Inishowen Basking Shark Study Group

Final Report 2011

PROJECT

DEPTH CHARGE

Investigating the depth profile of Basking sharks in Malin waters for potential eco- tourism operators

'The European Agricultural Fund for Rural Development: Europe investing in rural areas'.

LEADER

I.B.S.S IRISH BASKING SHARK SURVEY

Comhshaol, Pobal agus Rialtas Áitiúil
Environment, Community and Local Government

CONTENTS

SUMMARY

The aim of this project was to build on previous Inishowen based tagging studies, 2008 -2010 and go below the surface to research the dive behaviour of basking sharks with a view to link the findings, in a practical manor, to marine tourism operators. In order to quantify the time sharks spend 'basking' on the surface and what the key drivers of this behaviour are, newly developed Timed Depth Recorders (TDR's) were deployed on individual sharks. The TDR's were developed and built in conjunction with CEFAS and Queens University Belfast Marine Biological Lab and field tested in April.

Unusual weather during May and early June resulted in less predictable shark migration patterns than previous years (2005 -2010). As a result the original plan of deploying 30 TDR's was adjusted to maximise the data gained from the potentially lower number of shark encounters. A new plan was formulated which aimed to deploy 10 TDR's combined with the development and purchase of 2 Wildlife Computers MK 10 F fastloc satellite tags. These tags provide real time shark surfacing data and similar to the TDR's have never been deployed on sharks before.

In total 14 TDR's were deployed at different stages of the season, 6 have been recovered to date and 3 are awaiting re-deployment. This provides a higher than average recovery rate of 43% compared with similar studies of 10%. The data recorded is better than hoped and clearly demonstrates the link between shark surfacing patterns and particular weather variables. Wind speed and direction both determined the time sharks spent on the surface and their location on the Inishowen coastline. A weather time lag was detected which inferred that the previous two/three days was more important than the actual day in determining time spent on or near the surface. During the season April – August, the usual sharply defined shark encounter peak of late May and early June was replaced by a more diverse spread of encounters in July and August. More than 157 individual sharks were encountered during approx. 125 hours of defined survey. 64 Visual tags were deployed three of which were re-sighted in Scottish waters, 5 Slime DNA samples were taken and numerous photos and sub aqua video clips captured. The public sightings schemes recorded 54 shark encounters with a total of 261 individual sharks in the study area.

The Information gathered throughout this project will be of great assistance to marine tourism operators who need to know with reliability, when and where the sharks will be on the surface in Malin waters. This information will be made available as a pdf download on the enhanced website, www.baskingshark.ie. Whilst carrying out this investigative research the aim was also to build on the projects established scientific and media presence as well as facilitating television productions. Due to the adverse weather in May only one production was facilitated for UTV, through Evergreen media. Numerous talks, media interviews and reports were given on BBC and RTE radio. Articles appeared in many of the national and regional print press as well as a number of specialist magazines.

During 2011 the Basking shark project in Inishowen was significantly developed in both the scientific field and the general public's view. A partnership with Queens University Belfast was established which secures access to pioneering science. The project again demonstrated the potential that these iconic sharks have in securing positive media promotion for Inishowen throughout a diverse range of communities. Malin head has the potential to become the shark eco-tourism capital of Ireland and if managed correctly, Western Europe. The basking shark project is a major component of that potential which depends on a continued blend of relevant scientific research and significant media/ public interest.

BACKGROUND

In recent years basking sharks in Malin waters have been host to a number of internationally significant scientific studies, these studies have also raised the profile of the shark and Malin head in the media and publics view. However at present basking shark watching, diving, swimming etc. are not tourism products offered in Malin head waters. This is potentially due to a lack of licensed operators, gaps in the relevant knowledge base and the perceived unpredictability of the sharks surfacing behaviour. This project set out to address part of that knowledge gap.

The study area in question is Inishowen coastal waters centring on Malin head and Inishtrahull Island (*Fig 1*). It encompasses approx. 100 km of coastal waters. Access is provided by numerous small harbours and piers throughout the peninsula. For ease of operations and equipment loading the survey team were based out of Fahan Marina. This gives approx. 30 minute trip at 20knots to reach potential shark habitat north of Lenan head. Fishermen operating out of Malin head, Glengad, Bunagee pier and Lenan are operating directly into potential shark territory.

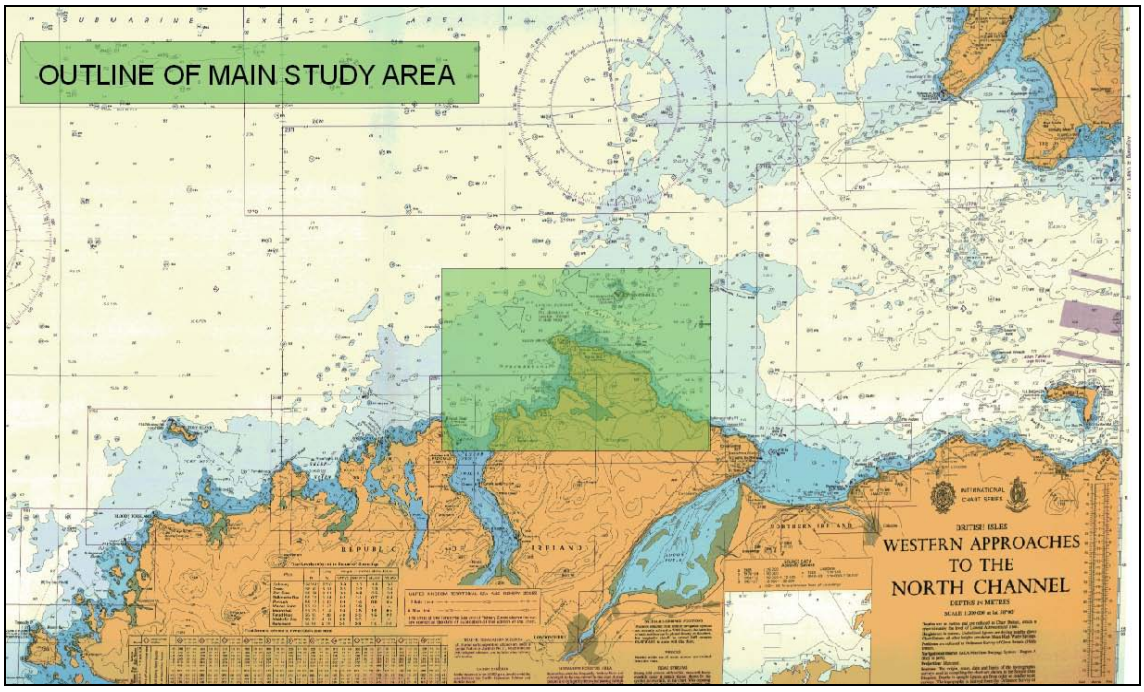


Fig 1: Showing the location of the study area which is displayed on standard admiralty chart incorporating Lenan,, Dunaff,, Malin head, Glengad, Glasheedy Island and Inishtrahull Island.

The study aimed to deploy 30 Timed Depth Recorders during peak shark activity periods; these usually occur in late May and early June. The tags record the depth to the nearest cm at which the shark is at any given time. By comparing the sharks depth with weather and other factors such as sea surface temperature, salinity and plankton behaviour, we can deduce the critical factors effecting the time basking sharks spend 'basking' and thus predict the most likely scenarios that will result in shark surface activity in Inishowen waters.

The following report is broad in nature and does not focus on the scientific details of the results but rather aims to present the findings in a manner which is easily understood and assimilated by all. Maps and graphs are used were possible to illustrate findings. The scientific methods and results are undergoing further analysis and will be prepared for submission to publication in early 2012.

GENERAL NARITTIVE OF SEASON

The project started with a tight time frame and once funding was secured the team moved as fast as possible to implement the plan. During April 10 timed depth recorders were initially developed and field tested because CEFAS had only 10 of the necessary G5 epoxy coated mini sensors available to buy off the shelf. The remaining 20 G5 sensors were ordered at this stage.

In previous years 2006 – 2010 basking shark sightings and encounters peaked during late May – Early June. *See Fig 2.* However in 2011 shark timings were different to the previous 5 years. 2011 saw an unusually sharp wave of shark activity during April before the tags were fully developed and field tested. May and June failed to record any substantial shark activity. These unusual findings were discussed with other marine based project leaders throughout the North Atlantic and it was quickly realised that the Inishowen coast was not the only area affected. Large scale change was occurring all along the western European coastline.

The situation was rapidly re-appraised and it was decided to switch the projects focus to monitoring plankton, which are the basis of all life in the oceans and more specifically the main component of basking sharks diet. A plan was devised to monitor plankton movements and densities within the study area in order to investigate these unusual happenings. This would at least provide data to enable comparisons between 2011 and previous season's results. This could highlight the reasons for the changes in oceanic and shark behaviour. Provided sharks did return to Inishowen waters before the end of the season this information would also provide insight into the key differences of plankton behaviour when sharks are not visible and when they are present at the surface. This is an aspect of basking shark behaviour which has not been studied in detail before. It could provide valuable assistance to eco tourism operators by indicating the oceanic conditions during which basking sharks are most likely to be on the surface in the study area.

