
HWDT Science Report

Silurian Monitoring 2003-2004

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Background

This document summarises the data collected during the surveys carried out from the Silurian during 2003 and 2004. The defined monitoring area ranges from North Mull, out to west of Coll and Tiree and down to the bottom of the Mull of Kintyre, however occasional surveys out of this area have taken place on an opportunistic basis (e.g. bottlenose survey around Skye, military activity surveys and detour to take ID shots of the humpback off SE Skye).

The data is in the process of being analysed as part of my PhD looking at cetacean distribution and modelling relative abundance with topographical and oceanographic variables such as depth, sea temperature, tides, amongst others.

Methods

The surveys are carried out to standard line transect methodology, with protocols as detailed in the appendix. Essentially, visual surveys are carried out in all sea states less than 3.5 unless visibility is particularly bad. Two observers are placed in front of the mast to scan 0-90° either side of the boat for an hour, changing sides halfway through. For each sighting, the species, estimated distance, bearing and heading are recorded along with the group size, cue and behaviour.

One person is responsible for the data entry (this person changes every hour). All sightings data is recorded in the IFAW Logger database, along with boat traffic, environmental conditions (sea state, wave height, swell, visibility, GPS position, boat speed & direction, wind speed & direction, and depth), effort and acoustic data. Every 15 minutes the hydrophone is monitored for a minute, and a recording is made – this involves the engine being put into neutral if under motor. For each listening station, the sound is evaluated for dolphin whistle and clicks, boat noise, remote boat noise (including active fishing gear), snapping shrimp, and water noise on a scale of 0 (quiet) – 5 (loud). During sailing, Logger is set to make 30 second recordings every 2 minutes automatically. The porpoise detector is run continuously throughout the whole survey.

Whenever a sighting is made of a minke whale, bottlenose dolphin, Risso's dolphin, killer whale, humpback, or basking shark, the boat is taken off-effort ('with whales') for photo-ID. At the end of the encounter (generally less than an hour), the boat returns to the track line to continue the survey.

Surveys are generally carried out in all daylight hours, surveying between 8am and 7pm.

Results

Survey track & effort

Visual and acoustic surveys of the Argyll Island area were carried out monthly from April – October 2003 and March – August 2004, porpoise acoustic data have been collected during these surveys since October 2003. In addition, oceanographic data was collected using a SeaBird 19 CTD on loan from UKHO from May 2004. In total, 1258 hours of surveys were carried out (693 in 2003 and 564 in 2004), of which 85% was dedicated monitoring surveys of the Argyll Island area (72% on effort). Non-monitor trip data is mostly from Millport training exercises and the bottlenose survey carried out in 2004.

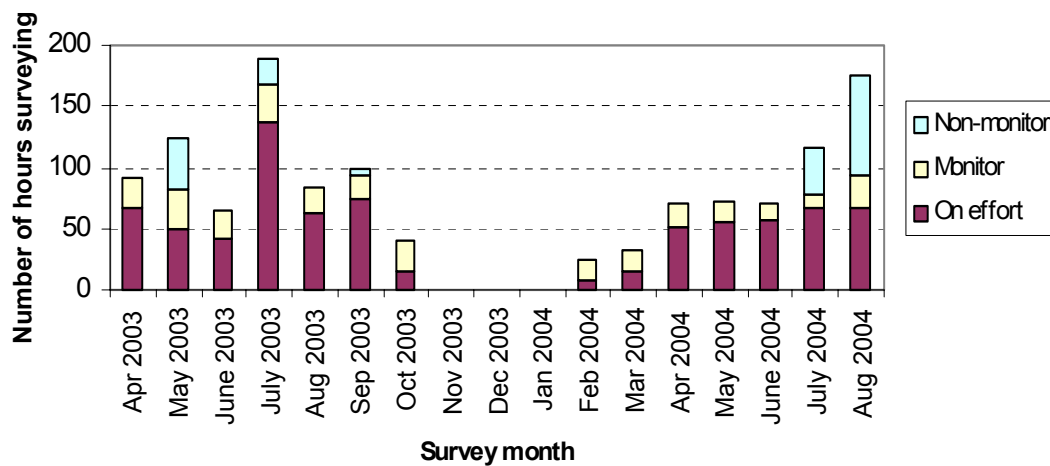


Figure 1 - Distribution of survey effort per month for monitoring & non-monitoring survey data

