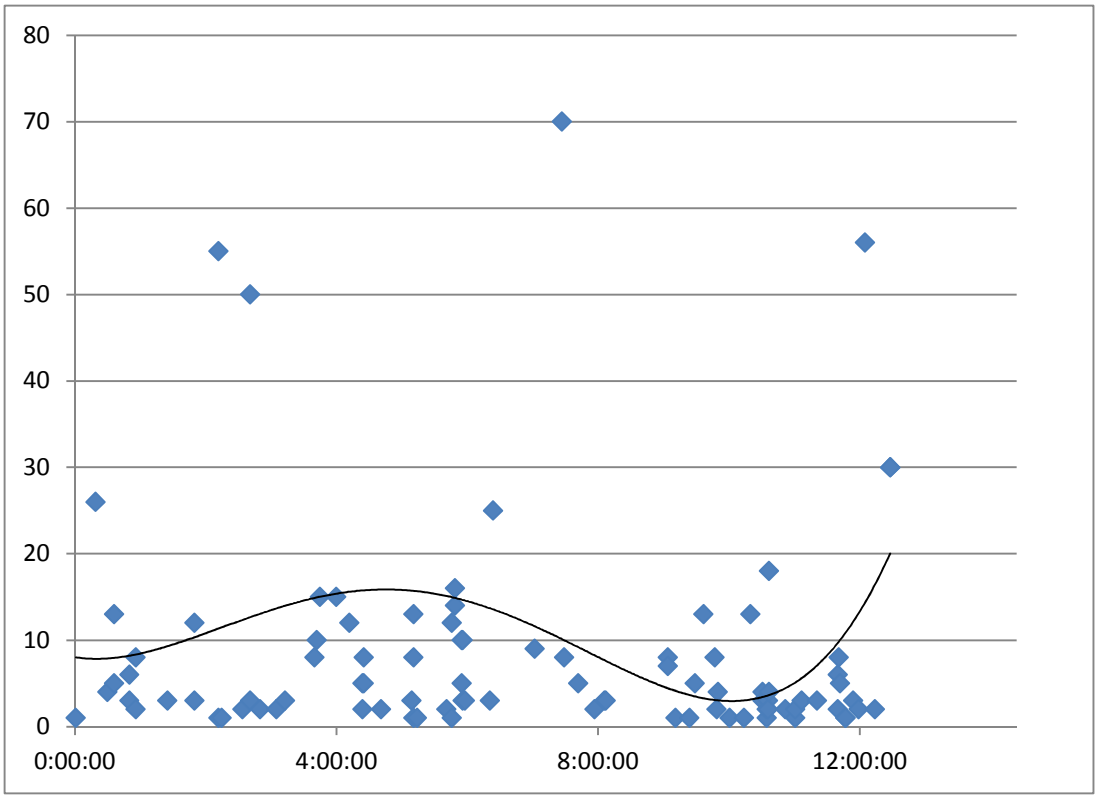

Figure 27: Common Tern numbers with respect to tide with a polynomial trendline (4th order). 3 outliers removed as well as all 0 values due to limitations of Excel (data exceeded max sample size allowed).

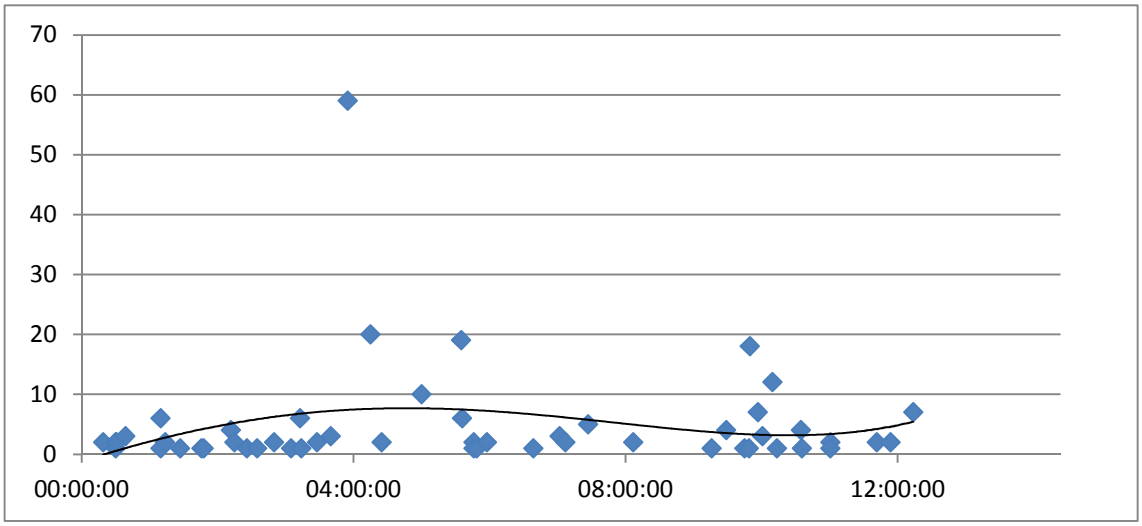

Figure 28: Numbers of Sandwich Tern with respect to tide with a polynomial trendline (4th order). All 0 values removed due to limitations of Excel (data exceeded max sample size allowed).

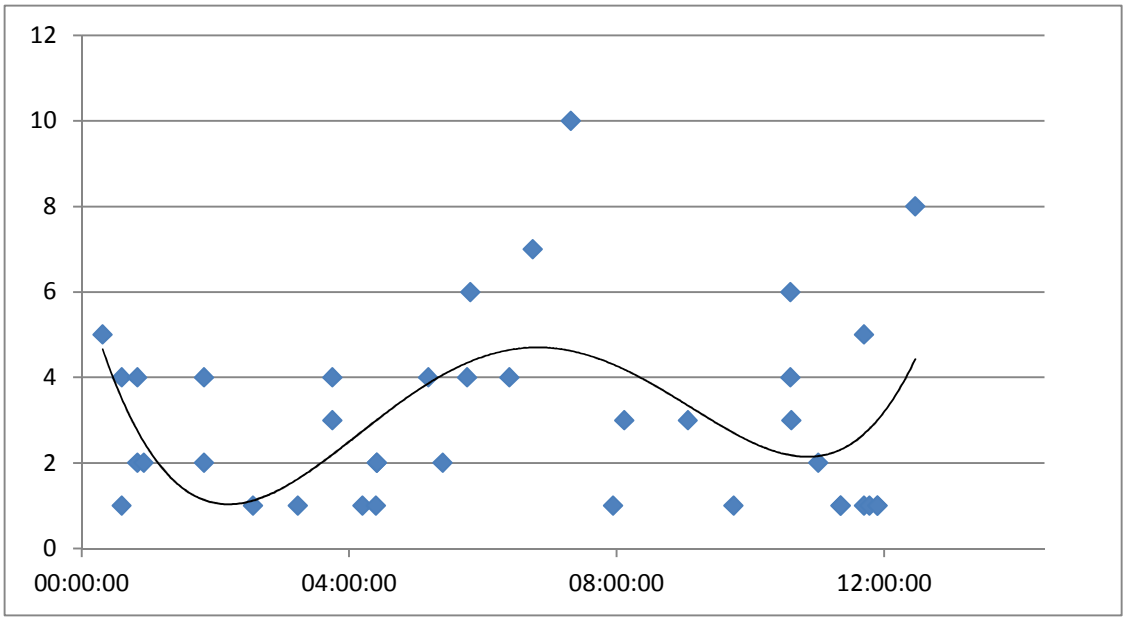

Figure 29: Numbers of Little Tern with respect to tide with a polynomial trendline (4th order). All 0 values removed due to limitations of Excel (data exceeded max sample size allowed).

