NOISE DISTURBANCE – BASELINE LEVEL MONITORING IN THE SOLENT

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1 INTRODUCTION

The Solent coastline hosts thriving harbours, ports and other coastal industry, meaning there is a high volume of activity interacting with the marine environment. The majority of this activity creates a level of noise that can lead to the disturbance and displacement of Special Protection Area (SPA) bird features. The SPAs in the Solent area with marine components are the Solent and Southampton Water SPA, Portsmouth Harbour SPA, Chichester and Langstone Harbours SPA and Solent and Dorset Coast SPA.

In particular, most birds are sensitive to above water noise. This pressure relates to any anthropogenic loud noise made onshore or offshore by construction, vehicles, vessels, tourism, mining, blasting etc. that may disturb birds and reduce time spent in feeding, resting or breeding areas.

Above water noise is benchmarked as the introduction of airborne noise above background levels, however there is currently a lack of data on what background noise levels are. Therefore, assessing the risk of an activity disturbing birds through the introduction of above water noise has proven difficult.

This work, commissioned and funded by Natural England, has been designed to fill this data gap for the overwintering period through noise monitoring in key areas across SPA sites in the Solent with the objective of providing data on background noise levels in order to more accurately determine the likely significant effect on birds when responding to anthropogenic noise.
Nine areas of high activity have been identified. These areas are hotspots for anthropogenic activity and cross over with key areas of designated SPAs. These areas are therefore used as the main sites for the background noise surveys and are representative of the Solent as a whole.