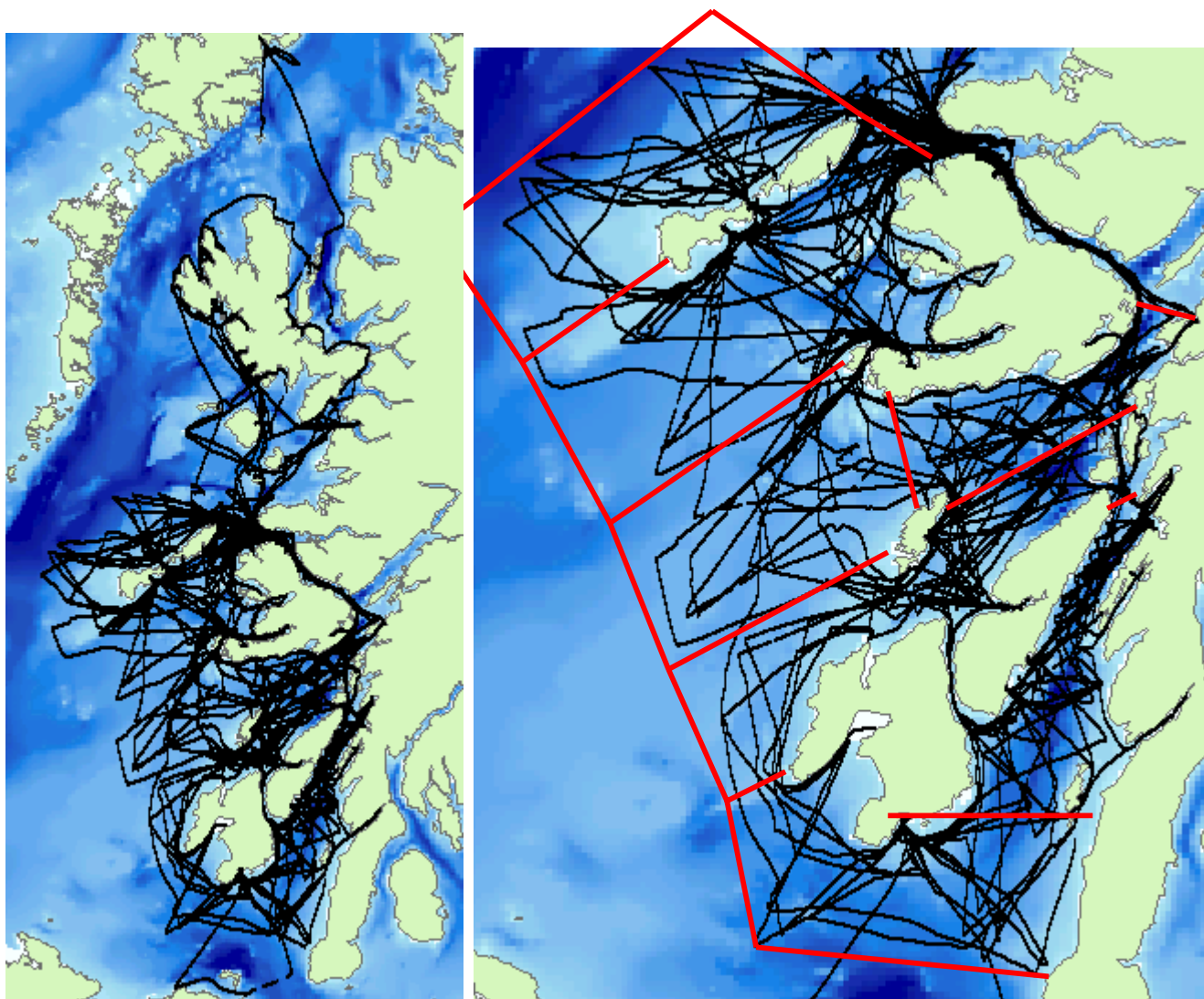


Figure 2 - raw survey tracks for all data collected during 2003/2004 (monitor and non-monitor trips). The red lines show the approximate boundaries of the survey area.

There appears to be reasonable coverage of the majority of the survey area, though the data is sparse in the more offshore regions that are difficult to get to except in good sea & weather conditions. There are some patches of high coverage density around ports and 'bottleneck' passages such as the Sound of Mull, Firth of Lorne and Sound of Jura. Coverage in some passages (such as sound of Mull) could be improved if the central track was varied.

Sea conditions

During the surveys that took place, 70% were in sea states of 3 or lower, and 43% were at sea state 2 or lower. On two occasions, the weather was too poor to conduct the survey at all (first 5 day survey of October 2003, and the 10 day monitor trip in September 2004), and on several occasions poor weather conditions forced the boat to stay in port or reduced the length of the survey day. Offshore monitoring (to the south & west of Isla & Colonsay, and the NW of Coll & Tiree) was only possible in good weather conditions.

