WHALE DEPREDATION

DATA COLLECTION GUIDELINES

Vol 1.

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INTRODUCTION

Marine mammal interactions with fisheries are a growing major world-wide issue with both substantial ecological and economic consequences. Most longline fisheries operating around the world, including many toothfish fisheries in the Southern Ocean, are seriously affected by these interactions i.e. marine mammals eating fish directly from fishing gear, known as "depredation", causing losses of tens of millions dollars to the fishing industry annually (Tixier et al. 2010). s. Depredation can also have negative impacts on the conservation of recovering marine mammal populations as a result of incidental bycatch, lethal responses from illegal fishers, and increased dependence through artificial food provisioning. Finally, depredation can affect the management of fisheries and the fish stock assessment if depredated fish are disregarded when defining quotas. Stocks that have also been under pressure from illegal fishing activity are even more so sensitive to the effects of depredation. Most depredation activity in the Southern Ocean is due to interactions with odontocetes (toothed whales), specifically sperm whales and killer whales.

To begin addressing these issues globally, the first international workshop dedicated to odontocete depredation on demersal longlines operating in high latitudes was organised by the Coalition of Legal Toothfish Operators (COLTO) in Punta Arenas, March 2016. This workshop emphasised the urgent need to find global solutions to this issue. The Patagonian toothfish (*Dissostichus eleginoides*) fisheries, which are operated in Australian, French, SG&SSI, Argentinian, Chilean, South African and international waters of the Southern Ocean, experience either well-established or increasing depredation by killer whales (*Orcinus orca*) and/or sperm whales (*Physeter macrocephalus*). However, the state of local knowledge about, and efforts and means to reduce depredation varies substantially between these fisheries. As was discussed at the workshop, in several fisheries the potential or suspected increase of depredation paired with a lack of research effort could lead towards a threat to the fisheries' economic viability, and further have affect the targeted fish stocks and depredating marine mammal populations if mitigation solutions are not found in the near future.

The workshop concluded that routine data collection framework across fisheries confronted with interactions with odontocetes is important for a better understanding of depredation and for solutions to be developed, both locally and globally.

Using the COLTO workshop as an excellent example of international science, industry, government and NGO collaboration, this resulting document aims to provide basic guidelines for observer programmes that are relatively new to dealing with marine mammal interactions or are interested in expanding their observation efforts. It is based on ten years of experience around the islands of Kerguelen and Crozet (Southern Indian Ocean), mainly with sperm whales and killer whales interacting with the longline fishery targeting Patagonian toothfish in this region. In this fishery seven vessels operate all year round using only automatic (weight integrated) bottom longlines. The fishery has had 100% observer coverage for the last 15 years. Data on interactions with marine mammals has been collected for 60,000 fishing events and more than 100,000 pictures of odontocetes have been taken for photo-identification purposes.

1.DATA COLLECTION

1.1. INTRODUCTION

In the process from establishing whether a depredation problem exists to mitigation and understanding of wider ecosystem effects, there are several levels of data collection and knowledge, with each step appropriate to address different kinds of questions. In some fisheries there is no information at all available on the magnitude and extent of the depredation problem other than verbatim reports from fishers and operators, while other fisheries have spent substantial time and resources in describing, assessing, mitigating and managing this issue. This volume provides guidance on what data collection efforts are appropriate to answer which kinds of questions.

This chapter describes the data collection used on a routine basis with 100% coverage of the fishery by independent observers in the French EEZ around Crozet and Kerguelen Islands. Here, every haul is observed for odontocetes even one longline is hauled in two sections - data are collected for each of these sections. Within CCAMLR a minimum of 25% of lines are observed including mammal interactions, but in many cases mammal interactions are observed 100% voluntarily. In the French EEZ longlines are set only at night so observations are only possible during hauling.

Basic data collection for each haul includes:

- Date and time, latitude and longitude and depth for setting and hauling, start and end
- Catches by species, number and weight

1.1.1 Practical example

The section below (Table 1) shows an example from the French observer programme and the tables and fields they are asked to fill out as part of their observation duties.

Table 1 - example of data collection

	latitude		longitude		depth	latitude		longitude		depth	hooks	toothfish		grenadier	
longline	°	min	°	min		°	min	°	min			number	kg	number	kg
1	47	05,23	69	08,03	1 316	47	09,90	69	14,86	1 032	10 000	162	342	411	1 191
2	46	44,35	68	49,42	911	46	51,66	68	58,24	823	10 000	193	1 375	412	983
3	46	26,16	68	14,27	1 046	46	27,33	68	19,48	1 171	10 000	340	1 754	283	650
4	46	22,41	67	46,36	1 316	46	31,75	67	48,03	860	10 000	240	1 852	458	1 120
5	46	37,40	67	10,18	796	46	40,36	67	17,07	689	10 000	308	2 743	394	956
6	47	00,94	66	51,57	817	47	06,26	66	55,93	1 166	10 000	471	2 601	67	136
7	47	30,38	66	42,78	1 359	47	33,15	66	52,43	1 197	10 000	160	1 393	285	905
8	48	03,02	66	44,33	861	48	04,93	66	47,14	1 433	10 000	171	1 115	155	567
9	48	36,74	66	50,02	1 222	48	46,47	66	53,03	843	10 000	628	2 566	132	341
10	49	10,45	67	01,39	918	49	16,62	67	09,64	1 421	10 000	298	2 496	612	1 421
11	49	47,38	67	21,55	956	49	50,31	67	29,81	939	10 000	71	432	142	299
12	50	28,05	67	59,80	1 283	50	30,05	67	59,00	1 226	10 000	250	1 482	246	868
13	51	03,90	68	44,25	1 016	51	04,13	68	46,58	1 147	10 000	651	1 797	144	562
14	51	27,99	69	05,96	1 296	51	33,92	69	12,14	965	10 000	164	396	377	987
15	51	19,42	69	26,64	1 460	51	23,74	69	26,75	1 004	10 000	631	1 809	159	604
16	50	54,81	69	57,14	510	50	61,13	69	59,00	640	10 000	103	673	395	843
17	50	30,72	70	21,43	731	50	31,33	70	27,95	1 001	10 000	397	1 318	639	1 295
18	50	09,32	70	42,11	1 022	50	18,83	70	43,06	1 412	10 000	109	852	522	1 394
19	49	41,49	71	10,02	1 205	49	43,74	71	17,47	663	10 000	125	696	234	825
20	49	00,60	71	33,12	626	49	10,10	71	37,26	1 287	10 000	518	2 593	413	1 357
21	48	27,64	71	49,82	1 311	48	28,45	71	56,32	1 055	10 000	104	994	71	221
22	47	55,53	71	56,02	945	47	59,12	71	58,86	598	10 000	63	271	35	108
23	47	17,53	71	58,61	1 397	47	18,53	71	59,00	601	10 000	1 027	2 596	6	20
24	46	50,24	71	47,75	1 252	46	59,00	71	55,21	815	10 000	115	795	209	537
25	46	28,30	71	23,98	1 181	46	34,52	71	32,12	751	10 000	125	322	195	753
26	46	14,92	70	48,31	741	46	22,68	70	54,13	765	10 000	14	36	256	518
27	46	19,74	70	19,88	756	46	25,35	70	24,69	1 215	10 000	867	2 003	438	1 036
28	46	29,37	69	53,52	1 223	46	30,62	69	59,00	1 231	10 000	309	2 449	173	469
29	46	42,21	69	31,81	1 001	46	47,79	69	41,06	1 295	10 000	43	362	325	932
30	47	12,72	69	14,23	655	47	16,82	69	19,75	501	10 000	179	1 127	72	284

For each haul and each species of sighted odontocetes, specific data collection includes four main fields:

- presence/absence data;
- number of individuals;
- interaction with fishing gear;
- photo-identification;

and four additional fields:

- Estimated Time of Arrival (ETA);
- Number of magazines with presence;
- Interaction between killer whales and sperm whales;
- Comments.

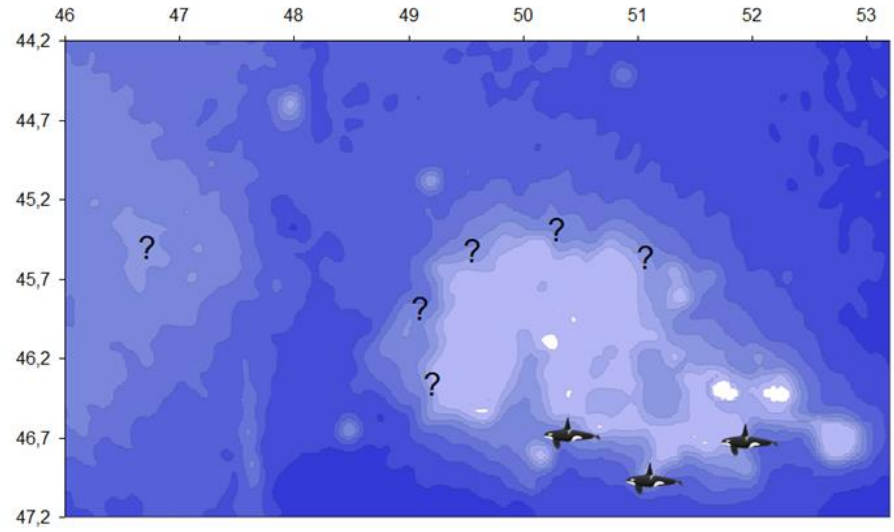
Sections 1.2 - will go through these field in detail below.

1.2. PRESENCE/ABSENCE DATA

1.2.1. Aims and Use

Presence only data provides information on where mammals were sighted, but not where they were not sighted.

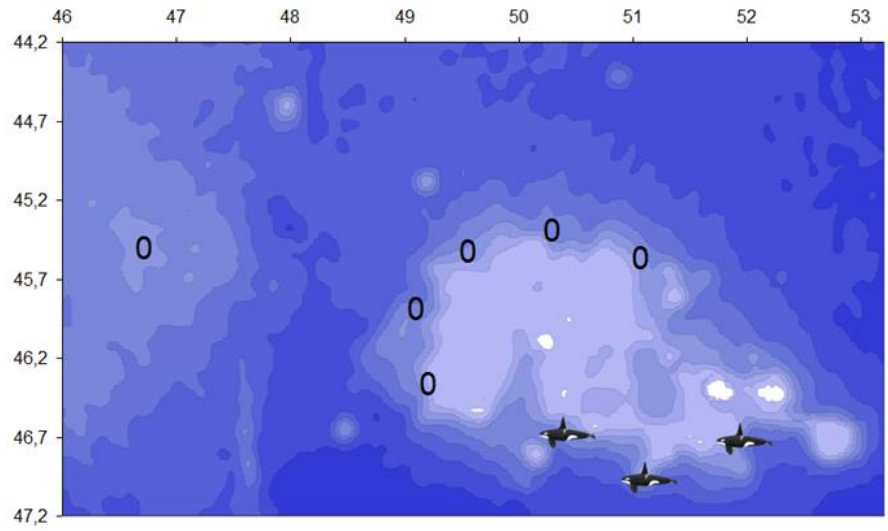
longline	killer whale
1	present
2	
3	
4	
5	present
6	
7	



Location of whales is known, but location of whale absences is not known.

Presence-absence data takes presence-only observations one step further and provide crucial information on where mammals are not observed as well as where they are observed. This is the minimum requirement for assessing whether depredation is occurring to any noticeable level and to make observations on spatial distributions and patterns. Presence-absence data, collected continuously over time, enables to gain a rough estimate of presence/absence trends over time as well as spatially.

longline	killer whale
1	present
2	absent
3	absent
4	absent
5	present
6	absent
7	absent



1.2.2. Description

Variable type	Drop down menu	comment
String (letters)	Presence Absence Not observed	Has to be one of the 3 options, cannot be left blank

Requirement: data must be collected for every haul.

This field is mandatory and the observer must enter one of three choices. These three different cases are:

Presence / absence / not observed.

"Presence": Favourable conditions (visibility is at least several hundred meters with sufficient light) and observation by the observer (observer can be alerted by the crew when whales are sighted). The presence of whales is confirmed by direct observation of at least one individual at the surface in the vicinity of the vessel at least once during 1 haul. Note that presence can also be observed at night when killer whales come very close to the boat.

"Absence": Favourable conditions and no odontocete spotted at any time during the entire haul.

"Not observed" is used either if the observer did not have time to gather information (e.g. if line broke), or if conditions are too bad to observe (either weather conditions, or hauling at night).

Using this system allows to use collected data for presence/absence even if the observer did not record any numbers. The other advantage of this field is to remove empty fields that are

always difficult to interpret as they can be either line observations without any odontocetes, or not observed at all, which is a common confusion for observers at sea.