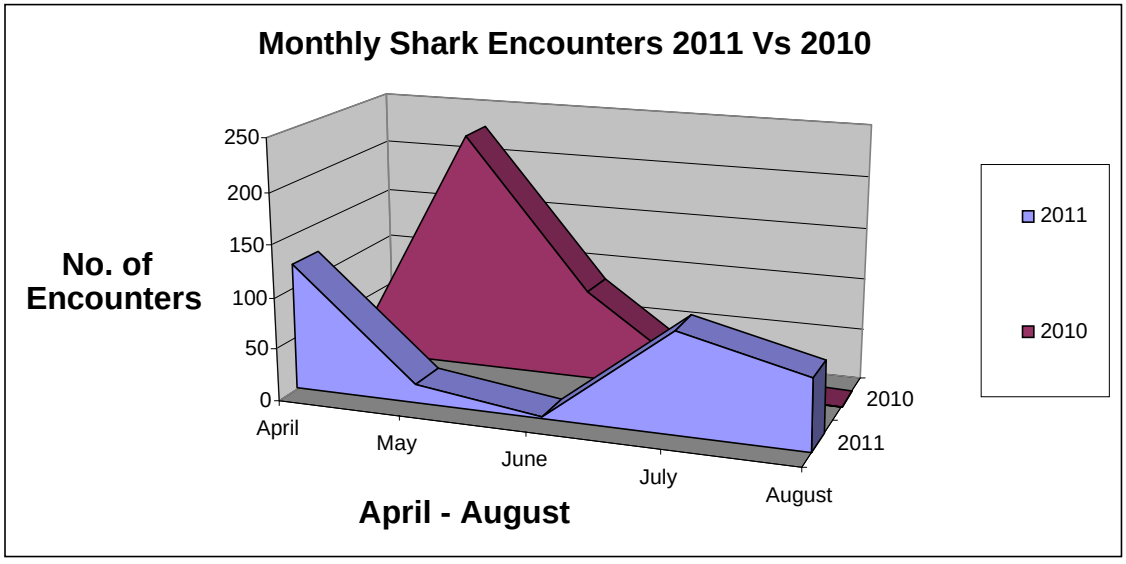


Figure 2: Comparison of monthly shark activity within study area during 2010 and 2011

At this stage the team had only managed to deploy two TDR's on a test basis and were encountering very few sharks. It was decided to use the remaining funding to purchase 2 Wildlife Computers MK10F fastloc tags and not 20 TDRs. The MK10F have been previously deployed in other International projects to record and transmit marine animal positions on the surface. They have only been deployed twice before, 2009 and 2010 and never on sharks. These tags would maximise any shark encounters during the remainder of the season, as only two sharks would be required to gain an incredible amount of surface behaviour data.

The MK10F Sat Tags took longer to be adapted for shark deployment and despite assurances the components were delayed in their postage from the USA. It also took time to set up an account with the ARGOS satellite system which oversees the recovery and transmission of global wildlife GPS data. The tags arrived in late July and the decision was taken to hold off on their deployment as they are extremely expensive (6000 euro each tag and approx. 500 euro for satellite time) and data for August would only be recovered before the sharks moved off shore for the winter months. By deploying the tags in early 2012 five months or a whole season worth of data will be recovered and the aim is to deliver an educational media campaign through a number of local schools with the tags.

In early July we started to see a rise in shark activity and we deployed all 9 remaining TDR tags within a short period of time, *Table 1*. Three recovered TDR's were re-deployed on the 31st of August. Shark activity was sustained for an 7 week period from July through to the start of September, *Figure 2*.

In retrospect with 64 visual tags deployed it is obvious 30 TDR's could have been deployed throughout the season. However after so few encounters in May, the unusual lack of shark activity was unsettling and the team did not have confidence in encountering enough sharks so as to be able to deploy 30 TDR's. Please note Approx. 60 close encounters are needed to deploy 30 tags as effectively half of all sharks encountered on the water are tagged. The decision to change to two satellite based tags was based on this premise and the possibility of requiring only 2 sharks for a similar amount of data returned. However due to the high return rate 43% (**To Date**) of TDR tags recovered the team actually achieved the amount of tag recoveries aimed for at the start of the project. A 50 Euro or Pounds reward is offered for each tag recovered. There were six returns from 14 TDR tags deployed; an estimated 10% recovery rate based on similar studies was initially projected. The team successfully recovered more than the minimal publishable sample for scientific papers, and intend to publish the findings in early 2012.

Picture 1: Fisherman Gerrard 'Jacky' Mcloughlin with recovered tag, Pic 2: TDR on shark, Pic3:Ryan Farren with recovered tag.

FIELD WORK BY MONTH

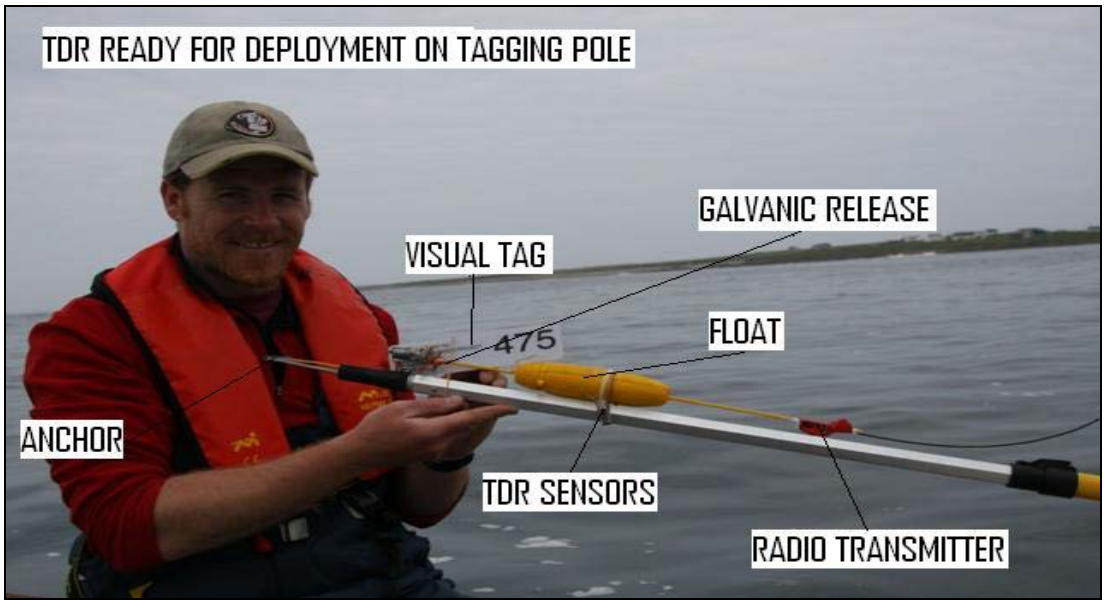
April

Dynamic tests were run by towing the galvanic release links in order to determine the difference between the times given by the manufacturer for static loads and the dynamic loads which will be applied on a moving shark. The difference was a reduced attachment of approx. 25% in the desired temperature bands, it was not possible to test the variable corrosion rates at much lower temperatures which could occur should the shark dive to significantly deep depths. Field tests were also run for boat and land based detection distances, accuracy of directions and height advantages' for the radio transmitters and receivers.

TDR float systems were developed and field tested to ensure correct size so as to be practical for deployment, large enough for viewing and recovery on the water but small enough so as not to change the sharks behaviour once attached. The system incorporated a Visual Tag and Anchor which provides the shark with an individual ID number for future reference and monitoring. This tag also provides an anchor under the skin of the shark for TDR attachment; the TDR sensors (35mm by 12mm) are attached to the Dan-Buoy float which also holds the Radio Transmitter to aid recovery on the upper end with sufficient weight on the lower end, the complete system is attached to the visual tag via a Galvanic release link which dissolves in water over a specific period of time, *See Picture 4.* A Flag and extra buoyancy was added after these field trials to aid visual recovery and the stability of radio transmission.

Two MK1 TDR's were deployed on two individual sharks during April – *see table1*

- Visual tag; White 455 with TDR A06478 and radio transmitter broadcasting on 150.079mhz
- Visual tag; White 475 with TDR A06475 and radio transmitter broadcasting on 150.137Mhz.
- A06478 broadcasting on 150.079mhz was recovered two hours later using radio receiver to detect and pinpoint position.



Picture 4: Showing TDR, Float, Visual Tag, Galvanised Link and Radio Transmitter.

A talk was given promoting the project in the Seaman's Club, Dublin 1 as part of the Irish SubAqua club CFT, lecture series. Numerous media articles were also released.

May

Due to unseasonal weather patterns very little field work was carried out during what is usually the peak month of shark activity *see figure 2*. Preparations and tests for TV production are undertaken. A talk was given in the NIEA Coastal Centre in PortRush highlighting the project.

June

The teams focus changed to Plankton monitoring and a new plan was devised to sample the water column at differing depths. Equipment including a *Van Dorn* sampler was sourced from QUB and a methodology established, *See Pictures 5, 6 and Fig 3.* Line transect surveys were continued but very little shark activity was recorded. Some television recording was carried out and media articles were released.

Picture 5: Plankton sampling with VAN DORN Bottle, Picture 6: Transect Survey and Tow

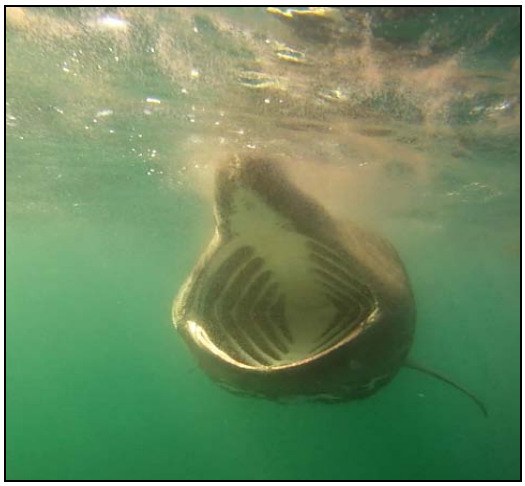
July

A period of settled weather resulted in an increase in shark activity, *see figure 2* and nine TDR's were deployed, *see Table 1 and Figure 4.* Visual tagging was conducted in tandem with slime sampling and video capture, *see Pictures 7 and 8*. Plankton studies were continued and samples throughout the water column were taken in front of feeding sharks and within feeding groups. A BBC Ulster Radio reporter is taken onboard to record a feature programme on the project. Underwater video is recorded and more television work carried out was well as a number of news articles in the print media.

August

Shark activity continued enabling tagging, sampling and video capture. Three TDR's were recovered by fishermen and a beach walker. Two of these TDR's were redeployed on the final day of August *(Table 1).* The new website with improved features was developed and all information rapidly collated, processed and the final report written up.

