# Shetland Tidal Array Monitoring Report July 2023 to June 2024

*Revision 1.0*

## Document control

| | |
|---|---|
| Title: | Shetland Tidal Array Monitoring Report July 2023 to June 2024 |
| Document ID: | STA013 |
| Version | Revision 1.0 |
| Prepared for: | Marine Directorate Licensing Operations Team<br>and Shetland Islands Council |
| Author: | Kate Smith |
| Approved by: | Gavin McPherson |
| Release date: | 31-Dec-24 |
| Confidentiality: | PUBLIC REPORT |

## Revision history

| **Version** | **Release date** | **Purpose/summary of amendments** |
|---|---|---|
| 1.0 | 31/12/2024 | First draft for submission to MD-LOT and SIC |

## Notice

# Contents

# 1 Non-Technical Summary

This report provides details of environmental monitoring carried out at the Shetland Tidal Array from July 2023 to June 2024. It is the latest in a series of reports produced by Nova since monitoring of the operational tidal stream array in Bluemull Sound started in 2016.

The data analysed in this report gathered from turbine-mounted cameras between July 2023 and June 2024 continues to show that the likelihood of collisions between mobile species and turbines in the Shetland Tidal Array is extremely low. **No collisions or near misses were observed between marine wildlife and turbines** (either when operating or not operating) in any of the video footage analysed comprising four hundred and ninety-seven (497) video files, or circa 50 GB data. 88% of the video files analysed contained no marine wildlife.

Marine wildlife was observed in sixty (60) video files (12% of the video files analysed), most of which were fish (fifty-six video files). There were no observations of marine mammals and just three video files containing diving birds, all European shag (*Gulosus aristotelis*) and all at times when the turbine was not operating. Of these diving bird events, two are likely to be of the same bird, being separated by just two minutes. One of the video files containing European shag also contained a large shoal of fish. Two video files contained jellyfish.

Fish (individuals or shoals of varying size) were the most commonly observed marine wildlife in video footage, but nevertheless were still observed relatively infrequently (11% of the video files analysed). Fish account for 92% of all marine wildlife observed in the subsea video footage analysed. The majority of these fish observations (96%) occurred in October and November 2024, with virtually no fish present in footage from the other months sampled. Just three of the twenty-three days in October and November 2024 for which footage was analysed did not contain fish.

36% of fish observations (twenty video files) were when tidal flow exceeded the cut-in speed of 0.8 m/s and turbines were operating, with all other fish observations at times of limited or no tidal flow, when turbines were stationary.

Thirteen video files were shoals of fish feeding in the wake of the turbulent flow downstream of turbines on the ebb or flood tides. These fish were never observed moving into the rotor-swept area. Six video files were small whitefish passing quickly through the camera's field of view with fast flowing currents. It has not been possible to identify these individuals to species level nor confirm with total confidence that they are live fish. While some of the objects (assumed to be fish) were observed to pass through or close to the rotor-swept area no collisions with the turbine blades were observed when video was viewed at the slowest possible speed.

The results presented in this report continue to demonstrate that **the risk of collisions occurring between fish, diving birds or marine mammals and operating turbines in the Shetland Tidal Array is very low (probably close to zero)**.

This report also further demonstrates the application of machine learning to automate analysis of the significant volumes of data generated by the Shetland Tidal Array environmental monitoring programme. This highlights the importance of leveraging strategic funding to enable further development of automation tools and methods based on machine learning and AI to enable more efficient and cost-effective data analysis at Bluemull Sound and other tidal energy sites.

# 2 Introduction

This report is provided in support of discharge of conditions attached to the following licences for Nova Innovation's Shetland Tidal Array in Bluemull Sound between the islands of Yell and Unst:

1. Marine Licence MS-00009110, issued by Marine Scotland Licensing Operations Team on behalf of the Scottish Ministers, under the Marine (Scotland) Act 2020.
2. Shetland Islands Council (SIC) Works Licence 2023/015/WL, issued by Shetland Islands Council under the Zetland County Council Act 1974.

This monitoring report is the latest in a series produced by Nova since monitoring of the operational array in Bluemull Sound commenced in 2016. It details environmental monitoring carried out at the Shetland Tidal Array between July 2023 and June 2024, which was focused on the following activities:

1. Use of turbine-mounted optical video cameras to monitor any nearfield interactions between turbines in the array and marine wildlife (including collisions or near misses).
2. Further development of automated processing and analysis of subsea video, building on work presented in the previous Shetland Tidal Array monitoring report (Nova Innovation, 2023).
3. Review of biofouling on the turbine-mounted cameras, its effects on image quality and options for long-term management.

This report covers points 1 and 2. A separate report, covering point 3 has been provided to MD-LOT reviewing biofouling on cameras over the lifetime of the Shetland Tidal Array monitoring programme.

# 3 The Shetland Tidal Array

The Shetland Tidal Array is situated in Bluemull Sound, between the islands of Yell and Unst, just offshore from the Ness of Cullivoe, shown in Figure 3-1.

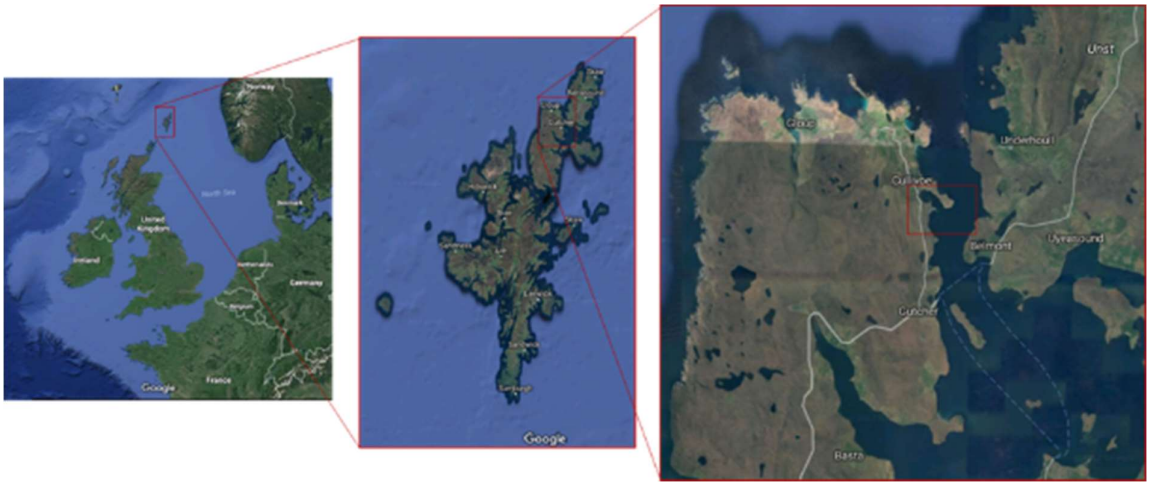



**Figure 3-1:** Location of the Shetland Tidal Array in Bluemull Sound, Shetland. *Source: Nova Innovation.*

During the current reporting period (July 2023 to June 2024), the Shetland Tidal Array comprised three Nova M100-D 100 kW direct drive tidal turbines.

Figure 3-2 shows an M100-D turbine on the quayside in Bluemull Sound, before being installed in the Shetland Tidal Array.

**Figure 3-2:** The Nova M100-D turbine. *Source: Nova Innovation.*

Two of the three turbines (T5 and T6) currently operating in the Shetland Tidal Array were installed in Bluemull Sound and commissioned in January 2023. Both turbines operated continuously throughout the current reporting period.

Results of environmental monitoring for their first six months of operation (January to June 2023 inclusive) are detailed in the previous Shetland Tidal Array annual monitoring report (Nova Innovation, 2023).

The third turbine (T4) was first installed in Bluemull Sound in 2020. However, at the start of the current monitoring period this turbine was undergoing scheduled maintenance onshore so was not in situ in Bluemull Sound. T4 was re-installed on site in October 2023 and continued to operate throughout the remainder of the current reporting period.

Turbines in the Shetland Tidal Array are installed subsea at a depth of 30-40m. Figure 3-3 shows the 'as installed' position of the three turbines (T4, T5 and T6) and associated infrastructure.

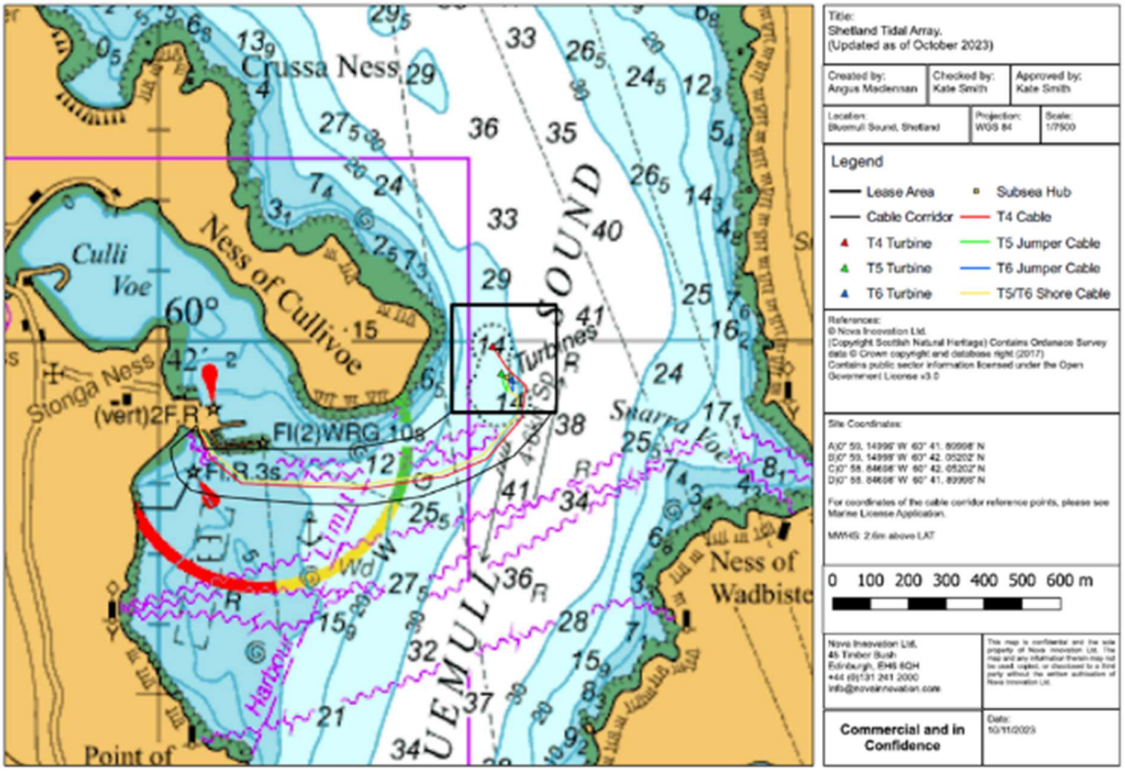



**Figure 3-3:** Position of turbines and infrastructure in the Shetland Tidal Array. *Source: Nova Innovation.*

# 4 Monitoring activity July 2023 to June 2024

## 4.1 Overview

The Project Environmental Monitoring Plan (PEMP) (Nova Innovation, 2024) provides full details of all environmental monitoring activities for the Shetland Tidal Array. The key objective of the environmental monitoring (set out in the PEMP) is to gather data to improve the evidence base on the likely nature and consequences of any nearfield interactions between marine mammals and diving birds with the operating turbines.

Environmental monitoring during the current reporting period (July 2023 to June 2024) has focused on the following key activities:

1. Use of turbine-mounted optical video cameras to monitor any nearfield interactions between turbines in the array and marine wildlife (including collisions or near misses).
2. Further development of automated processing and analysis of subsea video, building on work presented in the previous Shetland Tidal Array monitoring report (Nova Innovation, 2023).
3. Review of biofouling on the turbine-mounted cameras, its effects on image quality and options for long-term management.

This report covers points 1 and 2. A separate report addressing point 3 has been provided to MD-LOT reviewing biofouling on cameras over the lifetime of the Shetland Tidal Array monitoring programme. This report is not in the public domain as it includes commercially sensitive details on the Shetland Tidal Array.

## 4.2 Subsea video monitoring

Each of the three turbines in the Shetland Tidal Array is equipped with a single turbine-mounted camera with a horizontal field of view in water of 900, a sensitivity LUX rating of 0.1 and a resolution of 412,000 pixels. The camera configuration is illustrated in Figure 4-1.

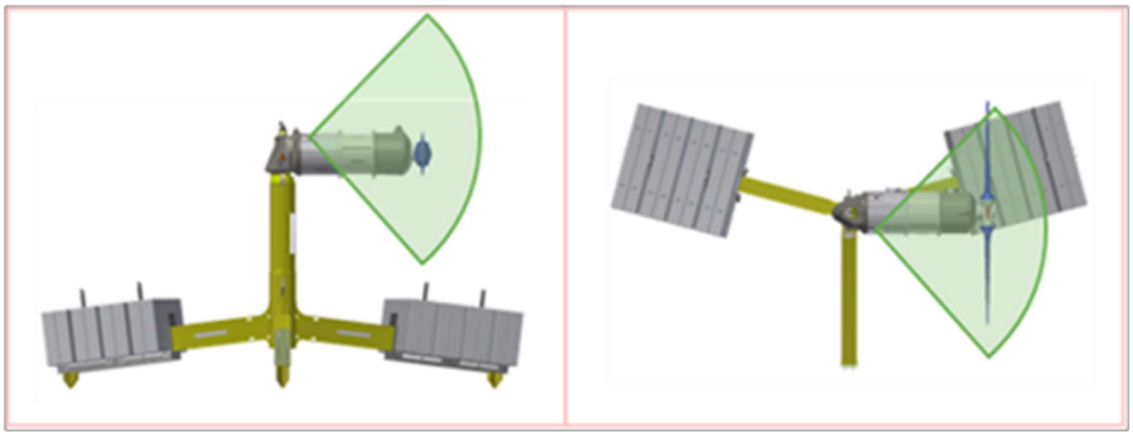


**Figure 4-1:** Turbine-mounted subsea camera system. Camera position and field of view is indicative only, for illustrative purposes. *Source: Nova Innovation.*

The field of view of the cameras, based on CAD modelling, is indicated in Figure 4-2, estimated to be 30-35% of the rotor-swept area.