PREY TYPES

Various types of prey were observed being caught and fed to chicks. Here is a quick summary:

Red finned freshwater fish

This covers a range of species but the presence of red fins was a generally accurate identifier that the fish species was freshwater (combined with observing where the parent bird flew in from). These fish would primarily be Rudd, Roach and Perch which are common in the gravel extraction pits. These fish were seen being fed to chicks of Common Tern at all three main nesting sites.

Sandeel

This name covers the Greater and Lesser Sandeel species and they are together the preferred food item for breeding terns. Despite no fish seen in the process of catching these fish, and the lack of them in the small fish surveys, several Sandeels were seen being carried by Common and Sandwich Terns. These were of varying size but several were quite large (15-20cm).

Herring/Sprat

The majority of fish caught in the small fish surveys, these fish lack many distinguishing features and can be confused even in the hand so all sightings were aggregated into a Herring/Sprat category. These fish do not contain as many calories as the preferred Sandeel but are still high quality food items and provide good nutrition for chicks, especially older chicks that can swallow larger fish.

Flatfish

This category includes all flat fish, locally dominated by species such as Plaice, Sole, Brill, Dab and Flounder. These fish can be seen being brought to chicks but above a certain size are inedible to

tern chicks due to their sheer width. The presence of these fish in tern catches is thought to be an indicator of poor fishing conditions and often correlates with poor breeding success. Several periods were observed in 2014 where a large proportion of fish being fed to Common Tern chicks were flatfish species. Some were able to be eaten but many were too wide and left discarded on nesting islands.

Very Small "Fish"

This category covers all species of fish when they are at a small size. Although often unidentifiable, even in the hand, these species are vital for tern chick development. Recently hatched Common and Sandwich Terns must be fed very small fish to be able to swallow them and Little Terns are subject to this problem for a longer period due to their small body size. Although Little Terns were observed catching large numbers of this size group very close to shore, Sandwich Terns struggled to find enough small fish and this is probably why any hatching chicks did not survive the first few days in 2014.

Shrimp

Crustaceans are thought to be a poor choice compared to the calorific value of Sandeel and Herring/Sprat but can play a large role in tiding chicks over in between quality fish meals. Many Common Tern were seen catching shrimps in the pools along the shore of Rye Harbour at low tide but none were seen fed to chicks so were probably eaten by the fishing adults.

Invertebrates

Other invertebrates, such as flies and beetles, were seen to be taken from the water's surface by birds surface dipping. These items were too small to be of any use in feeding chicks but could provide significant amounts of energy to hunting adults, especially as this type of hunting was often seen very close to the nesting site (most commonly on the gravel extraction pits at RSPB Dungeness).

TRANSIT ROUTES/AREAS

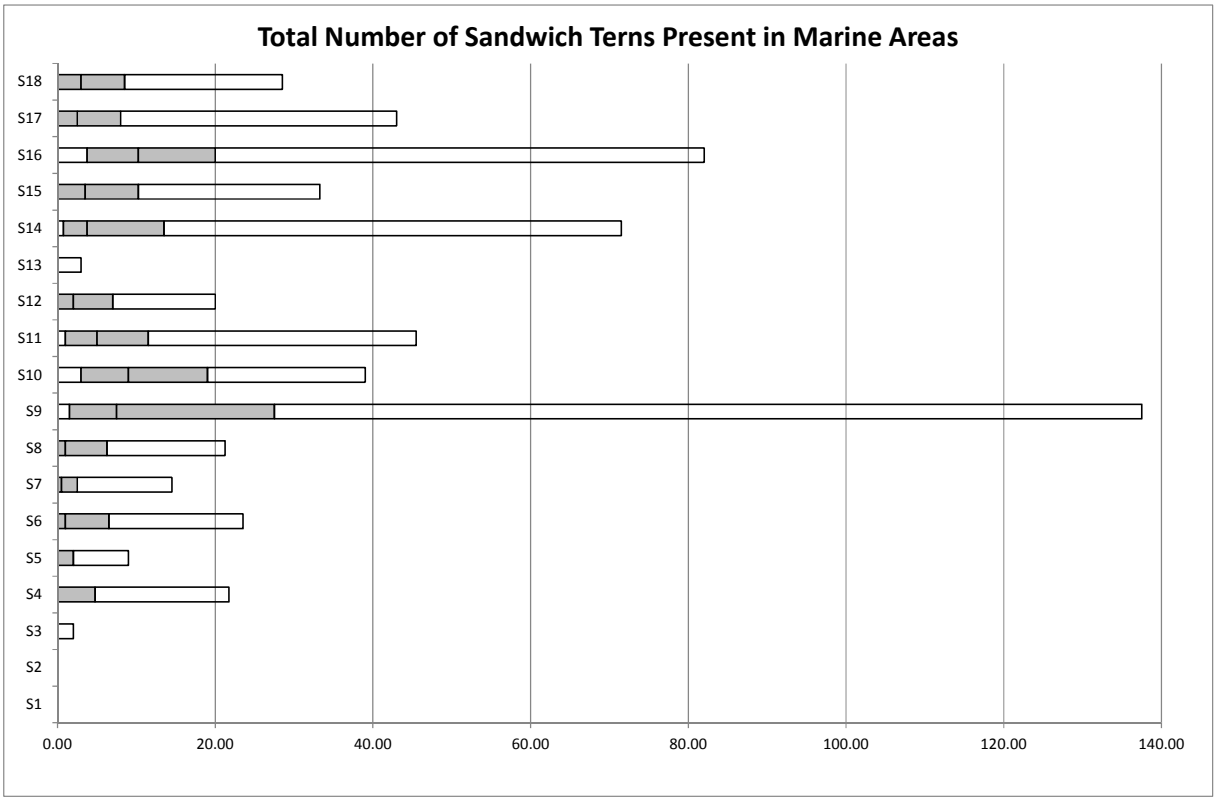

Fig 30: Total number of Sandwich Tern (number of birds fishing was negligible). Shows lower limit, median, upper limit and interquartile ranges. S9 was immediately in front of nesting area at Rye Harbour so includes all exiting and returning birds.