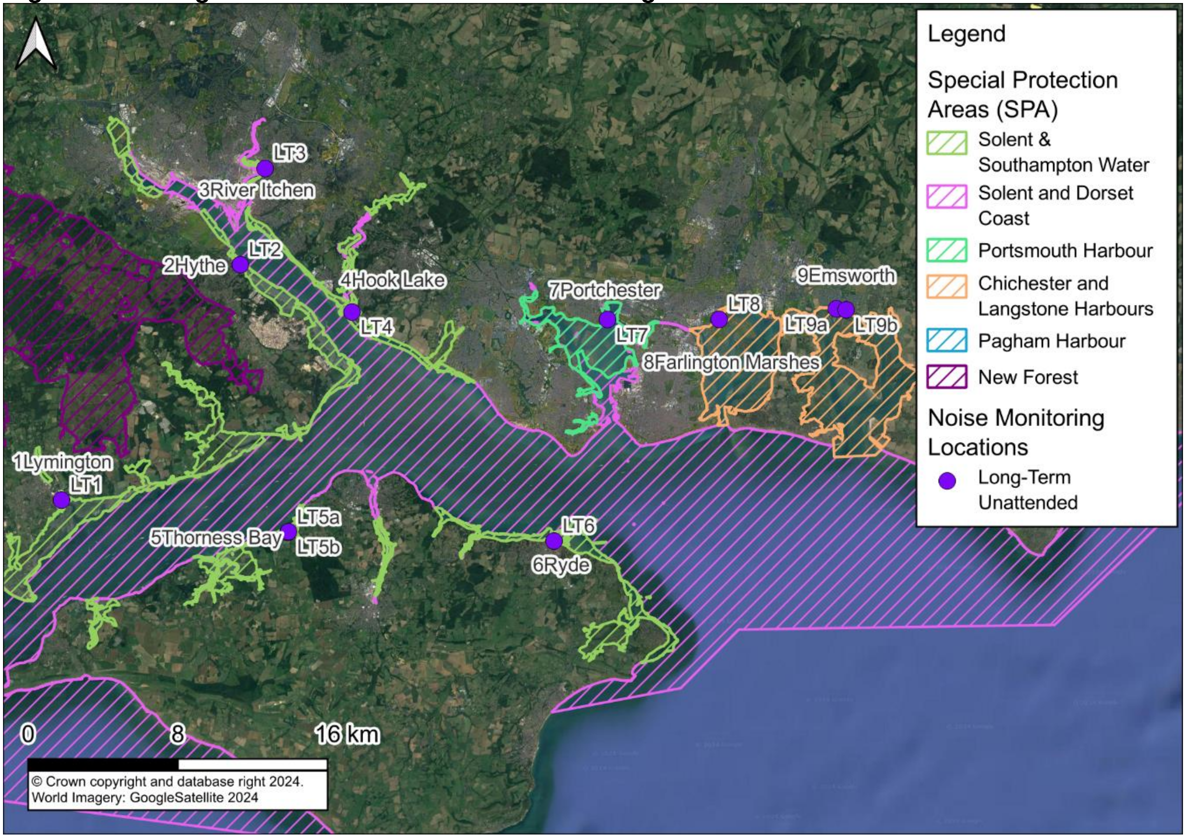
2 METHODOLOGY

2.1 Long-term Baseline Noise Monitoring

A monitoring survey was undertaken to characterise the baseline ambient noise levels currently experienced on site at nine SPA locations. Measurements were taken in general accordance with BS 7445-1:2003: Description and Measurement of Environmental Noise – Guide to quantities and procedures[1].

The baseline monitoring survey was undertaken monthly from October 2023 to February 2024 at the nine SPA locations presented in **Figure 2.1** with measurements being made unattended in 5-minute intervals over a minimum of 72-hour period at each site per month.

Figure 2.1: Long-term Unattended Noise Monitoring Locations



2.1.1 Data Analysis for Long-term Noise Monitoring

The collected data per measurement period were divided into daytime hours (07:00 – 23:00) and night-time hours (23:00 – 07:00) to reflect the operational hours of anthropogenic activities. The local weather conditions for the duration of measurement were established using Weather Underground, an online resource which provides real-time and historical weather information. Where appropriate due to periods of heavy rain or high wind speeds, data was omitted from analysis.

Background noise levels are usually described using the L_{A90} index (i.e. the sound level exceeded for 90% of the measurement period). This sound index was chosen to represent the background noise levels in the areas studied and the modal L_{A90} sound level of each 5-minute measurement is used to represent the overall background noise levels during the daytime and night-time periods.

It should be noted that some measurement periods were omitted due to equipment failure as a result of poor weather conditions or unsuitable weather conditions to set up the equipment. All locations were monitored for a period of at least four months except for 2Hythe and 6Ryde due to meter failures during both October and November long-term surveys at 6Ryde and during February long-term survey at 2Hythe.

2.2 Short-term Noise Monitoring

Short-term noise monitoring was undertaken to coincide with the long-term unattended baseline noise monitoring in order to observe the bird species present, their behaviour and any responses to anthropogenic noise in the area. Observations were made during high, low, rising and falling tides.

Up to three observation positions near to the long-term noise meter were chosen to maximise the likelihood of observing bird species. Bird count and species identification within an approximate range

of 500m were undertaken using binoculars and a telescope for a total of three times during the observation period.
The short-term noise meter was set up to measure the sound levels in 1/3 octave bands and 1-second intervals over a minimum period of 2 hours during the daylight hours. Observations of any anthropogenic noise were noted to include the source of noise, time of the noise event, whether the disturbance is also visual in nature, estimated sound pressure level at the measurement position, and the distance of noise source to the birds being observed as well as the measurement position. The respective distances between the noise source and the location of the bird and the measurement position are estimated using the map on the Survey123 application used. Bird responses to the anthropogenic noise were categorised as one of the following:
0 – no response
1 – freeze/stress response
2 – staying at site but moving away from noise
3 – flight response with settlement within 100m
4 – flight response with settlement beyond 100m

2.2.1 Data Analysis for Short-term Noise Monitoring

Where any bird response was noted during the survey, the sound pressure level at the meter location is used to estimate the sound pressure level at the location of the bird using the relationship below as referenced in The Little Red Book of Acoustics written by R Watson and O Downey[2].

$$L_2 = L_1 - 20 \log_{10} (r_2/r_1)$$

$L_{(n)}$ is the sound pressure level at a location and $r_{(n)}$ is the distance from the noise source to the location. In this case, ‘1’ refers to the monitoring location and ‘2’ refers to the location of the bird.