Percentage good sea state in each survey month

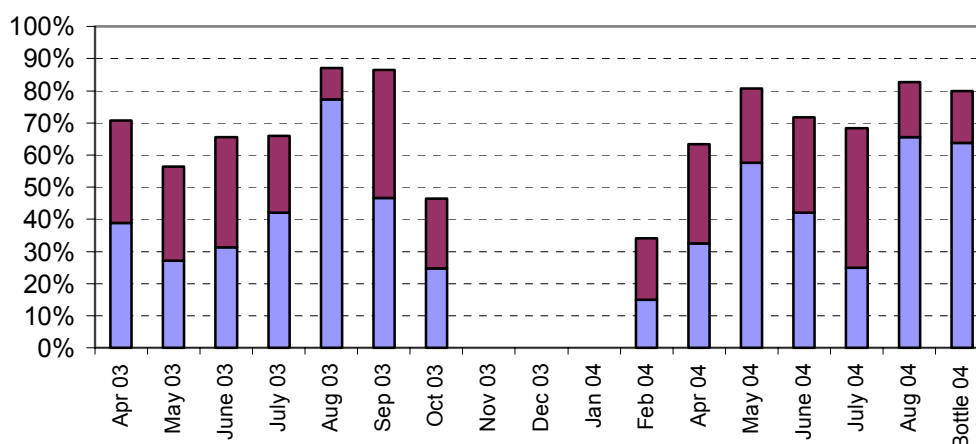


Figure 3 - Percentage 'good' sea state for each month surveyed. Blue = percentage time at sea state ≤ 2 (i.e. good for porpoise sighting), maroon = percentage time at sea state > 2 but ≤ 3 (i.e. good for general cetacean sighting).

Visual surveys

In total over the two years of data collection (excluding the dedicated bottlenose survey data), there were 603 recorded sightings of cetaceans & basking sharks (1082 individuals) of which around half were on-effort sightings. Table 1 shows the breakdown of the main species over the two years, in addition to which there were individual sightings of a white-beaked dolphin in July 2003, and sightings of a group of orca in May 2004, and a juvenile humpback in August 2004.

	2003		2004	
	All sightings	On effort	All sightings	On effort
Harbour porpoise	249 (179)	122 (96)	135	90
Minke	73 (50)	28 (22)	39	17
Bottlenose dolphin	8 (8)	5 (5)	5	2
Risso's dolphin	14 (8)	9 (7)	1	1
Common dolphin	4 (4)	1 (1)	0	0
(Basking shark)	50 (44)	32 (31)	22	6

Table 1 - Numbers of sightings of the most common species found in the HWDT survey areas for 2003 & 2004. Numbers in brackets exclude the data collected in September & October 2003.

Interestingly there were fewer sightings of all species in 2004 than in 2003, although some of this difference may be explained by the lack of sampling in September and October 2004.

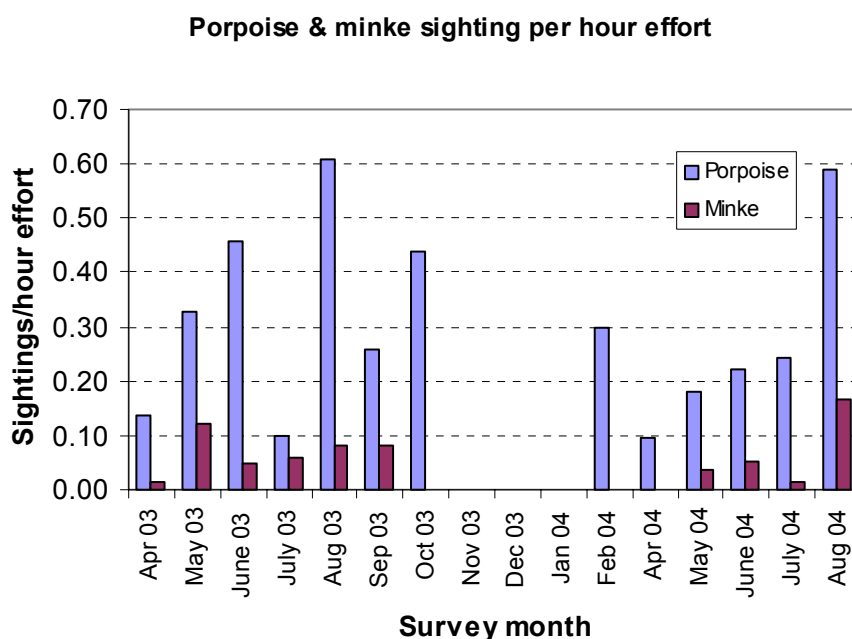


Figure 4 - Monthly sightings/hour effort for harbour porpoises and minke whales during 2003 & 2004 (excluding the data from the bottlenose survey in August 2004). Excludes all sightings made off-effort.