Picture 7: Tagging shark



Picture8: Video capture of shark feeding

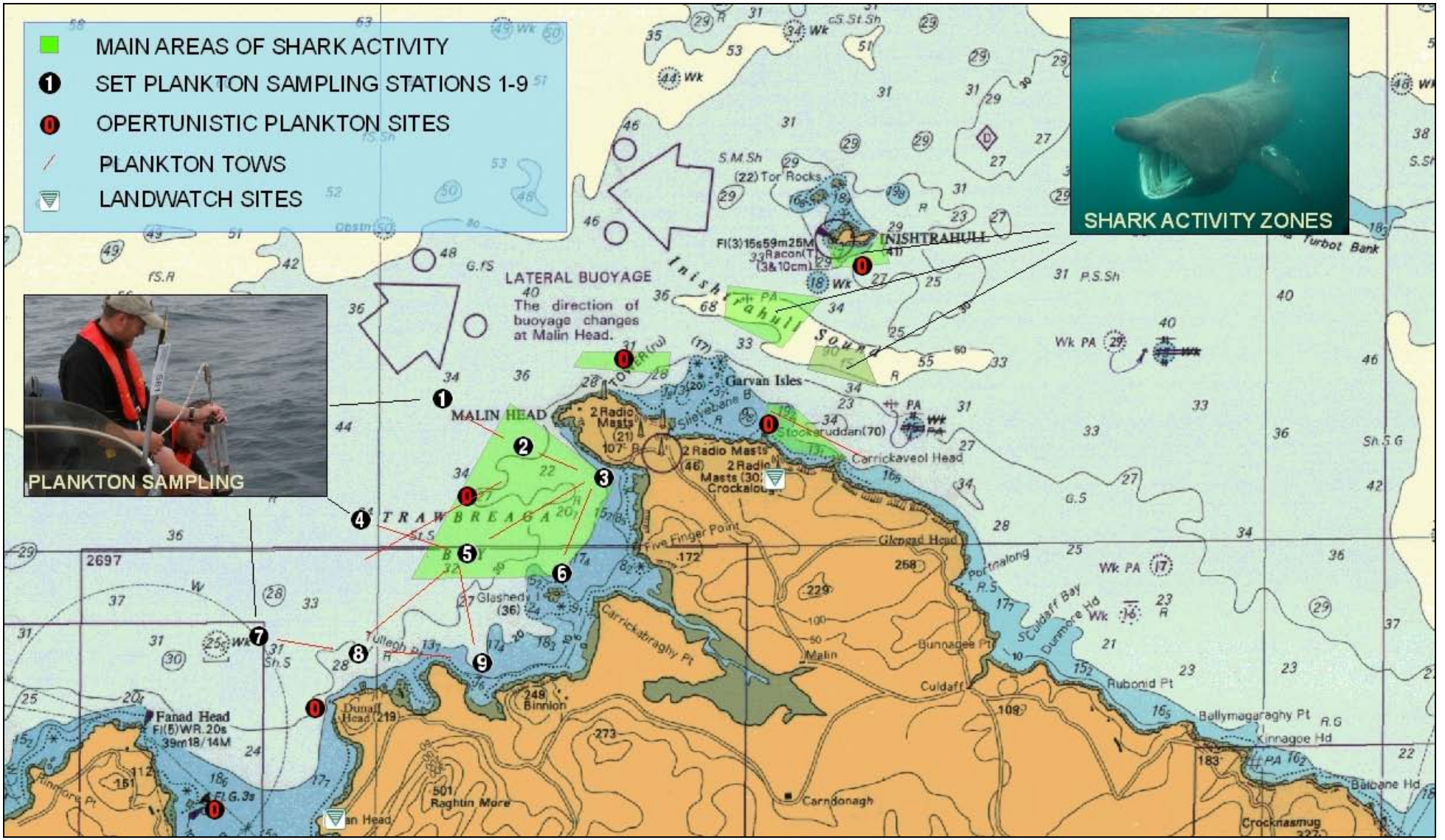


Figure 3 Plankton sampling points and sites of opportunity

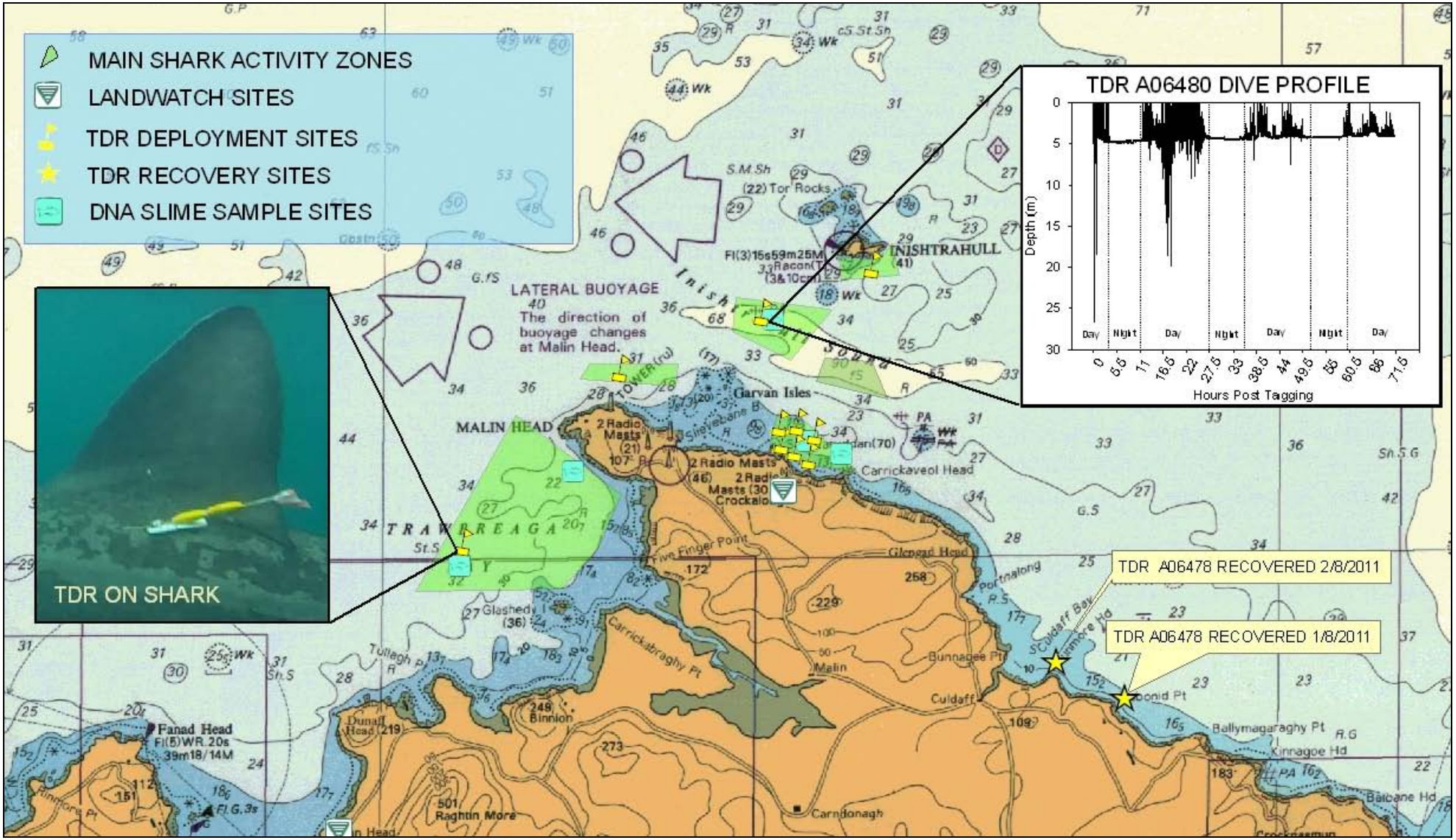


Figure 4 TDR deployment locations & DNA slime sample sites (exc. redeployments 31 August)

RESULTS

Six TDR's have been recovered to date from a deployment of 13; this gives a recovery rate of 31%. *See Table 1.* As a trial run of the practicalities of deployment and recovery the first two tags were deployed for an approx. 3 hour period. Here the three longest deployments are discussed with emphasis on the relationship between the dive profiles, the prevailing weather and key oceanographic variables at the time.

Visual Tag ID	TDR Tag and Radio Transmitter	Date	Release Time	Location	Recoveries To Date
W455	TDR A06478 150.079mhz	28/4/2011	3 hour	Tory Island	On site + 2hrs
W475	TDR A06475 150.137mhz	28/4/2011	3 Hour	Tory Island	No
W555	TDR A06474 150.102mhz	12/7/2011	3 Day	Inishtrahull S.	Whiterocks,
W456	TDR A06473 150.017mhz	13/7/2011	3 Day	Inishtrahull I.	Portballintrae
W553	TDR A06480	23/7/2011	3 Day	N. Malin Head	Ballyharry
W554	TDR A06478	23/7/2011	3 Day	Stookaruddan	Dunmore Hd
W551	TDR A06471	23/7/2011	3 Day	Stookaruddan	No
W552	TDR A06472	23/7/2011	3 Day	Stookaruddan	No
W558	TDR A06476	24/7/2011	3 Day	Stookaruddan	Malin Head
W559	TDR A06479	24/7/2011	3 Day	Stookaruddan	No
W560	TDR A06477	27/7/2011	3 Day	S. Malin Head	No
W572	TDR A06474	31/8/2011	3 D ay	Stookaruddan	No
W570	TDR A06478	31/8/2011	3 Day	Stookaruddan	No

Table 1: Details of TDR deployments and recoveries

Background: shark activity and frontal developments off Malin head

Plankton development and therefore shark activity at Malin head is dictated by the southern edge of what is known as the Islay front. This is where the cooler waters of the Irish Sea meet warmer Atlantic waters. The sharpness and definition of this front varies with weather conditions. Complex coastal bathymetry in the study area adds an additional variable to this oceanographic picture due to the deep trench of Inishtrahull sound. This trench acts as a second source of cool water particularly when prolonged calm conditions prevail and the main body of the front is often formed further north. Thus two frontal formations are interacting within the study area and during certain conditions a defined front can be detected through satellite imagery, *see figure 5*.