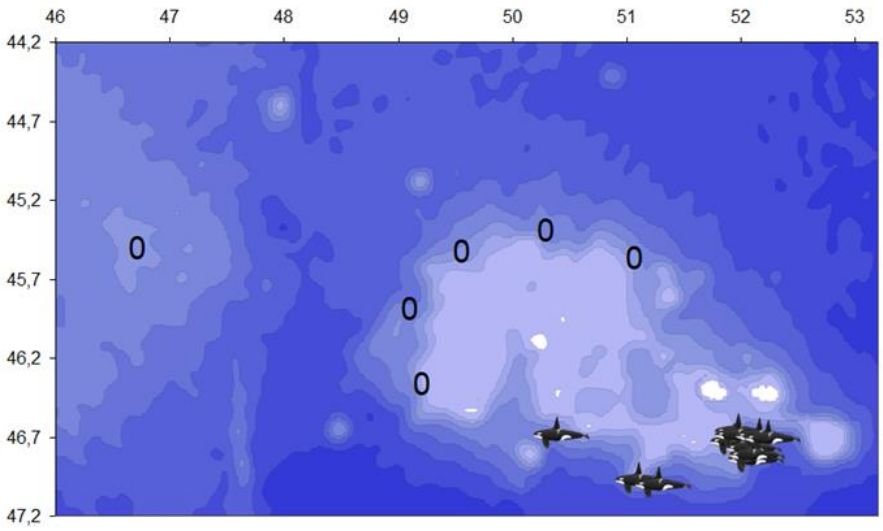
1.3. NUMBER OF INDIVIDUALS

1.3.1. Aims and use

The next step after collecting presence-absence data is to quantify the presence data, i.e. by specifying the number of observed animals to some level. Ideally this quantification is exact, but an approximate (e.g. 0, >5, >10 etc) will already provide useful information. Quantification of presence data together with absence data allows to gain information on densities, groups, hot-spots and changes in these trends over time.

Together with fishery data (catch, effort, spatial, set and hauling variables), this is the minimum requirement of data collection for an estimation of depredation that can be included into stock assessments.

longline	killer whale	number
1	present	30
2	absent	
3	absent	
4	absent	
5	present	5
6	absent	
7	absent	



1.3.2. Description

Variable type	Drop down menu	Comment
Number	<none>	Conditional formatting flags (red color for example) when min number is > to max number

Requirement: data must be collected for every haul.

Counting sperm whales is difficult as they dive for long periods of time (usually > 20min). When interacting with longline vessels they often tend to come to the surface at the end of the

line, but that is not a general rule. Counting killer whales is equally challenging as they have different operating ranges to the vessels - some individuals stay at distance from the vessel (killer whales are thought to interact with a longline within a 1 mile range from the vessel), they don't stay long at the surface and they move rapidly. For these reasons it can be difficult for observers to estimate exact numbers. To account for these uncertainties, observers may fill in two fields:

Minimum estimate of the number of individuals

Maximum estimate of the number of individuals

Those two fields are not mandatory. When odontocetes are present, they can be either both filled in or only one of them.

Example:

Presence?*	**min**	**Max**	**comment**
Not observed			Hauling at night
Absence			Line observed for whales and no whale around
Presence			Whales are present but no idea how many
Presence	10		Whales are at least 10
Presence		15	Whales are not more than 15
Presence	10	15	Whales are between 10 and 15

Inconsistencies in the data set need to be detected preferably at sea, such as:

Presence/absence	minimum	maximum
Absence	10	15
not observed	10	15

1.4. QUANTIFYING OBSERVATIONS OF INTERACTIONS WITH LONGLINES

1.4.1. Aims and use

Knowing exactly when depredation occurs will increase the accuracy of the presence/absence data. By removing all the sets for which odontocetes were present but did not depredate any fish will limit bias when assessing the influence of factors influencing depredation.

1.4.2. Description

Variable type	Drop down menu	Comment
Boolean (yes/no)	Yes No	A comment field related to interaction is also available for observers to comment on interactions details

This field is mandatory if presence of odontocetes is recorded for this haul.

Example:

Killer whales	Signs	Example (if any)
Interaction	Whales swim at high speed towards the boat	
	Whales remain in the vicinity of the vessel: from a few meters to 1 Nm	
	When surfacing, whales are surrounded by numerous seabirds	
	In some cases, whales surface with depredated fish	
	Whales alternate short (<1min) and long (>5min) dives	
	Whales frequently change direction	
	Individuals are spread out; lone individuals or small sub-groups	
	Slicks of fish oil are visible at the surface	
No Interaction	Whales are just passing by; they are travelling and moving in one clear direction	
	All the individuals are together and they are all heading to the same direction	
	All the whales coordinate their diving frequency	
	The bird activity around the whales is limited	

	Whales do not remain in the vicinity of the vessels, they become out of sight as they move away from the vessel, not because the vessel leaves the area.

Sperm whales	Clues	Example (if any)
Interaction	Whales dive in the vicinity of the vessel, usually in direction of the longline being hauled	
	Whales remain in the vicinity of the vessel: from a few meters to 1 Nm Whales alternate surface phases and long dives (>15 min) Whales follow the vessel when it moves short distances between sets Whales are usually spread out and operate by themselves, except when co-occurring with killer whales around the vessel. In the latter case, sperm whales often gather up and form small groups with synchronized diving frequencies	
No Interaction	Whales are just passing by; they are travelling and moving in one clear direction Whales do not remain in the vicinity of the vessel, they move out of sight as they move away from the vessel.	

1.5. PHOTO-IDENTIFICATION DATA

1.5.1. Aims and use

This field is used to archive the pictures taken by the observers. For further details on the aims of photo-identification, please refer to chapter 2.

1.5.2. Description

Variable type	Drop down menu	Comment
Boolean (yes/no)	Yes No	Photo-identification data collected?

This field is mandatory.

With this field, observers indicate whether they took pictures of whales for photo-identification purposes or not during the haul of the set.

1.6. IDENTIFICATION OF INDIVIDUALS

1.6.1. Aims and use

Collecting photo-identification data on every haul with presence of whales can be made difficult by the weather conditions and/or the workload of observers. However, photographic collection is not always necessary as some individuals are very distinctive (e.g. large notches on the fin – see Figure 1 and Chapter 2) and can be recognized even at a distance. In some whale groups, if they have been monitored for a long time, between-individual social affinity and group composition can be known with great accuracy. Additionally, species such as killer whales usually live in highly stable and long-lasting social groups, and thus knowledge of one individual can allow to infer the identities of the remaining group.

Figure 1 - ADD CAPTION

1.6.2. Description

Variable type	Drop down menu	comment
String (letters)	List of individuals	Other text than what is in the dropdown menu can be entered

This field is not mandatory. Observers may fill it in with alphanumeric codes used as the ID of individual whales (available in Photo-ID catalogues provided to observers) only when they are confident about the presence of some individuals, usually the most distinctive ones (see Chapter 2 on photo-identification).

1.7. ESTIMATED TIME OF ARRIVAL (ETA)

1.7.1. Aims and use

This information is used to assess the distance at which whales detect the ship in different places and can give information on natural foraging areas.

1.7.2. Description

Variable type	Constraints	comment
Time (format hh:mm)	>00:00 <24:00	If this is filled in a crosscheck occurs that the abundance field is filled in with 'presence'

The Estimated Time Arrival here corresponds to the time between the first hook of the line hauled on board and the arrival of sperm whales / killer whales. If whales are already present when hauling starts, then ETA is zero.

1.8. NUMBER OF MAGAZINES WITH PRESENCE

1.8.1. Aims and use

If reliable, this information can be useful to increase the accuracy of depredation rate estimates.

1.8.2. Description

Variable type	Drop down menu	comment
decimal	<none>	

Depending on the vessel, magazines generally correspond to 750 or 900 hooks around Crozet and Kerguelen, which is an easy to use sub-division of the longline, formalised by a knot between the sections. Odontocetes sometimes arrive after the haul has started, which means their impact is only on part of the hooks hauled.

1.9. INTERACTION BETWEEN KILLER WHALES AND SPERM WHALES

1.9.1. Aims and use

Killer whales and sperm whales are also seen depredating together during the same hauling operations. The collection of information on their interactions allows to quantify the frequency of occurrence and their spatial distribution. Paired with photo-identification data, the killer whale groups/individuals that are most likely to interact with sperm whales can be identified.

1.9.2. Description

Variable type	Drop down menu	Comment
String (letters)	(no)	

This is a comment field in which observers may specifically report any interaction between killer whales and sperm whales when co-occurring around the vessel. Clues at the surface include killer whales swimming at high speed towards sperm whales; sperm whales gathering; sperm whales strongly reacting to killer whales surfacing nearby; possibly blood at the surface; etc.

1.10. COMMENT

1.10.1. Aims and use

Any issues or comments from the observer are noted in this field, allowing the person involved in data processing and analysis to be aware of any special circumstances during data collection. It can also provide any additional information specific to whale interaction with the vessel for this specific haul.

1.10.2. Description

Variable type	Drop down menu	Comment
String (letters)	(no)	

Any useful comment from the observer on behaviour of whales, data collection, etc.

1.11. SUMMARY

Example of data collected for each field.

		sperm whale	killer whale
abundances	presence or absence or not observed	presence	presence
	number min	12	10
	number max	15	15
identification		CRO0147 present ?	C037 and others
interaction with LL	yes / no	yes	yes
	comment	high depredation	
estimated time arrival		00:30	00:20
photos	yes / no	yes	
	comment	good series of tail	stay a bit far
number of magazines with presence		12:00	00:00
Interaction between KW / SW	yes / no	yes	
	comment	SW form circles with tails outside to flap water, blood seen at surface when KW attack one individual left alone	
comment		dive and come up at surface all together	same group as yesterday

2.PHOTO-IDENTIFICATION

This chapter is a synthesis of experience acquired since the 1960's around the Crozet (Division 58.6) and Kerguelen Islands (Division 58.5.1). It is provided as guidance and support in starting a photo-identification programme.

Since 2003, all fishery observers working aboard French Patagonian toothfish fishing vessels are equipped with advanced photographic gear. These observers have collected about 100,000 whale pictures from fishing vessels between 2003-2016.

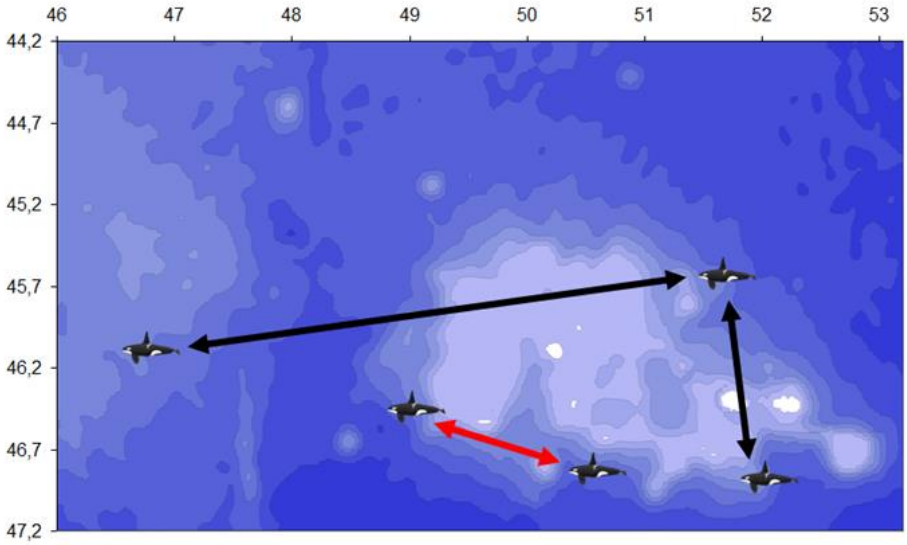
The photo-identification technique consists of taking pictures of individuals to be able to recognize them between different sightings by using shape, colours, scars and notches on the body. This information can be used in mark-recapture models to assess the dynamics and the behaviour of populations in relation with fisheries.

2.1. AIMS AND USE

Photo-identification data, or photographing depredating odontocetes consistently and continuously, is the highest level of data collection (in addition to the minimum described in 1.1.3) implemented around Kerguelen and Crozet.

With photo-identification allows to:

- study movements of depredating odontocetes;
- build catalogues to match individuals with other areas;
- study differences in interaction rate between individuals or groups (e.g. identification of “most wanted”)
- assess the demographic parameters of odontocete populations by performing “Capture-Mark-Recapture” analyses
- investigate how depredation may spread across individuals/groups in populations.



