

PROTOCOLE

2014



# Scopoli's and Yelkouan Shearwater monitoring protocol for Mediterranean Small Islands

**Auteurs** : Lorraine Anselme et Jean-Patrick Durand (Parc National des calanques), Mathieu Thévenet (Conservatoire du littoral), Bernard Cadiou (Bretagne Vivante). Validé par les groupes de travail puffin de l'Initiative PIM

This document was drawn up by the CEN PACA agents and is one of the outcomes of the last Port-Cros workshop (June 2013, participants: OEC for Corse du Sud, CEN Corse for la Giraglia, CEN PACA for Marseilles Islands and the National Park of Port-Cros)

This protocol proposal is aimed at standardize the monitoring techniques for the Mediterranean colonies of shearwaters and provide a guideline of good practice concerning field study of this species. This document outlines the essential information needed for such activities, and also the basic security rules having to be followed to avoid accident on the field and to limit disturbance caused by observers.

## SUMMARY

Presentation of the species .....	3
- Scopoli's Shearwater <i>Calonectris diomedea diomedea</i>	3
- Yelkouan Shearwater <i>Puffinus yelkouan</i>	4
Necessary knowledge before going on site .....	5
- Fieldworker security	5
- Disturbing the colony	5
- Necessary equipment	5
Census method.....	7
- Nocturnal surveys	7
- Daytime surveys	7
- Mapping and data entry	8
Reproduction survey .....	10
- Main objective	10
- Timeframe, survey implementation and data to be gathered on site	10
- Data entry	12
- Banding operations	13
Knowledge of the environment.....	15

## Presentation of the species

- Scopoli's Shearwater *Calonectris diomedea diomedea*



Adult Scopoli's Shearwater (© JP. Durand, CEN PACA)

The Scopoli's Shearwater is the biggest nesting pelagic bird of the *procellariidae* species; it can measure between 45 to 56 centimetres long with a wingspan of 110 to 125 centimetres. The adult's average weight is 650g.

The top plumage is brown or greyish brown, and the bottom white. It has a large yellow beak that is lighter at the base and dark at the end with tubular nostrils.

This pelagic species only goes to the reproduction sites at night, except during incubation periods when an incubating adult will also be there during the day, from the end of February to mid-October. They only reproduce on islands or small islands and nest in holes, caves, trenches or burrows dug out by other species. They can also nest on the ground under plants, roots or even artificial places (such as holes in walls).

Breeding adults are part of colonies of various sizes, which can be monospecific or mixed (with the Yelkouan Shearwater). Adults remain faithful to their partners as well as to their reproduction site.

This species lays a single egg each year, which is completely white and which will not be replaced in case of failure. Synchronised laying occurs at the end of May and hatching at the beginning of July (end of July on the Balearic Islands). The average incubation time and rearing period are respectively 52 days and 89 days.

In autumn, after the reproduction period, the birds desert the Mediterranean colonies and migrate to the Atlantic coasts off southern Africa.

Their diet is mainly composed of small pelagic crustacean species, fish and cephalopods.

	Nov.	Dec.	January	February	March	April	May	June	July	August	Sept.	Oct.
Observation of the colonies												
Mating												
Laying												
Hatching												
Fledging												

	Presence on the colonies
	Activity period
	Absence

Phenology of the Scopoli's Shearwater

- Yelkouan Shearwater *Puffinus yelkouan*



Adult Yelkouan Shearwater (© N. Bazin, CEN PACA)

The Yelkouan Shearwater, endemic to the Mediterranean, is a pelagic bird of the *procellariidae* species which measures between 30 to 35 centimetres long with a wingspan of 73 to 88 centimetres. Its plumage is blackish brown on top, in sharp contrast with its underside and under its wings which are nearly completely white, apart from a dark part at the tip and posterior side of the wings as well as across the secondary coverts, and occasionally on their flanks or under the tail. Their legs are pink and black and the beak is black with tubular nostrils. They alternate between hovering and flapping their wings.

The colonies vary in size and are monospecific or mixed (with Scopoli's Shearwater). They are occupied from October to the end of July and are active only at night. The reproduction sites, strictly insular, are located on coastal cliffs where the couples nest in burrows, cracks, under big blocks of rock or in small caves. Adults remain faithful to their partners as well as to their reproduction site.

This species lays a single egg each year, which is completely white and which will not be replaced in case of failure. Synchronised laying occurs in March and hatching at the end of April. The young take flight at the beginning of July, and then disperse across the Mediterranean.

The species feeds offshore, eating crustaceans and pelagic fish which they can catch several dozen meters deep.

	Nov.	Dec.	January	February	March	April	May	June	July	August	Sept.	Oct.
Observation of the colonies												
Mating												
Laying												
Hatching												
Fledging												

	Presence on the colonies
	Activity period
	Absence

Phenology of Yelkouan Shearwater reproduction

The Yelkouan Shearwater populations located further south in the Mediterranean seem to present a more precocious reproduction phenology, North African populations (Zembretta, Tunisia) can be up to two weeks earlier compared to French populations.

## Necessary knowledge before going on site

### - Fieldworker security

The shearwater colonies are found in rough terrain. Therefore, fieldworker will often be working in dangerous areas (cliffs, slippery or brittle rocks...). The work may also sometimes take place at night. For all these reasons, the agents will have to take extreme care and not take any unnecessary risks. The nocturnal surveys imperatively require a previous daytime survey or excellent knowledge of the terrain. It is highly recommended to not work alone, or at least to work in pairs. One or more teams can be trained according to the available workforce and the size of the island to be surveyed

Of course operations must be avoided when the weather conditions are unfavourable (strong winds, rain...).