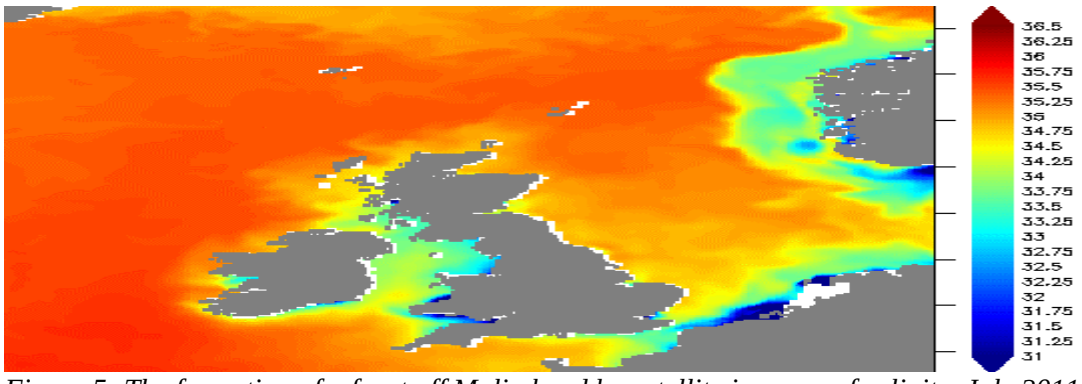


Figure 5: The formation of a front off Malin head by satellite imagery of salinity, July 2011

TAG A06474

TDR number A06474 was deployed on shark White 555 approx. 2 miles north of Malin head. This tag was recovered by a walker on Whiterocks beach in Northern Ireland. A 50 euro/pounds reward is offered for each tag recovery. This shark was in the 4-6m category indicating an immature shark. Photos and video were taken of the shark which was associating with two other sharks above a wreck on the north western edge of the trench within Inishtrahull sound. After an initial sharp dive to 28m immediately after deployment the shark remained within the top 5m of the water column for 98% of the 3 day deployment. Importantly although the shark often came to the surface it was for very short durations and the majority of its time was spent between 3 and 5 m.

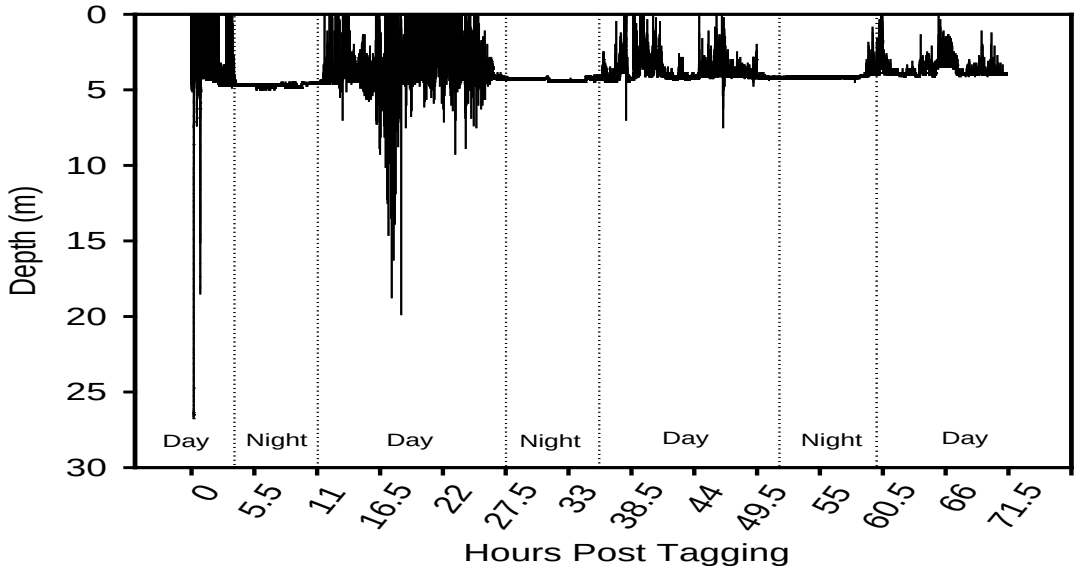


Figure 6: TAG A06474Depth profile

During the deployment a stable high was present over Malin head with winds in the F3-F4 category and good sunshine hours recorded, *Figure 7, 8 and 9*. The preceding week had recorded light to variable winds with short durations of no more than F4; this allowed the stable front north of Malin head to develop clear temperature and salinity differentiation on the surface. Winds when present were from the east which interacts with the flow of the strong spring tides (4-5 knots) within Inishtrahull sound and can periodically create relatively rough sea conditions (sea state 3-5) even with light winds. This interaction between periods of the strongest tidal flow east and the easterly wind is clearly visible when the sharks surfacing times are analysed in detail. The subsequent day or 13th of July recorded little or no winds with variable direction until late evening (approx 6pm) when winds increased and the shark showed a marked decrease in surface behaviour. Subsequent days 14th and 15th recorded a deterioration of conditions and a marked decline in the amount of time the shark spent foraging on the surface.

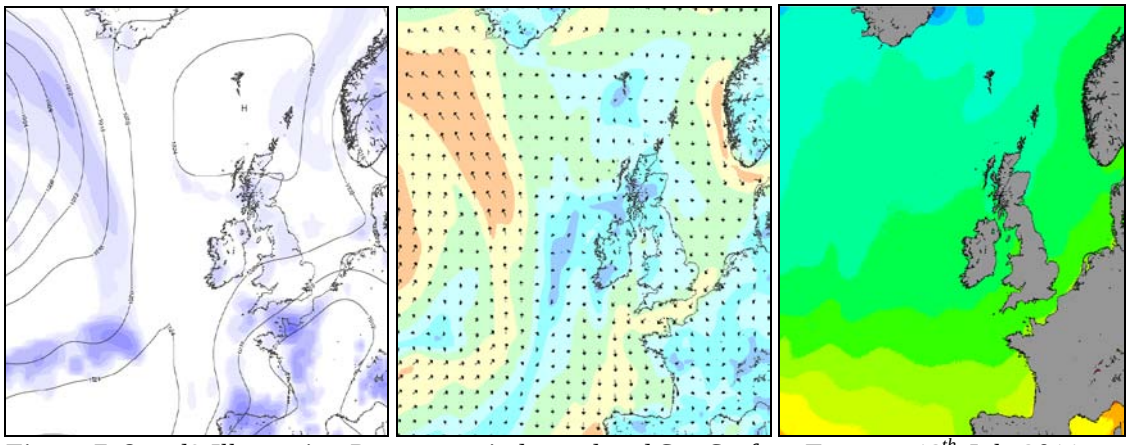


Figure 7, 8 and9 Illustrating Pressure, wind speed and Sea Surface Temp on 12th July 2011

TAG A06480

TDR A06480 was deployed on the 23rd July on White 553 approx. 400m north of Malin head signal tower. The tag was recovered by Gerrard 'Jacky' McLaughlin off Harry's nose, Ballyharry on the 1st of August. This shark was a juvenile in the 3-4m range. Photos were taken for Identification. A plankton sampling station was undertaken immediately after deployment in order to record the density and dispersal of plankton throughout the water column.

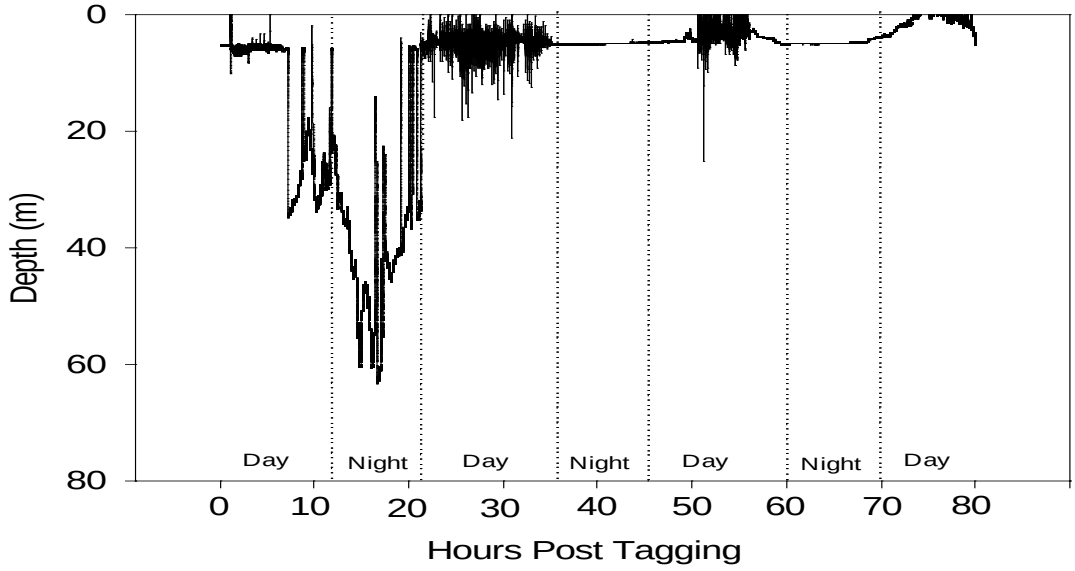
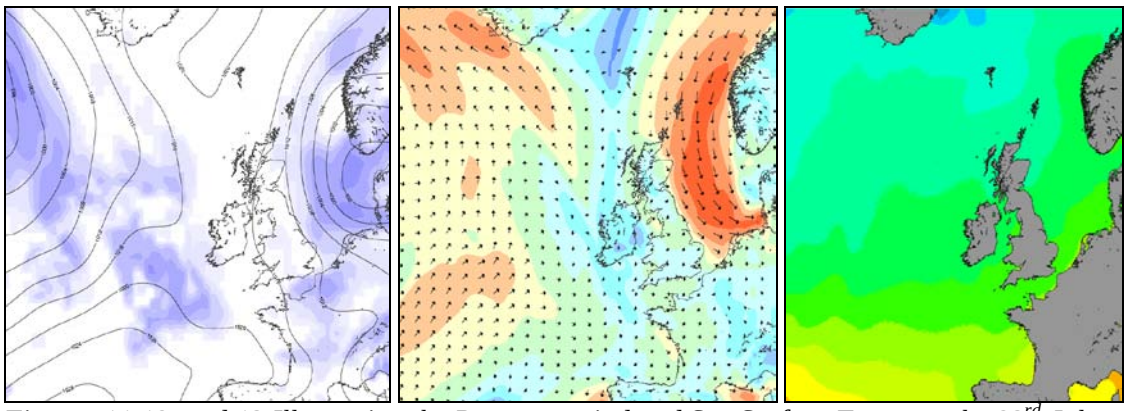


Figure 10: TAG A06480 Depth profile

The shark W553 did not display any obvious behavioural change immediately after deployment and spent the remainder of the day within 5m of the surface before diving in the early evening and continuing to forage at depths of up to 60m during the night of the 23rd. During the 80 hour period of this deployment a weak high pressure struggled to maintain its presence over Malin head area *see figures 11, 12 and 13*. The high pressure was sandwiched between two lows which dictated wind speeds and direction in the study area. Light northerly and north easterly winds of approx. F1-2 prevailed. Sea conditions were localised and their variability was dictated by neap tides (2-3 knots). On the 24th the shark ranged/ foraged up and down between 7 and 2m depth. It spent short periods of time on the surface before dropping to a 5m depth for the night. The 25th recorded lighter wind speeds throughout the middle of the day and the shark increased its surface time considerably before returning to the 5m depth for the evening and night. On the 26th the shark spent the majority of its time on the surface with Northerly winds of F1 being recorded.