**Figure 4-2:** Field of view of turbine-mounted cameras in the Shetland Tidal Array. *Source: Nova Innovation.*

Between July 2023 and June 2024 the three turbine-mounted cameras recorded continuously during daylight hours (dawn to dusk). Footage triggered by a motion detection system based on differences of contrast of light and dark across successive frames was retained and stored. Video was retained from a few seconds

before the trigger up to a minimum of 10 seconds, or until motion was no longer observed, up to a maximum of 15 minutes, at which point the trigger was reset. Due to the movement of turbine blades, all footage from dawn to dusk during which turbines were operating was retained.

All retained footage was saved as MPEG video files with a unique code that includes an automatically assigned time and date-stamp (in GMT). The video clips were stored in folders organised by date and turbine.

# 5 Data analysis

## 5.1 Video metadata

The reliability of Nova's next-generation direct drive turbines currently operating in the Shetland Tidal Array has extended maintenance intervals by many months. During the reporting period covered by this report (July 2023 to June 2024) biofouling became established on the subsea cameras that affected the quality of some of the video footage. Full details of biofouling in the current monitoring period were provided in a separate report provided to MD-LOT which also considered long-term management options to reduce the effects of biofouling on sensors.

Despite the effects of biofouling a significant quantity (circa 0.4 TB) of high quality video footage was acquired from turbine-mounted cameras between July 2023 and June 2024. A proportion of this full dataset has been analysed in this report using a combination of automated and manual analysis. The best quality footage available was from T4, which was re-installed in Bluemull Sound in October 2023 following a period of scheduled maintenance.

## 5.2 Sample selection

Samples of the full good quality video dataset from July 2023 to June 2024 were selected for automated and/or manual analysis to provide representative monthly and tidal cycle coverage, during times when turbines were operating as well as stationary. Details of the sampling protocol and the resulting samples are provided in Table 5-1.

**Table 5-1:** Sampling protocol for video footage acquired from July 2023 to June 2024.

| Video Subset | Subset details | Rationale for selecting subset | Subset size | Analysis |
|---|---|---|---|---|
| 1 | All footage from two days during neap tides and two days during spring tides. | Provides coverage of the neap/spring tidal cycle. Includes footage when turbines are operating and not operating. | 16.2 GB<br>198 files | Automated (manual review) |
| 2 | At least two days per months of footage selected when the turbine is operating. | Provides coverage of all months when good quality footage is available during the monitoring period. Covers times of potential for nearfield encounters between marine wildlife and operational turbines. | 27.0 GB<br>242 files | Automated (manual review) |
| 3 | Random video files from at least 8 days per month (different days to those covered by subsets 1 or 2). | Provides coverage of further days for months when good quality footage is available. Includes footage when turbines are operating and not operating. | 5.98 GB<br>57 files | Manual |

This protocol generated samples comprising a total of four hundred and ninety-seven (497) video files, or approximately 50 GB data for analysis. This comprises between 15 and 20% of the full dataset[1] of good quality footage acquired from turbine-mounted cameras between July 2023 and June 2024.

In addition to the video samples detailed in Table 5-1, footage from the turbine-mounted cameras is routinely reviewed by Nova's engineers to monitor turbine performance. Nova's standard operating protocol requires that engineering personnel conducting these routine checks must report any instances of diving birds or marine mammals in footage immediately to Nova's Environmental Manager for further investigation. No diving birds or marine mammals were observed in footage reviewed by Nova engineers over the current reporting period.

## 5.3 Automated analysis

Although automated analysis of the video footage from the Shetland Tidal Array is significantly more efficient than fully manual review (Nova Innovation, 2023; see also Section 6.5) it requires external support, since Nova does not have in the expertise or capacity to do this in-house[2].

The samples of video footage detailed in Table 5-1 were automatically analysis followed by manual review. Video files were processed using a model based on machine learning (Love et al, 2023) to filter 'unwanted footage' and extract only files containing marine mammals, diving birds or fish ('targets'). Unwanted footage includes video files in which any movement is due to moving turbine blades, seaweed fragments and other detritus drifting in currents, or biofouling on the turbines. Samples of 'unwanted footage' were manually reviewed for ongoing validation, quality assurance and model improvement purposes. All video files that the model identified to contain targets were also reviewed manually, as detailed in the next section.

A results report is automatically generated for all data analysed by the model that were identified to contain wildlife. Four thumbnail frames are captured for each video identified to contain wildlife. The auto-generated reports for the data analysed in this report are provided in Appendix 3.

## 5.4 Manual analysis

All manual review of video was carried out by Nova's Environmental Manager.

All four hundred and forty (440) video files in Subsets 1 and 2 (see Table 5-1) that the model identified to contain targets were manually reviewed, in addition to Subset 3, which was not subject to any initial automated processing.

All files were analysed to confirm or identify marine wildlife targets and identify to species level or the lowest taxonomic classification level possible. Footage was scrutinised at slow speed to establish whether any collisions or near misses with turbine blades had occurred. Any notable behaviours exhibited by animals in videos were also recorded.

[1] Proportion of the full dataset varies depending on the metric used (number of files, size of files or length of files).

[2] In June 2024 Ecodetect Ltd. was established to develop machine learning models and AI solutions for environmental monitoring of marine renewable infrastructure, particularly tidal stream devices, including advancing previous models developed to automate analysis of Shetland Tidal Array video footage (e.g., Love et al, 2024).

In addition to species identification, each file that manual scrutiny confirmed to contain marine wildlife was assigned to various categories denoting turbine operational status, tidal state and fish group size (where fish were present).

One of six tidal states was assigned to all video files containing marine wildlife using Nova's hydrodynamic model of Bluemull Sound, shown in Figure 5-1.

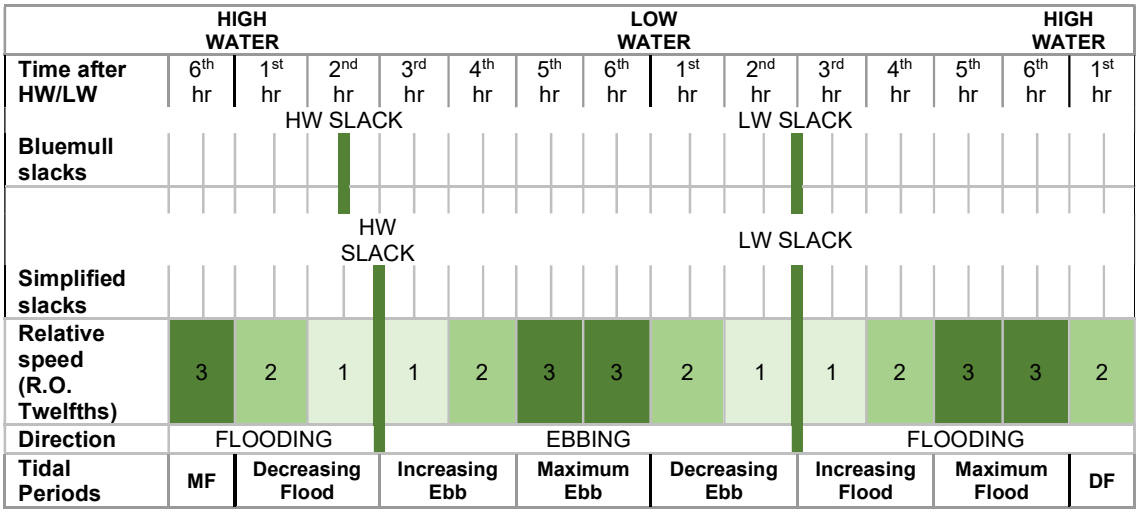



**Figure 5-1:** Bluemull Sound hydrodynamic model detailing the tidal cycle.

Assigned tidal categories were validated through observations of drifting detritus in videos, since tides in the site (particularly timings of slack) can be unpredictable and influenced by prevailing meteorological conditions.

Details of all of the categories assigned to video files containing marine wildlife are provided in Table 5-2.

**Table 5-2:** Categories assigned to video files containing marine wildlife.

| Factor | Category | Detail |
|---|---|---|
| **Turbine status** | Operating | Rotor is moving for the entire video. |
| | Not operating | Rotor is stationary for the entire video. |
| | Powers up (starts)/down (stops) | Rotor starts to turn or slows to a halt during the video. |
| **Tidal state** | Flood: decreasing/ increasing/maximum | Tide runs from north to south past the turbines. Subcategory assigned using Nova's hydrodynamic model of Bluemull Sound. |
| | Ebb: decreasing/ increasing/maximum | Tide runs from south to north past the turbines. Subcategory assigned using Nova's hydrodynamic model of Bluemull Sound. |
| **Fish group size** | Individual | Single fish observed in video. |
| | Small group | Small group of between 2 and 10 fish observed in video. |
| | Large group | A large shoal of greater than 10 fish observed in video. |

# 6 Results

## 6.1 Collisions or near misses

No collisions or near misses between fish, diving birds or marine mammals occurred in any of the video footage from July 2023 to June 2024 analysed in this report.

## 6.2 Overview of wildlife observations in video footage

Of the four hundred and ninety-seven (497) video files analysed in this report 88% contained no marine wildlife. The remaining 12% of files contained either fish, diving birds or jellyfish.

Marine wildlife was observed in sixty video files (12% of all footage analysed). There were no observations of marine mammals in any of the video footage analysed. Three video files contained diving birds, all European shag (*Gulosus aristotelis*), all at times when the turbine was not operating. Of these events, two are likely to be of the same bird, being separated by just two minutes. One of the video files containing European shag also contained a large shoal of fish.

Two video files contained jellyfish. All remaining video files in which marine wildlife was observed contained fish (individuals or shoals of varying size).

Figure 6-1 summarises the content of all the video analysed in this report.

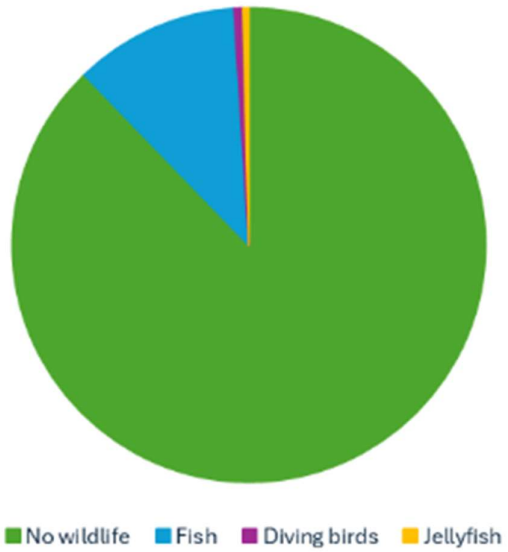



**Figure 6-1:** Content of all video analysed in this report (total 497 video files).

Fish (individuals or groups of varying size) were the most commonly observed marine wildlife in video footage, but were still only observed infrequently, in just fifty-six video files (11% of all footage analysed). Fish account for 92% of all marine wildlife observed in the subsea video footage analysed. 36% of fish observations (twenty video files) were when tidal flow exceeded the cut-in speed of 0.8 m/s and turbines were operating, with all other fish observations at times of limited or no tidal flow, when turbines were stationary.

Table 6-1 summarises all of the marine wildlife observations in the footage analysed in this report. Fish are presented by group size (individual, small groups of between two and ten individuals and large groups of more than ten individuals). The last column indicates whether any of the observations occurred when turbines were operating.

**Table 6-1:** Marine wildlife in the four hundred and ninety-seven individual video files from July 2023 to June 2024 analysed in this report.

| Wildlife category | Number of files | Proportion of all files | Occurrences when turbines operating? |
|---|---|---|---|
| No wildlife | 437 | 87.9% | n/a |
| Marine mammals | 0 | 0% | n/a |
| Diving birds (European shag, *Gulosus aristotelis*) | 3 | 0.6% | No |
| Single fish (*Pollachius* sp.) | 17 | 3.4% | Yes |
| Small group of fish (*Pollachius* sp.) | 12 | 2.4% | Yes |
| Large group of fish (*Pollachius* sp.) | 27 | 5.4% | Yes |
| Other (jellyfish) | 2 | 0.4% | Yes |
| **Total** | **497** | **100%** | **n/a** |

Appendix 1 provides full details of each observation of marine wildlife in the video files analysed.

Appendix 2 provides details for the four hundred and ninety-seven individual video files analysed.

Appendix 3 provides the automatically generated results reports for data analysed by the machine learning model.

Further details of European shag and fish occurrences in the video analysed are provided in the next sections.

## 6.3 Diving birds

There were observations of individual diving birds in three video files. All of these were European shag (*Gulosus aristotelis*) and all at times when tidal flow was minimal and the turbines were not operating. Table 6-2 provides details of the three video files containing European shag.

**Table 6-2:** European shag (*Gulosus aristotelis*) observations in video footage from July 2023 to June 2024.

| DATE | TIME | TIDAL STATE | TURBINE OPERATING? | DETAILS |
|---|---|---|---|---|
| 09/01/2024 | 14:36 | Decreasing ebb | No | Single bird observed diving past camera towards the seabed in apparent pursuit of prey, although no fish were seen. |
| 01/03/2024 | 14:03 | Decreasing flood | No | Single bird seen pursuing a large shoal of fish (genus Pollachius). |
| 01/03/2024 | 14:05 | Decreasing flood | No | Single bird observed returning towards the surface. |

The first of these three observations of European shag was on 09/01/2024 at 14:36 when a single European shag was observed diving past camera towards the seabed in apparent pursuit of prey. Figure 6-2 shows a still image of the bird taken from this video file.


**Figure 6-2:** European shag (*Gulosus aristotelis*) observed in video footage on 01/09/2024.

No fish were seen throughout this video. Tidal flow was minimal throughout this video (decreasing ebb tide), and the turbine was stationary.

On 01/03/2024 two consecutive video files contained instances of individual European shag. The first was at 14:03, when a bird was seen in pursuit of a large shoal of fish (genus Pollachius). In the next video 2 minutes later at 14:05 a bird was seen returning towards the surface. Figure 6-3 (over) shows still images of the bird(s) taken from these video files.

These two videos may feature the same individual bird, since European shag are capable of foraging dives of periods of greater than two minutes (Carlsen et al, 2021). Analysis of data from vantage point surveys previously carried out as part of the Shetland Tidal Array monitoring programme recorded a maximum European shag dive duration of 164 seconds within the array area (Holmes, 2021). In both of these videos, the tidal state was decreasing flood and the turbine was stationary.