Similar to the above, the loudest instantaneous noise levels L_{AFmax} which correspond to the noise events where bird responses were observed are also estimated at the location of the bird.

3 RESULTS

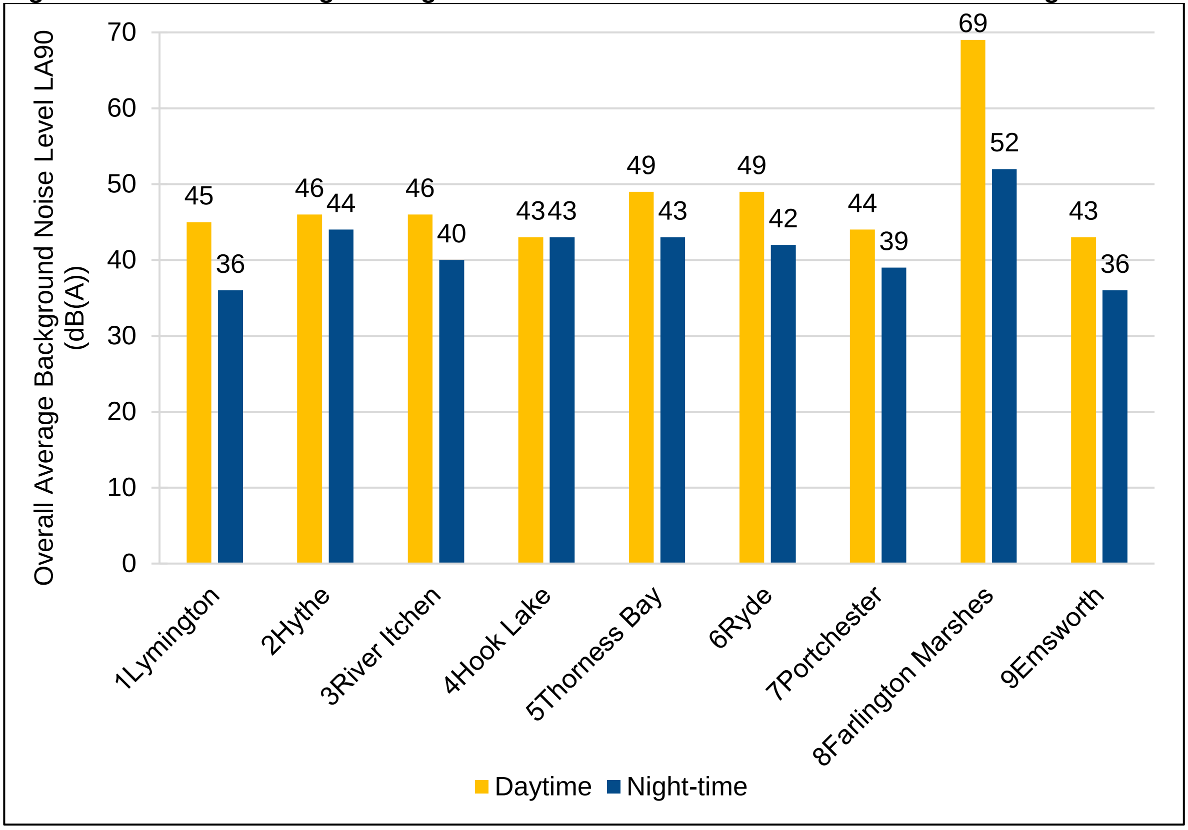
3.1 Background Noise Levels

The background noise levels during the daytime vary from month to month by up to 5.0 dB(A) at all locations except for 5Thorness Bay, 6Ryde and 7Portchester where the differences are in the range of 7.0 to 13.0 dB(A).