The variation of harbour porpoise and minke sightings over the survey period from April 2003 to August 2004 is shown in figure 3. The highest sighting rates of porpoises were made in August of both years, and there appears to be a general trend of increasing sighting rates from April to August. There was a surprisingly low detection rate of porpoises in July 2003.

The distribution of the main species for all surveys is shown in figure 5. There does appear to be some seasonal variation in distribution throughout the season, especially with minke whales (highest numbers May-December), and basking sharks (only present in the summer months, and highly concentrated around Coll & Tiree). All bottlenose sightings have been coastal.

Acoustic (porpoise) surveys

Since October 2003, the surveys have incorporated automatic detection of harbour porpoise vocalisations. So far only 3 months of porpoise data have been analysed, however there is a much higher detection rate of porpoises acoustically than visually in all the months surveyed so far. In fact, in October 2003 there was a sightings rate of only 0.6 porpoises/hour effort, but the passive acoustic detection rate was 5.0 porpoises/hour – an 8-fold increase in detection rate. An example survey is shown in figure 6.

Oceanographic Sampling

CTD casts (which measure the salinity & temperature through the water column) were taken at regular intervals during surveys from May 2004 whenever the weather conditions were calm enough and the Silurian was not under sail (the boat had to be stationary in the water to lower the CTD). In total 55 casts were taken throughout the Argyll island waters, and the temperature and salinity profiles are being analysed by Phil Gillibrand at SAMS.