**Figure 6-3:** A European shag (*Gulosus aristotelis*) observed pursuing a large shoal of schooling fish on 01/03/2024 (top image). Two minutes later a shag was seen returning towards the sea surface (bottom image), possibly the same bird.

## 6.4 Fish

No collisions or near misses between fish and turbines were observed in any of the footage.

Table 6-2 details the fifty-six fish observations in the footage analysed for this report, categorised by group size (individual, small groups of between two and ten individuals and large groups of more than ten individuals). The proportion of the observations when turbines were operating is shown.

**Table 6-2:** Summary of fish observations in video footage from July 2023 to June 2024. Numbers in brackets are the % of all footage analysed.

| Fish category | No. files | No. files when turbine operating | Proportion of fish category observations when turbine operating |
|---|---|---|---|
| Single fish | 17 (3.4%) | 9 (1.8%) | 52.9% |
| Small group (≤ 10 individuals) | 12 (2) | 3 (0.6%) | 25.0% |
| Large group (> 10 individuals) | 27 (5.4%) | 8 (1.6%) | 29.6% |
| **All fish observations** | **56 (11.3%)** | **20 (0.8%)** | **35.7%** |

Fish were the most commonly observed marine wildlife in video footage, but were observed infrequently, in just fifty-six video files (11% of all footage analysed). Fish account for 92% of all marine wildlife observed in the subsea video footage analysed. 35.7% of fish observations (twenty video files) were when tidal flow exceeded the cut-in speed of 0.8 m/s and turbines were operating, with all other fish observations at times of limited or no tidal flow, when turbines were stationary.

The majority of all fish observations (96%) occurred in October and November 2024, with virtually no fish present in footage from the other months sampled. Just three of the twenty-three days in October and November 2024 for which footage was analysed did not contain fish.

Some distinctive fish behaviours were observed in the video analysed, detailed in the next sections.

### 6.4.1 Shoaling at weak current speeds

As in previously reported for the Shetland Tidal Array, the most frequently observed behaviour in fish (*Pollachius* sp.) was individuals and groups aggregating around turbine nacelles and when tidal flow was absent or very limited. This accounted for 64.3% of all fish observations (thirty-six video files).

Fish displaying this behaviour generally occurred in groups, with individuals mostly swimming independently to one another. Some examples of this behaviour observed in footage from July 2023 to June 2024 are shown in Figure 6-4. This behaviour is typical of species of pollack, which are known to aggregate around shipwrecks and other artificial subsea structures.

**Figure 6-4:** Examples of fish (*Pollachius* sp.) aggregating at hub height when tidal flow was absent or very limited.

### 6.4.2 Swimming into strong currents

On occasion during the ebb tide, when flow is from south to north through Bluemull Sound, large aggregations of fish (*Pollachius* sp.) could be seen downstream (north) of the turbine, often remaining in this area for long periods of time. This behaviour was observed in thirteen video files (2.6% of all footage analysed).

This fish behaviour was only observed in footage from October and November 2024 and has not previously been reported for the Shetland Tidal Array. It may be a new fish behaviour, or it may be another example of the enhanced target detection capabilities of the machine learning model, compared to manual review alone. The ability of the model to detect marine wildlife that had been missed by manual review was reported in 2023 (Nova Innovation, 2023) in relation to small whitefish passing turbines rapidly in fast flowing currents (see also Section 6.4.4) for examples from the current reporting period.

The aggregations of fish downstream of operating turbines on the ebb tide were often positioned at nacelle height some distance beyond the turbine. Their distance from the turbine meant that they were at no risk of collisions and individuals were never observed near the rotor-swept area. The behaviour of these fish was suggestive of feeding activity in the turbulent flow created in the wake of the turbine. Examples of these observations are shown in Figure 6-5.

**Figure 6-5:** Groups of fish (circled in red) observed downstream of the operating turbine during the ebb tide when flow runs south to north through Bluemull Sound.

It is likely that on the flood tide, groups of feeding fish may also aggregate in the wake (south) of operating turbines. The forward facing field of view of the cameras mean this cannot be confirmed, but some examples of individual fish or small groups were seen moving into and out of the field of view from the south during the flood tide. Again, individuals were never observed moving into the rotor-swept area. Examples of this are shown in Figure 6-6.

**Figure 6-6:** Fish downstream of the operating turbine during the flood tide when flow runs north to south through Bluemull Sound.

### 6.4.3 Schooling

As detailed in Section 6.3, on 01/03/2024 a European shag was seen on a decreasing flood tide (the turbine was stationary) pursuing a large group of schooling fish. On 23/10/2023 (11:55) on a decreasing ebb tide (the turbine was stationary) a large shoal of fish milling at hub height displayed sudden and rapid schooling towards the seabed, shown in Figure 6-7. No diving birds or mammals were observed in any of the footage analysed for 23/10/2023[3], but the presence of a predator may have induced this rapid schooling response, which could also have been caused by other factors such as a passing vessel.

[3] All the good quality footage from 23/10/2023 (68 files spanning 07:00 to 17:05) was analysed.


**Figure 6-7:** A large shoal of fish displaying sudden and rapid schooling behaviour towards the seabed on 23/10/2023. No predator was observed in footage.

### 6.4.4 Transiting on fast flowing currents

In six video files (1.2% of all footage analysed) objects which may be small whitefish were detected passing quickly through the camera's field of view with fast flowing currents, on both the ebb and flood tides. It has not been possible to identify these individuals to species level nor confirm with total confidence that they are live fish. While some of these objects (assumed to be fish) were observed to pass through or close to the rotor-swept area no collisions with the turbine blades were observed when video was viewed at the slowest possible speed.

Such instances of possible whitefish transiting rapidly past the turbines with the tidal flow was first reported in 2023, having been detected as potential targets by the machine learning model (Nova Innovation, 2023). Whitefish transiting through Bluemull Sound with the tidal flow is assumed not to be a new behaviour, but one previously been missed during manual review of videos.

Examples of these possible whitefish transiting turbines at fast current speeds in video from July 2023 to June 2024 are shown in Figure 6-8.

**Figure 6-8:** Examples of potential whitefish observed passing turbines in fast flowing tide, on 10/10/23 (left image) when tidal state was increasing ebb and 30/10/2023 (right image) when tidal state was maximum flood. Turbines were operating in both images but no collisions or near misses were observed.

## 6.5 System performance

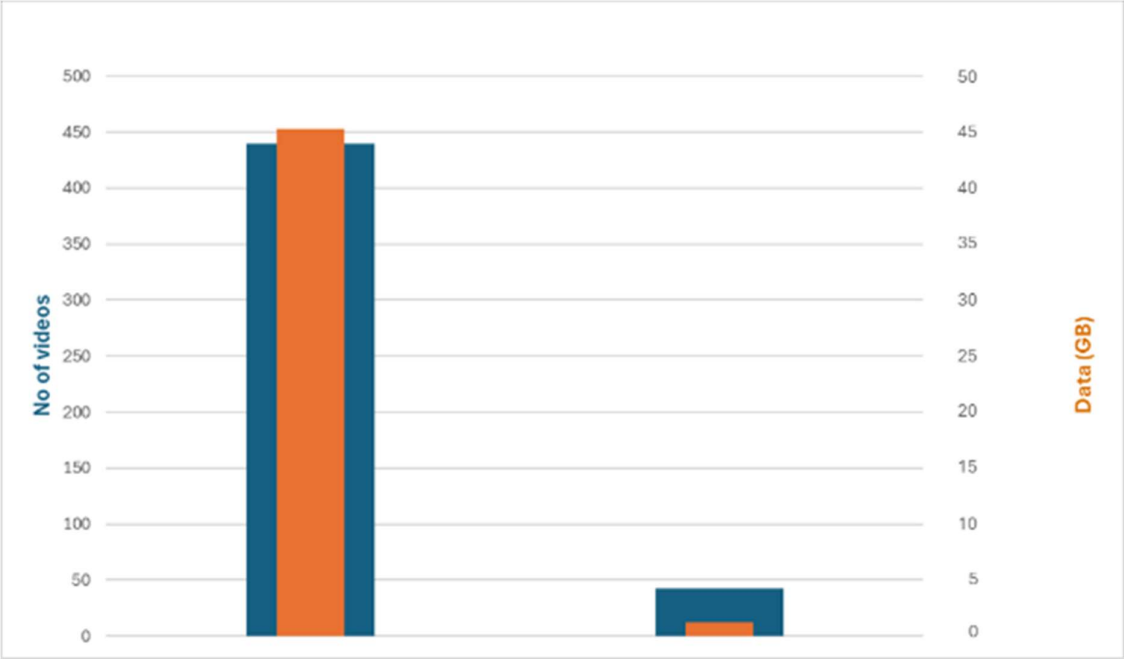
The typically excellent water clarity in Shetland year-round and the relatively simple monitoring approach means that optical cameras continue to be an effective method for monitoring nearfield interactions between turbines and marine wildlife. The cameras operate 24 hours a day, but only footage from dawn to dusk is retained. Daylight in winter in Shetland averages between 6 and 7 hours, while in summer it averages between 17 and 18 hours. Some of the footage over the reporting period was affected by biofouling on cameras (detailed in a separate report to MD-LOT), but around 0.4 TB of high quality video footage was acquired from turbine-mounted cameras between July 2023 and June 2024.

The use of the model based on machine learning continues to provide an efficient and effective means of automatically filtering subsea video to remove 'unwanted footage' and extract only video containing marine mammals, diving birds or fish ('targets'). Use of machine learning for the data analysed in this report delivered a reduction in the quantity of footage requiring manual review of up to 97%[4] .

Figure 6-9 demonstrates the increased efficiency achieved by using machine learning for the data analysed in this report as a reduction in a) the size of the dataset (number of individual video files and total GB) and b) the length of footage (hours) before and after automated processing. Only the files identified by the model to contain marine wildlife 'targets' required manual review.

[4] The reduction in the quantity of footage requiring manual review varies depending on the metric used (number of files, size of files or duration of recording), but ranges from 90% to 97%.

a) Size of dataset (GB and number of video files)




b) Length of footage (hours)

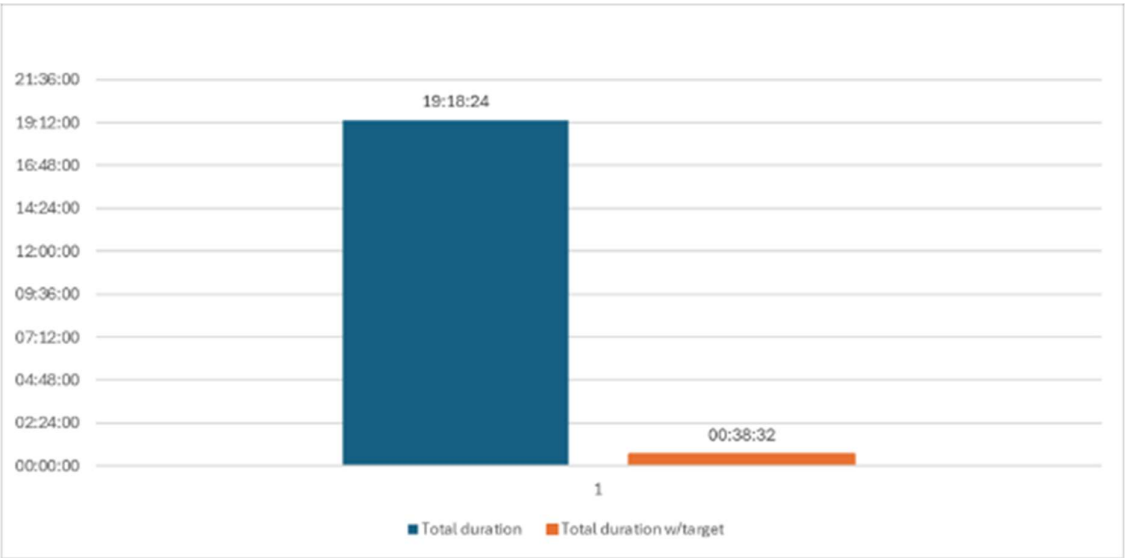



**Figure 6-9:** Dataset reduction by automated video analysis. Data reduction is shown as a) the number of videos and size of the dataset (GB), and b) the length of the video dataset (hours).

The machine learning model performed well, correctly identifying marine wildlife targets and filtering 'unwanted footage' so reducing the quantity of data requiring manual review. Targets were successfully identified in footage captured in very low lights levels, as well as small fish targets passing turbines very quickly on fast flowing currents. Prior to the machine learning model first being used for Shetland Tidal Array data analysis in 2023, these fish targets had not been detected or reported (Nova Innovation, 2023).

However, since being highlighted by the model, such occurrences of fish were detected in the subset of data in this report subject only to manual review, with no prior filtering by the model (see Table 5-1).

Figure 6-10 shows an example of one of the most 'cryptic' targets detected by the model in the data analysed within this report, demonstrating its capabilities. In this video, captured at 07:30 on 30/10/2024 in very low light levels just after dawn[5] a small whitefish was detected quickly passing the turbine on an increasing flood tide.


**Figure 6-10:** Example of a whitefish detected by the machine learning model in low light levels and passing the turbine on fast flow during the increasing flood tide.

# 7 Discussion

This report presents the latest results from Nova's long-term programme of environmental monitoring at the Shetland Tidal Array and covers data gathered from July 2023 to June 2024 using turbine-mounted cameras. In accordance with the monitoring objectives in the Project Environmental Monitoring Plan (Nova Innovation, 2024), the focus of monitoring activity during this period has continued to be gathering evidence on the likely nature and consequences of any nearfield interactions between marine mobile species and turbines (i.e., collision risk).

**No collisions or near misses were observed between marine wildlife and turbines in the Shetland Tidal Array in the current reporting period** (either when operating or not operating) in any of the video analysed in this report. The four hundred and ninety-seven (497) individual video files, or circa 50 GB data analysed in this

[5] Dawn on 30/10/2023 was at 07:23 https://www.tidetimes.org.uk/bluemull-sound-tide-times-20231030

report add to the growing body of evidence of an **absence of collisions or near misses over the lifetime of the Shetland Tidal Array**. In spite of this, the risk of collisions having occurred cannot be completely ruled out for the following reasons:

1. Not all subsea video has been analysed.
2. The subsea video monitoring is limited to daylight hours.
3. The quality of some of the video footage is limited due to biofouling on cameras.