For the night-time, the background noise levels vary from month to month by up to 3.0 dB(A) at locations 1Lymington, 3River Itchen, 4Hook Lake, 9Emsworth whilst the other locations vary by up to 10.0 dB(A).

Figure 3.1 below presents the overall average daytime and night-time background noise levels across the entire monitoring period for each location.

Figure 3.1: Overall Average Background Noise Levels Across the Whole Monitoring Period



Generally, the overall average daytime background noise levels at all locations are between 43.0 dB(A) to 49.0 dB(A) with the exception of location 8Farlington Marshes where the overall average daytime background noise level is 69.0 dB(A).
Similarly, the overall average night-time background noise levels generally range from 36.0 dB(A) to 44.0 dB(A) at all locations except 8Farlington Marshes where the overall average night-time background noise level is 52.0 dB(A).

3.2 Bird Response

Where there were bird responses observed during the short-term noise monitoring survey, the noise events which triggered the response are analysed. The analysis includes the type of response from the birds as well as the estimated sound pressure level (SPL) and L_{Amax} levels caused by the noise event at the location of the bird.

Bird responses were only observed at locations 2Hythe, 3River Itchen, 6Ryde, 7Portchester and 9Emsworth with SPL from the noise events at the location of the birds estimated to be in the range of 46.9 – 85.4 dB(A). These bird responses were from 11 species out of the 51 species observed throughout the attended short-term monitoring. Most of the responses observed were also from Brent Goose (BG). The type of response observed were mainly of flight response with settlement within/beyond 100m with a few freeze/stress responses.

Although loud noise events (SPL between 30.0 dB(A) to 79.7 dB(A) at the location of the birds) caused by anthropogenic activities were observed at the other locations, no bird responses were noted.

Furthermore, the noise events which triggered bird responses include horns from vehicles, airplanes and helicopters passing overhead, trains passing, metal works, industrial noise, boats and hovercrafts, and people walking/talking. These are mostly also visual in nature. It should also be noted that all of the observed bird responses at the location 6Ryde were triggered by frequent hovercrafts.

The range of estimated L_{Amax} levels at the location of the birds for the noise events which resulted in bird responses is between 48.2 – 86.4 dB(A). However, it should be noted that no bird responses were observed for other perceptible noise events with similar estimated L_{Amax} levels in the range of 32.2 – 81.2 dB(A) at the location of the birds.

The estimated L_{Amax} levels which triggered bird responses are similar (within + 0.5 to 4.1 dB(A)) to their corresponding estimated SPL.

4 DISCUSSION

4.1 Background Noise Levels

The results of the long-term noise monitoring show that the overall average background noise levels at all locations are between 43.0 dB(A) to 49.0 dB(A) during the daytime and 36.0 dB(A) to 44.0 dB(A) during the night-time. However, higher overall average background noise levels (69.0 dB(A) daytime and 52.0 dB(A) night-time) at 8Farlington Marshes were recorded.

The long-term noise monitoring location LT8 at 8Farlington Marshes is approximately 120m south of the major road, A27. Based on strategic noise mapping data for road sources published by Extrium, the noise levels from road traffic at the monitoring location are predicted to be between 65.0 – 69.9 dB $L_{Aeq,16hours}$ during the daytime and between 60.0 – 64.9 dB $L_{Aeq,8hours}$ during the night-time. Other monitoring locations are at least 500m from any major roads. In the case of LT6 in 6Ryde, the main road A3055 (approximately 110m south of LT6) is considerably less noisy than the road A27 adjacent to LT8. As such, the noise contribution from road traffic is highly likely to be the reason for the higher background noise levels measured at LT8.