Figures 11,12 and 13 Illustrating the Pressure, wind and Sea Surface Temp. on the 23rd July

TAG A06478

TDR A06478 was deployed on the 23rd July on White 554 100m off the Stookaruddan east of Malin head. The tag was recovered by Michael and Ryan Farren at Dunmore Hd on the east side of Culdaff Bay on the 2nd August. This shark was also a juvenile of 3-4m length. It was feeding with a group of approx. 6-10 sharks on high densities of plankton which was being blown into the small bay east of the 'Stook' by light north easterly winds. A Plankton net was dipped in front of the shark to sample the food species and makeup.

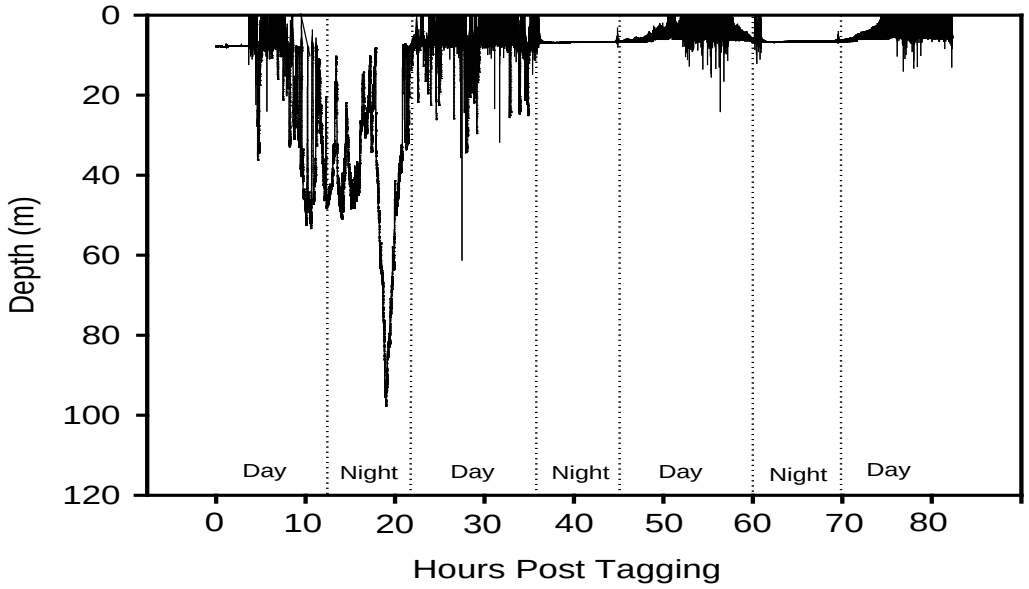


Figure 14 TAG A06478 Depth Profile

The shark W554 did not display any obvious behavioural change immediately after deployment and spent 50% of the remainder of the day on the surface before diving in the early evening and continuing to forage at depths of up to 95m during the night of the 23rd. This deployment was over the same period as TDR A06480 and thus the same weather conditions were recorded. On the 24th the shark spent the majority of its time on the surface with numerous short dives to approx. 20m and one short dive to 60m. The 25th and 26th were spent foraging on the surface during the middle of the day when sea surface temperatures were at their highest and a slack high tide created calm surface conditions.

Pictures 9, 10 and 11 showing approach to tag W555, Shark W554 and 553 with tags attached

DISCUSSION

The sharks which hosted the recovered TDR's in the study area were all relatively small sharks 3-6m in length and they are possibility not a true representative sample of the range of shark sizes and age that we find around Malin head (2-10m). However they do provide for direct comparison without the unknown of shark behavioural change with age and maturity being a decisive factor. Two of the recovered tags were deployed for the same time period and offer a unique insight into the difference in behaviour by two similar sized sharks within a defined area under similar environmental conditions. Both of these tags were recovered within 1 km and one day of each other indicating the sharks stayed within the study area for the duration of the deployment and they also stayed within relatively close quarters to each other.

The sharks spent the majority of their time in the top 8m of the water column with approx. 60% time spent between 5 and 8m and approx. 12% spent actually 'basking' on the surface. This might not appear to be significant but considering the Fin of the basking shark is on average 1m in height and the sharks foraged in calm conditions by continually ranging up and down throughout the top 5m. It can be deduced that the shark Fin would be visible during much of this time, it is worth noting that records during the 2011 and previous study seasons indicate that sharks feed in groups and thus at any one time a single fin can indicate a greater number of sharks. This is supported by observations made throughout the past 3 years during visual tagging activities when it was noted that a single shark on the surface indicated on average 4 more sharks below the surface. The average visibility in the study area waters during the season depended on the sea state and plankton densities but sharks at 3-5m depth were seen at close quarters (100m) by dedicated surveyors when viewing from a height of greater than 3m.

The temperature variance crossed by the sharks indicated the Islay frontal system was also being affected by the cooler waters of Inishtrahull trench. Cold waters are high in nutrients but warmer water temperatures are required to enable phytoplankton to multiply sufficiently for a plankton 'bloom' to develop. They both have different densities due to differing salinity and this measurement can be used to indicate a frontal formation through satellite imagery, *figure 5*. There is only one location with a depth more than 35m in the study area and that is the trench within Inishtrahull sound. Two of the tags dived to depths of more than 60m with Tag three diving to 95m or the maximum depth of Inishtrahull sound trench. This shark was literally ranging for food throughout the complete water column. This indicates that plankton was dispersed evenly throughout the water column at this time (night) with few concentrations.

Plankton normally practices a Diel Migration by dropping down to lower depths during periods of strong sunshine 'day' and rising to shallower depths during low sunlight periods 'Night'. Our preliminary analysis indicates the plankton switched to a reverse Diel migration (surface at day and deeper at night) when prolonged calm conditions were experienced. These are the conditions in which basking sharks are attracted to the surface as high concentrations of plankton are aggregating in the top 5m of the water column. The longer the calm conditions prevail and the stronger the sunshine/ temperature gradient the higher the densities become. The longer the calm conditions were recorded the greater the surface activity was. Of particular interest was the observed lag of 2-3 days before significant shark activity started. Once shark activity did increase it was observed that shorter periods of increased winds or sea state did effect the time the sharks spent on or near the surface but it did not affect their presence in the area.

Sea conditions were highly localised and their variability was usually dictated by the timing and strength of tide. The first shark A06474 was recorded during spring tides and showed a reduced surfacing rate during the periods of strongest tidal flow. In

comparison the two subsequent sharks A06480 and A06478 were both recorded during neap tides and maintained longer surface durations during the then strong tidal periods. Tag one was subject to light southerly winds (F1-2) and maintained its presence within 5m of the surface for the majority of the three day period. In comparison the two subsequent tags experienced light North easterly winds and maintained less time in the top 5m of the water column but a higher percentage of time on the surface when tides were slack and winds were weak (F1).

According to Met Eireann it was the driest July at Malin Head since 1983, Daily maximum temp. values on the 12th were the highest for July since 1989, and the Malin head station measured its highest daily sunshine value on the 11th Of July. Mean wind speeds for the month of between 6 and 10 knots *(11 and 19 km/hour)* were below normal. This all indicates that the 11th and 12th of July was the start of a period of high temperatures and calm weather which also coincided with a sharp increase in Shark activity. These types of conditions have been associated with May and June in previous years but also with mid -late July in 2008. Interestingly shark W555 with Tag A06574 was tagged on the 12th of July in the exact location a number of sharks were visual tagged in mid July in 2008. White 555 was also subsequently photographed off the Isle of Bute, Scotland on 21st July so although sharks numbers remained high in the area during late July, W555 did not stay in the area for more than 5-6 days. This is supported by the lack of re-sightings of visual tags (64 deployed) during field work were each individual shark encountered post 6 hours of tagging proved to be a new un-tagged shark *see figure 15.* This is tempered by the fact that sharks W 554 and W 553 clearly stayed within the study area for a minimum of three days as evidenced by their deep dives in Inishtrahull trench and the location of the recovery sites, but neither shark was re-sighted by the survey team during that period.

Another survey technique employed throughout the survey period was the continuation of the visual tagging programme. This provides crude site-fidelity information and also assists in distinguishing one shark from another during field work. Photo ID of the fins is also used but this has proved less effective when compared with the visual tags. We had three returns from a total of 64 tags deployed; all returns were from commercial eco-tourism operators in Scottish waters. These operators are very keen to get involved in the project as it boosts their promotion. In total the Inishowen based team have visual tagged over 220 sharks in Donegal waters since 2008 out of a total of 350 in Irish waters. There is no other visual tagging scheme of Basking sharks in the world.

DNA slime sampling was carried out sharks on 5 sharks which were definitively sexed through the use of underwater video and visual tagged to ensure ID. This technique was developed at Malin head by Dr Simon Berrow during a visual tagging session. It is now the standard method world wide and samples are sent to Professor Les Noble of the University of Aberdeen. DNA samples have increased in the order of multiples since this method has been established and it is hoped that DNA will provide insights into the broader scale questions that remain unanswered about this species.