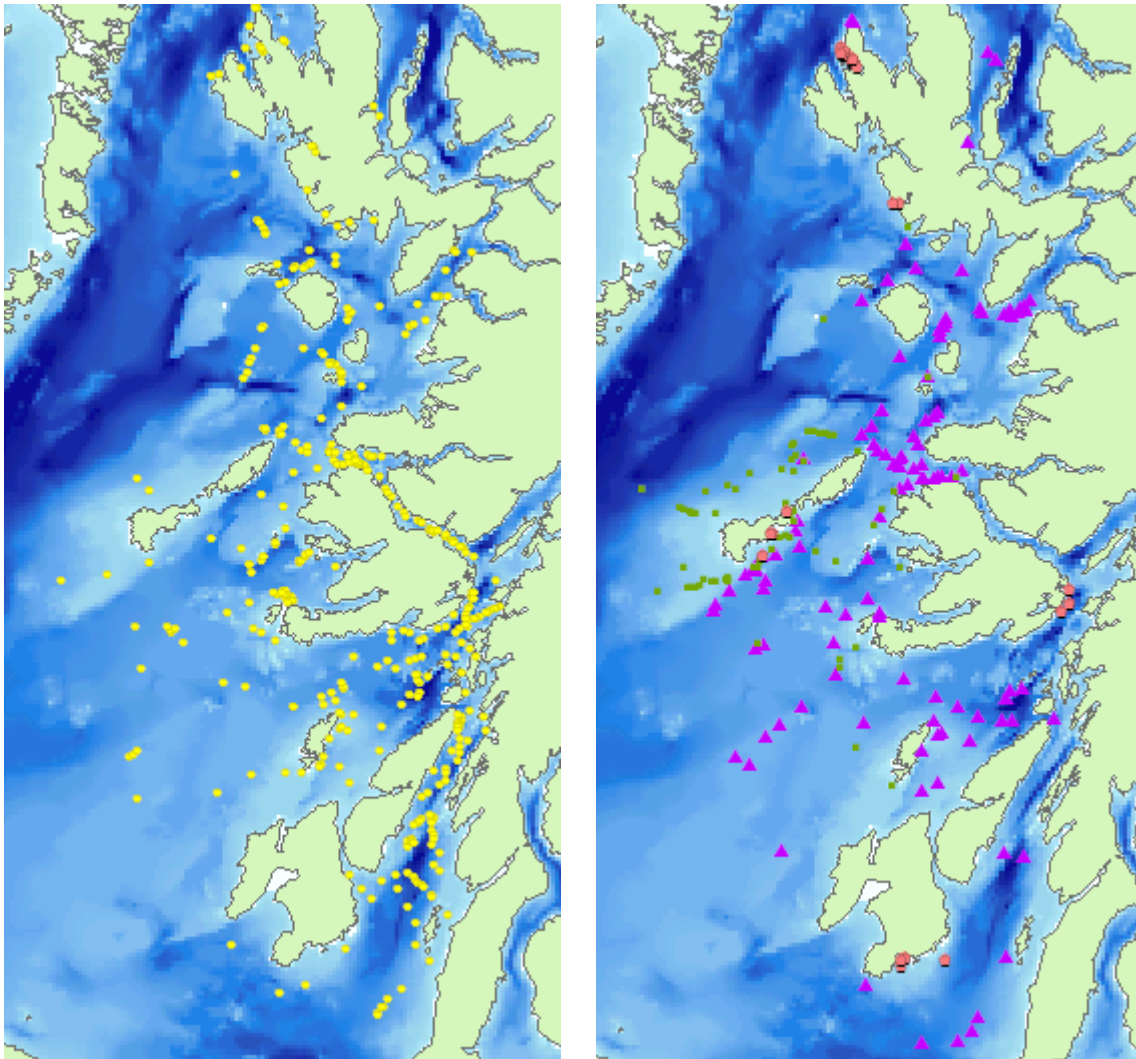


Figure 5 - Distribution of sightings for harbour porpoises (yellow dots), minke whales (purple triangles), bottlenose dolphins (red circles) and basking sharks (green dots) for 2003 & 2004.

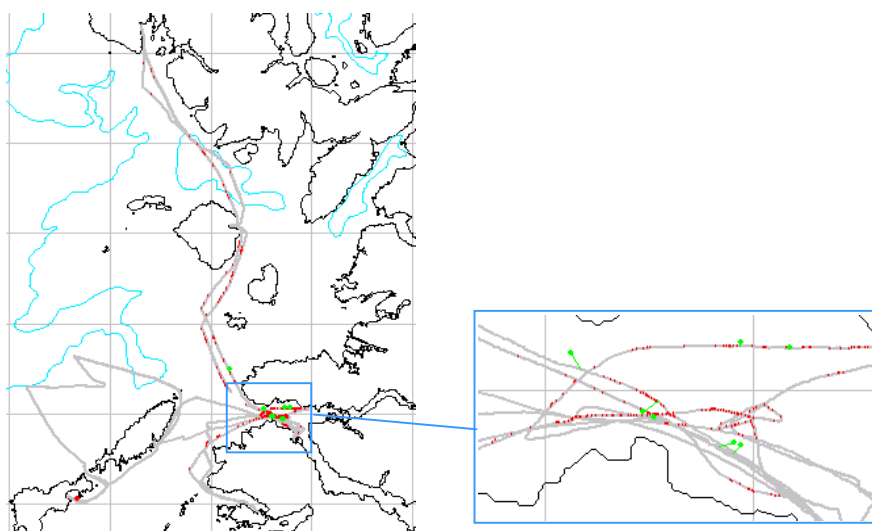


Figure 6 - Track with sightings (green = porpoise sighting) and acoustic detections (red) for the Feb/March 2004 survey.

Recommendations for future surveys

Survey track & area

Generally coverage of the survey is reasonable (as can be seen from figure 1), although coverage varies from month to month, generally dependent on weather conditions. The full survey area originally suggested is not being covered adequately; in particular waters to the west of Islay and Coll/Tiree. Density of coverage around ports and in areas such as the Sound of Mull and upper part of the Sound of Jura is very high.

Suggestions:

- Reduce the core survey area so that there is a greater chance of ensuring coverage of the whole area each month
- We should consider whether to keep more offshore waters in our survey area albeit with a lower survey effort and whether to prioritise these areas when weather conditions are favourable.
- Try to ensure even coverage over the whole area each month (wherever possible).
- Use Distance to help design survey tracks – as originally anticipated – or devise rules to allow more even survey tracks to be determined.
- ...if there are two surveys a month – why not make one concentrated on the usual survey area, and use the other to survey the productive waters around the Small Isles and south of Skye?
- Beyond 2005 should survey goals change to focus on identifying “hot spots”, testing models of distribution, obtaining a consistent long-term data set?

Methods

Distance and bearing to groups is recorded for every sighting. Bearing was originally recorded with sighting binoculars but an angle board is now used which has reduced rounding errors. These rounding errors arise because it is difficult to take a precise bearing from a compass that is moving due to the motion of the boat. Using an angle board also makes it easier to determine perpendicular distance from the trackline to the boat for standard line-transect calculations. However, distance estimation remains a difficult task, especially for volunteers who have had no experience of cetacean monitoring in the past.

In addition, the use of ‘half’ sea states has not been used evenly, as shown in the histograms shown in figure 7.