Despite higher background noise levels, at least 29 bird species, both breeding and non-breeding, were observed in the area during attended monitoring in 8Farlington Marshes. However, further and/or longer monitoring is likely required to determine if the birds are affected by the anthropogenic noise in the area.

4.2 Comparison of Observed Noise Events to Background Noise Levels

The results presented in this report indicate that bird responses typically occur when the sound pressure level at the location of the birds is at least 20.0 dB(A) higher than the typical background noise level $L_{A90,16hours(daytime)}$. This is relatively comparable to the study on laying hens by J. L. Campo, M. G. Gil and S. G. Dávila (2005)[3] which showed that hens were found to be more stressed and fearful when exposed to higher sound levels (90 dB) for 60 minutes which consisted of background noises plus truck, train and aircraft noises compared to the control group which was exposed to only background noise levels at 65 dB.

However, this is unlikely to be the main factor for the bird responses observed during the attended noise monitoring as several of the bird responses noted at the location 9Emsworth were triggered by people walking into the beach where the sound pressure levels at the locations of the birds are estimated to be only 3.9 dB(A) to 11.3 dB(A) above the daytime background noise level. This response is likely to have been triggered by the visual nature of the disturbance rather than noise. It was also observed that majority of the noise events with sound pressure levels less than 20 dB(A) above the background did not trigger bird responses.

J. R. Barber et al. (2009)[4] suggested that animal responses to anthropogenic noise are likely to depend on the intensity of perceived threats rather than on the intensity or level of noise. This may apply to most of the observations made during the attended surveys but particularly in the case of the bird responses observed from people walking into the beach at 9Emsworth.

Furthermore, the bird responses observed at 9Emsworth from airplane passing overhead and at 7Portchester from a boat leaving the harbour showed a difference between the sound pressure levels and background noise levels of only 9.0 dB(A) and 14.3 dB(A) respectively.

In a study of brent geese and human disturbance, Owens (1977)[5] suggested that larger birds with slow wingbeats such as Great Black-backed Gulls (GB) are also liable to causing flight responses in brent geese and intensity of responses to aircraft may be partly due to the visual resemblance of aircrafts to large birds. This could be the trigger to the bird response observed at 9Emsworth mentioned above.

At 6Ryde, three noise events from hovercrafts which resulted in a difference of more than 20.0 dB(A) between sound pressure levels at the locations of the birds and the background noise level showed no response. However, bird responses were observed for subsequent noise events from hovercrafts within the same survey period.

Most of the bird responses observed particularly at 6Ryde were also from brent geese. This might suggest that brent geese are more sensitive to noise events, but it is more likely that the brent geese were loafing on the water closer to the noise sources such as hovercrafts compared to other species including waders which were foraging along the shoreline.

Furthermore, the type of responses observed were mainly flight responses with two freeze responses due to airplanes overhead. It is highly likely that other freeze responses were not immediately noticeable compared to the flight responses and thus were missed out. It is nearly impossible for the surveyor alone to analyse whether a bird is showing a freeze response to a noise event when simultaneously observing other birds of different species in the survey area. As such, for any future works, it may be beneficial to also record the birds and retrospectively analyse the data by playing back the recording.

4.3 1/3 Octave Band Analysis of Noise Events

In a study on the effects of highway and urban noise on birds conducted by R. J. Dooling et al. (2019)[6], it is suggested that anthropogenic noise can affect birds' abilities to detect prey, assess their acoustic environments and communicate with other birds. If the noise includes enough energy in the bird's region of best hearing or dominant frequency, at close distances, the noise can have a significant impact on how well the birds can hear their species-specific vocalisations. This in turn may cause behavioural and/or physiological responses from the birds.

This is also shown in a study by Rheindt (2003)[7] which consisted of population assessments in an oak-beech forest close to a motorway where it was concluded that bird species with higher-pitched vocalisations or songs with dominant frequencies well above the typical frequencies of traffic noise (up to 1 kHz) were less susceptible to noise pollution. Rheindt also stated that most bird vocalisations, in contrast, are in the range of 2 kHz to 9 kHz.