To summarise: a prolonged period of calm conditions is needed to develop sufficient densities of plankton to attract significant numbers of basking sharks into the area (11th-14th July). Once established in the area the sharks will maintain their presence even through short periods of high winds and rough sea state (mid July – early September). When in the area the period of time the sharks spend on the surface is directly related to the sea state (sea state 0-1, approx. 50% time on surface). Sharks feed in groups at a number of different local ‘hotspots’ around the coastline. The prevailing wind direction determines which location *see Appendices; Tour Operators guidelines.*

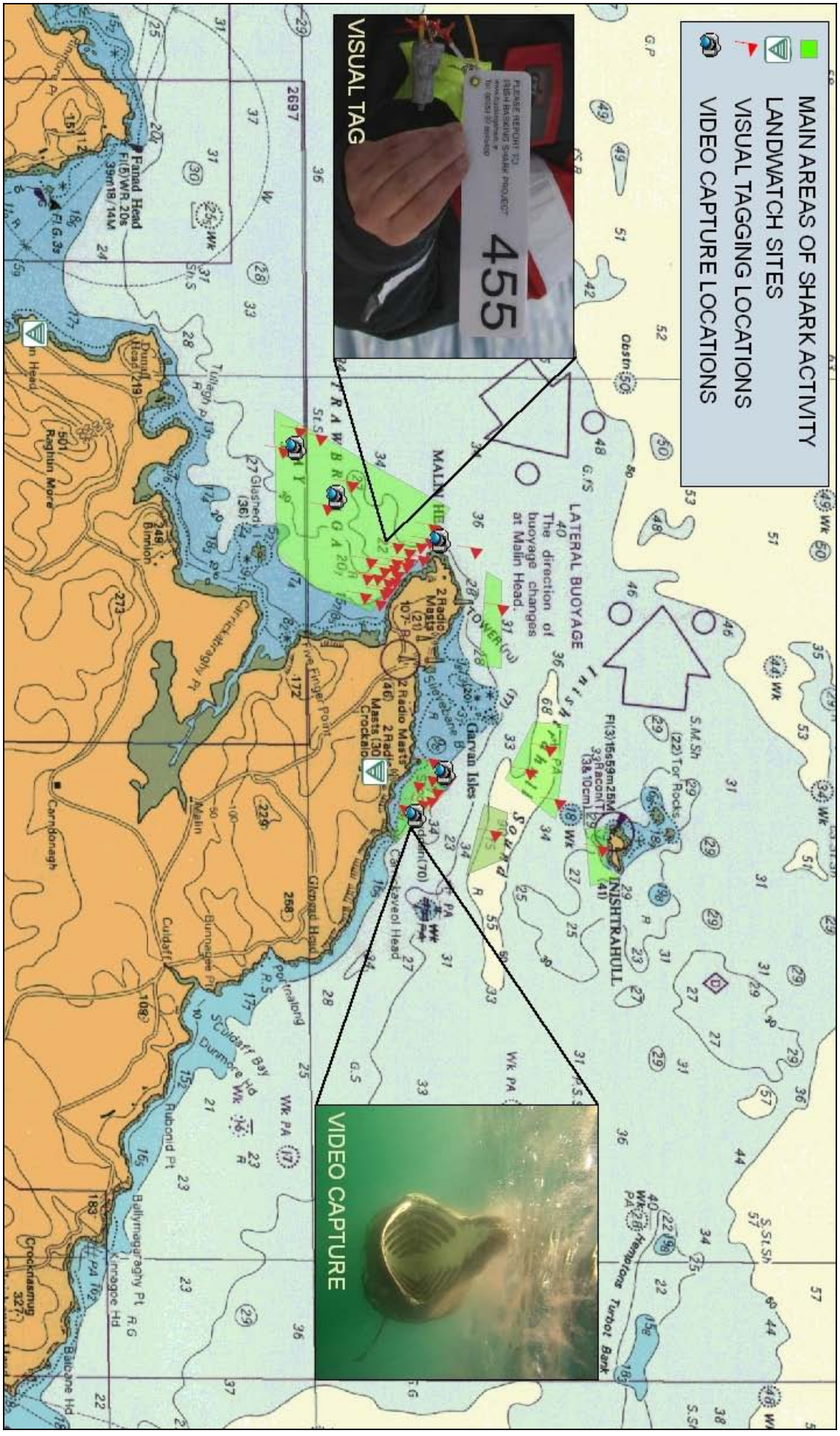


Figure 15 Visual tag deployment sites and sub aqua video recording locations

MEDIA AND PUBLIC AWARENESS

Public Sightings Scheme

As part of the media and public awareness campaign a public sightings scheme is run locally which also feeds into the national sightings scheme run by the Irish Whale and Dolphin Group via their website. This gives members of the public an opportunity to feed their single pieces of information (sightings) into a central database which is collated and presents an overall picture of shark activity and movements on a much broader scale than distance sampling surveys. It often provides tagging teams with up to date information on shark activity and is invaluable in the organisation of any shark watching or study project, *see figure 16*. This scheme is also an important way of encouraging the resident commercial and leisure fishermen to engage with the project as well as a practical means of demonstrating to them the value of their individual sightings. In total the local scheme recorded 35 sightings of 70 individual sharks and exclusively within the study area the national scheme recorded 20 sightings of 142 individual sharks. This is significantly down on the 2010 season which recorded 65 sightings in the local scheme and 37 in the National scheme. This could reflect the lack of shark intensity during the early part of the year and the smaller aggregations[1] of sharks in July and August.

Talks

A number of talks and presentations were given locally with two high profile talks been presented out with the region. A talk was given in the Countryside Centre Portrush as part of their Thursday evening lecture series which attracts many of Northern Irelands environmental decision makers, on this day a workshop was also run for third level and post graduate marine biology students.
A presentation was given on the project at the Seaman's Club in Dublin by invitation of Sea-search Ireland and CFT. This is part of the CFT (Irish Dive Association) spring lecture series which aims to inspire divers to explore new areas and get involved with new projects. Feedback from this presentation was good with numerous contacts made later in the season by individuals who decided to visit the area as a result.

Print Media

Numerous local and regional papers featured the project on a regular basis. With National coverage on 14th June and Sunday 10th July with one International paper the UK edition of the Daily Mail running a small feature box on the 11th August 2011.
Articles were also featured on the front page of numerous websites, including the IWDG, CFT and QUB. The project also contributed numerous photos and information to leaflets, interpretation signs and a book on the area.

Radio

The project was featured by local radio stations including, ICR, Highland and BBC Foyle which conducted a 10min programme on the project. Regional and national stations also featured the project including BBC NI – Evening extra programme, BBC NI also recorded an on site feature programme for 'The sea and us' radio documentary series. RTE briefly featured the project on Drive time and it also got a brief mention by Monty Halls on Pat Kenny and Today FM.

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[1] Studies have shown that individuals are less likely to report small groups of sharks (2-3) than larger aggregations such as 20.

TV

Before the start of the season the project was contacted by numerous TV production companies which expressed a desire to record the projects work. These included.

- Evergreen Media – for ITV
- Eco – Eye for RTE
- Gmarsh productions, Coilin Staford Jonston, 'Living the Wildlife' for RTE
- Wildlife SOS International for Animal Planet and Discovery channel
- TG4 – documentary on coasts and island lifes
- RTE News – Eileen Magnor

All of these productions could not be facilitated and the research work completed in one season. It was decided to work with as many teams as possible but prioritise the ones with most relevant and largest viewership (UK and International Viewers). Unfortunately the season did not develop as planed with little or no activity in May and June, the usual peak periods. The team had to make a call and judging on previous year's levels of activity in July and August, we cancelled the filming with all but one production, Evergreen media. Evergreen are based locally (NI) and could move with speed and low overheads. It was a difficult decision at the time, but during May when normally large aggregations of sharks are on the coast we had no possibility of encounters. It is irresponsible to ask production teams to come into the field and incur the large expense without a good possibility of delivering the product. In order to maintain our reputation and avoid a bad name in the industry we believe we made the right decision. A number of the productions expressed an interest in coming in 2012. As our understanding of the shark's habits and the profile of the project grows it is hoped that the project will be able to secure a feature programme on Animal Planet/ Discovery Channel. This involves allot of ground work and is a serious undertaking with a production team being resident in the area for the whole season. We are in preliminary discussions for this for either 2012 or 2013 depending on the production company's commitments in the developing Series.
One significant issue was raised a number of times by the TV and Radio production companies during initial discussions. The issue is that of Insurance on the water and in the research vessel. Unfortunately the team do not have a coded boat and it is not possible to cover commercial operators or productions working for profit without a coded vessel. This is a serious concern for the ability of the project to facilitate TV productions in the future.

Website

The project team completely re- developed the website from a static page site which was controlled by a single web designer/administrator to a more interactive site which project leaders can use on a daily basis.

- Project leaders can now upload News articles, pictures, video etc. in their own time ensuring the site is maintained up to date with developments.
- A facebook scroll was also fitted to further enhance the sites ability to keep relevant up-to-date information on its front page.
- A Shark ID section has been added and this will be developed further once all photos from the season have been processed.
- New pages and features including information on projects and the species were also included.
- Video and photo galleries have been added which will be further developed as the team works through the captured footage and pictures.
- Website banners were also provided for the VisitInishowen.ie webpage scrolls and top banner.

Requests for information by Tourists and potential visitors

The project received over 100 requests for information from potential ‘tourists’ (people who reside outside Donegal) on how to view, swim with or encounter basking sharks. 36 of these were by email, 33 by Phone and 31 by personal contact. Two contacts were made from families resident in the USA, both of which subsequently changed their plans to include Inishowen on their itinerates having previously not planned to visit north of Galway. The majority of contacts were from Irish residents based in Dublin or Galway with approx. 30 % from UK and NI residents. More market research is needed on visitor numbers with an interest in marine activities; web traffic monitoring is an easily monitored guideline of public interest but it is difficult to establish the conversion from interest to footfall.