Requirement at sea:

- photo identification gear (SLR camera, lens, memory card, computer)
- naming convention for pictures

Requirement after trip:

- hard drive archiving
- sorting pictures and collect data on individuals etc, can be time consuming
- data base storage and data treatment

2.2 WHAT PICTURES TO TAKE?

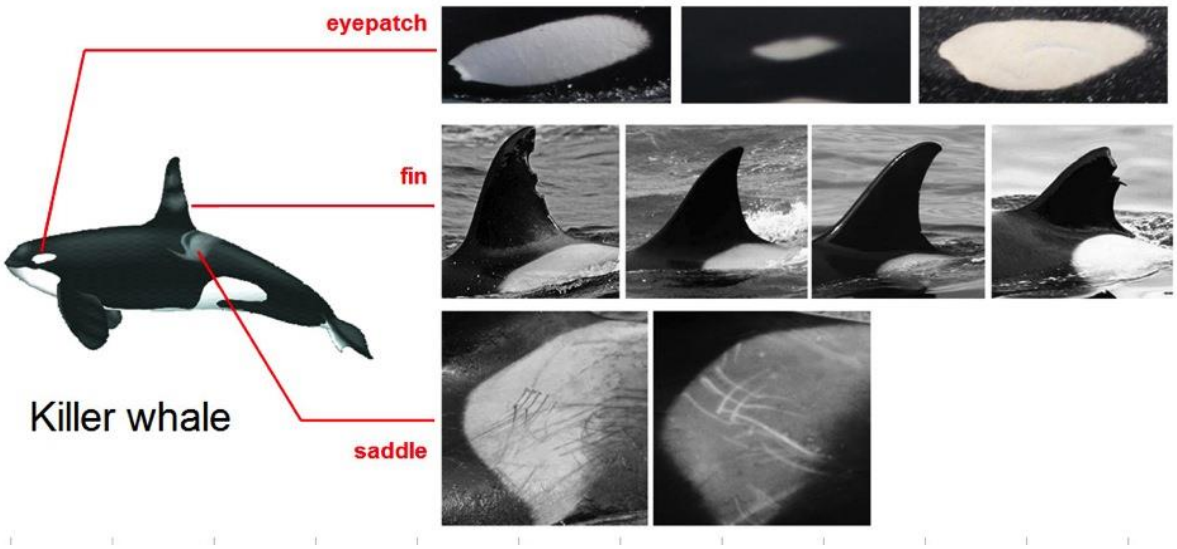
2.2.1 Photographing killer whales

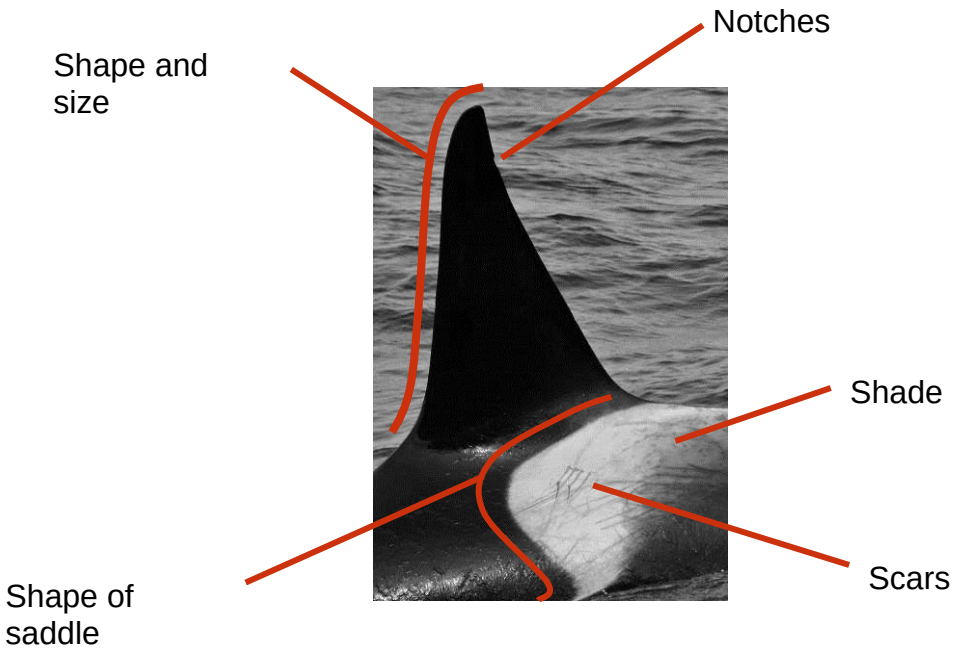
Killer whales can be very fast when depredating on a line and predicting where they will come at the surface to breathe can be difficult. Experience is the key here and with time, observers are usually able to anticipate the behaviour of whales at the surface with their camera gear ready to take photographs. For that matter, it is strongly advised to use the burst mode (multiple exposures) of the camera and to take multiple pictures when whales are coming up to the surface. However, to be of scientific use, photo-identification data require specific features of killer whales to be targeted.

Body parts to target

Killer whales are primarily identified by the shape of the dorsal fin and by natural markings such as notches and scars on both the dorsal fin and the saddle patch. The eye patch, which shape of the forepart is unique to each individual may also be used as the third key photo-identification feature, especially for young individuals. The best strategy is thus to take pictures of the sides of whales, that is when the subject is surfacing with a 90° angle from the observer. It is also important to photograph both sides of individuals as the markings used for photo-identification may vary between the left and the right sides.

Body parts of killer whales to target for photo-identification

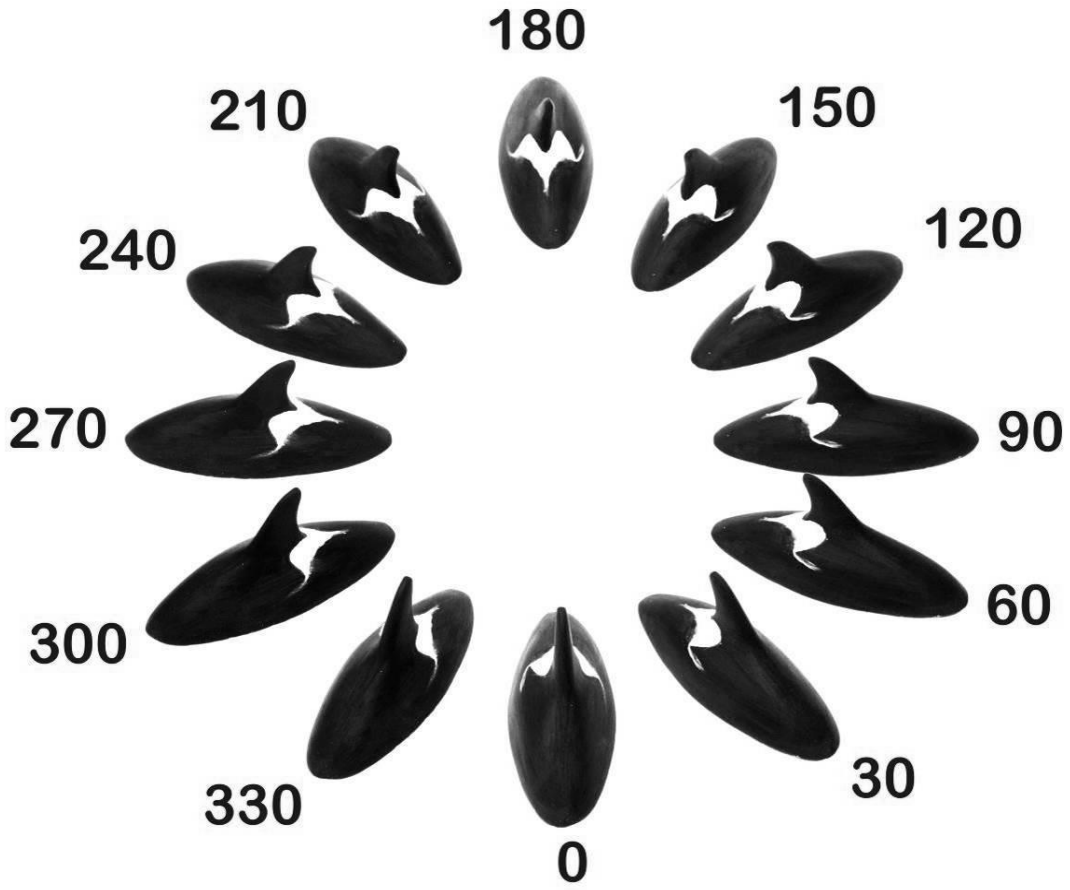




Best photographic angle

All the morphological features of killer whales used for photo-identification are best represented and visible when individual are making either a 90° (i.e. displaying the right side) or a 270° angle (i.e. displaying the left side) with the photographer. However, angles of 60 to 120° and 240 to 300° are tolerated as they still display the requested features.

Angles between the photographer and killer whales used for photo-identification



Number of pictures and distance to the subject

Since a digital camera allows to take a lot of pictures without additional cost, **the number of pictures should not be a constraint** when taking pictures.

It is impossible to know if a group of killer whales is going to come closer to the vessel or not, some might come very close and some other groups never get closer. To increase chances of collecting photo-identification information, the observer must take a series of pictures as soon as they are sighted and then take more pictures if they get closer.

Examples: distance of killer whales to the photographer

Linking eye patch and dorsal fin/saddle patch

Collecting photographs of all the body parts used for photo-identification will increase the chances of repeatedly recognising individuals over time. It is important, therefore, to know which morphological feature belongs to which individual. While the saddle patch and the dorsal fin are easy to capture on the same photograph, taking successive side pictures of a whale when coming up to the surface using the burst mode of the camera will eventually allow to link the eye patch to the dorsal fin/saddle patch of that individual.

Example: full session of pictures of a killer whale surfacing and displaying both th eye patch and the dorsal fin/saddle patch

or

Taking pictures with multiple individuals

Observers should not always only focus on taking photographs of one individual at a time. Killer whales usually move in groups, and taking pictures showing several individuals on the same frame is often possible and important to do. These photographs can be used to examine the association patterns of killer whales, which over time allows to characterize social groups. In killer whales, these social groups are formed by genetically related individuals led by a female and are called “matrilines”. Individuals of the same matriline are usually constantly associated, which makes these social groups highly stable over time. This stability is important when estimating the number of whales present during hauls, as

seeing/photographing one individual of a social group means the other individuals of the group are also present even if not seen in the photographs.

Example: pictures of groups of killer whales

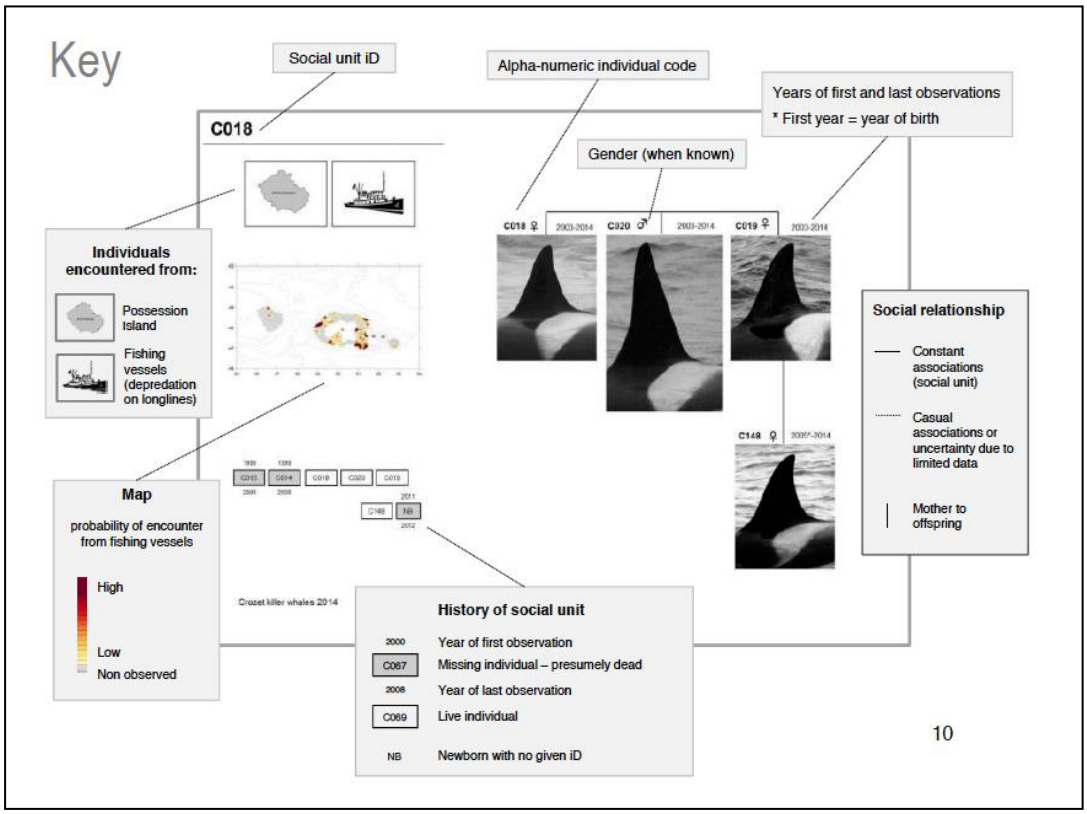
Targeting as many individuals as possible

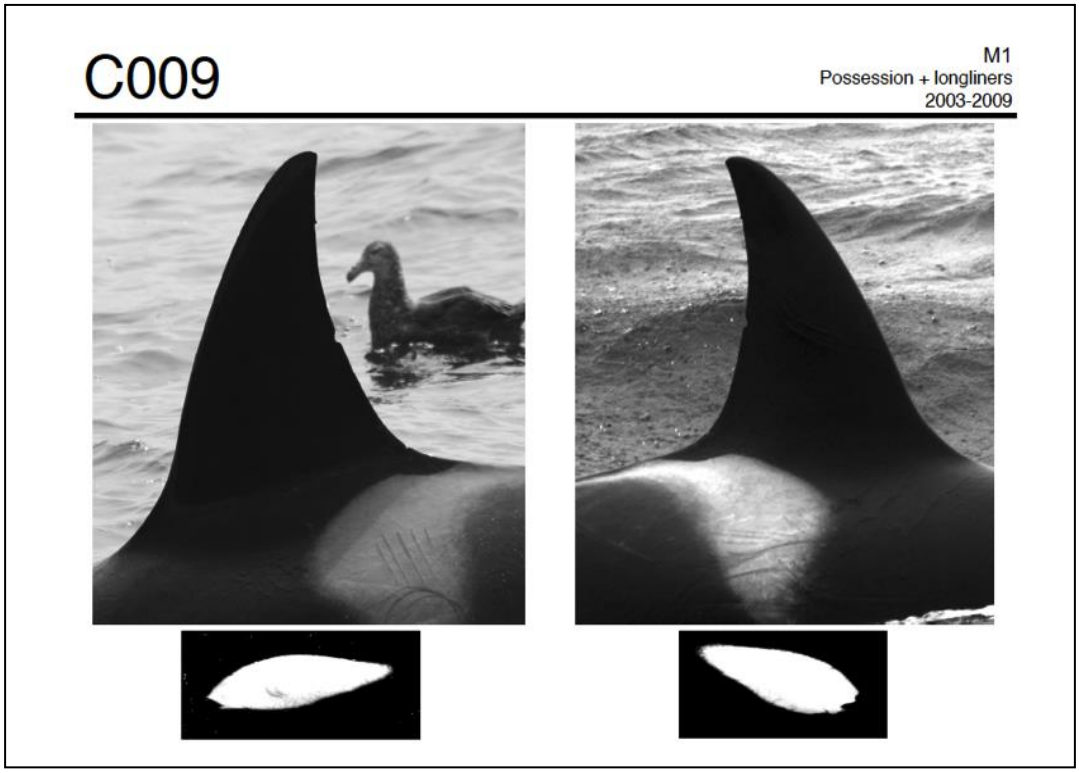
One common oversight made by observers when collecting photo-identification data is to focus on only a few individuals, usually the closest and the most distinctive ones (e.g. big adult males). However, it is important to try to capture as many individuals as possible when killer whales are interacting with a vessel. This is best achieved by starting a session taking photographs of the closest or most distinctive individuals, and then to look for other individuals around the vessel, even if they remain further away.