The 1/3 octave frequency data for each noise event which triggered a bird response shows no obvious correlation between specific frequencies and bird response. However, the sound pressure level of the noise event at each frequency is generally above the background noise level measured during the attended short-term monitoring. **Figure 4.1** below present the visualisation of the 1/3 octave frequency data (from 12.5 Hz to 20 kHz) for all noise events which triggered bird responses.

Figure 4.1: 1/3 Octave Frequency Leq (top) and Lmax (bottom) for All Noise Events with Bird Responses (dB linear)

Leq (dB)

Location	Species	% Disturbed*	Noise Event	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz	12.5 kHz	16 kHz	20 kHz
LT6	75 BG	20%	Hovercraft	59	59	56	57	58	56	56	57	56	53	50	54	56	50	51	53	53	54	54	53	53	52	49	47	46	45	43	41	37	34	28	21	12
LT6	65 BG	17%	Hovercraft	74	75	71	68	67	65	66	63	70	75	67	69	69	65	66	64	62	60	62	60	59	57	55	53	51	49	47	45	42	39	36	30	22
LT6	40 BG	38%	Hovercraft	60	64	62	63	69	67	63	66	69	62	67	69	70	69	72	68	66	65	63	59	55	55	54	52	49	47	44	43	39	34	31	26	18
LT6	5 BG	8%	Hovercraft	57	62	63	62	60	59	66	73	58	58	63	65	64	62	58	59	59	59	58	57	56	56	55	53	51	50	48	46	44	42	39	35	27
LT6	9 BG	15%	Hovercraft	77	74	68	69	69	71	68	69	71	75	70	72	71	69	74	69	65	63	60	61	58	56	56	56	52	49	45	41	38	36	32	28	20
LT6	35 BG	60%	Hovercraft	77	74	68	69	69	71	68	69	71	75	70	72	71	69	74	69	65	63	60	61	58	56	56	56	52	49	45	41	38	36	32	28	20
LT7	200 BG	91%	Boat leaving the harbour and noise from the industrial estate	47	49	45	46	49	49	48	51	50	53	50	47	44	44	44	48	50	50	50	50	51	54	53	52	54	49	45	37	25	18	15	12	8
LT9b	3 BG	1%	Small motor boat in the channel	50	55	52	54	53	54	61	56	56	53	51	50	44	44	45	43	39	41	41	40	36	32	27	22	16	13	12	13	10	9	10	8	6
LT6	2 BH	3%	Hovercraft	76	73	73	71	74	70	70	68	70	73	68	69	72	68	67	62	59	57	57	59	56	55	53	52	50	48	46	44	42	39	36	32	25
LT7	2 BH	66%	Boat leaving the harbour	45	53	48	50	55	61	58	51	53	50	48	50	47	42	41	41	41	41	41	38	35	28	25	21	17	12	9	8	8	9	9	8	6
LT9a	22 BH	23%	People walking into the beach	63	53	54	56	55	53	46	45	43	43	40	35	34	33	31	31	32	33	34	35	33	31	29	26	22	20	18	16	14	12	11	9	7
LT7	75 TT	75%	Boat leaving the harbour and noise from the industrial estate	47	49	45	46	49	49	48	51	50	53	50	47	44	44	44	48	50	50	50	50	51	54	53	52	54	49	45	37	25	18	15	12	8
LT7	1 CU	33%	Metal works	43	47	43	50	52	57	53	59	59	51	49	48	45	51	53	50	51	53	51	54	53	51	48	47	48	42	35	26	21	18	16	12	8
LT9a	6 RK	15%	People walking into the beach	63	53	54	56	55	53	46	45	43	43	40	35	34	33	31	31	32	33	34	35	33	31	29	26	22	20	18	16	14	12	11	9	7
LT9a	8 OC	57%	People walking into the beach	63	53	54	56	55	53	46	45	43	43	40	35	34	33	31	31	32	33	34	35	33	31	29	26	22	20	18	16	14	12	11	9	7
LT9a	2 DN	4%	People walking into the beach	63	53	54	56	55	53	46	45	43	43	40	35	34	33	31	31	32	33	34	35	33	31	29	26	22	20	18	16	14	12	11	9	7
LT9b	1 CO	11%	Airplane passing overhead	47	50	51	48	48	50	47	61	66	45	45	49	55	50	49	43	42	39	41	41	41	39	35	32	28	26	26	24	23	19	17	13	9
LT2	1 HG	25%	Loud horn from yard	51	46	47	51	53	54	51	50	49	49	51	52	45	53	51	52	50	52	48	49	47	44	37	35	31	26	19	16	14	14	11	9	6
LT3	1 MS	5%	Airplane passing overhead	61	59	61	62	65	62	61	59	56	61	68	70	68	61	69	64	66	64	62	65	64	63	65	66	70	62	59	64	48	34	21	13	8
LT3	1 H.	100%	Train passing	49	54	51	54	55	52	55	53	52	50	46	43	41	41	42	41	41	42	42	44	43	42	41	40	39	38	36	34	32	30	27	23	15