NESTING AREAS

The map below (Fig31) shows the nesting locations for terns during the 2014 season:

- **CT 1** The most westerly nesting location. An artificial scrape at the edge of Pett Levels managed by The Wetland Trust. 57 pairs of Common Tern bred here in 2014.
- **CT 2** A small number of Common Tern nested on an island at the western end of Ternery Pool. The island was shared with several pairs of Black-headed Gull and later predated by Herring Gulls. All nests were abandoned and adults were thought to be among the later broods on the Quarry.
- **CT 3** The Quarry was the main nesting site for Common Tern at Rye Harbour. The islands held the majority of the 90 pairs to breed at this reserve. Fox and Badger were present within the electric fencing enclosure but no predation was observed from these ground based predators.
- **CT 4** RSPB Dungeness had 36 pairs of Common Tern nest at a single location, based on three rafts. These pairs reached large chick stage but ultimately none fledged, presumably due to a combination of food shortage and adverse weather.

- **LT 1** The main nesting site for Little Tern in Rye Bay. An enclosure was set out with decoys, call playback and extra fencing but the birds settled outside of this area, on the Flat Beach section of Rye Harbour Nature Reserve. The large distance from accessible viewpoints meant that very few direct observations of nests were made.

- **LT 2** A small group of Little Tern (c. 3 pairs) started to settle on the foreshore at Rye Harbour but did not reach the egg stage. This was an exposed site open to the public and ground predators.

- **ST** Sandwich Tern nested on the eastern half of Ternery Pool at Rye Harbour. Initially on a single island, the birds moved sequentially over five of the islands as nests failed at earlier locations. Badger and Fox were present within the electrc fence unit and are thought to have reached at least one island this season.

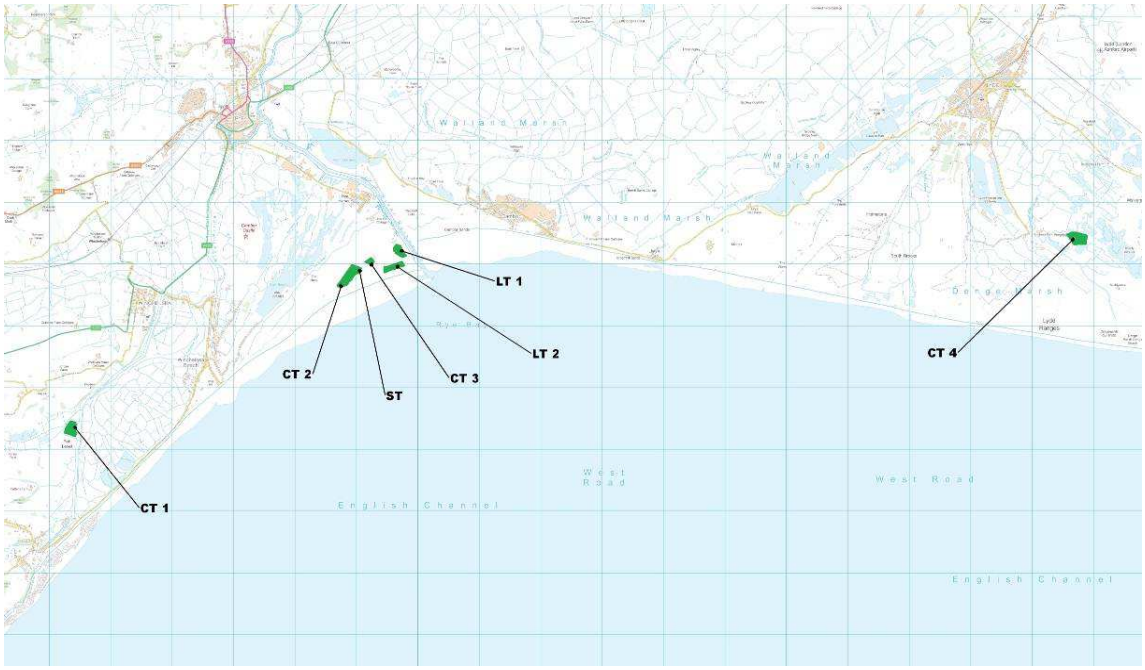

Fig 31: A map showing the nesting locations for all breeding terns within Rye Bay during 2014.

ROOSTING AREAS

The map below (Fig 32) shows the major roosting locations across Rye Bay in 2014. There were often small and temporary roosts forming on tidal areas as the tide receded but only the more regular sites with higher densities of roosting birds have been mapped here:

R 1 The stretch of coast between the Mary Stanford lifeboat house and the river mouth was often the site of roosts as the tide receded. The sand bank here provides island refuges from disturbance whilst the tide is falling and was mostly utilised by Common Tern (with numbers ranging from a few scattered pairs to up to a hundred in a denser roost) although smaller numbers of Sandwich and Little Tern were seen also.

R 2 This roost was almost entirely utilised by Sandwich Tern. Before settling at the nest sites this area on the seaward edge of Ternery Pool was used by up to 500 terns who either rested or used the

pool to wash. Once pairs were nesting the site was used in lower numbers but was still regularly occupied by 50-150 Sandwich Tern.

R 3 The Quarry has a group of low lying, linear islands at its eastern extent (bordering the Flat Beach area). These were unsuitable for nesting due to flooding but provided safe roosting for Sandwich, Common and Little Tern. Varying with the tide, this roost was often used by up to 100 birds.

R 4 A smaller roost was present on the Flat Beach area of Rye Harbour. This was used by Little Tern during most of the season, especially nearer the brackish pool's edge, and by Sandwich Tern nearer the end of the season, possibly by significant number of migrating birds.

R 5 The shallow slope of Camber beach left a large expanse of sand at low tide. A dispersed roost of 30-50 Common Tern were often observed in the centre of this patch but were often disturbed by walkers, dogs and water sports activities.

R 6 The stretch of coast directly inshore from The Patch, near the Dungeness power stations was usually home to a small roost of Common and Sandwich Tern. This varied greatly with an approximate count of 100 birds being the maximum.

R 7 This section of tidal mud and sand was often used by a dispersed roost of Sandwich and Common Tern. Numbers were normally low (up to 50 terns in general) but the lack of disturbance meant that this area was rarely unoccupied as the tide went out.

Fig 32: A map showing the main roosting locations of terns across Rye Bay in 2014.

PRODUCTIVITY/BREEDING NUMBERS (2014 VS. PAST)

Generally, the breeding success of 2014 was quite similar to recent years' outcomes. The charts below (showing Rye Harbour Nature Reserve data only) show that Sandwich Tern breeding success has been essentially nil since the last productive season in 2010, and general numbers have

also been depressed. Similarly the breeding success of Common Tern has been significantly lower since the last "good year" of 2010. The Little Tern population, however, has been steadily declining since the mid-1980s and although fledged chicks remain scarce there has been a slight rise in active pairs during 2010-14 compared to the complete absence of Little Tern in 2008 and 2009.