Building up a photo-identification catalogue

Observers should keep in mind that the pictures they take will be used to build photo-identification catalogues. These catalogues aim at putting together the best photographs of a maximum of individuals interacting with vessels as a reference for future "re-identification" of killer whales. The best photographs are those showing the specific features of individuals, and pictures with the best angle, light, focus and resolution will be selected. Catalogues are usually built using a standardised procedure. Pictures are cropped using a specific picture ratio (i.e. ratio width vs. height of the image) for adult males and for adult females/youngsters. Pictures are also often transformed in black and white pictures to emphasise morphological features. Each individual is assigned a unique alpha-numeric code (e.g. "C018" – "C" for "Crozet" and "018" for the number of this specific individual). Years of first and last sighting are usually indicated along with the individual code. In the catalogue, one page may be used to display the left and rights sides of the dorsal fin/saddle patch and eye patch of individuals or one page may be used to display a full group of individuals (if social analyses have been performed) with one picture per individual of this group. Powerpoint is a simple application that can be used to build catalogues. The contrast of pictures may also be adjusted to emphasise the important markings to use for photo-identification.

Example: Pages of a typical photo-identification catalogue of killer whales





Catalogues examples are made available for downloading in Data Object Identifier:

Sperm whale of the Crozet and Kerguelen islands:

http://dx.doi.org/10.6084/m9.figshare.1414472

Labadie G., Tixier P., Vacquié Garcia J., Trudelle L., Gasco N., Guinet C.

Killer whale of the Crozet Islands:

http://dx.doi.org/10.6084/m9.figshare.1060247

Tixier P., Gasco N., Guinet C.

Type-D killer whales of the Crozet Islands:

http://dx.doi.org/10.6084/m9.figshare.1060259

Tixier P., Gasco N., Poupart T., Guinet C.

2.2.2. Photographing sperm whales

Body parts to target

The main body part used for sperm whale photo-identification is the tail (i.e. caudal fin). More specifically, the global shape of the tail flukes paired with the presence of notches of the edge and the size/shape of these notches are unique features, which greatly vary between individuals. Sperm whales may also bear very distinctive markings on other body parts such as the dorsal fin (e.g. notches) or the back (scars). However, because these markings remain rare and not very diversified between individuals, they are only used as additional information for individuals that have already been identified by the tail flukes.

Body parts of sperm whales to target for photo-identification

Prioritizing effort on the tail flukes

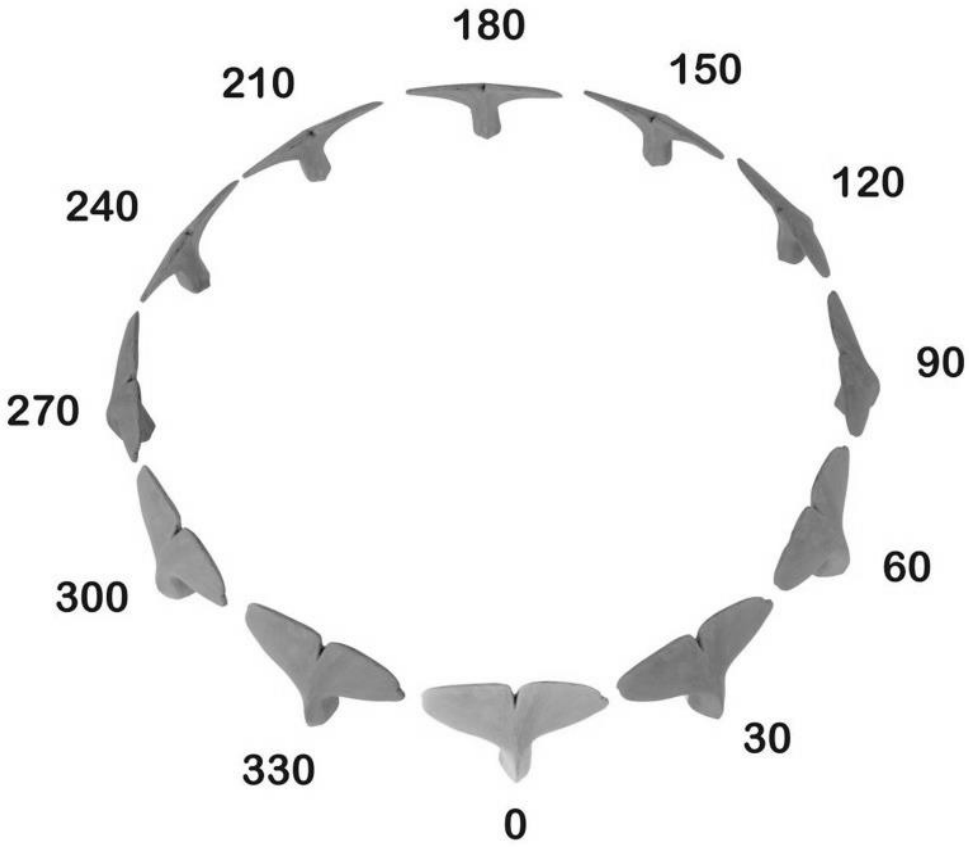
Tail flukes are the most informative body parts of sperm whales in terms of photo-identification. The global shape of the tail and the number/size of notches on the edge are the features with most variations between individuals. Good pictures of these features may therefore allow for clear identification of individuals with limited uncertainty. However, taking good photographs of this feature can be difficult. The angle is a deciding factor and as explained below, pictures taken with 0° or 180° angles are the best for later processing but can be difficult to obtain as it depends on the angle of the animal towards the vessel. In addition, tail flukes can only be captured well when sperm whales go for a long dive, which may happen after several minutes (usually >10 min) spent at the surface. The key to good sperm whale photographs is patience, waiting for the sperm whale to dive and hoping for the best fluke angle. At this point the burst mode should be used to capture the full diving sequence. This will allow the person processing the pictures to select the best photograph of the sequence for photo-identification purposes.

Example: full sequences of a dive of sperm whale displaying the tail flukes

Best photographic angle

The shape and markings of sperm whale tail flukes used for photo-identification are best represented and visible when individuals are at either a 0° (i.e. displaying the dorsal side of the tail) or a 180° angle (i.e. displaying the ventral of the tail) to the photographer. However, angles of 330° to 30° and 150° to 210° can be used as they still display the necessary features.

Angles between the photographer and sperm whales used for photo-identification



Additional features to capture if useful

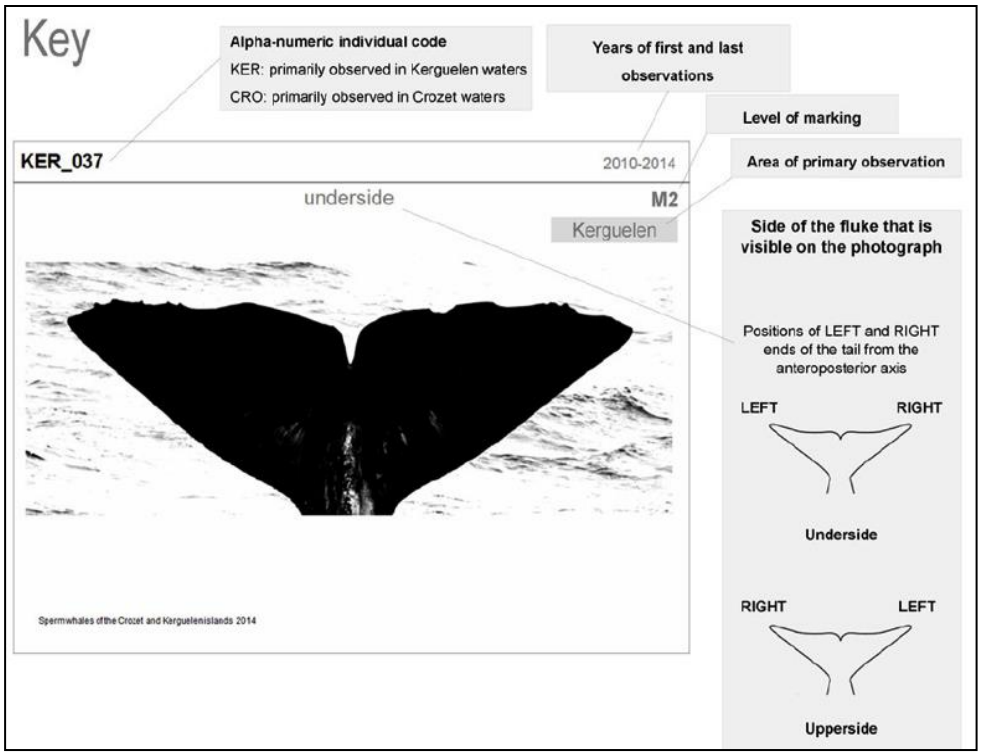
As mentioned above, the dorsal fin and the back of sperm whales may help in identifying sperm whales. These features are easier to capture when individuals remain at the surface before going for a dive. It is thus advised to also take a few pictures of these features, and try to link them to the tail flukes.

Example: picture of the dorsal fin of a sperm whale

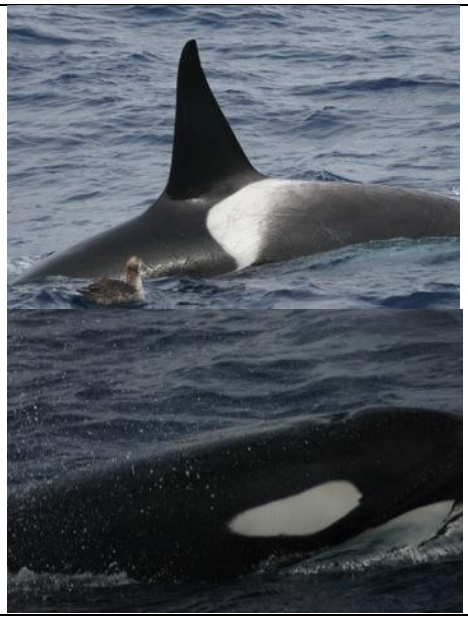
Building up a photo-identification catalogue

As for killer whales, photo-identification catalogues of sperm whales are built using the best photograph per individual through standardised cropping (size ratio of the picture) and colour transformation (black and white) procedures. As sperm whales are usually solitary when visiting high latitudes, social groups are harder to characterize and individuals are thus usually displayed one per page. Information on the years of first and last sightings individual, along with the side of the tail flukes displayed (ventral or dorsal side) may also be given next to individual pictures.

Example: typical photo-identification catalogue for sperm whales



2.2.3. Summary for killer and sperm whales

	Killer whales	Sperm whales	
Best pictures to take			
Angle	90° [60-120] and 270° [240-300]	0° [330-30] and 180° [150-210]	
Morphological features to target	Dorsal fin / Saddle patch / eye patch	Tail flukes	

Useful sequence (burst mode)			
Range	From  to 	From  to 	
Additional pictures to take	Group pictures 	Dorsal fin/back pictures 	

2.2.4. Photographing other species of cetaceans

Pictures taken of other species of whales encountered from vessels but not interacting with longlines, such as large baleen whales (e.g. blue whales and humpback whales), may be useful for other scientific programmes. For blue whales, dorsal pictures are preferred as individuals are identified according to their back pigmentation. But even sighting information (presence) about this critically endangered species can be useful as it helps in monitoring the recovery of populations in historical whaling areas.

For humpback whales, photos should be taken of the under-side of the tail flukes, which is the main photo-identification feature for that species. These pictures can be a very valuable contribution to refining our understanding of movement of that species between tropical breeding grounds and Sub-Antarctic/Antarctic feeding grounds.