Lmax (dB)

Location	Species	% Disturbed*	Noise Event	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz	12.5 kHz	16 kHz	20 kHz
LT6	75 BG	20%	Hovercraft	61	62	59	61	61	58	59	59	59	56	53	57	59	52	52	54	57	57	55	55	55	53	50	47	47	47	45	42	39	35	28	22	13
LT6	65 BG	17%	Hovercraft	81	79	74	71	70	67	70	65	71	77	69	71	72	66	69	66	63	62	64	62	60	59	56	53	53	50	48	46	44	41	37	32	23
LT6	40 BG	38%	Hovercraft	64	66	65	68	71	69	66	68	72	63	69	72	73	71	76	69	67	67	65	60	56	57	55	53	51	48	44	44	40	35	32	27	20
LT6	5 BG	8%	Hovercraft	64	65	67	64	63	62	70	75	60	61	65	67	65	65	60	60	60	61	60	58	57	57	56	55	53	52	49	47	46	43	41	37	29
LT6	9 BG	15%	Hovercraft	82	78	72	72	73	74	71	71	74	77	72	75	73	71	77	71	67	65	62	63	60	58	58	57	53	50	46	42	39	36	34	28	20
LT6	35 BG	60%	Hovercraft	82	78	72	72	73	74	71	71	74	77	72	75	73	71	77	71	67	65	62	63	60	58	58	57	53	50	46	42	39	36	34	28	20
LT7	200 BG	91%	Boat leaving the harbour and noise from the industrial estate	50	52	49	51	52	53	52	56	53	55	52	48	46	46	45	50	51	52	52	52	53	57	56	55	58	53	48	40	27	20	19	15	12
LT9b	3 BG	1%	Small motor boat in the channel	53	58	55	58	56	58	63	60	61	56	54	51	46	45	46	45	41	44	43	41	36	33	30	24	20	14	14	15	11	10	10	8	7
LT6	2 BH	3%	Hovercraft	87	87	84	88	81	84	80	78	74	73	69	64	61	56	57	54	54	54	54	54	51	50	51	49	49	46	44	43	40	38	35	31	23
LT7	2 BH	66%	Boat leaving the harbour	48	57	51	54	58	63	60	54	55	53	50	51	49	44	42	42	42	43	42	39	37	30	26	23	19	14	9	9	9	9	10	8	7
LT9a	22 BH	23%	People walking into the beach	69	59	58	61	60	55	48	47	45	45	43	37	35	34	35	34	34	36	36	37	35	33	31	27	23	21	19	18	16	13	12	10	7
LT7	75 TT	75%	Boat leaving the harbour and noise from the industrial estate	50	52	49	51	52	53	52	56	53	55	52	48	46	46	45	50	51	52	52	52	53	57	56	55	58	53	48	40	27	20	19	15	12
LT7	1 CU	33%	Metal works	48	49	51	54	55	59	55	61	61	53	52	53	50	55	58	54	54	57	55	57	58	54	51	51	52	46	39	31	29	26	23	19	11
LT9a	6 RK	15%	People walking into the beach	69	59	58	61	60	55	48	47	45	45	43	37	35	34	35	34	34	36	36	37	35	33	31	27	23	21	19	18	16	13	12	10	7
LT9a	8 OC	57%	People walking into the beach	69	59	58	61	60	55	48	47	45	45	43	37	35	34	35	34	34	36	36	37	35	33	31	27	23	21	19	18	16	13	12	10	7
LT9a	2 DN	4%	People walking into the beach	69	59	58	61	60	55	48	47	45	45	43	37	35	34	35	34	34	36	36	37	35	33	31	27	23	21	19	18	16	13	12	10	7
LT9b	1 CO	11%	Airplane passing overhead	50	53	54	53	51	53	50	63	68	46	48	51	57	52	51	44	44	41	43	43	43	41	39	37	34	34	31	30	30	26	24	19	13
LT2	1 HG	25%	Loud horn from yard	54	51	50	53	57	57	55	52	52	51	53	54	47	56	54	54	52	57	53	56	53	49	42	39	39	31	23	19	21	20	17	10	7
LT3	1 MS	5%	Airplane passing overhead	65	62	65	65	68	64	66	62	58	65	69	72	70	63	72	66	69	67	64	67	67	66	67	69	72	65	62	68	51	37	22	13	9
LT3	1 H.	100%	Train passing	55	57	54	57	60	54	58	57	54	52	47	45	43	42	44	45	43	44	44	45	44	44	42	41	40	40	38	35	33	31	29	25	16