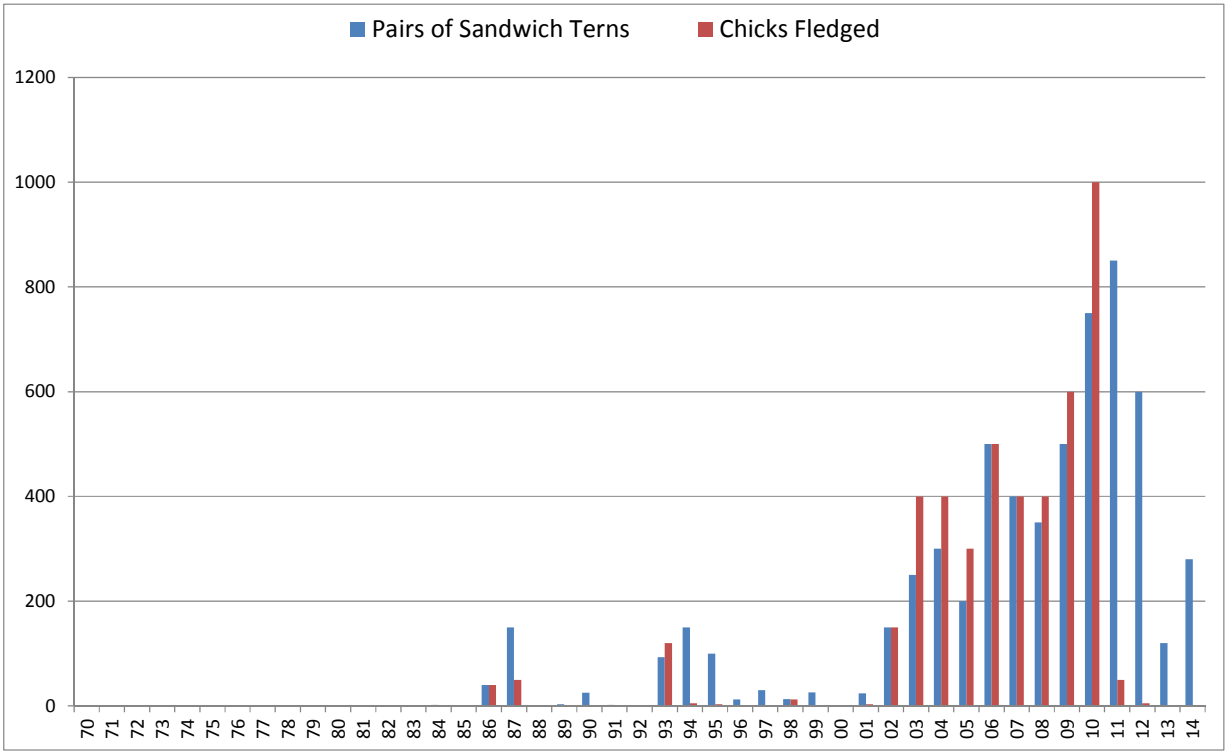

Fig 33: the numbers of active pairs of Sandwich Tern and the numbers of chicks fledged at Rye Harbour since 1970.

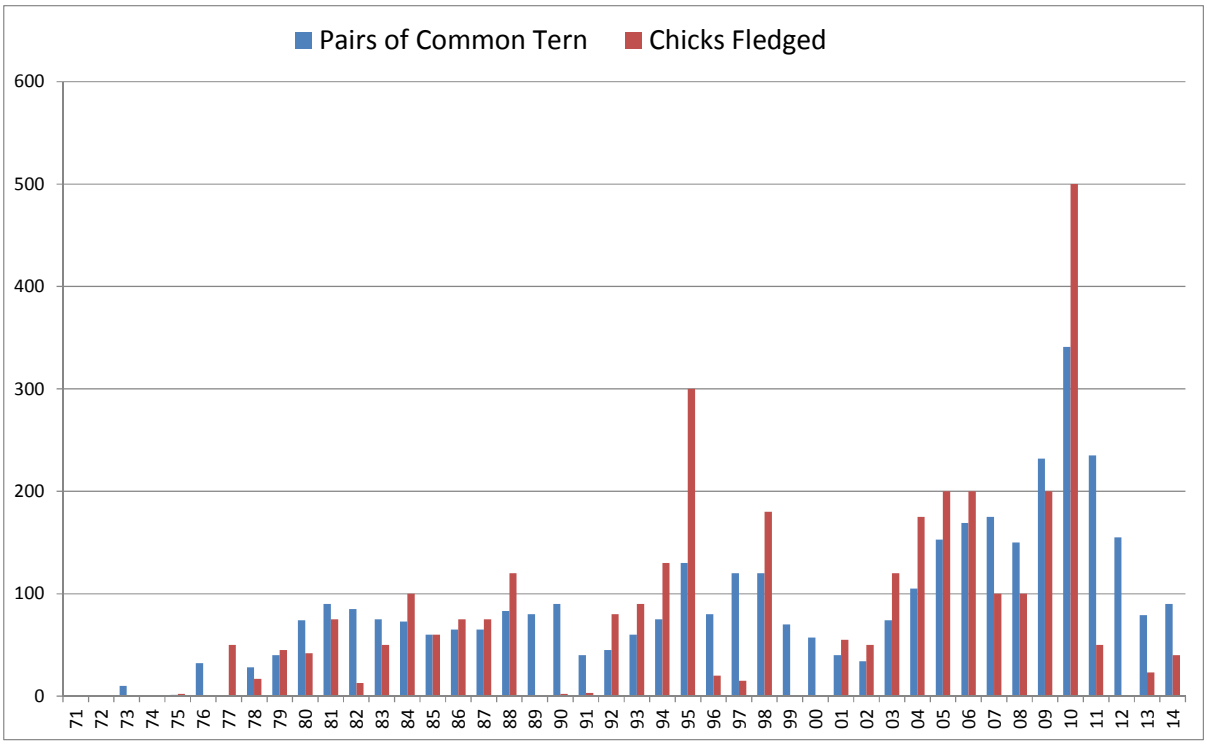

Fig 34: The number of active pairs of Common Tern and chicks fledged at Rye Harbour since 1970.