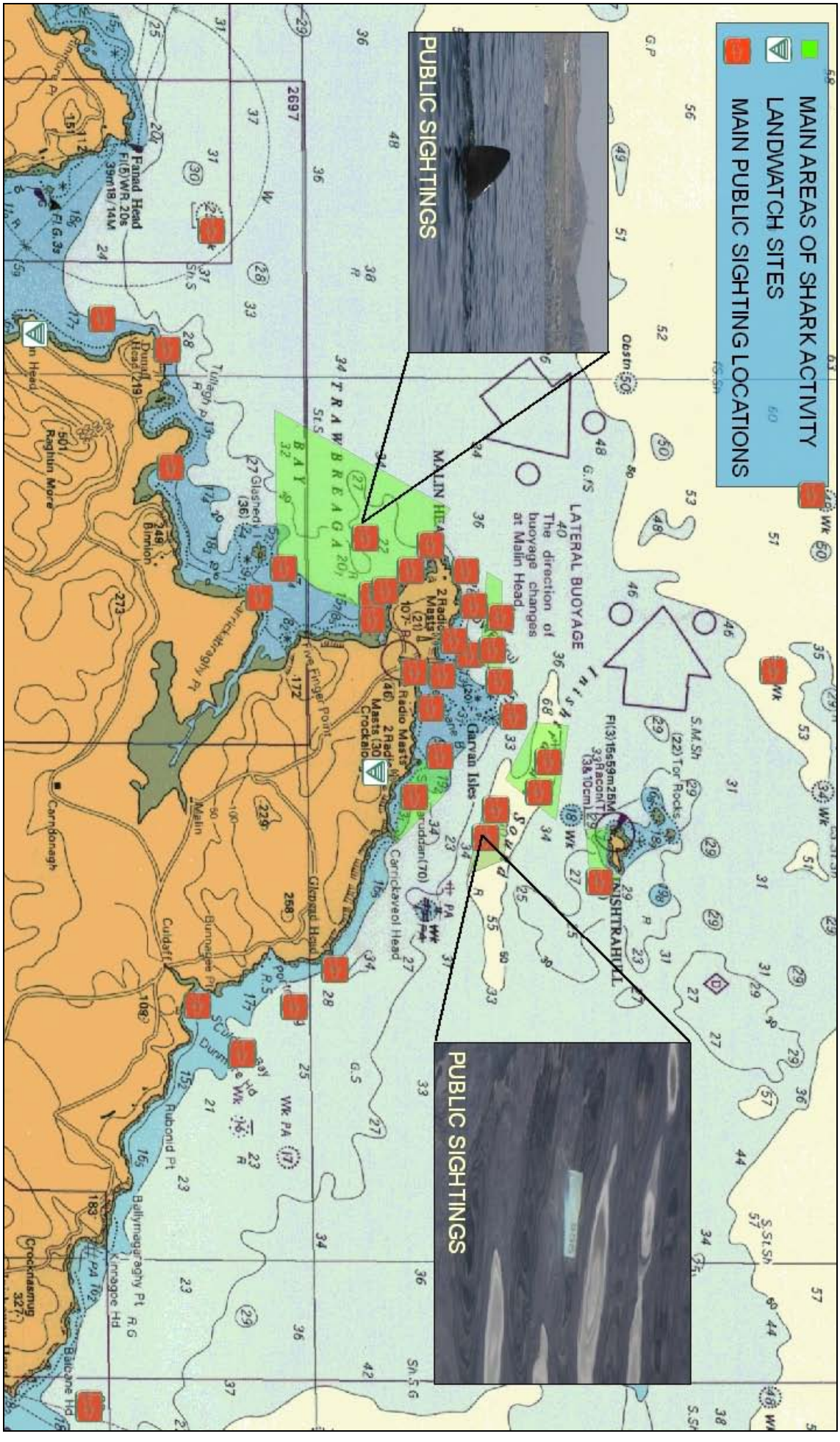

Figure 16 Main Public sightings locations overlaid on main shark activity zones

OUTLINE OF COSTS

Financial information is with the Principal sponsor Inishowen Development Partnership and subject to review before public publication.

CONCLUSION AND RECOMENDATIONS

This project achieved its main aim of linking oceanographic and weather variables to the time basking sharks spend on the surface. It is now possible to predict with a practical degree of confidence the conditions when basking shark sightings are highly probable. Further to this the sustained research programme over the past number of years has highlighted a series of shark 'hotspots' around the coastline of Inishowen. It is now also possible to predict with a degree of probability the conditions during each location is most productive. These 'Hotspots' are illustrated on marine charts as part of the tour operators guidelines which will be made available as a pdf download on www.baskingshark.ie, *see appendix 1*. This is a valuable tool for marine and land based tourism operators who can use the guidelines to understand and predict suitable conditions and locations for basking shark watching throughout Inishowen waters.

Recommendation: Tour Operators Guidelines are provided to both leisure and commercial users.

Potential marine tour operators will need to understand that in depth knowledge of the species and its habits is essential in order to deliver a quality sustainable product to tourists. The Inishowen basking shark study group with its newly established partner Queens University Belfast are gathering that essential information but need further engagement with the coastal community and commercial marine users. Many marine operators are not computer literate and/or aware of the wealth of information available online. The ability to gather locally and disseminate nationwide the information present within the north Inishowen marine community on a daily basis can only be based on an internet portal. Therefore any future training provided for potential marine tour operators should involve IT skills and highlight the importance of reporting their sightings both locally and nationally. Marine focused tourists monitor up to date marine sightings on the IWDG, MCS and IBSSG websites, this information is regularly used to determine their weekend or summer vacation destinations.

Recommendation: Training for Tour Operators should focus on knowledge of the species and the value of IT as a tool for marine tourism product management.

The newly developed website provides a valuable portal for engaging with potential tourists and the local community. It highlights the wealth of marine life found around the coast of Inishowen and illustrates the realistic opportunities that are available to see basking sharks on our coastline. The basking shark is not the only marine mega fauna species found on the coast around Malin head but it is one of the most predictable and numerous. It offers a sense of adventure which attracts high levels of both media and public attention. The research team encountered numerous other species during the survey work including whales, dolphins, porpoise, sunfish and other shark species, *see figure 17*. These species would complement the basking shark tour product, but further research is needed on their habits and movements around the coast. It has been shown in similar locations nationwide that the development of a fledgling 'tourism Industry' based around a specialist subject mater involves focused targeting and development of facilities and knowledge for the specialist community before the general public start to engage. Good examples of this include Arts in Galway and Surfing in Bundoran. Therefore it is necessary to continue to support the positive promotion of the areas marine life through the subject mater discovered by relevant scientific research projects.

Recommendation: The website should be developed and promoted as a tool for Tour Operators to use as a means of locally collating information (sightings) on a daily basis and disseminating that information nationwide as a 'Live' advertisement of the product.

In 2011 reports by fishermen dropped considerably. This could be a reflection of the lower numbers of sharks or a lowering of levels of interest. To get the local community on board the project needs to engage them through more than one method. A proven method of engaging local communities and highlighting local resources to the wider public is through high profile school projects. In 2012 the research team aim to undertake a significant community based shark project involving local schools and the two satellite tags purchased in 2011. This project will engage the students on many levels including bringing applied science to the classroom and facilitating the re-discovery of coastal heritage.

Recommendation: A high profile school based project should be run to encourage the local community to take ownership of the project and the species.

This project established a partnership between a non- governmental conservation group, an internationally renowned marine research team and University Lab as well as a locally focused development organisation. It enabled access to skill sets and a substantial knowledge base which complemented each other in every way. The project continued the positive International promotion and association of Malin head as an internationally significant basking shark hotspot. The 2011 season was not an isolated event but formed an essential step within the IBSSG strategic plan and research programme for Malin head waters. It increased the awareness, appreciation and understanding of Inishowen's and Ireland's most iconic marine species. It recorded essential knowledge for the sustainable management, conservation and development of basking sharks as an eco-tourism product in Inishowen waters. It furthered the group's core value of sustainable management and conservation of the species and the areas marine resources.

Recommendation: The balance between relevant conservation led science or 'product development' and promotional activities should be maintained and reflected in future financial applications.

The involvement of the Inishowen Development Partnership in the 2011 season brought a funding boost to the project and also established the research within the community's psychic as a locally funded and locally driven project. Internationally the scientific research demonstrates the potential that Malin head offers as a study site for marine mega fauna. It highlights the ease and quality of access to what are considered elusive and unpredictable animals. Sharks attract media and public attention. They invoke a sense of adventure that appeals to many individuals who want to experience untamed nature in a wild environment. Malin head offers an easily accessible location with a remote image and pristine natural habitat. It is the ultimate backdrop to the ultimate marine tourist icon. Developing the marine life of Malin head waters into a reliable and sustainable product will take time and considerable financial support. However it should be noted that the most important component in the development of a sustainable marine product at Malin head is the local community. They must engage with any proposals on a level that indicates they not the project organisers or funders claim ownership of the product. The basking shark offers a well established totem project for the development of sustainable marine tourism at Malin head and with the support of all levels of the community it has the potential to establish Malin head as the shark eco-tourism capital of Ireland and Western Europe.

Recommendation: The basking shark should be the totem species for the development of a broader marine tourism product involving all ecological aspects of the Malin head marine environment.