Highest dB … Lowest dB

*****The percentage of the birds disturbed is the percentage calculated from the total number of the same species observed during the survey.

[The common names of the bird codes used above are given below.
Breeding birds: coot (CO), grey heron (H.), herring gull (HG), mute swan (MS), black headed gull (BH), oystercatcher (OC)
Non-breeding birds: curlew (CU), dunlin (DN), brent goose (BG), redshank (RK), turnstone (TT)]

The events above are grouped by the species triggered as responses that are frequency dependent would also likely be species dependent due to vocalisations being species-specific. However, no obvious correlation can be seen between specific frequencies to bird responses observed during the short-term noise monitoring and majority of the noise events have low dominant frequencies (below 200 Hz).

As such, it is unlikely that these bird responses were caused by any specific frequencies, particularly as most bird vocalisations, and their dominant frequencies, are in the much higher frequency range.

5 CONCLUSION

Typically, the daytime background noise levels range between 43.0 dB(A) to 49.0 dB(A) at all monitoring locations with the exception of one location – Farlington Marshes within the area of Chichester and Langstone Harbours SPA – where the daytime background noise level is 69.0 dB(A) due to the location's proximity to a major road.

In addition to this, short-term attended noise monitoring was undertaken to coincide with the long-term monitoring. During the short-term noise monitoring, observations of anthropogenic noise and any bird responses as a result of the noise were made. The sound pressure levels which triggered the bird responses were estimated in order to gain some understanding of the reason for the response.

The results show that birds are more likely to respond to noise disturbance when the sound pressure levels at the location of the birds are at least 20.0 dB(A) above the typical background noise level. However, the visual nature of any noise disturbance is also likely to cause responses from the birds. The findings of this study will help to determine the impacts of anthropogenic noise on overwintering birds in the Solent; a key challenge given the national and international significance of these populations.

6 REFERENCES

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