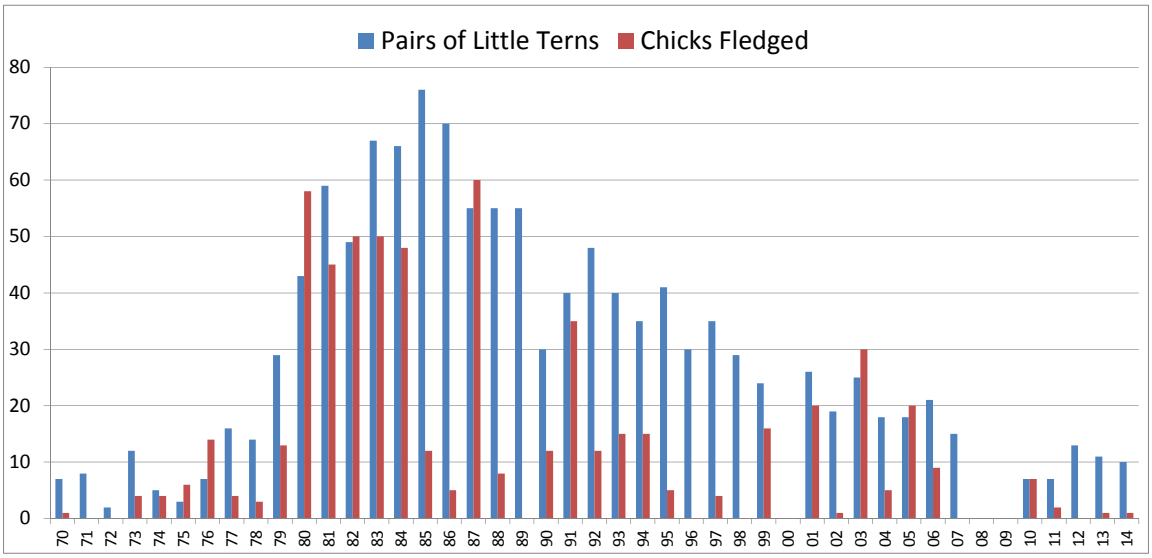

Fig 35: The number of active pairs of Little Tern and chicks fledged at Rye Harbour since 1970.

PREDATION

Terns are subject to numerous predation pressures, the history and present status is run through species by species below. Throughout this project the reserves with breeding terns continued their usual predator surveillance and management. In addition to this, two remote cameras funded by The Seabird Group, were placed within predator fenced areas at Rye Harbour to aid the detection of ground predators (a sample of pictures are included below). At the end of this project these were donated to Rye Harbour Nature Reserve to aid future monitoring.

Badger

Badgers have not always been present in Rye Bay, with Hastings and East Sussex Naturalists group reporting them in Pett from 1933. But in 1992 the stronger protective legislation led to increased numbers, with setts in the Rye Harbour area increasing from two to more than twenty by 2010 (current estimates being a minimum of 22 setts). There is also one sett affecting the RSPB Dungeness site. Their strong tunnelling behaviour and ability to swim out to islands has made them difficult to exclude from terneries and have caused total breeding failures in the past.

At Rye Harbour this year there was a strong presence within the fencing around Ternery Pool as well as within the electric fence where the Little Terns nested.

Figure 36: (6/5/2014) shortly after installation of the first camera at Ternery Pool this badger was observed, the same night an island of nesting Black-headed Gulls had been partially predated.

Figure 37: (8/5/2014) this badger can be seen looking out to the near island and is regularly captured passing in front of the Parkes Hide

Figure 38: (13/5/2014) this badger has put up Sandwich Terns from the nearby nesting island

As low numbers of badgers were proven to have access to breeding areas at Rye Harbour, diversionary feeding was carried out to try and minimise their impact. This seems to have reduced their impact on the terns but may have negative impacts in the longer term.

Fox

Foxes used to be kept at very low densities but due to reduced prices for fox winter pelts in the mid-1980s, their numbers have risen. In the 1990's foxes regularly swam (or waded at times of low water levels) out to nesting islands and caused total breeding failures. Since then, significant improvements have been made to electric fences. Also foxes are shot over winter and early spring by local sheep farmers. The management of Rye Harbour Nature Reserve includes fox shooting January-July, and problematic individuals are controlled by RSPB management at Dungeness.

In 2014 there were 2 fox earths present at RSPB Dungeness and foxes were present within the Ternery Pool and Quarry/Flat Beach fenced areas at Rye Harbour.

Fig 39: (10/5/2014) Fox in Ternery Pool

Fig 40: (24/4/2014) Fox inside quarry fencing unit, a nursing mother

Mink

Mink can be very effective predators of ground nesting birds and are present at the three nesting sites in Rye bay. However they seem to have little impact at present due to management methods. At RSPB Dungeness they are controlled and have been seen in large numbers this season, but steep sided rafts placed in deep water make access to tern nests very difficult for them. Terns at Rye Harbour also escape significant impact from mink, mostly due to trapping carried out throughout the year and the local geography seeming to limit them to more inland sections of the reserve. The Wetland Trust maintain a rigorous control program for mink across their wetland reserve.

Corvids

Corvids have the potential to have a large impact on tern productivity. They were historically a rare group in Rye Bay but since the mid-1900s have been common, being controlled by game keepers before then (HESN).

Their aerial access cannot be controlled and their intelligence allows them to easily hunt out chicks which are left without adult protection for much of their development. At Rye Harbour they are controlled (c. 40 caught in Larsen traps during April-May 2014) and many electric fence posts are topped with spikes to deter perching. A group of around 20 Carrion Crows were also present at RSPB Dungeness and were regularly seen harassing terns on the rafts. They were usually seen off but when an early wave of chicks died of suspected starvation they were able to take advantage within a few days.

Raptors

There are a variety of raptors present in Rye Bay but the two of most impact here are the Kestrel and Marsh Harrier. Marsh Harriers are rare visitors to the breeding areas but in Rye Harbour one could occasionally be seen landing on breeding islands and predating Black-headed Gull chicks. The repulsive efforts of the adult terns and gulls were largely ineffective. These attacks probably had a relatively small effect on productivity over the entire season.

Kestrels took fewer chicks per visit but are much more common visitors to nesting areas, especially for Little Terns. The relatively long life span of the Kestrel enables some individuals to specialise in predating Common and Little Tern chicks. Diversionary feeding has been tried elsewhere but has had mixed results. A small study by the RSPB recently has had generally positive results but with a small sample of predatory birds and effects seem greatly impacted by the individual birds involved (Smart et al.). In 2014 Kestrels were not seen to be regularly hunting around the tern nesting areas, presumably finding more small mammal prey in surrounding fields than there were available chicks.

Gulls

Large gulls have a large impact on the local tern populations, but species differ.

Lesser Black-backed Gulls do take chicks from breeding areas but do not seem to focus on tern chicks, often taking Black-headed Gull chicks. During 2014 they were observed to take several chicks but most of these were indeed gull chicks, and many attacks were repelled by the joint effort of parent Common Terns and Black-headed Gulls. Large gulls rarely take chicks from Sandwich Tern nests and have not been observed predating Little Tern nests (which presumably are sufficiently camouflaged).

Black-headed Gulls can also be seen to take tern eggs and chicks and are present in large numbers (2,600 pairs in 2010) in very close proximity to nesting terns. However this proximity leads to them protecting terns from other predators which approach nesting areas (e.g. large gull, crow, fox), adding their attacks to the general repulsive force of parent birds. This protection is greatest for the tern eggs and young chicks as the gulls nest approximately 4 weeks earlier in the season. It has been shown that eggs on the fringes of colonies benefit most from this protection, which are

normally of less mature birds that generally have a lower breeding success, so the protection can have a large impact on overall colony productivity (Fuchs et al., 1977).

Herring Gulls pose a much larger threat to breeding Black-headed Gulls, Common and Sandwich Terns. If a pair of Herring Gulls nest on an island with other species on they can clear it of active nests in a few days. Sandwich Terns are usually less affected due to their more aggregated nesting and association with Black-headed Gulls but Common Tern can be highly impacted. During 2014 Herring Gulls at Rye Harbour did predate Common Tern nests and two pairs were controlled under license due to their large impact.