2.3. BEST GEAR CONFIGURATION

Here is the list of what is provided to observers at sea in the French EEZ:

- DSLR camera body
- Canon EF 100-400mm f/4.5-5.6L IS II USM
- 2 SD memory card, high speed and high capacity (>32 Gb)
- one memory card reader
- Hard drive to archive copies of the pictures

Best results are obtained with a 100-400mm lens, which allows the photographer to take pictures of individuals close to the boat as well as individuals at a distance without the need to change lenses, which can be difficult on a vessel. The contribution to picture quality coming from the camera body is not as important as the lens quality.

Flash drive: the size of memory cards available has increased substantially over the past few years. A single sighting usually uses less than 4 GB. It's worth having a High Speed Memory Card, as the buffer of the camera body will not be filled as easily and saving files on the card is quicker.

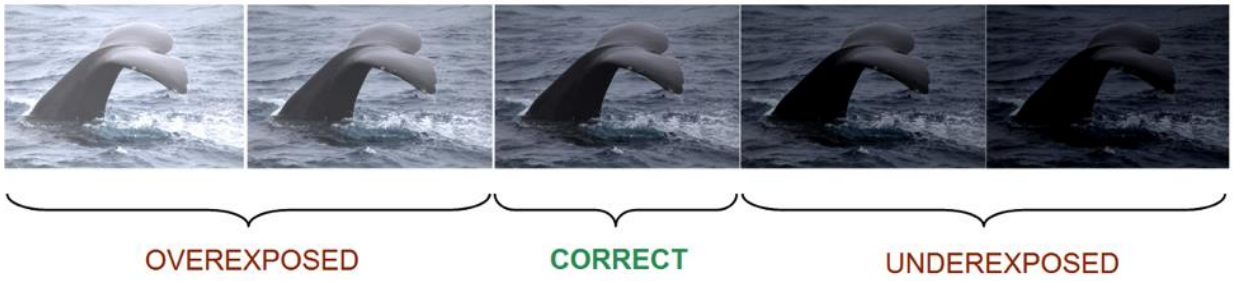
It is better to collect pictures with a compact camera than to have no pictures at all, but those pictures will be very limited when it comes to analysing observations of presence and individual identification, especially if the whales are at distance. A compact camera cannot compete with a digital SLR camera with a large zoom lens of 100-400mm. New generation SLR are small in size and can be easily transported and handled by observers while at sea.

2.4. GEAR PROTECTION

The lens should be protected by a UV filter, so that water drops can be cleaned without any risk to the lens itself. The gear should be protected from water splashes by a plastic bag. However, taking pictures in bad weather is not recommended at all as the electronics will not stand long in these conditions.

2.5. UNDERSTANDING YOUR CAMERA

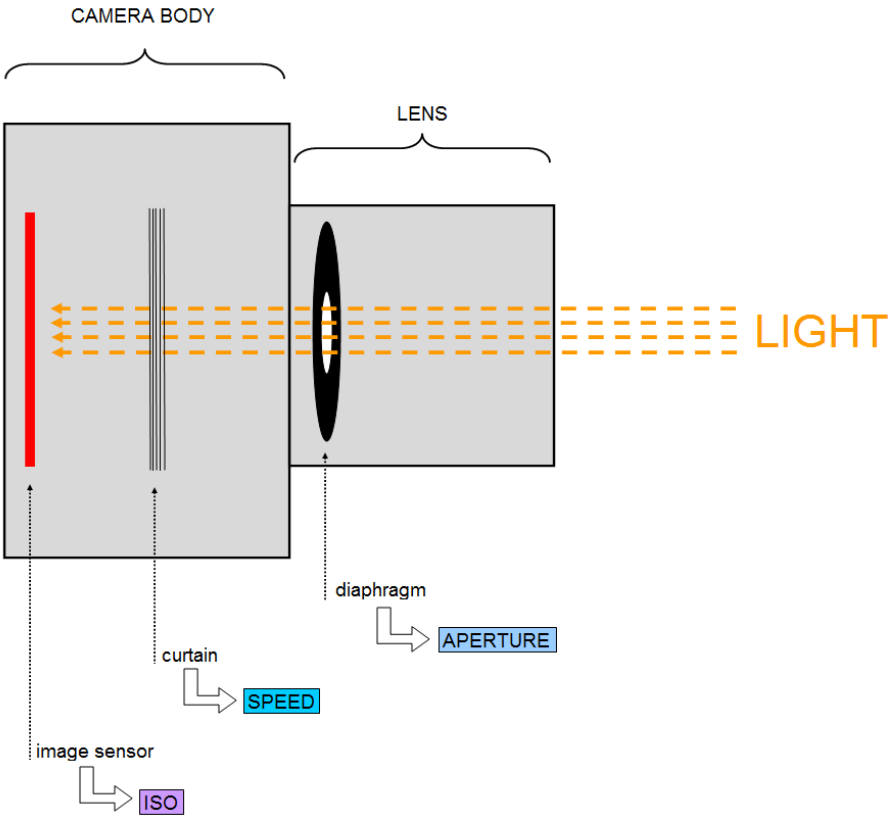
The camera is there to get a well-balanced picture, not too dark and not too bright.



Everything is dependent on the amount of light that gets into the camera.

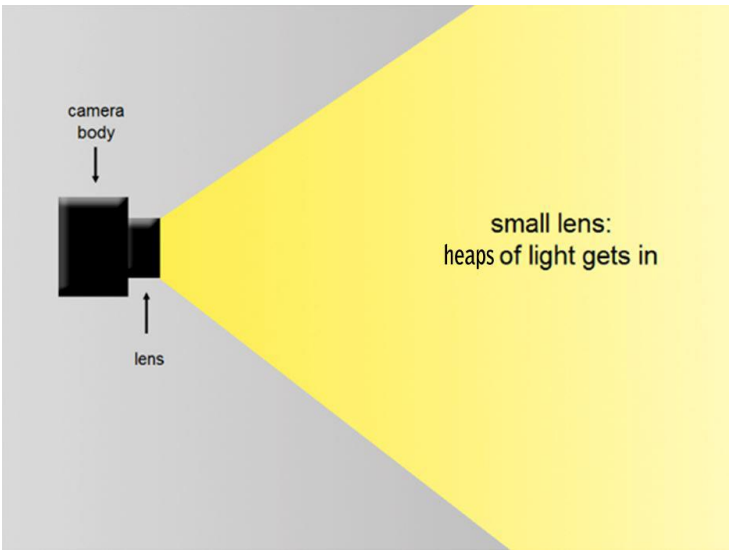
Three parameters can be adjusted for that:

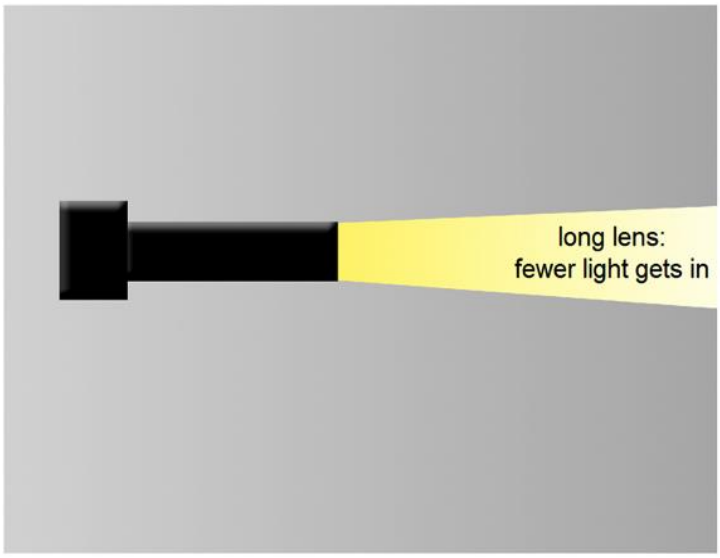
- ISO (how sensitive the image sensor is to light)
- Speed (how long the curtains stay open)
- Aperture (how wide diaphragm is open)



2.5.1. Lens

Depending on the kind of pictures taken, the lens used will be different. Taking close focus pictures of orcas 500 m away will be a different situation compared to landscape. The difference is in the amount of light that can get in the camera.





For photo-identification purposes a long lens will be needed, which means that there isn't much light getting into the camera.

LENS ADVICE: we obtained best results with a 100-400 mm lens that allows to take pictures of whales at distance (400 mm) as well as very close to the boat (100 mm)

2.5.2. Speed

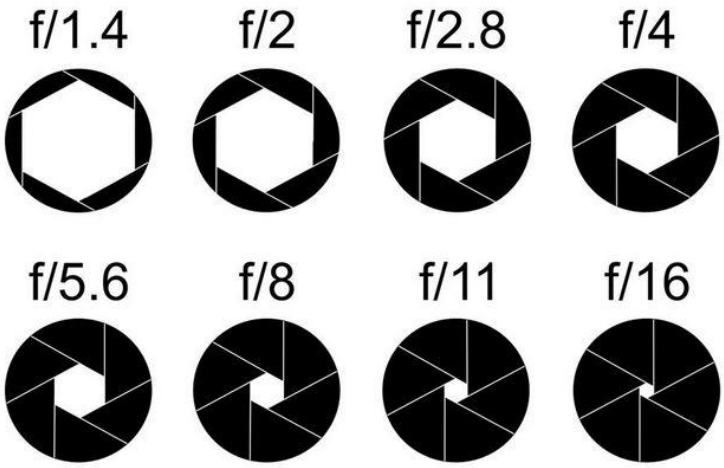
Shutter speed is how long the shutter "curtains" stay open to allow light into the camera. Fast speed allows you to freeze the action, as seen in the example below where water drops were shot at 1/1000s. A speed of 1/125s gets twice as much light than when the speed is at 1/250s.

When taking photographs for photo-identification, the camera should be set on Speed Priority and speed should be at 1/1000s. Slower speed will not allow to have 100% focused images, and higher speed will only use more of the available light without improving focus. We experienced that very low speed can give very interesting results for art exhibitions, but not really for photo ID. Photo-identification conditions are difficult because there is not much light available when using high speed and a long lens.

Best choice for photo identification:
1/1000s at all times

2.5.3. Aperture

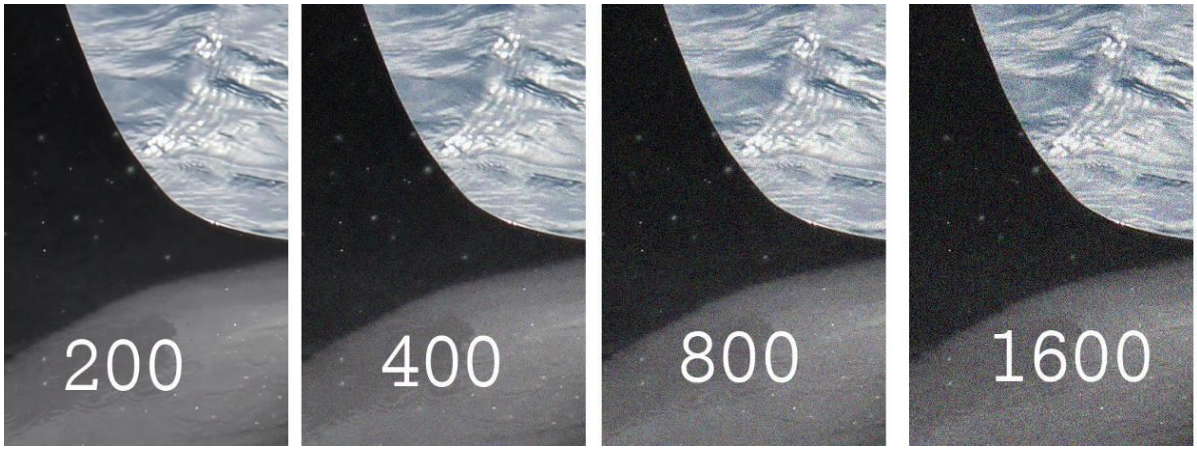
The aperture controls how much light enters the camera, so the further it is shut, the less light will enter. For example, if the aperture is set to 4 there will be two times more light entering than if it is set to 5.6. The aperture values are not sequential, but are given below:



Best choice for photo identification:
let the camera calculate aperture using the speed priority mode.

2.5.4. ISO

The ISO determines how sensitive the camera image sensor is to light. A high ISO requires less light but the image will be grainier. A low ISO requires more light but the image will be "cleaner".



High ISO values (e.g. 1600) can be used to take pictures in low-light conditions.

If the maximum ISO is used and there still isn’t enough light, then the picture will be too dark in any case. Below are some examples of what can be done with a dark picture in post-processing. It's better to have a dark picture than none at all, as it may capture individuals not seen during daytime. It’s not advised to use ISO in automatic mode, ISO should always be set as low as possible because resolution is lost when it increases. While 100 ISO would be the best, in conditions at sea it is often not possible to have enough light. Setting to 200 ISO as a standard gives sufficient resolution and the observer does not need to switch between ISO settings.

Best choice for photo identification:
200 ISO, higher only if necessary

2.5.5. Speed priority mode

The above sections describe changes that can be made in order improve the quality of pictures for phot identification. However, changing these three settings for every picture would be unmanageable at sea when taking rapid photographs for ID. Changing settings manually was necessary in the pre-digital time, but most cameras today can manage settings automatically.

The camera can be set to three basic modes:

- Manual: user controls all the settings. For photo identification, this mode is often unmanageable.
- aperture priority: User choses aperture, camera calculates appropriate speed. For photo identification, this is not the best mode as the speed will be too low and pictures will be blurred.
- **speed priority**: Speed is set to a chosen value by user, and the camera calculates the amount of light needed, opening or closing the diaphragm accordingly. The user does not need to make any changes.