Nevertheless, the results presented in this report continue to indicate that **the risk of collisions between mobile species and turbines in the Shetland Tidal Array is very low (probably close to zero)**. Accurately quantifying this very low risk of unlikely or rare collision events occurring continues to be challenging.

Copping et al (2023) developed a conceptual probabilistic methodology to apply empirical evidence to elucidate the collision risk to marine animals from operational tidal turbines, as illustrated in Figure 7-1. The methodology is represented by seven sequential events (steps) that must take place for a marine animal to approach an operational turbine, be struck by a turbine blade and be harmed (i.e., suffer a critical injury or mortality). This methodology provides a useful stepwise framework for interpreting the results of the Shetland Tidal Array monitoring programme.

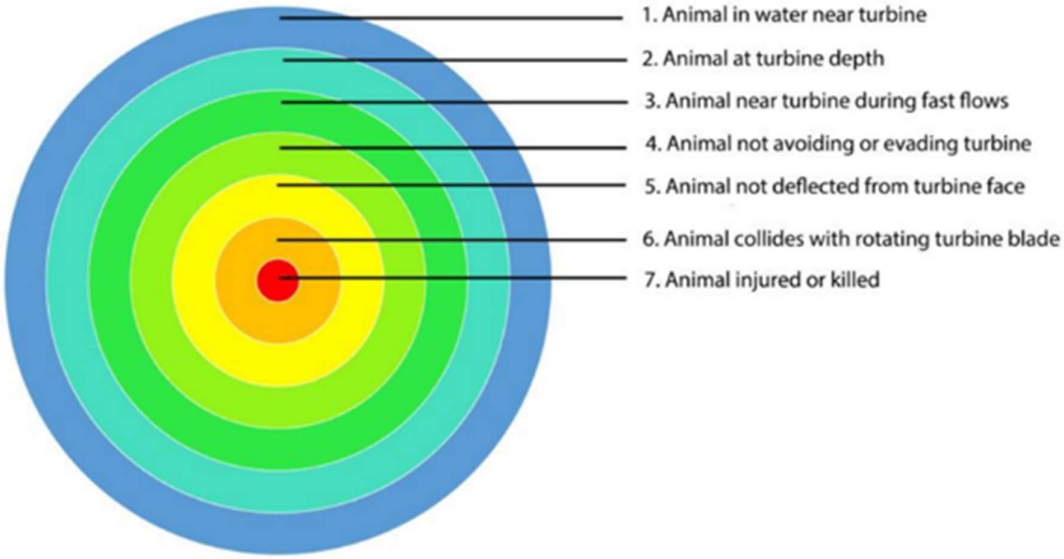



**Figure 7-1:** Conceptual probabilistic framework for applying Shetland Tidal Array monitoring data to assess the likelihood of collision risk for marine animals and the operating turbines. From Copping et al, 2023.

Table 7-1 presents the results from the Shetland Tidal Array subsea video monitoring between July 2023 and June 2024 in the context of the seven steps in this probabilistic framework. Wider evidence from the long-term Shetland Tidal Array monitoring programme[6] is also presented in the table to build an overall picture of the likelihood of collision risk for marine mammals, diving birds and fish.

[6] Subsea video monitoring of the array using turbine-mounted cameras began in 2016 and land-based bird and mammal surveys were carried out from 2010 to 2023.

**Table 7-1:** Assessment of the likelihood of collision risk to a) marine mammals, b) diving birds and c) fish from operational turbines in the Shetland Tidal Array, framed around a conceptual collision risk probabilistic framework (from Copping et al, 2023). Supporting evidence from subsea video monitoring between July 2023 and June 2024 is provided, as well as wider evidence from the long-term monitoring programme.

a) Collision risk to marine mammals

| Evidence from July 2023-June 2024 data | Evidence from the full monitoring programme (including July 2023-June 2024) | Conclusion and relevant step(s) in probabilistic framework |
|---|---|---|
| No marine mammals occurred in any of the video analysed. | Over the lifetime of the monitoring programme there have been 13 observations of harbour seal (*Phoca vitulina*) in the video footage analysed. Some of these are thought to be the same individual recorded on different cameras or in sequential triggered footage.<br>No other marine mammal species have occurred in any of the subsea video analysed (Nova Innovation, 2021a).<br>All harbour seal observations in subsea video occurred at times when the turbines were not operating (Nova Innovation, 2021a).<br>The land-based surveys between 2010 and 2023 consistently showed that mammal numbers in Bluemull Sound and the array area are very low.<br>Harbour seal (a designated feature of Yell Coast Species Area of Conservation (SAC), located to the south of Bluemull Sound between mainland Shetland and Yell) was the most frequently recorded mammal in land-based surveys. Even this species was only recorded within the array area in 0.3% of scans of this area (9 individuals). Records for all other mammal species were much lower (Nova Innovation, 2021b).<br>Analysis of land-based survey data between 2010 and 2019 concluded that the probability of nearfield encounters between all marine mammal species (including harbour seal) and turbines is negligible (Nova Innovation, 2021b). | Presence of marine mammals in the water near the turbine is very limited (Framework Step 1).<br>**Limited likely risk of collisions for marine mammals.**<br>Despite no collisions or near misses having been observed between marine mammals and turbines, the risk of collisions having occurred cannot be completely dismissed because monitoring is limited to daylight hours, not all subsea video has been analysed and some has been affected by biofouling. |

b) Collision risk to diving birds

| Evidence from July 2023-June 2024 data | Evidence from the full monitoring programme (including July 2023-June 2024) | Conclusion and applicable step in probabilistic framework |
|---|---|---|
| European shag occurred in 3 videos analysed, with 2 of these thought to be the same individual in sequential triggered footage.<br>All 3 European shag events occurred at times when the turbines were not operating.<br>No other diving birds were observed in any of the footage analysed. | There have been 13 observations of European shag (*Gulosus aristotelis*) and 6 observations of black guillemot (*Cepphus grylle*) in the analysed video over the lifetime of the monitoring programme, including the current reporting period. Some of these events are thought to be the same individual birds recorded on different cameras or in sequential triggered footage. All 19 diving bird observations have been at times when the turbines were not operating.<br>No other species of diving bird have occurred in any of the footage analysed.<br>The land-based surveys between 2010 and 2023 consistently showed that diving bird numbers in Bluemull Sound and the array area are very low, with the exception of European shag and black guillemot, which together accounted for over 90% of birds recorded in the surveys (Nova Innovation, 2021b).<br>Black guillemot were recorded diving in the array area in fewer than 3% of scans of this area and European shag in just over 1% of scans (Nova Innovation, 2021b).<br>Analysis of land-based survey data between 2010 and 2019 concluded that the probability of black guillemot and European shag diving in proximity to the turbines is < 0.05.<br>The probability of Atlantic puffin (*Fratercula arctica*) diving in proximity to the turbines is < 0.05 during the breeding season when numbers in Bluemull Sound can be high.<br>For all other species of diving bird, including red-throated diver (*Gavia stellata*), a designated feature of Bluemull and Colegrave Sounds Special Area of Protection (SPA) within which the Shetland Tidal Array is located, the probability is negligible at all times of the year.<br>Land-based surveys generally showed decreases in numbers of diving birds in the array area as a function of increasing in current speed in Bluemull Sound, consistent with previous studies (Robbins, 2017). This probably reflects the high energetic costs of diving under high velocity conditions (Waggitt et al, 2016). | Diving birds occasionally occur in the water near the turbine and at turbine depth (Framework Steps 1 and 2).<br>Presence of diving birds near the turbines during fast flows is very unlikely (Framework Step 3).<br>**Low likely risk of collisions for diving birds.**<br>Despite no collisions or near misses having been observed between diving birds and turbines, the risk of collisions having occurred cannot be completely dismissed because monitoring is limited to daylight hours, not all subsea video has been analysed and some has been affected by biofouling. |

c) Collision risk to fish

| Evidence from July 2023-June 2024 data | Evidence from the full monitoring programme (including July 2023-June 2024) | Conclusion and applicable step in probabilistic framework |
|---|---|---|
| Fish occurred in 11% of the subsea video analysed (56 video files).<br>64% of fish observations (36 video files) occurred when turbines were not operating.<br>36% of fish observations (20 video files) occurred when turbines were operating. This includes groups of *Pollachius* sp. shoaling in the turbulent flow downstream of turbines (13 video files), and individual whitefish passing turbines on fast flowing currents (6 video files).<br>96% of fish observations occurred in October and November.<br>No collisions or near misses between these fish and operating turbines were observed. | Fish have consistently been the most commonly observed marine wildlife in the analysed video over the lifetime of the monitoring programme, including the current reporting period. This includes observations of solitary fish, as well as groups (Nova Innovation, 2021a). Nevertheless, such observations are relatively infrequent, occurring in only around 10% of footage analysed.<br>The majority of fish observations occur at times of very limited flow when turbines are not operating. Groups of shoaling fish are sometimes seen in the vicinity of the nacelle and blades around the slack tide and the beginning and end of the flood and ebb tides. As flow speeds increase, fish move towards the seabed. This phenomenon was observed on downward-facing cameras attached to the first three turbines in the Shetland Tidal Array and is likely to be a behaviour reflecting the high energetic costs of remaining high in the water column under high velocity conditions (Nova Innovation, 2021a).<br>On occasion groups of fish have been observed at turbine rotor height during times of greater tidal flow when turbines are operating. These appear to be feeding downstream in the turbulent flow downstream of operating turbines and have never been observed moving into the rotor-swept area. This behaviour indicates that the energetic gains of food availability in the turbulent wake of operating turbines may outweigh the energetic costs of remaining in the water column under high velocity conditions.<br>Occasionally, individual whitefish have been seen quickly passing the turbines on fast flowing currents through or near to the rotor-swept area, but no collisions have been observed. It has not been possible to identify these individuals to species level, or to confirm with total confidence that they are live fish. | Fish occasionally occur in the water near the turbine and at turbine depth (Framework Steps 1 and 2), including at times during fast flows (Framework Step 3).<br>Fish observed feeding in the wake of the operational turbines are not within the rotor-swept area (Framework Step 4).<br>Individual fish observed passing turbines quickly on fast currents may pass through the rotor-swept area but their small size means they may be deflected by the turbine face (Framework Step 5 and 6).<br>**Medium likely risk of collisions for individual fish passing the turbines on fast flowing currents only.**<br>**Low likely risk of collisions for all other fish.**<br>Despite no collisions or near misses having been observed between fish and turbines, the risk of collisions having occurred cannot be completely dismissed because monitoring is limited to daylight hours, not all subsea video has been analysed and some has been affected by biofouling. |

The results presented in this report continue to demonstrate that **the risk of collisions occurring between fish, diving birds or marine mammals and operating turbines in the Shetland Tidal Array is very low (probably close to zero)**.

This report also further demonstrates the application of machine learning to automate analysis of the significant volumes of data generated by the Shetland Tidal Array environmental monitoring programme. This highlights the importance of leveraging strategic funding to enable further development of automation tools and methods based on machine learning and AI to enable more efficient and cost-effective data analysis at Bluemull Sound and other tidal energy sites.

# 8 References

Carlsen A.A., Lorentsen S.H. and Wright J. (2021). Recovery, body mass and buoyancy: a detailed analysis of foraging dive cycles in the European shag. Animal Behaviour 178. pp247-265. https://doi.org/10.1016/j.anbehav.2021.05.010

Copping A.E., Hasselman D.J., Bangley C.W., Culina J. and Carcas M. (2023). A Probabilistic Methodology for Determining Collision Risk of Marine Animals with Tidal Energy Turbines. Journal of Marine Science and Engineering 11(11). https://doi.org/10.3390/jmse11112151

Holmes L. (2021). Understanding Diving Seabird Behaviour in Tidal Stream Environments. MSc. Dissertation, Bangor University. pp52.

Love M., Vellappally A., Roy P., Smith K., McPherson G. and Gold D.P. (2023). Automated detection of wildlife in proximity to marine renewable energy infrastructure using machine learning of underwater imagery. Proceedings of the 15th European Wava and Tidal Energy Conference 2023. DOI:10.36688/ewtec-2023-623

Nova Innovation (2021a). Shetland Tidal Array monitoring report: Subsea video monitoring. EnFAIT-0364 Version 4.0. pp76. Available at Environmental Monitoring Reports – Shetland Tidal Array (as extended) – Bluemull Sound, Shetland – 00009110 | marine.gov.scot.

Nova Innovation (2021b). Shetland Tidal Array Monitoring Report: Vantage point surveys. EnFAIT-0347 Version 5.0. pp44. Available at Environmental Monitoring Reports – Shetland Tidal Array (as extended) – Bluemull Sound, Shetland – 00009110 | marine.gov.scot.

Nova Innovation (2023). Shetland Tidal Array Monitoring Report April 2022 to July 2023. Version 1.0. STA-002. Available at https://marine.gov.scot/node/23283

Nova Innovation (2024). Shetland Tidal Array Project Environmental Monitoring Plan (PEMP). Version 7.0. STA-009. pp67. Available at https://marine.gov.scot/data/project-environmental-monitoring-plan-pemp-shetland-tidal-array-extended-bluemull-sound

Robbins A.M.C. (2017). Seabird ecology in high-energy environments: approaches to assessing impacts of marine renewables. PhD thesis. University of Glasgow. http://theses.gla.ac.uk/8300/

Waggitt J.J., Cazenave P.W., Torres R., Williamson B.J. and Scott B.E. (2016). Quantifying pursuit-diving seabirds' associations with fine-scale physical features in tidal stream environments. Journal of Applied Ecology, 53(6): 1653-1666.

# Appendix 1: Details of all marine wildlife observations in video footage

This Appendix provides details of all marine wildlife observed in the video files acquired from turbine-mounted cameras in the Shetland Tidal Array between July 2023 and June 2024 and analysed in this report. **No collisions or near misses were observed between marine wildlife and turbines in any of the video footage analysed**.

Rows highlighted green in the table indicate that the turbine was operating at the time that the wildlife was observed. Rows in *black italics* are video files that were analysed manually only (i.e. no automated analysis by the machine learning model was carried out).