Rabbits

Although not true predators, it has been suggested that rabbits are taking a toll on ground nesting bird species. This has been suspected locally and has been proven to be the case for Least Tern in North America. Remote cameras captured rabbits (*Oryctolagus cuniculus*, European Rabbits) burying eggs and destroying artificial nests during the 2007 breeding season (Clements and Clements, 2011). This was alongside predation from American Crows and Brown Rats on Lovells Island, Boston Harbour in a situation not too dissimilar to coastal Sussex/Kent.

Although unproven in the local area, there is a large population of rabbits present. Even if it is a scarce behaviour in this population there is a chance that it is playing a small but significant role in nest failure rates of Little Tern. Further observation and the use of remote cameras could determine if this behaviour is present amongst rabbits at Rye Harbour.

In addition to this the large population of rabbits affects the numbers of foxes present. Larger numbers of rabbits can support a larger population of foxes but will at the same time provide more food as an alternative to ground nesting seabirds. Further study would confirm the relative strengths of these two opposing effects, although it is commonly believed that a larger fox population would lead to more opportunistic predation of tern nests.

KLEPTOPARASITISM

In most years the terns of Rye Bay have to evade the attacks of kleptoparasitic species including Mediterranean, Black-headed Gulls and Roseate Terns. Since 2010 counts of just under 200 Mediterranean Gulls have been common on Ternery Pool (max count 550+) but this year, despite a count of over 300 on 4/4/2014, there were just 8 seen there on 8/5/2014. Roseate Terns are not usually present in particularly high numbers but these too were less frequent than usual, perhaps in response to the generally poor tern breeding success of recent years. This meant that in 2014 the largest risk of kleptoparasitism came from Black-headed Gulls. Even here, the majority of these attacks witnessed were from young, inexperienced gulls so were less successful than attacks by adults or other, more specialist species. Overall the effect of kleptoparasitism was deemed negligible in Rye Bay during 2014.

However, studies have shown that kleptoparasitism can have large impacts on breeding terns. Sandwich Terns for example can be targeted for their larger Sandeel, over smaller Herring catches. This loss of preferred prey can lead to increased feeding effort and chicks being left for up to 80% of daylight hours in poor fish years (Stienen and Brennenkmeijer, 2002). Rye Bay Sandwich Terns are likely to be spared this pressure until breeding success improves in future years (as it will

not be a viable food source for the aggressor species until then) but it may well have played a role in the reduced success in recent years.

IFCA / NATURAL ENGLAND SMALL FISH SURVEYS

Small fish stocks have recently become the subject of survey work by local Inshore Fisheries Conservation Authorities and Natural England. These organisations replaced the Sea Fisheries Committees from April 2011 to assess and conserve the 0-6 nautical mile zone around British shores. The Sussex IFCA covers a large section of Rye Bay with surveys being carried out monthly from June to September at Rye Harbour, within 100m or so of all three species of nesting terns. The surveys at this site are specifically aimed at assessing the amount of prey available for the local terns so differ slightly in timing and method compared to surveys in other locations. They are however generally comparable so data from the Southern IFCA at Langstone Harbour has been compared alongside the success of the tern colony there which also contains Sandwich, Common and Little Terns.

These surveys are in the early stages as the IFCAs are still relatively new organisations, so far two survey seasons have been completed. It is hoped that these fish surveys will provide a strong indicator of tern breeding success (and vice-versa) once a baseline of survey seasons has been established. This approach has been proven to be successful for Common Terns with regards to the Herring/Sprat abundance in the North and Wadden Seas (Danhardt and Becker, 2001).

These surveys were carried out using a seine net with a 14mm mesh at the sides and a finer, 6.5mm mesh in the central panel. This ensures the net can be towed by hand in the water but the relatively large side mesh does allow very small fish to escape. This made the catch of juvenile fish uncommon and, technically, thin fish such as Sandeels could swim through the net head on. Pipefish were caught by these nets however which shows some Sandeels would be caught if they were present in significant numbers. Small fry were only caught once or twice when a portion of a shoal was caught side on and could not pass through the mesh. This shows that many more could be present and escape survey efforts. This is an important aspect of the fish stock to be considered when thinking of tern prey as parent terns feeding very young chicks need to catch prey small enough for them to swallow and Little Terns generally catch much smaller prey than the larger terns. Further study of this extremely small size group of fish could play a large role in explaining tern breeding failure in the future.

Comparison between locations

During surveys this year at Rye there were a variety of species caught, here the focus is on tern preferred species- mainly Herring, Sprat and Sandeel.

In 2013 there were only two Sandeels (*Ammodytes tobianus*) caught in the Rye Bay surveys, and these were from a boat based trawl catch rather than the seine net used in the shallow, tidal waters.

In **June 2014** there were **140 Herring** caught of an average length of 59mm. There were **16 Sprat** caught, averaging 52mm in length. There were **no Sandeels** caught.

This compares to Langstone Harbour, a tern breeding colony approximately 120km to the East of Rye Bay. Over three survey sites they had **18 Herring** averaging 69mm in Length. They caught **278 Sandeels** of an average 116mm in length. They caught **no Sprat**.

Species/Location	Langstone Harbour	Rye Bay
Sandeel	278 (mean 116mm)	0
Herring	18 (mean 69mm)	140 (mean 59)
Sprat	0	16 (mean 52mm)

Table 1: a comparison of the number (and mean length) of food species caught in IFCA surveys in June 2014 (carried out by separate groups using comparable methods)

Sandeels are significantly better quality food for tern chicks when considering calorific content. Models for determining calories from the length of fish have been used in many studies and although variety exists they all agree approximately. Using the formula of:

Sandeel calories = 0.0024*Length(mm)^3.806

gives 172.8 Kcal for the mean length of Sandeel caught at Langstone Harbour (116mm). This is significantly more than the value of Herring or Sprat given by the formula of:

Clupeid calories = 0.0057*Length (mm)^3.928

which gives 95.3 Kcal for the mean length of Herring caught in Langstone Harbour and 51.5 and 31.4 Kcal for the mean length of Herring and Sprat caught at Rye Harbour respectively. Comparing the Sandeels of Langstone Harbour with the Clupeids in Rye Bay gives a difference in energy of 3 to 6 times. This difference will have played a large part in the breeding success of the terns with Rye Bay birds having to catch 3-6 times more fish to provide the same energy needs for their chicks. This is reflected in the different productivity values for the different sites below, although this will almost certainly not be the only significant factor.