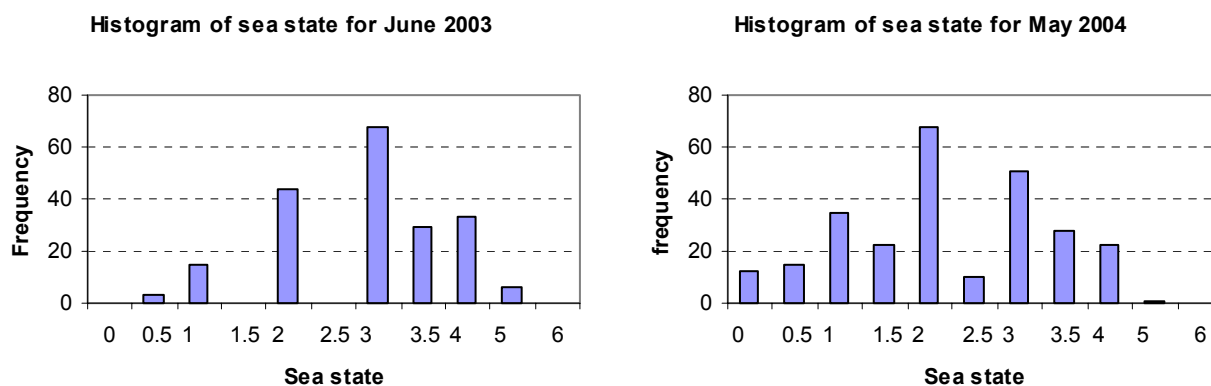


Figure 7 - Distribution of sea state records for June 2003 and May 2004, where the 'half' sea states are either lacking or recorded in much lower numbers than expected.

With respect to data recording, there are few noticeable errors (was a group of 17 porpoises really seen in September 2003 or was this a data-entry error?!), although it is difficult to determine data-entry errors. The most obvious data-entry problem was during the bottlenose survey when the same group of dolphins was followed, yet recorded in the database as separate sightings (i.e. 350 dolphins instead of only 25). It should be ensured that each sighting is a new animal wherever possible, or it could introduce significant errors into the analysis. Checking the database for errors at the end of each day may reduce some of this error.

At the moment survey effort is recorded per 'area', transects being defined as the period during that day in an area, and a new transect being recorded every time a new area is entered. This is difficult in practice to achieve, and is not necessary for the data analysis. It would be better for analysis purposes if a transect was recorded as being the period of time going in a single direction, and record a start and end of transect every time that the boat turns (makes it a lot easier to analyse for me).

Otherwise, effort was recorded well – although special care should be taken to ensure that whenever there is a person on the mast for visual surveying, it is recorded, and changed immediately after they come off the mast. Also, any sightings made by the mast observer rather than the deck observer should be recorded as such.

It would be useful to have more comprehensive comments noting the type of survey being carried out, and any reasons for finishing a survey early (or starting late).

Suggestions:

- Introduce alternative methods for training volunteers in distance estimation & test volunteers throughout monitoring trips (e.g. towing buoys behind the boat at set distances).
- Continue to use angle board – ensure that all on-effort sightings use the angle board for bearing estimation (with no rounding).
- Either abandon 'half' sea states, or make the definitions clearer so that the core crew members are able to correctly classify all categories.
- Ensure the same animals are only recorded once wherever possible (add comment if unsure if it's a different animal/group). This can be done by

adding a field to the sightings form to indicate whether sighting is a primary or secondary sighting

- Mark 'start transect' and 'end transect' at the beginning and end of each period that the boat is travelling in a single direction (i.e. every time the boat turns).
- Ensure effort on the mast is recorded accurately, and all sightings made by the mast observer are marked as such (add a field to the sightings form).
- Ensure all off-effort sightings in the observers search area are not shouted out. If animals are recorded as off-effort and subsequently seen by the on-effort observers while the animals are still in the observers area, the database entry should be changed to record the on-effort data (rather than have two entries).
- Add comments to explain days surveying (standard monitoring survey or not), and reasons for starting the survey late or ending it early.
- At the end of each day, the logger data should be checked for errors – things to be aware of include missing bearing or heading data, rounded angles, over-accurate distances (in a few early surveys there were some estimated distances of 1007m, 502m etc. – it's fine to round distances as they are difficult to estimate). Species should only ever be recorded if there was a positive ID, otherwise they should be logged as Unknown (or record to the closest group, e.g. whale, dolphin, seal)
- Data validation software are being developed as part of SCANS. It may be possible to adapt this software to assist with HWDT surveys.
- To consider and discuss. How should survey be conducted in the future. As models for distributions and densities are developed should some survey effort be expended to test these and to confirm "hot spots".

Acoustics

The hydrophone systems have worked well during the last 2 seasons. However, there are a few improvements that are required to ensure better data collection:

- Noise problems – the electrical noise from the fuel pump when the generator was on was so severe that it completely hampered either porpoise or dolphin acoustic detection. This needs to be fixed as the acoustics is able to provide much better porpoise distribution and density data than the visual surveys.
- Tow the hydrophone and continuously run the porpoise detector during all voyages including the education trips. If none of the science officers are able to be on board, then one of the crew members should be trained in deploying and operating the equipment to allow data collection. There was no porpoise monitoring during any education trips in 2003 and 2004, which is a huge lost opportunity.
- Make calibrated recordings whenever acoustic deterrent devices (ADDs) on fish farms are heard (train crew).
- A new porpoise detection system is being developed for SCANS by Doug Gillespie. It would be useful for HWDT and SCANS to have the new system running alongside the old one on the Silurian in 2005. This will require the

boat to tow two hydrophones and may involve a second more powerful computer.