Best choice for photo identification: Speed priority

Some cameras also have so-called "sport modes", which are set to high speed but often the ISO is set automatically here so this is not the best mode to use.

2.5.6. Resolution

The camera should be set to maximum resolution to obtain the best possible quality image.

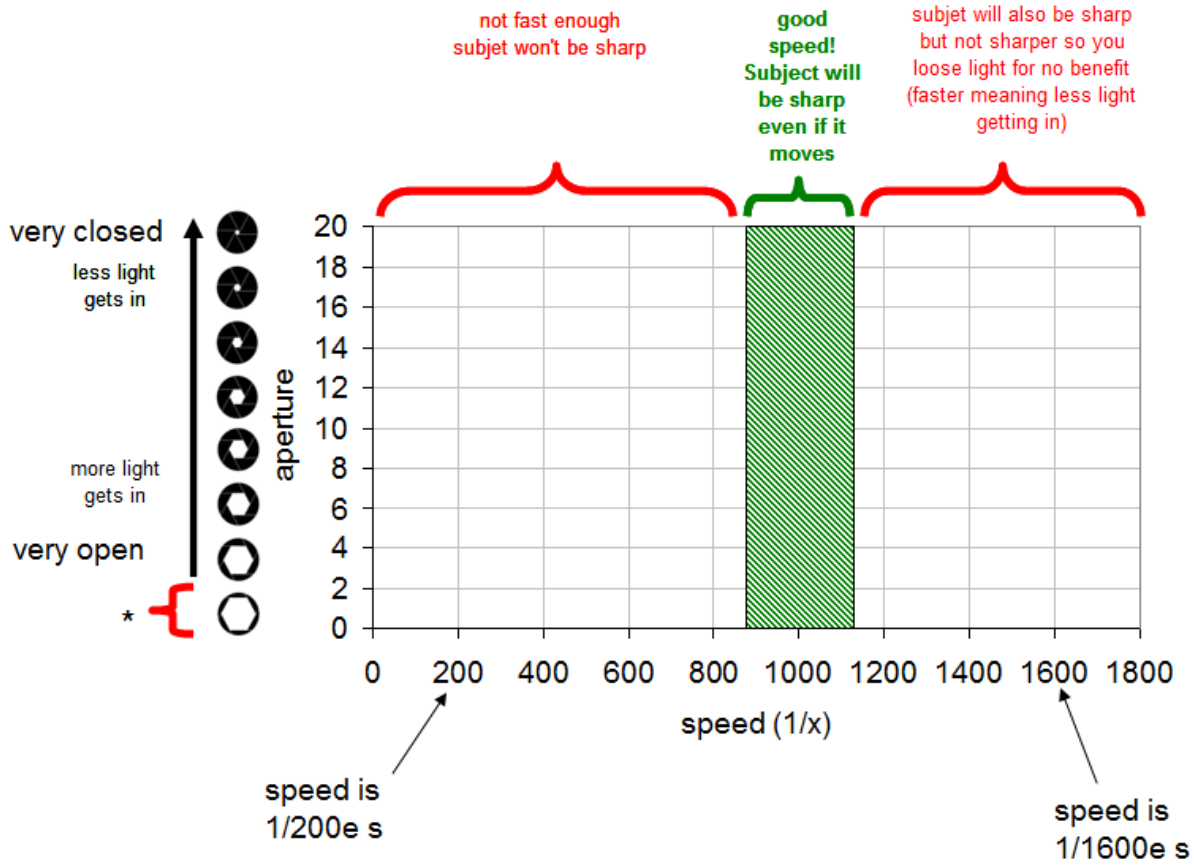
2.5.7. Summary

lens	100-400mm
memory card	Several, >32 Gb, high speed
mode	speed priority (shutter priority)
speed	1/1000s at all times
ISO	200, higher only when necessary
aperture	calculated automatically when using speed priority
quality	High resolution jpeg, highest quality available, RAW if possible
Autofocus	On

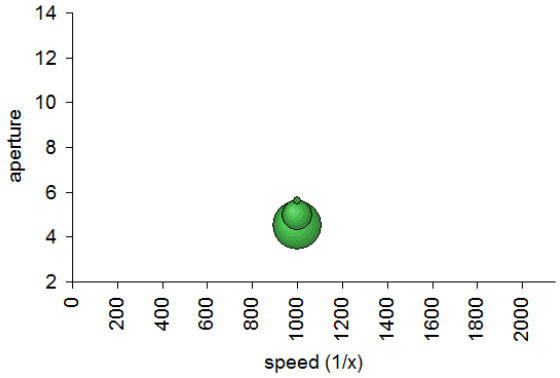
2.6. FEEDBACK TO OBSERVERS

Observers deal with hard working conditions, and it is important to recognize their work and give them feedback on the data and pictures they collected.

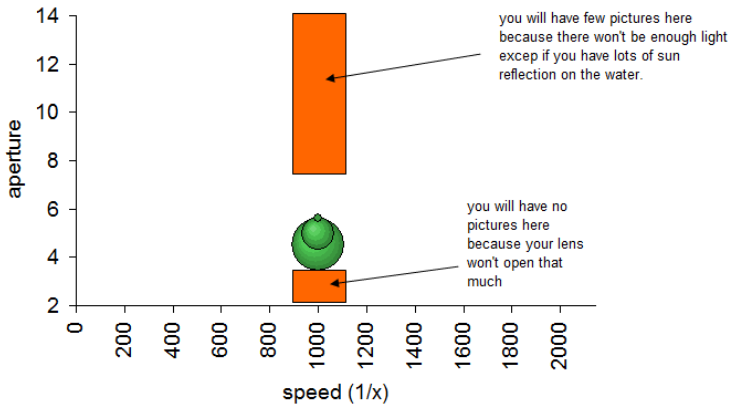
Feedback can consist of being referenced in scientific papers, or at conferences and presentations. Feedback on the quality and use of pictures collected can further serve training and improving their skills.
Graphs are produced using EXIF (Exchangeable image file format) data from pictures to visualize settings used by photographers (X axis corresponds to speed (1/x) and Y axis corresponds to aperture.), observers receive graphs from their previous trip when they go at sea:



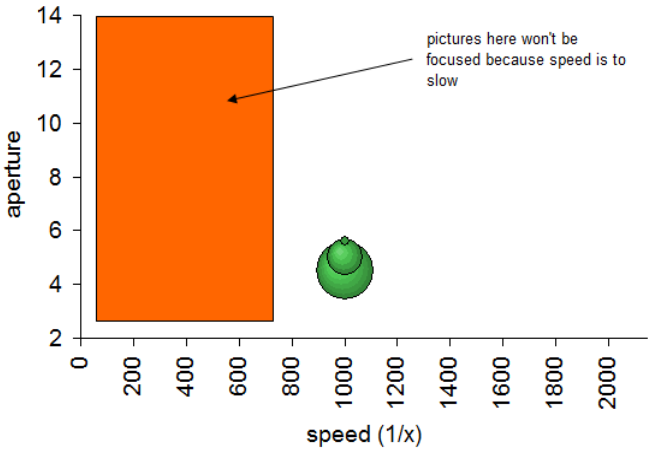
Ideally, in good conditions (not dusk, dawn, or dark weather) ISO should be set to 200, the speed to 1/1000 s and aperture will likely be around minimum (meaning around 5). On the plot below most of the pictures were taken with 1/1000s and aperture around 5 (larger bubble):



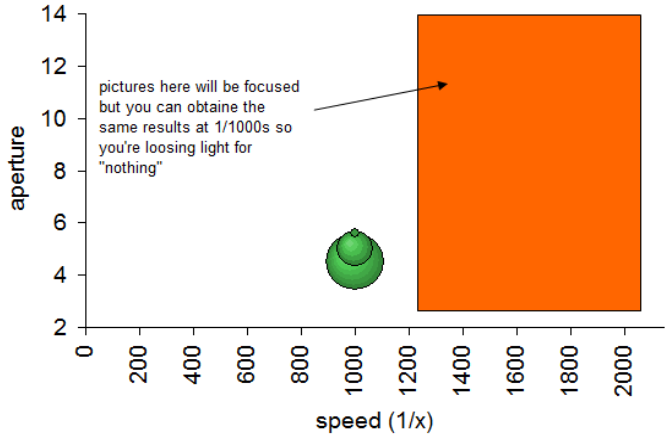
The aperture at this speed works like this:



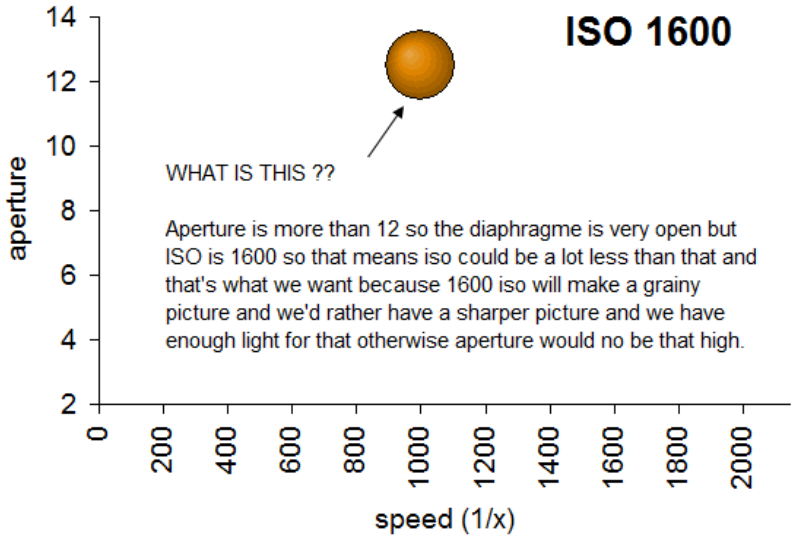
Lower speed:



Higher speed:



Example:

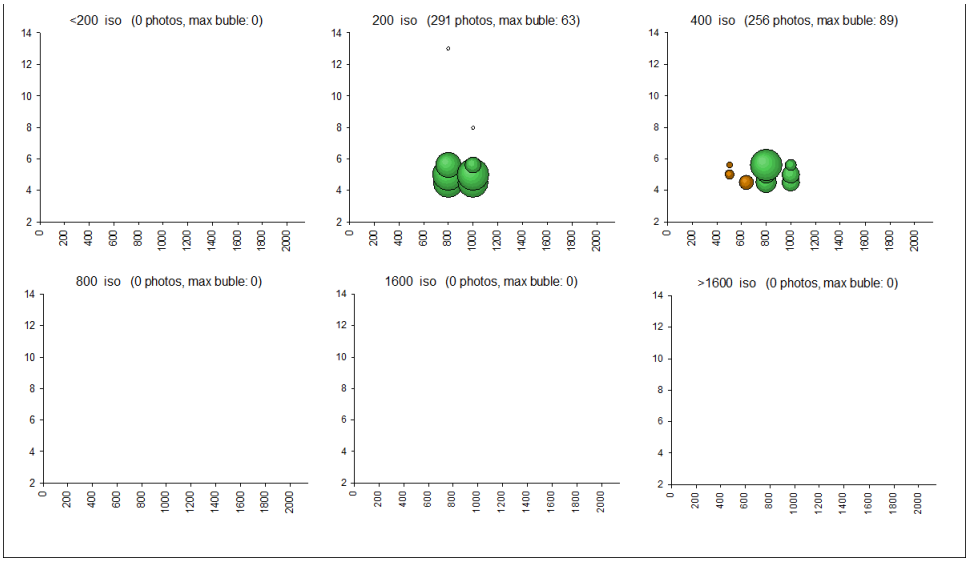


This situation can happen if 1600 ISO was used when conditions were very dark and the gear was not set back to 200 ISO afterwards. It is worth checking the settings from time to time to avoid situations where good pictures might be missed.

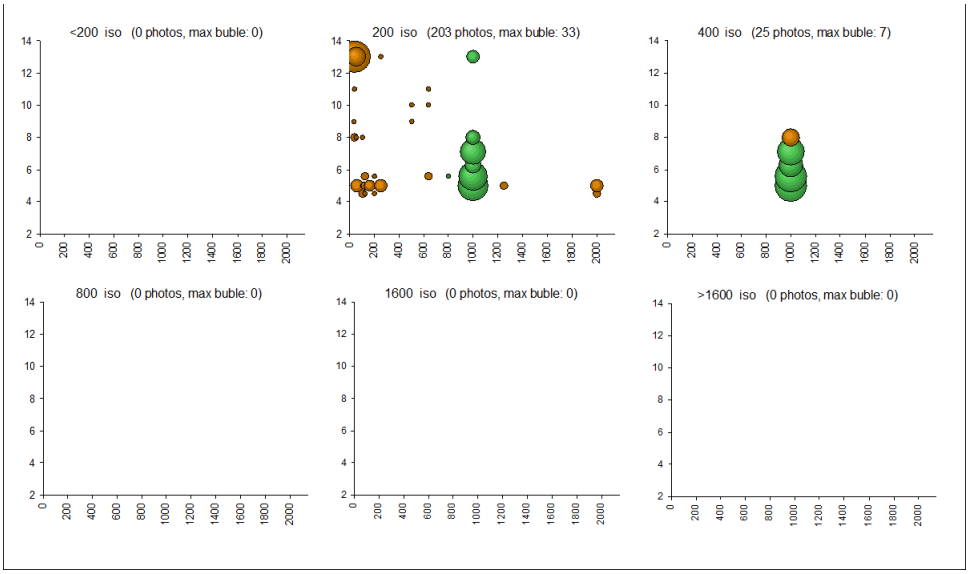
Commented examples:

We are thankful to all observers who took all those pictures, feedback is given to get things even better next time.