Tidal states provided for all observations are derived from Nova Innovation's hydrodynamic model for Bluemull Sound (see Figure 5-1). Modelled tidal state was validated in videos by observing the direction of flow using detritus carried in the water. Flow is from south to north on the ebb tide and north to south on the flood tide in Bluemull Sound.

| Filename (.mp4) | Date | Time GMT | Turbine operating? | Tidal state | Details |
|---|---|---|---|---|---|
| *1_2023-10-10_09-59* | *10/10/2023* | *09:59* | *Yes* | *Increasing ebb* | *Single fish passing the turbine in ebb flow from south to north with the direction of flow. Passes through or very near to turbine rotor-swept area, but no contact with blades.* |
| 1_2023-10-13_15-03-13 | 13/10/2023 | 15:03 | Yes | Decreasing ebb | Large group of fish shoaling (assumed to be feeding) in the wake of the operating turbine. |
| 1_2023-10-13_15-18-14 | 13/10/2023 | 15:18 | Yes | Decreasing ebb | Large group of fish shoaling (assumed to be feeding) in the wake of the operating turbine. |
| *1_2023-10-14_10-08-32* | *14/10/2023* | *10:08* | *No* | *Decreasing flood* | *Large group of fish milling at hub height including around rotor.* |
| *1_2023-10-18_15-45-56* | *18/10/2023* | *15:45* | *Yes* | *Increasing ebb* | *Large group of fish shoaling (assumed to be feeding) in the wake of the operating turbine.* |

| Filename (.mp4) | Date | Time GMT | Turbine operating? | Tidal state | Details |
|---|---|---|---|---|---|
| *1_2023-10-19_10-36-00* | *19/10/2023* | *10:36* | *Yes* | *Maximum flood* | *Single fish passing the turbine in fast flow from north to south with the direction of flow. Passes through or very near to turbine rotor-swept area, but no contact with blades.* |
| *1_2023-10-20_10-31-04* | *20/10/2023* | *10:31* | *Yes* | *Maximum flood* | *Single fish passing the turbine in fast flow from north to south with the direction of flow. Passes through or very near to turbine rotor-swept area, but no contact with blades.* |
| *1_2023-10-21_07-33-06* | *21/10/2023* | *07:33* | *Yes* | *Maximum ebb* | *Large group of fish shoaling (assumed to be feeding) in the wake of the operating turbine.* |
| *1_2023-10-22_10-03-32* | *22/10/2023* | *10:03* | *No* | *Decreasing ebb* | *Large group of fish milling at hub height including around rotor.* |
| 1_2023-10-23_11-16-23 | 23/10/2023 | 11:16 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_11-16-55 | 23/10/2023 | 11:16 | No | Decreasing ebb | Small group of fish milling at hub height including around rotor. |
| 1_2023-10-23_11-17-23 | 23/10/2023 | 11:17 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_11-18-35 | 23/10/2023 | 11:18 | No | Decreasing ebb | Single fish at hub height including around rotor. |
| 1_2023-10-23_11-28-14 | 23/10/2023 | 11:28 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_11-46-23 | 23/10/2023 | 11:46 | No | Decreasing ebb | Single fish at hub height including around rotor. |
| 1_2023-10-23_11-46-53 | 23/10/2023 | 11:46 | No | Decreasing ebb | Single fish at hub height including around rotor. |
| 1_2023-10-23_11-48-20 | 23/10/2023 | 11:48 | No | Decreasing ebb | Small group of fish milling at hub height including around rotor. |
| 1_2023-10-23_11-49-06 | 23/10/2023 | 11:49 | No | Decreasing ebb | Small group of fish milling at hub height including around rotor. |

| Filename (.mp4) | Date | Time GMT | Turbine operating? | Tidal state | Details |
|---|---|---|---|---|---|
| 1_2023-10-23_11-49-34 | 23/10/2023 | 11:49 | No | Decreasing ebb | Single fish at hub height including around rotor. |
| 1_2023-10-23_11-50-22 | 23/10/2023 | 11:50 | No | Decreasing ebb | Small group of fish milling at hub height including around rotor. |
| 1_2023-10-23_11-55-22 | 23/10/2023 | 11:55 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. Some schooling behaviour observed, but no predators in field of view. |
| 1_2023-10-23_11-58-06 | 23/10/2023 | 11:58 | No | Decreasing ebb | Small group of fish milling at hub height including around rotor. |
| 1_2023-10-23_11-59-31 | 23/10/2023 | 11:59 | No | Decreasing ebb | Small group of fish milling at hub height including around rotor. |
| 1_2023-10-23_11-59-42 | 23/10/2023 | 11:59 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_12-00-32 | 23/10/2023 | 12:00 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_12-03-24 | 23/10/2023 | 12:03 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_12-03-52 | 23/10/2023 | 12:03 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_12-05-10 | 23/10/2023 | 12:05 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_12-05-43 | 23/10/2023 | 12:05 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_12-06-29 | 23/10/2023 | 12:06 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_12-06-39 | 23/10/2023 | 12:06 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_12-08-02 | 23/10/2023 | 12:08 | No | Decreasing ebb | Single fish at hub height including around rotor. |
| 1_2023-10-23_12-09-40 | 23/10/2023 | 12:09 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |

| Filename (.mp4) | Date | Time GMT | Turbine operating? | Tidal state | Details |
|---|---|---|---|---|---|
| 1_2023-10-23_12-10-07 | 23/10/2023 | 12:10 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_12-10-30 | 23/10/2023 | 12:10 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_12-11-20 | 23/10/2023 | 12:11 | No | Decreasing ebb | Large group of fish milling at hub height including around rotor. |
| 1_2023-10-23_12-11-55 | 23/10/2023 | 12:11 | No | Decreasing ebb | Small group of fish milling at hub height including around rotor. |
| 1_2023-10-23_13-18-46 | 23/10/2023 | 13:18 | Yes | Increasing flood | Small group of fish orientated into and actively swimming against the flow. Turbine is not operating at full power. |
| 1_2023-10-23_13-33-47 | 23/10/2023 | 13:33 | Yes | Increasing flood | Small group of fish orientated into and actively swimming against the flow. Turbine is not operating at full power. |
| 1_2023-10-23_13-48-48 | 23/10/2023 | 13:48 | Yes | Increasing flood | Small group of fish orientated into and actively swimming against the flow. Turbine is not operating at full power. |
| 1_2023-10-23_15-18-53 | 23/10/2023 | 15:18 | Yes | Maximum flood | Jellyfish passively drifting past the turbine. |
| 1_2023-10-23_15-33-55 | 23/10/2023 | 15:33 | Yes | Maximum flood | Jellyfish passively drifting past the turbine. |
| 1_2023-10-23_15-48-56 | 23/10/2023 | 15:48 | Yes | Maximum flood | Single fish swimming into the flow. Turbine is not operating at full power |
| *1_2023-10-24_12-52-00* | *24/10/2023* | *12:52* | *No* | *Decreasing ebb* | *Large group of fish milling at hub height including around rotor.* |
| *1_2023-10-25_12-47-00* | *25/10/2023* | *12:47* | *Yes* | *Maximum ebb* | *Large group of fish shoaling (assumed to be feeding) in the wake of the operating turbine.* |
| *1_2023-10-26_12-06-03* | *26/10/2023* | *12:06* | *Yes* | *Increasing ebb* | *Large group of fish shoaling (assumed to be feeding) in the wake of the operating turbine.* |

| Filename (.mp4) | Date | Time GMT | Turbine operating? | Tidal state | Details |
|---|---|---|---|---|---|
| *1_2023-10-27_07-37-39* | *27/10/2023* | *07:37* | *Yes* | *Maximum flood* | *Single fish passing the turbine in fast flow from north to south with the direction of flow. Passes through or very near to turbine rotor-swept area, but no contact with blades.* |
| *1_2023-10-29_08-20-33* | *29/10/2023* | *08:20* | *Yes* | *Maximum flood* | *Single fish passing the turbine in fast flow from north to south with the direction of flow. Passes through or very near to turbine rotor-swept area, but no contact with blades.* |
| 1_2023-10-30_06-47-43 | 30/10/2023 | 06:47 | Yes | Increasing flood | Single fish passing the turbine in fast flow from north to south with the direction of flow. Passes through or very near to turbine rotor-swept area, but no contact with blades. |
| 1_2023-10-30_10-47-19 | 30/10/2023 | 10:47 | No | Decreasing flood | Small group of fish milling at hub height including around rotor. |
| 1_2023-10-30_10-52-13 | 30/10/2023 | 10:52 | No | Decreasing flood | Small group of fish milling at hub height including around rotor. |
| 1_2023-10-30_10-54-36 | 30/10/2023 | 10:54 | No | Decreasing flood | Single fish milling at hub height including around rotor. |
| 1_2023-10-30_11-01-53 | 30/10/2023 | 11:01 | No | Decreasing flood | Single fish milling at hub height including around rotor. |
| *1_2023-11-10_10-46-03* | *10/11/2023* | *10:46* | *Yes* | *Increasing ebb* | *Large group of fish shoaling (assumed to be feeding) in the wake of the operating turbine.* |
| *1_2023-11-11_16-30-49* | *11/11/2023* | *16:30* | *Yes* | *Increasing flood* | *Single fish passing the turbine in fast flow from north to south with the direction of flow. Passes through or very near to turbine rotor-swept area, but no contact with blades.* |
| *1_2023-11-21_09-08-42* | *21/11/2023* | *09:08* | *Yes* | *Maximum ebb* | *Large group of fish shoaling (assumed to be feeding) in the wake of the operating turbine.* |

| Filename (.mp4) | Date | Time GMT | Turbine operating? | Tidal state | Details |
|---|---|---|---|---|---|
| *1_2023-12-01_09-59-04* | *01/12/2023* | *09:59* | *Yes* | *Maximum flood* | *Single fish swimming into the flow in the wake of the turbine throughout the entire 15 min video.* |
| *1_2024-01-09_14-36-34* | *01/09/2023* | *14:36* | *No* | *Decreasing ebb* | *Single shag diving past camera towards the seabed in apparent pursuit of prey although no fish were seen.* |
| 1_2024-03-01_14-03-47 | 01/03/2024 | 14:03 | No | Decreasing flood | Large group of fish shoaling at hub height observed to suddenly school with a single European shag, *Gulosus aristotelis* in active pursuit. |
| 1_2024-03-01_14-05-47 | 01/03/2024 | 14:05 | No | Decreasing flood | Single European shag, *Gulosus aristotelis* returning towards surface. |

# Appendix 2: Details of all video footage analysed

This Appendix provides details of all the video files acquired from turbine-mounted cameras in the Shetland Tidal Array between July 2023 and June 2024 that were analysed in this report (497 individual video files and circa 50 GB data).

Targets, where present are identified to species level, or as low a taxonomic category as possible. All fish were genus Pollachius and have been categorised in the table as individual fish small groups of fish (between two and ten individuals), or large groups of fish (greater than ten individuals). Grey cells indicate where there were no marine wildlife targets in the video.

Full details of all marine wildlife observations in the video footage analysed are provided in Appendix 1.