Location	**Langstone Harbour (all)**	**Rye Bay- Rye Harbour**	**Rye Bay- RSPB Dungeness**	**Rye Bay- Panell Valley**
Number of AONs	117	90	36	57
Number of Chicks Fledged	0	40 - 50	0	8
Productivity (fledged chicks per pair)	0	0.44 - 0.55	0	0.14

Table 2: Common Tern productivity within Rye Bay and at Langstone Harbour

Location	Langstone Harbour (all)	Rye Bay- Rye Harbour
Number of AONs	66	280
Number of Chicks Fledged	27+	0
Productivity (fledged chicks per pair)	0.41+	0

Table 3: Sandwich Tern productivity within Rye Bay and at Langstone Harbour

Location	Langstone Harbour	Rye Bay- Rye Harbour
Number of AONs	31	10+
Number of Chicks Fledged	28+	1
Productivity (fledged chicks per pair)	0.9+	up to 0.1

Table 4: Little Tern productivity within Rye bay and at Langstone Harbour

Comparison Between Years

As a rough comparison of fish resources between the years, the tables below show the small fish survey results, from Rye, of 2013 alongside those of 2014. Regarding the percentage catch of different species, the composition has changed significantly between years. This is possibly due to a change in local fish populations but is more likely due to the method, perhaps a small sample size not posessing the resolution to pick out patterns on the small geographic or temporal scale. This variation should even out once a longer data set using the same survey method is gained if all else remains unchanged. For the main species relevant to terns there is an increase from 0% to almost 10% whilst Sandeels continue to be virtually absent from all samples and Herring remains at around 10% of the total catch.

Regarding general diversity of small fish stocks, there has been no significant difference between the two years. Although each month has changed significantly the values average out to be generally quite similar, with several hundred individuals of roughly 8 species being caught. Since last year the method has been adapted to include a larger sample of six seine net samples (rather than just two in combination with more effort intensive fyke net sampling) and this larger sample size should provide less variable data in a much shorter time scale than otherwise. Regardless, a longer dataset is needed from these surveys before we can come to any firm conclusions.

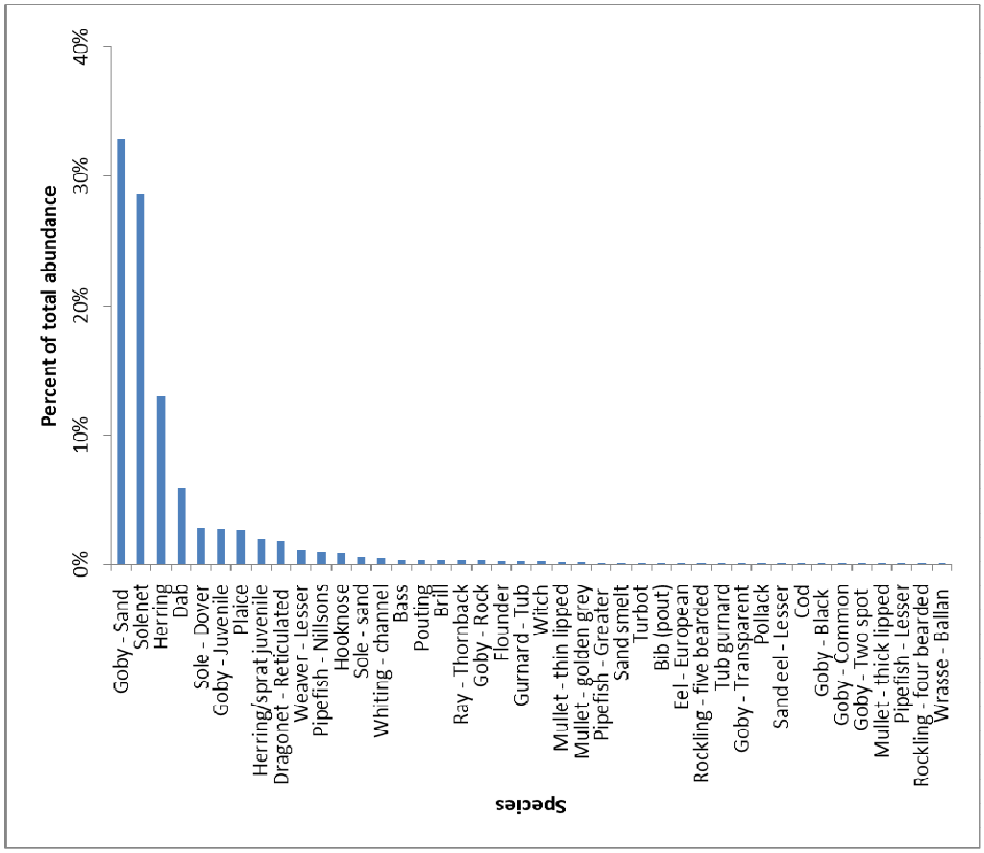

Figure 41: % abundance for species found in Rye in 2013, methods and months combined.

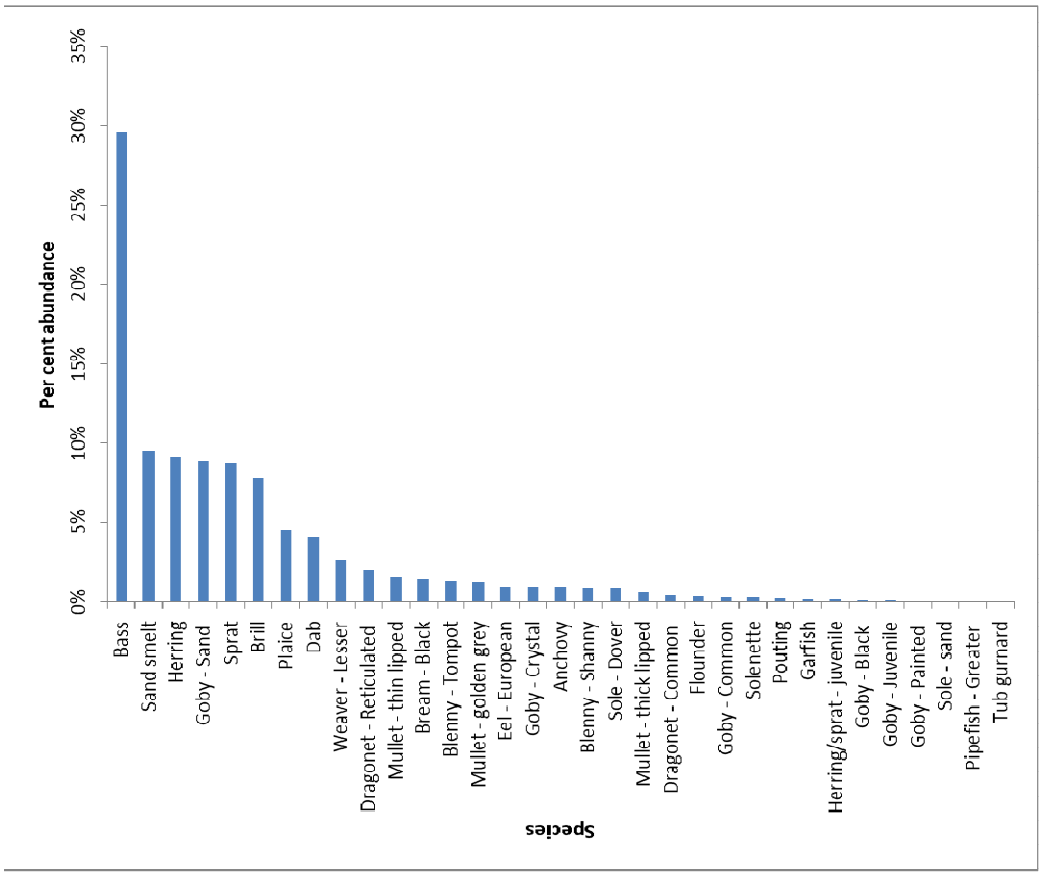

Fig 42: % abundance for species found in Rye in 2014, methods and months combined.