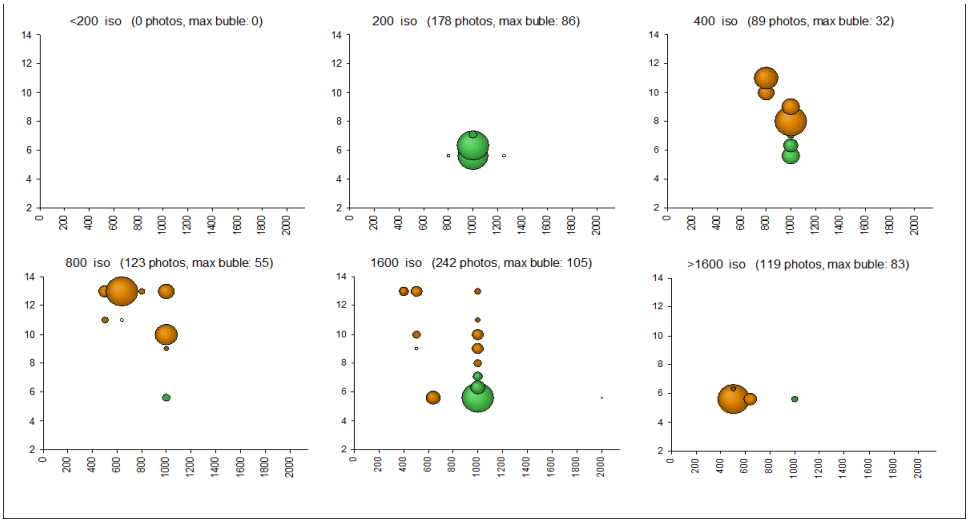
Below, a few images at 400 ISO that are too slow, but the remaining images in the batch are fine. The advice would be to not hesitate to take more pictures if possible:



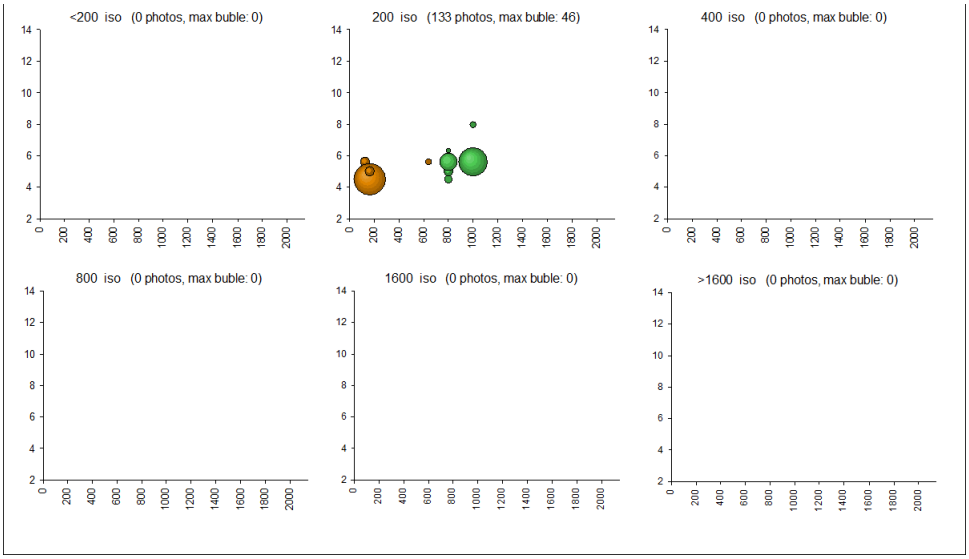
Below, something went wrong when using 200 ISO, the gear was not set properly and all the pictures on the left won't be usable. A few pictures were also taken at speed higher than 1/1000s. In summary, the advice would be to not change the gear settings too much and check periodically that they are still correct. We would also advise to take more pictures.



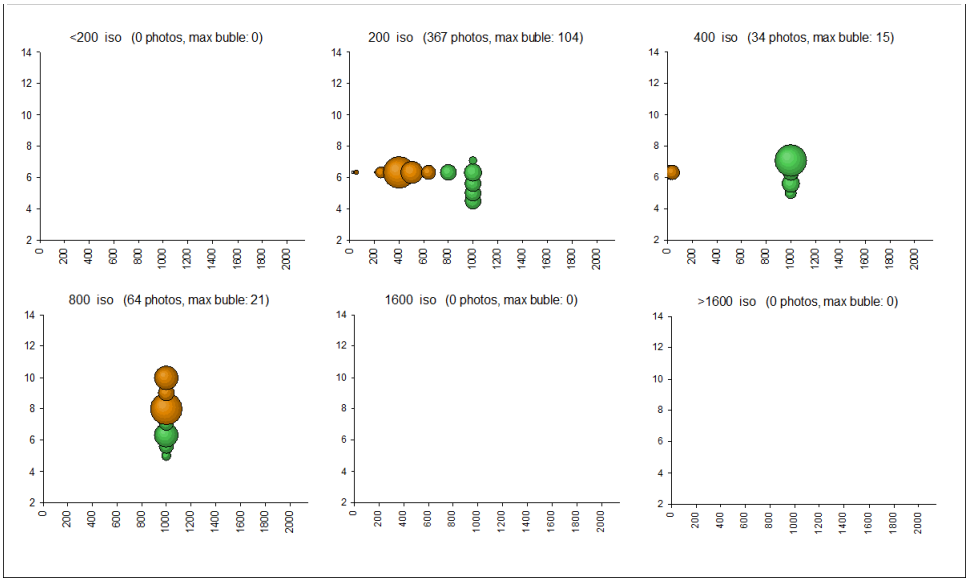
Below, using 200 ISO is fine, but many pictures are too slow and/or using 400 ISO when 200 would have been better (aperture is more than 5). The images falling into brown bubbles in 800 and 1600 should have been taken with 200 ISO. Apart from the pictures taken at speeds slower than 1/800s, all those pictures can still be used.



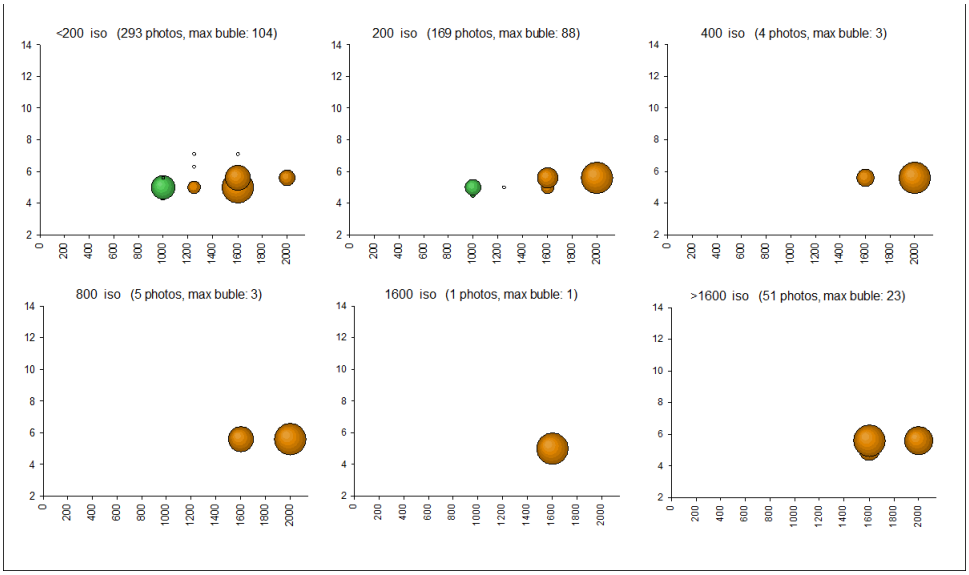
Below, the green bubbles are pictures that are fine but something went wrong with some pictures at very low speed. The advice would also be to take more pictures.



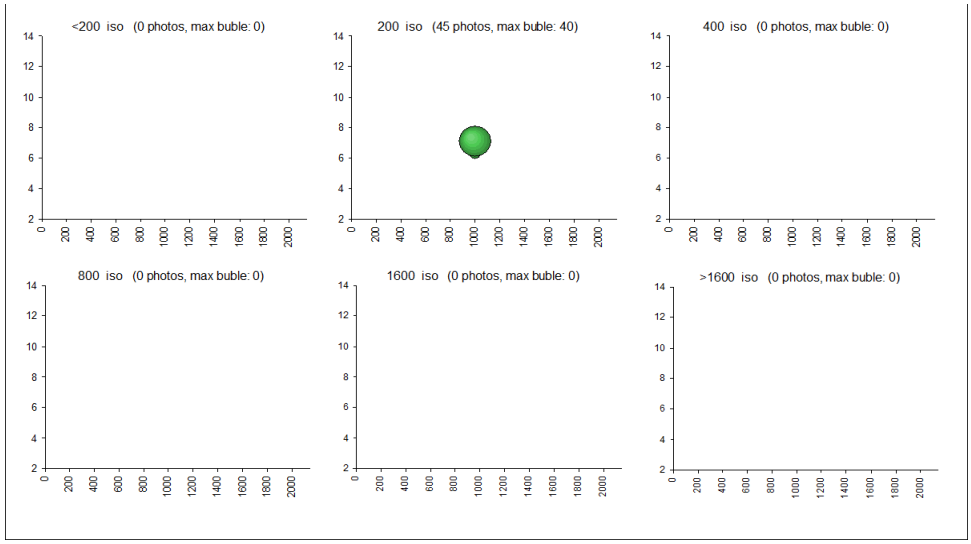
Below, something went wrong: the gear was set to aperture priority at some stage instead of speed priority. Also, 800 ISO was used when 200 ISO would probably have been enough.



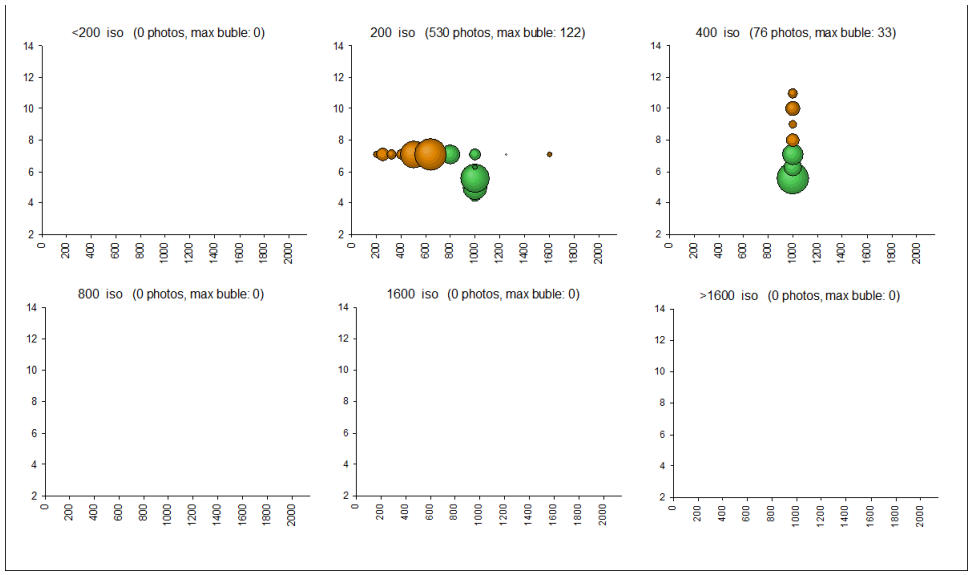
Below, this is very typical of a “sport mode” setting, this mode does give priority to speed but has no priority on ISO. All those pictures will probably be usable, but grainier than what they would have been if shot at 1/1000s with the correct ISO.



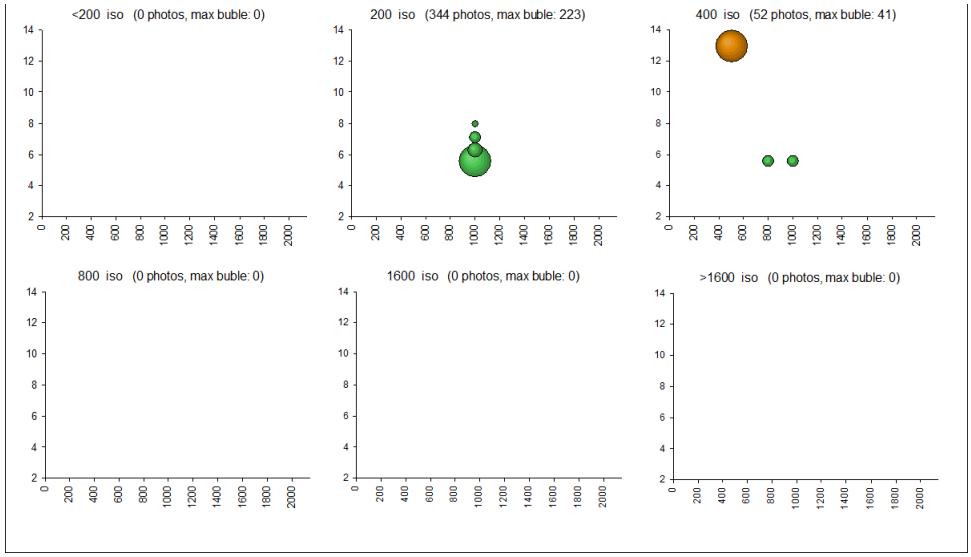
Below is an example of perfect pictures - too bad there were not more pictures because they area just perfect!