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2023-10-10_09-59-34 | 1.15 | Manual | | Yes |
| 1_2023-10-10_09-59-44 | 112.54 | Manual | Individual fish | Yes |
| 1_2023-10-11_06-05-05 | 324.74 | Automated | | Yes |
| 1_2023-10-11_06-20-06 | 361.07 | Automated | | Yes |
| 1_2023-10-11_06-35-06 | 204.67 | Automated | | Yes |
| 1_2023-10-11_06-50-08 | 178.85 | Automated | | Yes |
| 1_2023-10-11_07-05-08 | 199.75 | Automated | | Yes |
| 1_2023-10-11_07-20-09 | 180.19 | Automated | | Yes |
| 1_2023-10-11_07-34-29 | 1.44 | Automated | | Stops |
| 1_2023-10-11_10-50-41 | 83.77 | Automated | | Yes |
| 1_2023-10-11_11-05-42 | 98.97 | Automated | | Yes |
| 1_2023-10-11_11-20-43 | 97.95 | Automated | | Yes |
| 1_2023-10-11_11-35-43 | 127.72 | Automated | | Yes |
| 1_2023-10-11_11-50-44 | 119.83 | Automated | | Yes |
| 1_2023-10-11_12-05-44 | 114.00 | Automated | | Yes |
| 1_2023-10-11_12-20-45 | 108.63 | Automated | | Yes |
| 1_2023-10-11_12-35-47 | 98.82 | Automated | | Yes |
| 1_2023-10-11_12-50-48 | 102.68 | Automated | | Yes |
| 1_2023-10-11_13-05-50 | 108.56 | Automated | | Yes |
| 1_2023-10-11_13-20-51 | 9.96 | Automated | | Stops |
| 1_2023-10-12_12-35-59 | 111.18 | Manual | | Yes |
| 1_2023-10-13_06-32-59 | 187.32 | Automated | | Yes |
| 1_2023-10-13_06-47-59 | 195.68 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2023-10-13_07-03-00 | 182.16 | Automated | | Yes |
| 1_2023-10-13_07-18-01 | 167.33 | Automated | | Yes |
| 1_2023-10-13_07-33-01 | 125.83 | Automated | | Yes |
| 1_2023-10-13_07-48-01 | 118.69 | Automated | | Yes |
| 1_2023-10-13_08-03-02 | 110.56 | Automated | | Yes |
| 1_2023-10-13_08-18-03 | 110.25 | Automated | | Yes |
| 1_2023-10-13_08-33-03 | 115.78 | Automated | | Yes |
| 1_2023-10-13_08-48-05 | 124.01 | Automated | | Yes |
| 1_2023-10-13_09-03-06 | 62.09 | Automated | | Yes |
| 1_2023-10-13_11-33-03 | 87.24 | Automated | | Yes |
| 1_2023-10-13_11-48-04 | 82.78 | Automated | | Yes |
| 1_2023-10-13_12-03-04 | 80.83 | Automated | | Yes |
| 1_2023-10-13_12-18-05 | 82.07 | Automated | | Yes |
| 1_2023-10-13_12-33-06 | 89.16 | Automated | | Yes |
| 1_2023-10-13_12-48-07 | 89.36 | Automated | | Yes |
| 1_2023-10-13_13-03-08 | 82.65 | Automated | | Yes |
| 1_2023-10-13_13-18-09 | 83.96 | Automated | | Yes |
| 1_2023-10-13_13-33-09 | 84.54 | Automated | | Yes |
| 1_2023-10-13_13-48-10 | 93.87 | Automated | | Yes |
| 1_2023-10-13_14-03-10 | 101.02 | Automated | | Yes |
| 1_2023-10-13_14-18-11 | 90.00 | Automated | | Yes |
| 1_2023-10-13_14-33-11 | 96.85 | Automated | | Yes |
| 1_2023-10-13_14-48-13 | 93.81 | Automated | | Yes |
| 1_2023-10-13_15-03-13 | 103.99 | Automated | Large group of fish | Yes |
| 1_2023-10-13_15-18-14 | 82.11 | Automated | Large group of fish | Yes |
| 1_2023-10-13_15-27-17 | 1.96 | Automated | | Stops |
| 1_2023-10-14_10-08-32 | 2.31 | Manual | Large group of fish | No |
| 1_2023-10-15_11-50-55 | 84.91 | Automated | | Yes |
| 1_2023-10-15_12-05-56 | 82.09 | Automated | | Yes |
| 1_2023-10-15_12-20-56 | 91.11 | Automated | | Yes |
| 1_2023-10-15_12-35-56 | 103.18 | Automated | | Yes |
| 1_2023-10-15_12-50-57 | 95.34 | Automated | | Yes |
| 1_2023-10-15_13-05-58 | 94.70 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2023-10-15_13-20-58 | 81.05 | Automated | | Yes |
| 1_2023-10-15_13-36-00 | 81.92 | Automated | | Yes |
| 1_2023-10-15_13-51-01 | 87.85 | Automated | | Yes |
| 1_2023-10-15_14-06-01 | 79.00 | Automated | | Yes |
| 1_2023-10-15_14-21-01 | 80.98 | Automated | | Yes |
| 1_2023-10-15_14-36-03 | 83.64 | Automated | | Yes |
| 1_2023-10-15_14-51-03 | 86.90 | Automated | | Yes |
| 1_2023-10-15_15-06-04. | 102.06 | Automated | | Yes |
| 1_2023-10-15_15-21-05 | 102.85 | Automated | | Yes |
| 1_2023-10-15_15-36-06 | 103.65 | Automated | | Yes |
| 1_2023-10-15_15-51-07 | 120.66 | Automated | | Yes |
| 1_2023-10-15_16-06-09 | 113.50 | Automated | | Stops |
| 1_2023-10-16_13-05-51 | 83.74 | Manual | | Yes |
| 1_2023-10-17_12-50-48 | 88.55 | Automated | | Starts |
| 1_2023-10-17_13-05-49 | 86.44 | Automated | | Yes |
| 1_2023-10-17_13-20-50 | 97.31 | Automated | | Yes |
| 1_2023-10-17_13-35-51 | 92.56 | Automated | | Yes |
| 1_2023-10-17_13-50-53 | 94.20 | Automated | | Yes |
| 1_2023-10-17_14-05-53 | 96.58 | Automated | | Yes |
| 1_2023-10-17_14-20-54 | 95.60 | Automated | | Yes |
| 1_2023-10-17_14-35-55 | 92.56 | Automated | | Yes |
| 1_2023-10-17_14-50-55 | 99.49 | Automated | | Yes |
| 1_2023-10-17_15-05-56 | 105.79 | Automated | | Yes |
| 1_2023-10-17_15-20-57 | 109.14 | Automated | | Yes |
| 1_2023-10-17_15-35-58 | 107.95 | Automated | | Yes |
| 1_2023-10-17_15-50-59 | 116.95 | Automated | | Yes |
| 1_2023-10-17_16-06-00 | 133.10 | Automated | | Yes |
| 1_2023-10-17_16-21-01 | 181.71 | Automated | | Yes |
| 1_2023-10-17_16-36-02 | 175.18 | Automated | | Yes |
| 1_2023-10-17_16-51-03 | 241.00 | Automated | | Yes |
| 1_2023-10-17_17-06-03 | 281.20 | Automated | | Stops |
| 1_2023-10-18_15-45-56 | 164.21 | Manual | Large group of fish | Yes |
| 1_2023-10-19_10-36-00 | 83.82 | Manual | Individual fish | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2023-10-20_10-31-04 | 88.67 | Manual | Individual fish | Yes |
| 1_2023-10-21_07-33-06 | 186.52 | Manual | Large group of fish | Yes |
| 1_2023-10-22_10-03-32 | 4.14 | Manual | Large group of fish | No |
| 1_2023-10-23_07-00-51 | 14.73 | Automated | | Starts & stops |
| 1_2023-10-23_07-02-12 | 2.12 | Automated | | Starts & stops |
| 1_2023-10-23_07-08-35 | 177.58 | Automated | | Starts |
| 1_2023-10-23_07-23-35 | 139.93 | Automated | | Yes |
| 1_2023-10-23_07-38-37 | 124.11 | Automated | | Yes |
| 1_2023-10-23_07-53-38 | 118.17 | Automated | | Yes |
| 1_2023-10-23_08-08-39 | 101.13 | Automated | | Yes |
| 1_2023-10-23_08-23-41 | 97.27 | Automated | | Yes |
| 1_2023-10-23_08-38-42 | 90.93 | Automated | | Yes |
| 1_2023-10-23_08-53-42 | 87.47 | Automated | | Yes |
| 1_2023-10-23_09-08-43 | 96.62 | Automated | | Yes |
| 1_2023-10-23_09-23-44 | 92.40 | Automated | | Yes |
| 1_2023-10-23_09-38-44 | 80.83 | Automated | | Yes |
| 1_2023-10-23_09-53-45 | 81.06 | Automated | | Yes |
| 1_2023-10-23_10-08-45 | 76.63 | Automated | | Yes |
| 1_2023-10-23_10-23-46 | 76.24 | Automated | | Yes |
| 1_2023-10-23_10-38-48 | 75.70 | Automated | | Yes |
| 1_2023-10-23_10-53-50 | 28.53 | Automated | | Stops |
| 1_2023-10-23_11-00-19 | 0.56 | Automated | | No |
| 1_2023-10-23_11-16-23 | 2.11 | Automated | Large group of fish | No |
| 1_2023-10-23_11-16-55 | 1.03 | Automated | Small group of fish | No |
| 1_2023-10-23_11-17-23 | 0.70 | Automated | Large group of fish | No |
| 1_2023-10-23_11-18-35 | 0.64 | Automated | Individual fish | No |
| 1_2023-10-23_11-28-14 | 0.66 | Automated | Large group of fish | No |
| 1_2023-10-23_11-46-23 | 0.71 | Automated | Individual fish | No |
| 1_2023-10-23_11-46-53 | 0.81 | Automated | Individual fish | No |
| 1_2023-10-23_11-48-20 | 0.99 | Automated | Small group of fish | No |
| 1_2023-10-23_11-49-06 | 1.21 | Automated | Small group of fish | No |
| 1_2023-10-23_11-49-34 | 0.56 | Automated | Individual fish | No |
| 1_2023-10-23_11-50-22 | 1.16 | Automated | Individual fish | No |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2023-10-23_11-55-22 | 2.20 | Automated | Large group of fish | No |
| 1_2023-10-23_11-58-06 | 0.62 | Automated | Small group of fish | No |
| 1_2023-10-23_11-59-31 | 0.55 | Automated | Small group of fish | No |
| 1_2023-10-23_11-59-42 | 3.28 | Automated | Large group of fish | No |
| 1_2023-10-23_12-00-32 | 11.76 | Automated | Large group of fish | No |
| 1_2023-10-23_12-03-24 | 1.81 | Automated | Large group of fish | No |
| 1_2023-10-23_12-03-52 | 4.95 | Automated | Large group of fish | No |
| 1_2023-10-23_12-05-10 | 2.13 | Automated | Large group of fish | No |
| 1_2023-10-23_12-05-43 | 3.01 | Automated | Large group of fish | No |
| 1_2023-10-23_12-06-29 | 0.61 | Automated | Large group of fish | No |
| 1_2023-10-23_12-06-39 | 3.29 | Automated | Large group of fish | No |
| 1_2023-10-23_12-08-02 | 0.62 | Automated | Individual fish | No |
| 1_2023-10-23_12-09-40 | 1.67 | Automated | Small group of fish | No |
| 1_2023-10-23_12-10-07 | 0.84 | Automated | Large group of fish | No |
| 1_2023-10-23_12-10-30 | 2.08 | Automated | Large group of fish | No |
| 1_2023-10-23_12-11-20 | 2.31 | Automated | Large group of fish | No |
| 1_2023-10-23_12-11-55 | 0.88 | Automated | Small group of fish | No |
| 1_2023-10-23_12-40-57 | 6.10 | Automated | Small group of fish | Yes |
| 1_2023-10-23_12-42-14 | 0.86 | Automated | Small group of fish | Stops |
| 1_2023-10-23_12-48-43 | 75.68 | Automated | Small group of fish | Yes |
| 1_2023-10-23_13-03-44 | 78.12 | Automated | Individual fish | Yes |
| 1_2023-10-23_13-18-46 | 81.74 | Automated | Large group of fish | Yes |
| 1_2023-10-23_13-33-47 | 81.12 | Automated | Individual fish | Yes |
| 1_2023-10-23_13-48-48 | 81.33 | Automated | Individual fish | Yes |
| 1_2023-10-23_14-03-50 | 83.05 | Automated | | Yes |
| 1_2023-10-23_14-18-50 | 90.59 | Automated | | Yes |
| 1_2023-10-23_14-33-51 | 95.54 | Automated | | Yes |
| 1_2023-10-23_14-48-52 | 99.55 | Automated | | Yes |
| 1_2023-10-23_15-03-52 | 107.53 | Automated | | Yes |
| 1_2023-10-23_15-18-53 | 118.67 | Automated | Jellyfish indet. | Yes |
| 1_2023-10-23_15-33-55 | 123.40 | Automated | Jellyfish indet. | Yes |
| 1_2023-10-23_15-48-56 | 134.61 | Automated | Individual fish | Yes |
| 1_2023-10-23_16-03-57 | 170.54 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2023-10-23_16-18-57 | 171.11 | Automated | | Yes |
| 1_2023-10-23_16-33-58 | 221.38 | Automated | | Yes |
| 1_2023-10-23_16-48-58 | 359.59 | Automated | | Yes |
| 1_2023-10-23_17-03-59 | 6.42 | Automated | | Yes |
| 1_2023-10-23_17-04-18 | 4.04 | Automated | | Yes |
| 1_2023-10-24_12-52-00 | 1.58 | Manual | Large group of fish | No |
| 1_2023-10-25_12-47-00 | 76.95 | Manual | Large group of fish | Yes |
| 1_2023-10-26_12-06-03 | 98.05 | Manual | Large group of fish | Yes |
| 1_2023-10-27_07-37-39 | 193.26 | Manual | Individual fish | Yes |
| 1_2023-10-28_16-19-59 | 1.29 | Manual | | No |
| 1_2023-10-29_08-20-33 | 111.89 | Manual | Individual fish | Yes |
| 1_2023-10-30_06-47-43 | 387.64 | Automated | Individual fish | Yes |
| 1_2023-10-30_07-02-44 | 290.35 | Automated | | Yes |
| 1_2023-10-30_07-17-45 | 185.79 | Automated | | Yes |
| 1_2023-10-30_07-32-46 | 180.20 | Automated | | Yes |
| 1_2023-10-30_07-47-47 | 4.97 | Automated | | Yes |
| 1_2023-10-30_07-48-19 | 2.14 | Automated | | Stops |
| 1_2023-10-30_08-11-28 | 0.89 | Automated | | No |
| 1_2023-10-30_08-18-31 | 128.25 | Automated | | Yes |
| 1_2023-10-30_08-33-33 | 117.46 | Automated | | Yes |
| 1_2023-10-30_08-48-33 | 112.67 | Automated | | Yes |
| 1_2023-10-30_09-03-33 | 99.07 | Automated | | Yes |
| 1_2023-10-30_09-18-34 | 91.09 | Automated | | Yes |
| 1_2023-10-30_09-33-35 | 94.91 | Automated | | Yes |
| 1_2023-10-30_09-48-36 | 87.31 | Automated | | Yes |
| 1_2023-10-30_10-03-37 | 96.35 | Automated | | Yes |
| 1_2023-10-30_10-18-38 | 77.19 | Automated | | Yes |
| 1_2023-10-30_10-31-56 | 0.83 | Automated | | Stops |
| 1_2023-10-30_10-47-19 | 0.91 | Automated | Small group of fish | No |
| 1_2023-10-30_10-52-13 | 0.50 | Automated | Small group of fish | No |
| 1_2023-10-30_10-54-36 | 0.52 | Automated | Individual fish | No |
| 1_2023-10-30_11-01-53 | 0.48 | Automated | Individual fish | No |
| 1_2023-10-30_12-06-02 | 0.48 | Automated | | No |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2023-10-30_12-12-21 | 0.50 | Automated | | No |
| 1_2023-10-30_12-28-53 | 0.54 | Automated | | No |
| 1_2023-10-30_12-31-29 | 0.53 | Automated | | No |
| 1_2023-10-30_12-38-08 | 0.54 | Automated | | No |
| 1_2023-10-30_12-40-19 | 89.80 | Automated | | Yes |
| 1_2023-10-30_12-55-20 | 94.40 | Automated | | Yes |
| 1_2023-10-30_13-10-21 | 92.77 | Automated | | Yes |
| 1_2023-10-30_13-25-23 | 91.66 | Automated | | Yes |
| 1_2023-10-30_13-40-24 | 96.18 | Automated | | Yes |
| 1_2023-10-30_13-55-25 | 19.92 | Automated | | Yes |
| 1_2023-10-30_13-59-01 | 1.55 | Automated | | Stops |
| 1_2023-10-30_14-03-31 | 0.66 | Automated | | No |
| 1_2023-10-30_14-03-49 | 0.64 | Automated | | No |
| 1_2023-10-30_14-05-00 | 0.63 | Automated | | No |
| 1_2023-10-30_14-08-53 | 0.87 | Automated | | No |
| 1_2023-10-30_14-14-12 | 0.58 | Automated | | No |
| 1_2023-10-30_14-29-18 | 95.44 | Automated | | Yes |
| 1_2023-10-30_14-44-19 | 83.80 | Automated | | Yes |
| 1_2023-10-30_14-56-42 | 1.18 | Automated | | Stops |
| 1_2023-10-30_14-58-18 | 0.74 | Automated | | No |
| 1_2023-10-30_15-03-10 | 115.23 | Automated | | Yes |
| 1_2023-10-30_15-18-11 | 127.77 | Automated | | Yes |
| 1_2023-10-30_15-33-11 | 138.07 | Automated | | Yes |
| 1_2023-10-30_15-48-13 | 50.51 | Automated | | Yes |
| 1_2023-10-30_15-52-57 | 2.21 | Automated | | Stops |
| 1_2023-10-30_22-16-53 | 0.40 | Automated | | Too dark |
| 1_2023-10-31_08-02-47 | 1.19 | Manual | | No |
| 1_2023-11-09_10-02-15 | 99.70 | Automated | | Yes |
| 1_2023-11-09_10-17-15 | 103.37 | Automated | | Yes |
| 1_2023-11-09_10-32-16 | 114.47 | Automated | | Yes |
| 1_2023-11-09_10-47-17 | 111.54 | Automated | | Yes |
| 1_2023-11-09_11-02-18 | 98.58 | Automated | | Yes |
| 1_2023-11-09_11-17-19 | 98.38 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2023-11-09_11-32-20 | 104.01 | Automated | | Yes |
| 1_2023-11-09_11-47-20 | 98.58 | Automated | | Yes |
| 1_2023-11-09_12-02-20 | 93.16 | Automated | | Yes |
| 1_2023-11-09_12-17-21 | 93.64 | Automated | | Yes |
| 1_2023-11-09_12-32-23 | 97.23 | Automated | | Yes |
| 1_2023-11-09_12-47-23 | 92.15 | Automated | | Yes |
| 1_2023-11-09_13-02-24 | 93.64 | Automated | | Yes |
| 1_2023-11-09_13-17-25 | 50.90 | Automated | | Stops |
| 1_2023-11-10_10-46-03 | 103.71 | Manual | Large group of fish | Yes |
| 1_2023-11-11_16-30-49 | 223.98 | Manual | Individual fish | Yes |
| 1_2023-11-13_16-08-38 | 3.39 | Manual | | No |
| 1_2023-11-14_08-32-21 | 145.29 | Manual | | Yes |