Table 5: Number of species, total abundance and Gini-Simpson's index of diversity caught in the seine net at Rye Harbour in 2013.

	Number of species	Abundance	Index of diversity
July	7	623	0.05
August	5	13	0.81
September	12	157	0.72

Table 6: Number of species, total abundance and Gini-Simpson's index of diversity caught in the seine net at Rye Harbour in 2014. Figures in parenthesis are representative of all 6 samples, those without are of the 2 samples directly comparable with 2013 data.

	Number of species	Abundance	Index of diversity
July	8 (17)	200 (449)	0.65 (0.82)
August	9 (15)	164 (490)	0.49 (0.76)
September	7 (16)	139 (488)	0.72 (0.78)

Observations of tern activity were made on the small fish survey days to ensure that they were not different from the rest of the season. There were no significant differences in number of terns, or their diving rates, although our presence at some points in the falling tide meant terns avoided some shallow pools. Counts during these periods of obvious disturbance were not included in the final results.

WEATHER

The summer of 2014 was relatively benign for tern breeding efforts in Rye Bay, especially for the first half of the season. There was a later phase of much wetter and unsettled weather but this was relatively late on and would have had a much reduced impact than if it had occurred earlier in the year. The Sandwich Terns for instance had already failed and started to disperse by the time this weather arrived. A late wave of Common Tern chicks could possibly have been affected by adverse weather but many had already died by the time it hit so the weather was probably not a major factor in this failure.

This lack of significantly adverse weather suggests that if any problems exist for terns catching food, it is not due to weather conditions limiting their hunting activities. Future work in seasons with more disruptive weather would be needed to judge whether it would further reduce tern productivity.

DISCUSSION

In the context of the recent past, the 2014 season was favourable for the Terns of Rye Bay. The weather was relatively settled and, although a couple of periods of bad weather coincided with some Common Tern nests failing, the failure of Sandwich Tern nests was evident before these periods. Little Terns are harder to judge as they settled far from any observation points this year and it is possible that these brief periods of bad weather caused some nests to fail.

Kleptoparasitism was also at a low this year due to the lack of Mediterranean Gulls and Roseate Terns. Some Black-headed Gulls did try to steal food items but this was not a large pressure on the tern population.

Food at first glance seems to have been in good supply, with more Herring and Sprat recorded than last year. However, there were little to none Sandeels caught by the fish surveys for a second year and only a small proportion of birds carrying fish were in possession of Sandeels. And during a short period in the middle of the season, covering the first week to ten days of July, Common Terns were seen trying to feed flatfish to their young which they could not swallow. There also seemed to be a lack of very small fish available to Sandwich Terns, but these are too small even for the small fish surveys so a specific project would need to be carried out to confirm this.

The small fish surveys say that 2014 was generally better than 2013 for small fish but this series of surveys is only in its second year and a separate study of historical bird and fish data could be productive. The lack of data on very small fish also appears to be important for work relating to terns and a separate analysis looking solely at key species such as Herring, Sprat and Sandeel could be more revealing.

Predation was also still an issue this season. Small numbers of fox and badger were present inside the electric fencing at Rye Harbour and Corvids were active both at Rye Harbour and Dungeness. This is one pressure that is possible to supress with further improvement to predator fencing and other management measures at all sites.

As for the most important areas for feeding terns, each species predictably had its own favoured areas. Little Tern are very restricted in their hunting grounds, feeding almost entirely on the brackish waters on Flat Beach and the adjacent coastal waters (plots S8-S10). There were very occasional sightings slightly further afield but birds were mostly seen feeding in and just West of the river mouth in the S9 and S10 plots. They could often be seen at high tide very close to the shore line but otherwise exploited the small pools that formed as the tide receded. Little Tern have a need for a good supply of very small fish to raise their chicks and observations of Sandwich Tern suggest these may be lacking in Rye Bay (see below). The Little Tern nested too far from observation points this season to observe the presence of these fish so we cannot be certain.

Common Tern were much more dispersed and were seen fishing along the whole stretch of coastline, with a spike of activity immediately out from Ternery Pool, at S9. They also used a wide range of freshwater bodies, favouring Narrow Pit, Field 5 and Castle Water at Rye Harbour, the ARC and ND pits at Dungeness and the main scrape at the Pett Level nesting area. This use of freshwater fishing grounds seems to be a major factor in the breeding success of Common Tern. The presence of flatfish at the nest show that high quality fish were hard to come by at sea at times, so the ability to switch to freshwater fish is very valuable.

Sandwich Tern were observed to fish much less often, probably due to them fishing far offshore and out of sight from land based observers. When they did fish close to shore it tended to be in the far Eastern section of Rye Bay. They were often present at The Patch, but as previously discussed this probably did not provide any significant amount of food suitable for growing chicks. They did fish more generally around the Dungeness peninsular though, and some birds were seen

flying back towards Rye Harbour with food items suited to feeding chicks (many Herring/Sprat and Sandeel). However, only two birds were seen carrying small fish suitable for freshly hatched chicks and chicks were rarely seen more than 3 days or so after hatching. This strongly points to a lack of small fish being a cause of the total failure of Sandwich Tern in Rye Bay this season.

Overall, this study has shown the general feeding areas for the three species of breeding terns. These areas have roughly agreed with beliefs of local reserve staff but have shown that some areas are used less than thought- especially when considering the inland freshwater bodies and fishing Common Tern.

There are several problems that this report has highlighted:

- The continued presence of ground based predators at nesting locations.
- The lack of information on populations of the very small fish that are vital for recently hatched terns
- The difficulty in monitoring the whole range of the dispersed colonies of terns across Rye Bay.
- The difficulty in monitoring the feeding activity of Sandwich Tern far from land.

Sussex IFCA / Natural England Small Fish Survey using a seine

ACKNOWLEDGEMENTS

This project would not have been possible without the help of many people, local and further afield. Firstly I would like to thank the Natural England for funding this project and The Seabird Group for the donation of £320 which bought trail cameras for the monitoring of predators. Thanks also to The Sussex Wildlife Trust, Rye Harbour Nature Reserve, RSPB Dungeness and the Wetland Trust for access and information on the nesting terns. Thank you to Wez Smith at RSPB Langstone Harbour for information on the tern colony there and thank you to the Southern and South East IFCAs for their help with information on local fish stocks.

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