Below, taken in 200 ISO is a typical “aperture priority” horizontal pattern.



Below, something went wrong with low speed in 400 ISO, those 50 or so pictures won’t be usable but the 344 pictures in 200 ISO are just fine.



You can generate your own plots with PINT
https://dx.doi.org/10.6084/m9.figshare.3380269.v1

2.7. NUMBER OF PICTURES

During a normal length trip around Kerguelen and Crozet (around 3 months), and if whales are seen almost every day, the number of pictures can reach several thousands. If killer whales are around the vessel and conditions are ok, then several hundreds of pictures can be taken during one haul.

2.8. TRAINING

If, during observer training workshops, there are no killer whales or sperm whales near-by, an alternative is to project some video footage on a large screen and have observers practise taking pictures almost like in real conditions. This allows to gain familiarity with the gear.

2.9. CHECKING AT SEA

Checking the speed and exposure mode on the pictures returned by the observer after the trip highlighted that some observers, even when given clear instructions, did not correctly set the camera. Subsequently, since it's is very important that the time spent on taking pictures produces interpretable information, settings are checked before the arrival on fishing grounds.

Observers at sea in the French EEZ are asked to take several pictures on the way to the fishing grounds and to send those in low resolution by email:

- 3 pictures of a bird flying with the same settings as for photo-identification:



- 1 picture of the GPS

the pictures of the GPS allow the technical coordinator to check the correct settings of date and time while the 3 bird pictures allow him to check the settings of speed, ISO and speed priority mode by reading the EXIF information:

But you can use the PINT tool to read EXIF data:
https://dx.doi.org/10.6084/m9.figshare.3380269.v1

The following features are checked using the bird pictures:

file	Ex-ExposureTime	Ex-FNumber	Ex-ExposureProgram	Ex-ISOSpeedRatings
test 1.jpg	1/1000s	F5.6	shutter priority	100
test 2.jpg	1/1000s	F5.0	shutter priority	100
test 3.jpg	1/1000s	F4.5	shutter priority	100

In the example above, the observer was then advised to set the camera to 200 ISO instead of 100. This routine check is processed at the start of each trip at sea. Cameras with integrated GPS make evaluation easier, however the GPS utility needs to be switched on and set up correctly.

2.9.1. How often should pictures be taken?

Now that almost all individuals are correctly illustrated in a catalogue in our zone, two different types of sightings are conducted by observers: quick sighting and accurate sighting:

	quick	accurate
What information is sought?	To know which social unit(s) is interacting with each longline	Best quality pictures of all individuals present during the sighting to update catalogue.
How much time should be dedicated to this?	5 - 10 minutes	30 minutes or more
Quality and quantity	Get pictures of main individuals to identify the social unit(s)	As many pictures as possible of all individuals on both sides
How many pictures	As many as possible during the limited time	No limit
Conditions?	Even pictures taken from the open door of the bridge can be informative	Good weather conditions to go outside, and sufficient light.

2.10. UPLOADING PICTURES

Once a photography session is completed, the observer takes the flash memory out of the camera and uses a card reader to connect to his laptop through the USB port, which is faster than connecting the camera directly via USB, and saves the camera battery life. A tool has been developed for observers at sea which allows to rename pictures of whales and other species straight away into a standardised format, making data management and data analysis substantially easier. This tool is described below.

2.11. PINT – A TOOL FOR RENAMING OBSERVER PHOTOGRAPHS AT SEA

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Abstract

Within the CCAMLR area, high quantities of images are collected by scientific observers at sea while performing the tasks outlined the Scheme on International Scientific Observation (SISO). These include photos of tags, cetaceans, birds and bird bands, fishing gear, or unusual and unidentified species. In order to maintain version control, to process and file the photographs efficiently, and to ensure compatibility and transferability between statistical subareas during different observer deployments, it is crucial to develop a common naming convention that allows to keep track of where, when, and on which vessel a picture was taken by whom, together with basic information on the picture content. This paper describes the naming convention discussed between MNHN, CapFish, MRAG and CEFAS and the development of a tool in excel.

Introduction

Within the CCAMLR area, high quantities of images are collected by scientific observers at sea while performing the tasks outlined the Scheme on International Scientific Observation (SISO). These include photos of tags, cetaceans, birds and bird bands, fishing gear, or unusual and unidentified species, and together form a record of the observer's deployment at sea during a given trip. The images are an essential reference collection that can be used either during or after the trip for analysis, data checks, identification help of species or any potential conflict or compliance issues. In order to maintain version control, to process and file the photographs efficiently, and to ensure compatibility and transferability between statistical subareas during different observer deployments, it is crucial to develop a common naming convention that allows to keep track of where, when, and on which vessel a picture was taken by whom, together with basic information on the picture content.

This issue was discussed during a meeting on observer data collection held at MRAG in London earlier this year with representatives from CCAMLR, MNHN, CapFish, MRAG and CEFAS. As a result, the present organisations who provide observers agreed to a common naming convention for their observers deployed within the CCAMLR Area (see below), and to the trial use of an excel tool for batch-implementing a chosen naming convention already used by French observers. The tool and naming convention are described below and in the annex. Sharing the same naming convention allows users to share scripts for data processing allowing among other things:

- enhanced photo identification,

- automation of picture-to-trip assignment based on defined codes; and
- Linking of each photo to the vessel C2 data using the fishing event reference.

In addition, the naming convention within the French EEZ also accounts for pictures taken of marine mammals taken from land, which is not done in other CCAMLR Subareas. The tool has been trialled at sea outside the French EEZ during the 2014/15 season.

Naming convention

The naming convention between MRAG, Capfish, MNHN and Cefas for at-sea observer (or from dry land) photographs contains the following information:

	at sea		on dry land	
	1415 AUS 15 11 AUBA P_013 SPW		1415 CRO 15 12 AUBA P_098 KIW new group	
characters	description	example	description	example
4	CCAMLR Season. This will remain unchanged throughout the season	1415	season	1415
3	The vessel name, this uses a 3 letter code taken from the first 3 letters of the vessels name, or if two words are used the first letter from the first word and second two from the second	AUS	dry land location code using 3 letters	CRO
2	year start of trip	15	year of picture	15
2	month start of trip	11	month of picture	12
4	Name of the photographer. This uses a 4 letters code, this code is unique and related to one observer only.	AUBA	photographer	AUBA
5	longline number (or fishing event number, start at 1 and go up consecutively)	P_013	sighting ID	P_098
3	species (3 letters ccamlr code)*	SPW	species (ccamlr code)	KIW
no constraint	comment (optional and should be kept short)		comment (optional and should be kept short)	new group

***** The species are designated with the standard CCAMLR species code. However there are additional non-CCAMLR codes that can be used or developed, some examples are shown below:

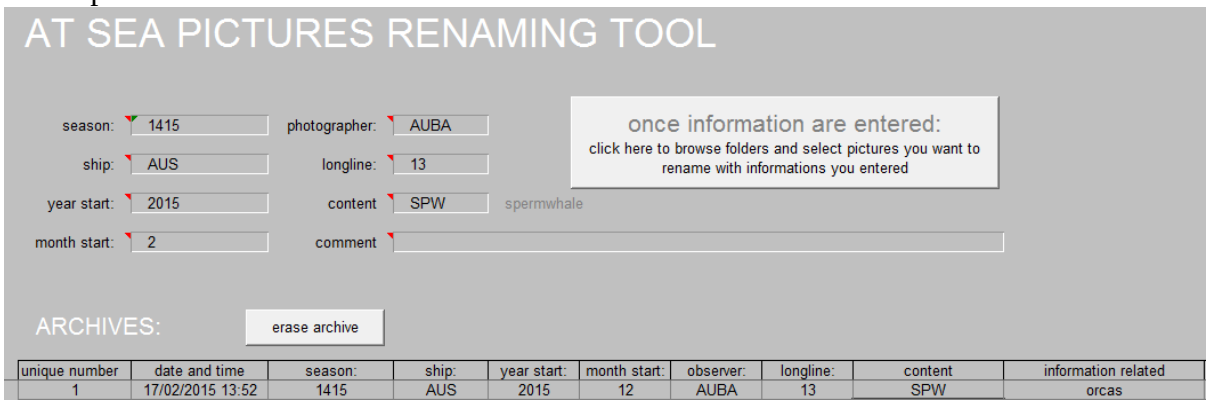
- **KSP –** Orcas and sperm whales together
- **TAG –** Tag return
- **BAN –** Bird band
- **GEA –** Fishing gear (hooks, line, weights etc.)
- **DEB –** Marine debris / oil
- **MIT –** Mitigation device
- **OTH –** Other event or object

- **Comment –** General comments, should be kept short. An example for tag recapture would be to enter the tag numbers with the lowest number first, space in between for example A213333 A213334.

The Picture Naming Tool (PiNT)

The picture naming tool allows observers to automatically rename anything from individual to large numbers of photos and to put them in a designated folder. Each photo will have a unique name generated through a number of fixed fields and codes. The instructions and outputs are shown below.

The interface allows to enter data using dropdown menus and to browse to folders to choose which pictures are to be renamed. Details are shown in the table below:



unique number	date and time	season:	ship:	year start:	month start:	observer:	longline:	content	information related
1	17/02/2015 13:52	1415	AUS	2015	12	AUBA	13	SPW	orcas

Drop down menus can be filled according to Subarea specifications, and conditional formatting highlights data with incorrect number of characters:

DROP DOWN MENU SOURCES

CONTENT

3 letters code	Species Name	Common Name
KIW	orcas	
SPW	spermwhale	
KSP	orcas + spermwhale	
AJH	Anthozoa	Anthozoa
AJZ	Alcyonacea	Alcyonacea soft corals
AQZ	Antipatharia	Black corals and thorny corals
ATX	Actiniaria	Sea anemones
AXT	Stylasteridae	Hydrocorals
AZN	Anthoathecatae	Hydroids, hydromedusae
BVH	Brachiopoda	Brachiopods, lamp shells
BWY	Bathylasmatidae	Barnacle
BZN	Bryozoa	Bryozoans
CNI	Cnidaria	Cnidarians nei
CSS	Scleractinia	Hard corals, stony corals
CVD	Cidaroida	Pencil urchins
CWD	Crinoidea	Feather stars and sea lilies
CXV	Chemosynthetic	Chemosynthetic communities
CZR	Chordata	Chordata
DMK	Adamussium colbecki	Antarctic scalop
DMO	Demospongiae	Siliceous sponges
ECH	Echinodermata	Echinoderms (starfish,urchins etc.)
GGW	Gorgoniidae	Gorgonians
HQZ	Hydrozoa	Hydrozoans
HXY	Hexactinellida	Glass sponge
NHE	Annelida	Annelid worms
NTW	Pennatulacea	Pennatulacea sea pens
OEQ	Euryalida	Basket stars
OOY	Ophiurida	Basket and snake stars
PBQ	Pterobranchia	Pterobranchs
SCX	Pectinidae	Scallops nei
SZS	Serpulidae	Serpulid tube worms
URX	Echinoidea	Sea urchins, etc. nei
XEF	Xenophyophora	Xenophyophores
ZOT	Zoanthidea	Zoanthids

PHOTOGRAPHER

4 letters code	information related:
ADER	Trop Ical
AUBA	
AUBJ	
BCHA	
BEAF	
BEAJ	
BEIL	
BERT	
BODI	
BOSIHDGF	
BOUN	
BOUT	
CADE	
CANT	
CAUV	
CPDV	
DELO	
DERR	
DISS	
ECOR	
FAUB	
FMOU	
GASC	
GASP	
GHOU	
GUIL	
HOAR	
JHUI	
MAKA	
OGRA	
RBOC	
SCAS	
THOM	

ship

3 letters code	information related:
T01	Tagan IOOO
AUS	
T03	
T04	
T05	
T06	
T07	
T08	
T09	
T10	
T11	
T12	
T13	
T14FDGH	
T15	
T16	
T17	
T18	
T19	
T20	
T21	
T22	
T23	
T24	
T25	
T26	
T27	
T28	
T29	
T30	
T31	
T32	
T33	
T34	
T35	
T36	

Conclusion

This paper gives a brief overview of a tool that can be used to easily rename photographs taken by observers during the season and suggests a format for the photograph names. We would recommend that a naming convention be considered by the secretariat as part of the SISO review, particularly in regards to those photos that are key to ensuring the quality of data collected, for example tag returns, so that they can easily be identified and accessed at a later date if necessary. We would also recommend that the PiNT be made available on the CCAMLR site as a resource for other members to use if needed.

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4. References

Tixier, P., Gasco, N., Duhamel, G., Viviant, M., Authier, M., Guinet, C. 2010. Interactions of Patagonian toothfish fisheries with killer and sperm whales off the Crozet islands: an assessment of depredation levels and insights on possible mitigation solutions. CCAMLR Science Series, 17: 179–195.