| 1_2023-11-16_12-32-55 | 0.99 | Manual | | No |
| 1_2023-11-18_13-53-50 | 1.09 | Manual | | No |
| 1_2023-11-21_09-08-42 | 139.61 | Manual | Large group of fish | Yes |
| 1_2023-11-27_15-38-54 | 146.74 | Manual | | No |
| 1_2023-11-29_12-36-02 | 131.26 | Automated | | Starts |
| 1_2023-11-29_12-51-03 | 134.28 | Automated | | Yes |
| 1_2023-11-29_13-06-04 | 143.40 | Automated | | Yes |
| 1_2023-11-29_13-21-05 | 155.49 | Automated | | Yes |
| 1_2023-11-29_13-36-05 | 153.69 | Automated | | Yes |
| 1_2023-11-29_13-51-06 | 182.02 | Automated | | Yes |
| 1_2023-11-29_14-06-07 | 200.25 | Automated | | Yes |
| 1_2023-11-29_14-21-08 | 190.09 | Automated | | Yes |
| 1_2023-11-29_14-36-09 | 215.26 | Automated | | Yes |
| 1_2023-11-29_14-51-09 | 255.37 | Automated | | Yes |
| 1_2023-11-29_15-06-10 | 256.96 | Automated | | Yes |
| 1_2023-12-01_09-59-04 | 93.51 | Manual | Individual fish | Yes |
| 1_2023-12-09_13-45-15 | 90.8 | Manual | | No |
| 1_2023-12-11_10-41-36 | 126.32 | Automated | | Yes |
| 1_2023-12-11_10-56-37 | 132.12 | Automated | | Yes |
| 1_2023-12-11_11-11-38 | 130.89 | Automated | | Yes |
| 1_2023-12-11_11-26-39 | 125.74 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2023-12-11_11-41-40 | 122.52 | Automated | | Yes |
| 1_2023-12-11_11-56-40 | 111.47 | Automated | | Yes |
| 1_2023-12-11_12-11-42 | 97.89 | Automated | | Yes |
| 1_2023-12-11_12-26-43 | 95.64 | Automated | | Yes |
| 1_2023-12-11_12-41-44 | 95.01 | Automated | | Yes |
| 1_2023-12-11_12-56-45 | 102.59 | Automated | | Yes |
| 1_2023-12-11_13-11-45 | 109.51 | Automated | | Yes |
| 1_2023-12-11_13-26-47 | 114.64 | Automated | | Yes |
| 1_2023-12-11_13-41-47 | 126.69 | Automated | | Yes |
| 1_2023-12-11_13-56-49 | 134.51 | Automated | | Yes |
| 1_2023-12-11_14-11-49 | 140.06 | Automated | | Yes |
| 1_2023-12-11_14-26-51 | 160.95 | Automated | | Yes |
| 1_2023-12-11_14-41-51 | 82.41 | Automated | | Stops |
| 1_2023-12-13_13-56-43 | 125.13 | Manual | | No |
| 1_2023-12-15_13-16-38 | 196.31 | Manual | | No |
| 1_2023-12-16_10-04-24 | 188.23 | Manual | | Yes |
| 1_2023-12-18_12-52-03 | 125.17 | Manual | | Yes |
| 1_2023-12-20_13-17-21 | 129.19 | Manual | | Yes |
| 1_2023-12-22_09-50-34 | 110.15 | Manual | | Yes |
| 1_2023-12-24_09-37-04 | 13.12 | Automated | | Starts |
| 1_2023-12-24_09-44-35 | 179.13 | Automated | | Yes |
| 1_2023-12-24_09-59-36 | 146.04 | Automated | | Yes |
| 1_2023-12-24_10-14-37 | 140.11 | Automated | | Yes |
| 1_2023-12-24_10-29-39 | 154.23 | Automated | | Yes |
| 1_2023-12-24_10-44-41 | 134.51 | Automated | | Yes |
| 1_2023-12-24_10-59-41 | 139.63 | Automated | | Yes |
| 1_2023-12-24_11-14-43 | 148.84 | Automated | | Yes |
| 1_2023-12-24_11-29-45 | 112.62 | Automated | | Yes |
| 1_2023-12-24_11-44-46 | 144.22 | Automated | | Yes |
| 1_2023-12-24_11-59-47 | 170.42 | Automated | | Yes |
| 1_2023-12-24_12-14-47 | 130.09 | Automated | | Yes |
| 1_2023-12-24_12-29-48 | 154.86 | Automated | | Yes |
| 1_2023-12-24_12-44-50 | 142.25 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2023-12-24_12-59-51 | 139.88 | Automated | | Yes |
| 1_2023-12-24_13-14-51 | 157.96 | Automated | | Yes |
| 1_2023-12-24_13-29-52 | 180.09 | Automated | | Yes |
| 1_2023-12-24_13-44-52 | 191.85 | Automated | | Yes |
| 1_2023-12-24_13-59-54 | 202.41 | Automated | | Stops |
| 1_2024-01-09_10-32-20 | 132.58 | Automated | | Yes |
| 1_2024-01-09_10-47-20 | 128.43 | Automated | | Yes |
| 1_2024-01-09_11-02-21 | 111.65 | Automated | | Yes |
| 1_2024-01-09_11-17-21 | 104.29 | Automated | | Yes |
| 1_2024-01-09_11-32-21 | 105.48 | Automated | | Yes |
| 1_2024-01-09_11-47-23 | 110.93 | Automated | | Yes |
| 1_2024-01-09_12-02-24 | 105.46 | Automated | | Yes |
| 1_2024-01-09_12-17-25 | 110.40 | Automated | | Yes |
| 1_2024-01-09_12-32-26 | 105.09 | Automated | | Yes |
| 1_2024-01-09_12-47-28 | 101.24 | Automated | | Yes |
| 1_2024-01-09_13-02-28 | 93.85 | Automated | | Yes |
| 1_2024-01-09_13-17-29 | 90.21 | Automated | | Yes |
| 1_2024-01-09_13-32-30 | 101.64 | Automated | | Yes |
| 1_2024-01-09_13-47-32 | 108.87 | Automated | | Yes |
| 1_2024-01-09_14-02-33 | 72.56 | Automated | | Stops |
| 1_2024-01-09_14-36-34 | 1.13 | Manual | European shag, *Gulosus aristotelis* | No |
| 1_2024-01-12_12-47-23 | 103.84 | Manual | | Yes |
| 1_2024-01-14_10-48-08 | 126.67 | Manual | | Yes |
| 1_2024-01-16_13-02-38 | 131.33 | Manual | | Yes |
| 1_2024-01-19_13-12-48 | 91.94 | Manual | | Yes |
| 1_2024-01-21_08-52-20 | 161.8 | Manual | | Yes |
| 1_2024-01-24_15-23-35 | 9.71 | Manual | | Yes |
| 1_2024-01-27_12-57-26 | 116.63 | Automated | | Yes |
| 1_2024-01-27_13-12-28 | 126.18 | Automated | | Yes |
| 1_2024-01-27_13-27-29 | 121.44 | Automated | | Yes |
| 1_2024-01-27_13-42-30 | 135.37 | Automated | | Yes |
| 1_2024-01-27_13-57-30 | 128.20 | Automated | | Yes |
| 1_2024-01-27_14-12-31 | 136.32 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2024-01-27_14-27-32 | 141.59 | Automated | | Yes |
| 1_2024-01-27_14-42-32 | 149.00 | Automated | | Yes |
| 1_2024-01-27_14-57-33 | 157.19 | Automated | | Yes |
| 1_2024-01-27_15-12-35 | 177.10 | Automated | | Yes |
| 1_2024-01-27_15-27-36 | 202.20 | Automated | | Yes |
| 1_2024-01-27_15-42-37 | 180.94 | Automated | | Yes |
| 1_2024-01-27_15-57-38 | 242.38 | Automated | | Yes |
| 1_2024-01-27_16-12-39 | 336.34 | Automated | | Yes |
| 1_2024-01-30_15-17-29 | 131.22 | Manual | | Yes |
| 1_2024-02-01_12-56-30 | 112.79 | Manual | | Yes |
| 1_2024-02-09_08-55-44 | 114.76 | Manual | | Yes |
| 1_2024-02-11_08-18-09 | 177.35 | Manual | | Yes |
| 1_2024-02-13_12-48-06 | 75.93 | Automated | | Yes |
| 1_2024-02-13_13-03-08 | 75.99 | Automated | | Yes |
| 1_2024-02-13_13-18-09 | 77.42 | Automated | | Yes |
| 1_2024-02-13_13-33-10 | 82.43 | Automated | | Yes |
| 1_2024-02-13_13-48-11 | 91.20 | Automated | | Yes |
| 1_2024-02-13_14-03-11 | 91.48 | Automated | | Yes |
| 1_2024-02-13_14-18-11 | 110.15 | Automated | | Yes |
| 1_2024-02-13_14-33-12 | 129.57 | Automated | | Yes |
| 1_2024-02-13_14-48-14 | 119.68 | Automated | | Yes |
| 1_2024-02-13_15-03-15 | 100.63 | Automated | | Yes |
| 1_2024-02-13_15-18-16 | 104.47 | Automated | | Yes |
| 1_2024-02-13_15-33-18 | 125.35 | Automated | | Yes |
| 1_2024-02-13_15-48-19 | 145.10 | Automated | | Yes |
| 1_2024-02-13_16-03-20 | 163.06 | Automated | | Yes |
| 1_2024-02-13_16-18-20 | 200.03 | Automated | | Yes |
| 1_2024-02-13_16-33-22 | 211.09 | Automated | | Yes |
| 1_2024-02-13_16-48-23 | 160.13 | Automated | | Yes |
| 1_2024-02-13_17-00-40 | 2.42 | Automated | | Yes |
| 1_2024-02-14_16-26-25 | 190.17 | Manual | | Yes |
| 1_2024-02-17_11-26-32 | 79.19 | Manual | | Yes |
| 1_2024-02-21_10-08-55 | 94.63 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2024-02-21_10-23-56 | 89.27 | Automated | | Yes |
| 1_2024-02-21_10-38-57 | 86.41 | Automated | | Yes |
| 1_2024-02-21_10-53-58 | 86.46 | Automated | | Yes |
| 1_2024-02-21_11-08-59 | 87.85 | Automated | | Yes |
| 1_2024-02-21_11-24-00 | 88.95 | Automated | | Yes |
| 1_2024-02-21_11-39-01 | 90.23 | Automated | | Yes |
| 1_2024-02-21_11-54-02 | 90.29 | Automated | | Yes |
| 1_2024-02-21_12-09-02 | 89.71 | Automated | | Yes |
| 1_2024-02-21_12-24-02 | 88.10 | Automated | | Yes |
| 1_2024-02-21_12-39-04 | 90.34 | Automated | | Yes |
| 1_2024-02-21_12-54-05 | 103.20 | Automated | | Yes |
| 1_2024-02-21_13-09-06 | 95.93 | Automated | | Yes |
| 1_2024-02-21_13-24-07 | 116.07 | Automated | | Yes |
| 1_2024-02-21_13-39-08 | 132.72 | Automated | | Yes |
| 1_2024-02-21_13-54-09 | 114.75 | Automated | | Yes |
| 1_2024-02-21_14-09-10 | 110.18 | Automated | | Yes |
| 1_2024-02-21_14-24-10 | 118.90 | Automated | | Yes |
| 1_2024-02-21_14-39-11 | 13.45 | Automated | | Yes |
| 1_2024-02-22_12-50-06 | 86.37 | Manual | | Yes |
| 1_2024-02-24_07-31-11 | 181.84 | Manual | | Yes |
| 1_2024-02-26_02-25-08 | 0.68 | Automated | | Too dark |
| 1_2024-02-26_06-47-04 | 393.63 | Automated | | Yes |
| 1_2024-02-26_07-02-06 | 235.92 | Automated | | Yes |
| 1_2024-02-26_07-17-06 | 201.78 | Automated | | Yes |
| 1_2024-02-26_07-32-07 | 193.70 | Automated | | Yes |
| 1_2024-02-26_07-47-08 | 149.38 | Automated | | Yes |
| 1_2024-02-26_08-02-09 | 147.88 | Automated | | Yes |
| 1_2024-02-26_08-17-10 | 140.40 | Automated | | Yes |
| 1_2024-02-26_08-32-11 | 131.52 | Automated | | Yes |
| 1_2024-02-26_08-47-12 | 120.36 | Automated | | Yes |
| 1_2024-02-26_09-02-13 | 120.40 | Automated | | Yes |
| 1_2024-02-26_09-17-14 | 115.40 | Automated | | Yes |
| 1_2024-02-26_09-32-15 | 115.10 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2024-02-26_09-47-16 | 96.67 | Automated | | Yes |
| 1_2024-02-26_10-02-17 | 93.24 | Automated | | Yes |
| 1_2024-02-26_10-17-18 | 91.49 | Automated | | Yes |
| 1_2024-02-26_10-32-19 | 91.61 | Automated | | Yes |
| 1_2024-02-26_10-47-20 | 89.50 | Automated | | Yes |
| 1_2024-02-26_11-02-21 | 39.87 | Automated | | Yes |
| 1_2024-02-26_11-09-11 | 0.71 | Automated | | Stops |
| 1_2024-02-26_12-00-30 | 85.98 | Automated | | Yes |
| 1_2024-02-26_12-15-32 | 92.36 | Automated | | Yes |
| 1_2024-02-26_12-30-33 | 91.94 | Automated | | Yes |
| 1_2024-02-26_12-45-34 | 94.94 | Automated | | Yes |
| 1_2024-02-26_13-00-35 | 94.37 | Automated | | Yes |
| 1_2024-02-26_13-15-35 | 98.42 | Automated | | Yes |
| 1_2024-02-26_13-30-36 | 103.11 | Automated | | Yes |
| 1_2024-02-26_13-45-37 | 103.35 | Automated | | Yes |
| 1_2024-02-26_14-00-38 | 101.46 | Automated | | Yes |
| 1_2024-02-26_14-15-38 | 100.66 | Automated | | Yes |
| 1_2024-02-26_14-30-40 | 102.50 | Automated | | Yes |
| 1_2024-02-26_14-45-41 | 100.38 | Automated | | Yes |
| 1_2024-02-26_15-00-42 | 100.09 | Automated | | Yes |
| 1_2024-02-26_15-15-43 | 98.19 | Automated | | Yes |
| 1_2024-02-26_15-30-44 | 97.17 | Automated | | Yes |
| 1_2024-02-26_15-45-45 | 94.22 | Automated | | Yes |
| 1_2024-02-26_16-00-46 | 96.54 | Automated | | Yes |
| 1_2024-02-26_16-15-47 | 111.85 | Automated | | Yes |
| 1_2024-02-26_16-30-48 | 128.75 | Automated | | Yes |
| 1_2024-02-26_16-45-50 | 151.89 | Automated | | Yes |
| 1_2024-02-26_17-00-52 | 195.21 | Automated | | Yes |
| 1_2024-02-28_16-52-21 | 190.57 | Manual | | Yes |
| 1_2024-03-01_06-34-39 | 349.73 | Automated | | Yes |
| 1_2024-03-01_06-49-40 | 204.62 | Automated | | Yes |
| 1_2024-03-01_07-04-41 | 117.53 | Automated | | Yes |
| 1_2024-03-01_08-26-40 | 93.53 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2024-03-01_08-41-42 | 82.04 | Automated | | Yes |
| 1_2024-03-01_08-56-44 | 86.59 | Automated | | Yes |
| 1_2024-03-01_09-11-46 | 84.16 | Automated | | Yes |
| 1_2024-03-01_09-26-47 | 86.92 | Automated | | Yes |
| 1_2024-03-01_09-41-48 | 91.84 | Automated | | Yes |
| 1_2024-03-01_09-56-49 | 92.34 | Automated | | Yes |
| 1_2024-03-01_10-11-50 | 94.42 | Automated | | Yes |
| 1_2024-03-01_10-26-51 | 98.01 | Automated | | Yes |
| 1_2024-03-01_10-41-52 | 99.54 | Automated | | Yes |
| 1_2024-03-01_10-56-53 | 99.39 | Automated | | Yes |
| 1_2024-03-01_11-11-53 | 98.01 | Automated | | Yes |
| 1_2024-03-01_11-26-54 | 96.98 | Automated | | Yes |
| 1_2024-03-01_11-41-56 | 93.98 | Automated | | Yes |
| 1_2024-03-01_11-56-56 | 92.55 | Automated | | Yes |
| 1_2024-03-01_12-11-56 | 92.14 | Automated | | Yes |
| 1_2024-03-01_12-26-58 | 92.41 | Automated | | Yes |
| 1_2024-03-01_12-41-59 | 91.17 | Automated | | Yes |
| 1_2024-03-01_12-57-01 | 85.32 | Automated | | Yes |
| 1_2024-03-01_13-12-02 | 1.91 | Automated | | Stops |
| 1_2024-03-01_14-03-47 | 1.73 | Automated | Large group of fish & European shag, *Gulosus aristotelis* | No |
| 1_2024-03-01_14-05-47 | 2.51 | Automated | European shag, *Gulosus aristotelis* | No |
| 1_2024-03-01_14-14-11 | 84.01 | Automated | | Yes |
| 1_2024-03-01_14-29-11 | 84.36 | Automated | | Yes |
| 1_2024-03-01_14-44-13 | 84.17 | Automated | | Yes |
| 1_2024-03-01_14-59-15 | 92.84 | Automated | | Yes |
| 1_2024-03-01_15-14-15 | 96.63 | Automated | | Yes |
| 1_2024-03-01_15-29-16 | 101.63 | Automated | | Yes |
| 1_2024-03-01_15-44-18 | 103.78 | Automated | | Yes |
| 1_2024-03-01_15-59-19 | 96.42 | Automated | | Yes |
| 1_2024-03-01_16-14-20 | 109.12 | Automated | | Yes |
| 1_2024-03-01_16-29-21 | 127.42 | Automated | | Yes |
| 1_2024-03-01_16-44-21 | 143.89 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2024-03-01_16-59-22 | 154.16 | Automated | | Yes |
| 1_2024-03-01_17-14-24 | 184.83 | Automated | | Yes |
| 1_2024-03-01_17-29-25 | 193.32 | Automated | | Yes |
| 1_2024-03-01_17-44-27 | 330.14 | Automated | | Yes |
| 1_2024-03-01_17-59-28 | 81.00 | Automated | | Yes |
| 1_2024-03-02_12-42-30 | 116.68 | Manual | | Yes |
| 1_2024-03-03_07-18-41 | 163.84 | Manual | | Yes |
| 1_2024-03-04_15-33-37 | 136.76 | Manual | | Yes |
| 1_2024-03-05_13-58-12 | 90.68 | Automated | | Yes |
| 1_2024-03-05_14-13-13 | 86.74 | Automated | | Yes |
| 1_2024-03-05_14-28-13 | 94.13 | Automated | | Yes |
| 1_2024-03-05_14-43-15 | 96.04 | Automated | | Yes |
| 1_2024-03-05_14-58-16 | 100.92 | Automated | | Yes |
| 1_2024-03-05_15-13-16 | 108.77 | Automated | | Yes |
| 1_2024-03-05_15-28-16 | 120.00 | Automated | | Yes |
| 1_2024-03-05_15-43-17 | 125.48 | Automated | | Yes |
| 1_2024-03-05_15-58-18 | 127.48 | Automated | | Yes |
| 1_2024-03-05_16-13-19 | 134.45 | Automated | | Yes |
| 1_2024-03-05_16-28-21 | 140.54 | Automated | | Yes |
| 1_2024-03-05_16-43-21 | 146.71 | Automated | | Yes |
| 1_2024-03-05_16-58-22 | 160.24 | Automated | | Yes |
| 1_2024-03-05_17-13-23 | 184.69 | Automated | | Yes |
| 1_2024-03-05_17-28-24 | 145.55 | Automated | | Stops |
| 1_2024-03-06_16-41-00 | 132.34 | Manual | | Yes |
| 1_2024-03-09_07-53-54 | 104.51 | Manual | | Yes |
| 1_2024-03-11_16-56-10 | 40.97 | Manual | | Yes |
| 1_2024-03-13_08-46-09 | 137.77 | Manual | | Yes |
| 1_2024-03-14_08-05-24 | 99.93 | Automated | | Yes |
| 1_2024-03-14_08-20-25 | 106.67 | Automated | | Yes |
| 1_2024-03-14_08-35-25 | 99.35 | Automated | | Yes |
| 1_2024-03-14_08-50-27 | 102.37 | Automated | | Yes |
| 1_2024-03-14_09-05-28 | 102.57 | Automated | | Yes |
| 1_2024-03-14_09-20-29 | 107.21 | Automated | | Yes |