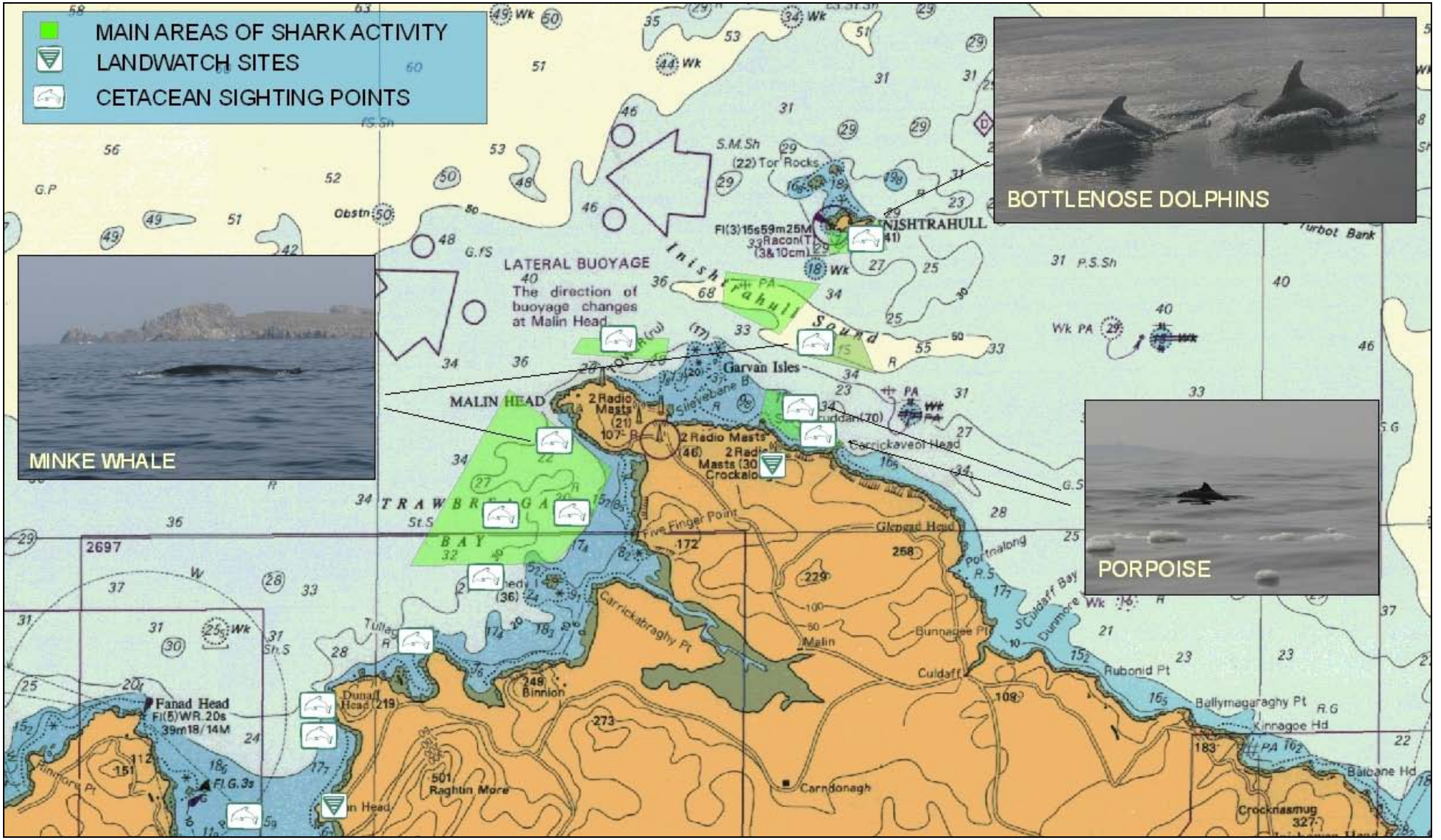

Figure 17: Location of cetacean sightings during dedicated surveys

ACKNOWLEDGEMENTS

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Mark Patterson supported with media content

The local community of Inishowen is the biggest benefactor to the project and as such the project team would like to thank all who contacted us throughout the season with sightings and shark information.

Shark Research Team

Emmett Johnston
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Clare Doherty

Assistants through out the season

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Kevin 'Gerrard' McLoughlin
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Niamh O'Raw
Rosemary McCloskey
Danny McFadden

Appendix One: Visual Tagging

Tag Number	Date	Location	Lat	Long	Time	Size
WHITE						
W451	10-Apr-11	Malin head	55 16.09N	007 32.05W	11:05	6m
W452	10-Apr-11	Malin head	55 21.78N	007 25.17W	12:30	6m -7m
W458	10-Apr-11	Malin head	55 21.82N	007 24.67W	12:45	7m
W459	10-Apr-11	Malin head	55 21.86N	007 24.56W	12:52	6m
W460	10-Apr-11	Malin head	55 22.23N	007 24.47W	13:10	7m
W461 Lost	10-Apr	Malin head	LOST			
W462	10-Apr-11	Malin head	55 22.28N	007 24.21W	13:50	6m
W463	10-Apr-11	Malin head	55 22.30N	007 24.15W	14:15	4m-5m
W464	10-Apr-11	Malin head	55 21.69N	007 23.43W	14:15	7m
W465	10-Apr-11	Malin head	55 21.63N	007 23.37W	14:30	7m
W466	10-Apr-11	Malin head	55 21.68N	007 23.38W	14:35	5m
W467	10-Apr-11	Malin head	55 21.85N	007 23.52W	14:50	8m+
W468	10-Apr-11	Malin head	55 21.86N	007 23.49W	14:52	7m
W469	10-Apr-11	Malin head	55 21.92N	007 23.47W	1453	5m
W470	10-Apr-11	Malin head	55 21.85N	007 23.46W	15:00	7m-8m
W471	10-Apr-11	Malin head	55 21.73N	007 23.43W	15:05	no record
W472	10-Apr-11	Malin head	55 21.65N	007 23.40W	15:14	7m
W473	10-Apr-11	Malin head	55 21.56N	007 23.13W	15:21	8m
W474	10-Apr-11	Malin head	55 21.20N	007 22.73W	15:24	6m
W455	28-Apr-11	Tory Island	55 15.253N	008 13.571W	12:19	5m
W475	28-Apr-11	Tory Island	55 15.275N	008 13.976W	12:38	5m
W476	28-Apr-11	Tory Island	55 15.235N	008 14.051W	12:49	5m
W477	28-Apr-11	Tory Island	55 15.179N	008 13.970W	12:54	5-6m
W478	28-Apr-11	Tory Island	LOST			
W479	28-Apr-11	Tory Island	55 14.663N	008 14.464W	17:33	6m
W480	28-Apr-11	Tory Island	55 15.182N	008 13.923W	13:05	6m
W481	28-Apr-11	Tory Island	55 15.123N	008 13.663W	13:12	6m
W482	28-Apr-11	Tory Island	55 15.072N	008 13.519W	13:19	7m
W483	28-Apr-11	Tory Island	55 14.989N	008 13.256W	13:28	4m
W484	28-Apr-11	Tory Island	55 14.979N	008 13.333W	13:37	6-7m
W485	28-Apr-11	Tory Island	55 14.943N	008 13.731W	13:53	6-7m
RESIGHTING	13-Jul-11	Cliad Bay, Coll, SCOTLAND				
W486	28-Apr-11	Tory Island	55 14.739N	008 13.780W	15:11	7m
W487	28-Apr-11	Tory Island	55 14.693N	008 13.646W	15:15	6m
W488	28-Apr-11	Tory Island	55 14.703N	008 13.726W	15:21	no record
W489	28-Apr-11	Tory Island	55 14.708N	008 13.760W	15:31	8-9m
W490	28-Apr-11	Tory Island	55 14.705N	008 13.803W	15:39	8m
W491	28-Apr-11	Tory Island	55 14.670N	008 13.669W	15:42	8m
W492	28-Apr-11	Tory Island	LOST			
W493	28-Apr-11	Tory Island	55 14.609N	008 13.572W	15:52	5m
W494	28-Apr-11	Tory Island	55 14.577N	008 13.532W	15:55	8m
W495	28-Apr-11	Tory Island	55 14.553N	008 13.502W	15:58	7-8m
W496	28-Apr-11	Tory Island	55 14.574N	008 13.617W	16:20	7-8m
W497	28-Apr-11	Tory Island	55 14.539N	008 13.755W	16:47	7m
W498	28-Apr-11	Tory Island	55 14.567N	008 13.925W	16:52	8m
W499	28-Apr-11	Tory Island	55 14.489N	008 13.808W	17:10	7-8m
W500	28-Apr-11	Tory Island	55 14.618N	008 14.251W	17:20	8-9m

W555	12-Jul-11	Malin head	55 24.426N	007 15.456W	17:46	4-5m
W555	re- sighting Garroch Head (Isle of Bute, Firth of Clyde) on 21st July, scotland					
TDR	recovered	on beach, white strand Northern Ireland				
W456	13-Jul-11	Inishtrahull Island	55 25.672N	007 14.527W	19:07	3-4m
W553	23-Jul-11	Malin head	55 23.559N	007 21.006W	11:15	3-4m
TDR	Recovered 1 august 2011	east of culdaff bay Ballyharry, harry's nose 50m off shore				
W554	23-Jul-11	Malin head - stookrudden	55 22.056N	007 16.704W	13:32	3-4m
TDR	Recovered 2nd august 2011	east of culdaff bay Dunmore hd, port elveret 100m - 200m off shore				
W551	23-Jul-11	Malin head - stookrudden	55 22.153N	007 16.483W	14:28	4m
W552	23-Jul-11	Malin head - stookrudden	55 22.056N	007 16.659W	14:48	4-5m
W557	23-Jul-11	Malin head	55 22.927N	007 23.987W	16:07	8m+
W558	24-Jul-11	Malin head - stookrudden	55 22.192N	007 16.766W	13:44	3-4m
W559	24-Jul-11	Malin head - stookrudden	55 22.240 N	007 16.610W	13:55	4-5m
W560	27-Jul-11	Malin head	55 20.839N	00724.185W	12:48	4-6m
W561	27-Jul-11	Malin head	55 22.886N	007 15.139W	16:28	8+m
W562	27-Jul-11	Malin head	55 22.871N	007 14.945W	16:42	3-4m
W563	27-Jul-11	Malin head	55 22.446N	007 24.239W	19:07	<2m
W564	27-Jul-11	Malin head	55 21.530N	007 23.011W	19:30	3-4m
W565	6th august 2011	Malin head	55 19.739N	007 26.864W	14:05	4m
W566	6th august 2011	Malin head	55 20.310N	007 26.019W	14:21	4m
W567	6th august 2011	Malin head	55 20.371N	007 25.317W	14:43	3-4m
W568	6th august 2011	Malin head	55 20.173N	007 28.251W	16:04	6-8m
W569	6th august 2011	Malin head	55 20.148N	007 28.414W	16:07	6-8m
W572	31st August 2011	Malin head stookaruddan	55 20.141N	007 28.428W	12:40	2m
W570	3nd August 2011	Malin head stookaruddan	55 22.342N	007 17.654W	14:55	2-3m

Appendix Two: Cetacean Sightings

Species	Date	Location	Lat/ Long	Time
Minke Whale	10-Apr-10	Malin head	55 22.17N 007 24.05W	14:10
Porpoise	16-Apr-11	Dunaff hd	55 13.00N 007 33.14W	10:15
Porpoise	20-Apr-11	Dunaff		10:30
Porpoise	20-Apr-11	Trawbreaga bay Glasheedy island		12:00
Porpoise	24-Jun-11		55 16.67N 007 32.12W	11:15
Porpoise	03-Jul-11		55 19.29N 007 28.56W	10:30
Porpoise	13-Jul-11	Dunaff head / Machamish point	55 09.21N 007 31.59W	09:10/21:40
Porpoise	22-Jul-11	Inishtrahull sound		12:00
Minke Whale	23-Jul-11	Inishtrahull sound	55 23.513N 007 15.26W	12:47
Porpoise	23-Jul-11	Stookaruddan	55 22.19N 007 16.39W	14:00
Porpoise	24-Jul-11	Stookaruddan	55 22.19N 007 16.39W	13:50
Porpoise	27th July 2011	Malin head Stookaruddan	55 22.19N 007 16.39W	14:30
Porpoise	27th July 2011	Malin head Stookaruddan	55 22.15N 007 16.345W	16:00
Sun fish	31st August 2011	Stookaruddan	55 22.00N 007 16.015W	14:00

TOUR OPERATOR GUIDELINES