Appendix. Original Research Plans and Protocols for Silurian

SILURIAN SURVEY OUTLINE

In this first year, the main objectives of the research conducted from the Silurian are to:

- 1) **Achieve a broad survey coverage of the Marine Outreach Project area. This will enable us to identify key cetacean “hotspots” (i.e. areas of high relative abundance) for different species.**
- 2) **In the long term, to investigate temporal variation of these distributions both on a seasonal basis and from year to year.**

The survey area will range from North Mull, out to West of Coll and Tiree and down to the bottom of Mull of Kintyre. [The survey area has been split into six blocks. Within each survey period we will aim to achieve an even coverage in each of the six blocks.](#) In order to fulfill both the education and survey requirements of the project dedicated time periods will be allocated to each. The current suggested time block is two weeks.

Standard survey protocols from Silurian will involve a combination of visual, photo-ID and acoustic studies. These will be carried out simultaneously.

1) Visual Surveys.

Depending on weather conditions different types of visual surveys will be employed.

- a) In sea states up to 3.5, dedicated transect surveys will be carried out within survey blocks. During these surveys the staysail and yankee sails will not be used to maintain a full field of view.
 - b) Above sea state 3.5, surveys in more sheltered coastal areas will be carried out.
- a) **Transect Surveys.**
- Using a GIS package developed by St Andrews University a survey route for each area will be defined to ensure an even coverage. Survey route will be followed, as far as possible, at a constant speed (approx 6 knots) on a 24 hour basis.
 - During daylight hours visual surveys will require an observer team of at least 5 will be required. Two ‘on effort’ observers will be positioned in front of the main mast. Assuming 0° is the bow of the boat the deck observers will be scanning arcs -90° to 0° and 0° to +90° respectively. Whenever possible another on effort observer will be positioned in the crow’s nest and scanning an arc from -45° to +45°. All observers will be using naked eye to scan, using binoculars to verify sighting.
 - ALL OTHER PEOPLE ON DECK MUST REFRAIN FROM CALLING A SIGHTING UNLESS IT IS PAST THE BEAM OF THE BOAT.
 - When a sighting is made the observer must record the following information. 1, Estimated distance (m) to animal. 2, Magnetic bearing to animal, and can be read from reticule in binoculars. 3, Magnetic bearing of animal’s direction, this can be read through facing the direction of travel of animal and reading bearing from reticule. These readings must be as exact as possible and avoid rounding to the nearest 0 or 5.

- Only those sightings made by an 'on effort' observer will be recorded as on effort sightings. Sightings made by other people or past the beam of the boat will be recorded as an off effort sighting.
- There will also be a data recorder who will input data into LOGGER and monitor the hydrophone. Information on environmental conditions will be regularly entered onto LOGGER every time there is an observer change or when conditions change. Details of survey effort will be entered as they change. LOGGER will still run when off effort so that any off effort sightings can also be logged.
- Depending on weather conditions these tasks will be rotated on an hourly or half hourly basis.
- These protocols will also be employed when on passage and conditions permit.

These data can be analysed to investigate relative abundance: the density of sightings in an area relative to the amount of effort (miles traveled/observation time).

b) Coastal Surveys

- When sea state is above 3.5 surveys running parallel to protected coastlines, or within lochs will be undertaken.
 - Silurian will travel 500m (??) from coast. A minimum of two observers on deck both facing towards to coast will scan using naked eye.
 - Environmental data and acoustic monitoring will carried out above.
- (The primary purpose of these surveys is to find bottlenose dolphins for photo-id studies.)

c) Acoustic Surveys

- Complement visual surveys. Acoustic studies can be carried out in poor weather conditions and on a 24 hour basis when it is not possible to conduct visual observations.
- [Acoustic methods can be used to determine porpoise density estimates. This is a priority for any future research proposals and will require the acquisition of approx £4000 of equipment.](#)

2) Acoustic Studies

The initial objectives of the acoustic studies are to:

- obtain a collection of vocalisations for a range of species, for reference, to allow species identification and for educational purposes.
- Obtain signature whistles from identified bottlenose dolphin groups.
- Investigate man made noise sources e.g acoustic devices on fish farms.
-

Currently Silurian has a stereo hydrophone with 75m of cable. Acoustic surveys can be carried out during Silurian daily surveys. The most suitable species are bottlenose dolphins, common dolphins, Risso's dolphins and white beaked dolphins. During acoustic surveys, the hydrophone will be towed from the aft of the boat. The hydrophone will be monitored carefully for 1 minute every 15 minutes and a 1 minute recording will be made. The boat should be slowed, and if the engine is on, should be put out of gear to minimize background noise when monitoring. These recordings will be saved and accompanying data entered into LOGGER. If vocalizing animals are encountered longer recordings may be made. Programs such as Whistle and Rainbow click will be used to obtain bearings to acoustic detections so that the animals can be closed with and identified.