| File name (.mp4) | File size (MB) | Analysis method | Target | Turbine operating? |
|---|---|---|---|---|
| 1_2024-03-14_09-35-30 | 108.11 | Automated | | Yes |
| 1_2024-03-14_09-50-30 | 104.55 | Automated | | Yes |
| 1_2024-03-14_10-05-31 | 108.05 | Automated | | Yes |
| 1_2024-03-14_10-20-32 | 107.66 | Automated | | Yes |
| 1_2024-03-14_10-35-32 | 104.74 | Automated | | Yes |
| 1_2024-03-14_10-50-33 | 106.98 | Automated | | Yes |
| 1_2024-03-14_11-05-34 | 105.40 | Automated | | Yes |
| 1_2024-03-14_11-20-35 | 103.11 | Automated | | Yes |
| 1_2024-03-14_11-35-36 | 102.55 | Automated | | Yes |
| 1_2024-03-14_11-50-37 | 102.61 | Automated | | Yes |
| 1_2024-03-14_12-05-37 | 100.46 | Automated | | Yes |
| 1_2024-03-14_12-20-38 | 76.72 | Automated | | Yes |
| 1_2024-03-15_11-11-22 | 106.27 | Manual | | Yes |

# Appendix 3: Automated analysis object detection reports

This Appendix provides the results report automatically generated for all data analysed by the machine learning model. Four thumbnail frames are captured for each video identified to contain wildlife.




1_2023-10-13_15-03-13.mp4




1_2023-10-13_15-18-14.mp4

1_2023-10-23_11-16-23.mp4

1_2023-10-23_11-16-55.mp4




1_2023-10-23_11-17-23.mp4




1_2023-10-23_11-18-35.mp4




1_2023-10-23_11-28-14.mp4




1_2023-10-23_11-46-23.mp4




1_2023-10-23_11-46-53.mp4




1_2023-10-23_11-48-20.mp4




1_2023-10-23_11-49-06.mp4




1_2023-10-23_11-49-34.mp4




1_2023-10-23_11-50-22.mp4




1_2023-10-23_11-55-22.mp4




1_2023-10-23_11-58-06.mp4




1_2023-10-23_11-59-31.mp4




1_2023-10-23_11-59-42.mp4




1_2023-10-23_12-00-32.mp4




1_2023-10-23_12-03-24.mp4




1_2023-10-23_12-03-52.mp4




1_2023-10-23_12-05-10.mp4




1_2023-10-23_12-05-43.mp4




1_2023-10-23_12-06-29.mp4




1_2023-10-23_12-06-39.mp4

1_2023-10-23_12-08-02.mp4

1_2023-10-23_12-09-40.mp4




1_2023-10-23_12-10-07.mp4




1_2023-10-23_12-10-30.mp4




1_2023-10-23_12-11-20.mp4




1_2023-10-23_12-11-55.mp4




1_2023-10-23_13-18-46.mp4



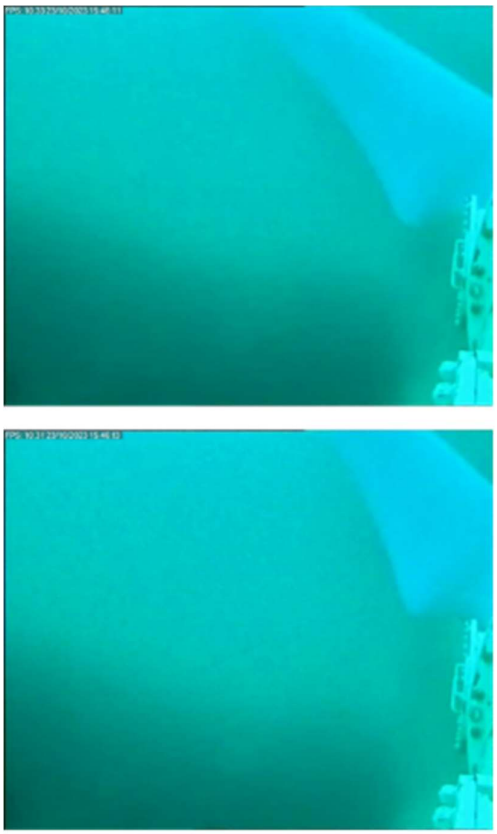

1_2023-10-23_13-33-47.mp4



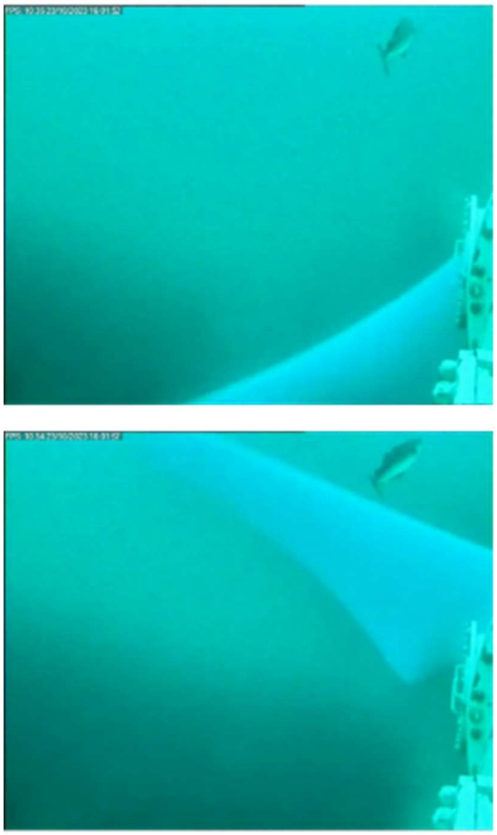

1_2023-10-23_13-48-48.mp4




1_2023-10-23_15-18-53.mp4



1_2023-10-23_15-33-55.mp4



1_2023-10-23_15-48-56.mp4




1_2023-10-30_06-47-43.mp4




1_2023-10-30_10-47-19.mp4




1_2023-10-30_10-52-13.mp4




1_2023-10-30_10-54-36.mp4




1_2023-10-30_11-01-53.mp4




1_2024-03-01_14-03-47.mp4




1_2024-03-01_14-05-47.mp4