Since this was written SMRU provided a 100m hydrophone with both audioban and porpoise hydrophones and porpoise detection equipment.

A training tape will be used to familiarise researchers with species vocalizations

3) Photo-identification Studies.

Some cetaceans can be recognized by dorsal fin shape, coloration and other distinguishing marks such as scars and fin nicks. This information can provide information on site residency and fidelity and range of individuals. Photo-identification can also provide other valuable insights into the conservation status of the studied population.

- incidences of scarring caused by fisheries entanglement;
- marine litter entanglement; predators (sharks/orcas);
- boat strikes;
- prevalence of skin disease and ectoparasites and

A substantial amount of Photo-ID work has already been conducted and includes:

- **10 years of minke whale data collected/maintained by Sea Life Surveys and HWDT jointly.**
- **New bottlenose dolphin catalogue initiated in 2001 as part of HWDT Bottlenose Dolphin Project.**
- **Data collected on Russo's dolphin by Alison Gill.**
- **Sea Watch Foundation also has data from Northern Hebrides.**

Photo-ID studies from Silurian will build on and compliment these existing datasets. Studies will be carried out on an opportunistic basis during Silurian daily surveys and will target the following species:

- **Bottlenose dolphins**
- **Killer whales**
- **Basking sharks**
- **Minke whales**
- **Risso's dolphins**

Some HWDT staff have received training in Photo-ID techniques and care and maintenance of cameras. Photo-ID pictures will only be taken by experienced researchers. The basic methods that will be employed include:

- Efforts should be made to photograph **every individual** in a group.
- If possible photographs should be taken of **both sides** of the dorsal fin.
- In addition to photographing the dorsal fin the animal may also have scars/markings that make it identifiable on other parts of its body.
- The HWDT camera cannot be set to record time and date on each frame. **It may be worth investigating in a data back for the camera.** These data will therefore be collected after each encounter. A form will be completed to record the number of frames/films taken for each group, with details on time/date/position/estimated number of animals in a group. If every individual in a group was not photographed, this should be noted. If possible the number not photographed should be determined All completed films should be carefully labeled with the time/date and sightings/encounter number.
- It is advisable to take a separating shot between each encounter. Will be used to record date, time and position on a white board.

In the rare event of a **humpback whale** or **sperm whale** sighting efforts should be made to photograph the flukes of the whale in addition to the dorsal fin. These pictures can be examined against Photo-ID catalogues produced for the North Atlantic by other organisations. All Photo-ID events will be recorded and slide/photos will be catalogued and stored appropriately.

Results of these studies will be catalogued and analysed in a variety of ways:

- **All images will be retained by HWDT.**
- **All minke ID shots will be analysed by Alison Gill in conjunction with Sea Life Surveys data. This will be maintained and updated on an annual basis.**
- **All bottlenose shots will be analysed by Phil Johnston and contribute to the HWDT Bottlenose Dolphin project (any chance of SLS also contributing to this?)**
- **Basking shark images will be contributed to the Shark Trust catalogue.**
- **All images of other species will be catalogued by HWDT.**

HWDT is very keen to actively contribute to the Sea Watch coordinated Europhlukes project. Europhlukes is a repository for all European Photo-ID catalogues and cover a range of species.

4) **Opportunistic Data Collection**

- **Strandings data** - in line with standard protocols.
- **Collection of fish scales to establish diet of minke whales** - This maybe a project that Sea Life Surveys are leading. HWDT would be happy to contribute samples.
- **Collection of whale faeces.** In conjunction with Nick Gales.
- **Marine debris** – During surveys all sightings of marine debris will be recorded on LOGGER. **Did we decide exactly how? If we don't do this consistently its not worth doing.** In collaboration with MCS, HWDT could facilitate beach cleans.
- **Marine Usage Surveys.** Using LOGGER all types of boat activity during passages will be recorded. Any boat will be logged as a sighting as it comes abeam of the boat up to 3km away. It will be the person on watch's responsibility to notify data collector of this. If a boat range is borderline it can be checked using the radar. **Boat ranges should be measured by the radar anyway.**
-