The use of appropriate security equipment can be necessary to advance and work in rough terrain and the more inaccessible areas (individual protection equipment: helmets, harnesses, ropes...).

For security reasons, the teams need to be able to communicate, with either portable radios or telephones. It is also important to be able to contact emergency services in case of a problem. In sectors where there is no available network, VHF devices enable contact with them.

### - Disturbing the colony

The agents must limit as much as possible any disruption to the birds of the colony. That is why it is important to move discretely, to make the least possible noise and to limit the amount of lighting used without however being in any danger. Beware of burrows collapsing under the weight of the observers, especially in areas of strong burrow density in loose soil. As some colonies can be found in areas of loose rocks, it is important to try not to cause any rocks to fall which could destroy other burrows. When taking breaks, move away from the burrows in order to limit any disruption to the birds.

### - Necessary equipment

The necessary equipment depends on the required measures. In addition to the lists bellow, security equipment is also needed (necessary individual equipment, radios and/or phones, VHF, good walking shoes...)

For reproduction monitoring and daytime survey operations:

- A good torch, if possible a small one. Even if a headlamp is sufficient, a pocket torch with rechargeable batteries is ideal. They are usually more manageable, more powerful and have a sharper beam. In deep burrows some individuals can often go by unnoticed with headlamps, whereas with a torch they would have been visible... Remember to bring spare batteries, or previously charged replacement batteries;
- A notebook, preferably small so it can easily fit in a pocket;
- Several pencils (they can easily be lost...). Avoid pens in case of rain or dropping the notebook in the sea, the data would be lost...
- Basemaps, if they exist, of the colonies with the locations of the burrows. This also allows to map out new discovered burrows;
- An endoscope, possibly, to explore the incubation parts of the nests that are not visible.

For nocturnal survey operations:

- A headlamp and spare batteries (sufficient lighting for night-time and allows to move with free hands);
- A notebook;
- Several pencils;
- Basemaps of the colonies with the burrow locations;
- Possibly an endoscope;
- A voice recorder: speakers + MP3 player with a good quality recording of the birdsong + cable. Bring spare batteries for the speakers and MP3 player.

For bird ringing operations requiring specific training, the necessary equipment will not be listed in this guideline.



Equipment required for shearwater monitoring and observation (© JP. Durand, CEN PACA)

## Census method

Globally there are two methods to consider for shearwater colony census, one based on the use of playback devices the other based on the inspection of potential reproduction cavities. These techniques are most often used in a complementary way, in order to obtain the most comprehensive census possible considering the limited access to the reproduction areas.

### - Nocturnal surveys

#### Main objective

Nocturnal surveys are based on locating the birds through vocal activity when they are present on the colonies. A powerful vocal recording system, replaying the birds' song, is used to stimulate the birds' vocal activities. This type of survey enables, on a large scale, to locate the reproduction colonies and, on a smaller scale, to precisely locate the shearwater burrows.

#### Census period

The surveys must be carried out over periods of moonless nights, when the birds are the most active on the colonies.

The most favourable periods to carry out this type of survey are before the birds start laying (pre-laying period) as well as during the feeding of the young. During these periods, the arrival of the birds back to the colonies at dusk, either looking for their partners to mate or trying to find their burrows, leads to intense vocal activity.

For the Yelkouan Shearwater the most conducive periods are from mid-February to mid-March and mid-May to the end of June; and for the Scopoli's Shearwater from mid-March to mid-May and mid-July to the end of August.

#### Colony census

Colony census can be carried out either from the sea on a light inflatable boat equipped with systems for broadcasting the birdsong and able to follow the coastline slowly, or on foot after disembarking on the island or the sector to be surveyed.

When the established birds are heard and there is a significant amount of activity, the presumed colony is then located on a map for future more precise surveying.

#### Reproduction site census

Precise location of reproduction sites is carried out nocturnally and on foot within a predefined sector. The birdsong is broadcasted regularly in order to refine the location of the burrows as the birds respond to the call. It is important to differentiate the birds on the ground that are generally confined to a reproduction site, from the birds flying that could be prospectors attracted by the recordings.

Once the burrow is located, its location is materialized on the site and natural landmarks are noted in order to be able to find it and map it later.

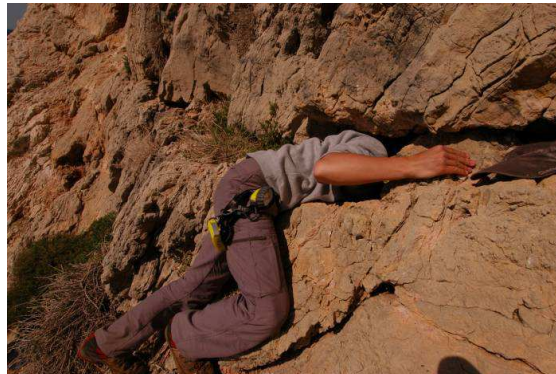
### - Daytime surveys

#### Main objective

The object of daytime surveys is based on searching for signs of presence of the shearwater in order to identify occupation and reproduction sites. Cavities where the shearwater might nest are inspected in search of signs of their presence such as droppings, feathers or the characteristic smell of shearwater burrows. There is a risk of possible confusion between signs of presence of the shearwater and that of seagulls, as some of the cavities can be occupied by adult seagulls for reproduction or by chicks sheltering there. It is therefore very important to be able to distinguish the feathers, the droppings and the smells of the two species

Sites presenting significant signs of presence are then further inspected with torches during favourable periods to search for the presence of individual birds. An endoscope can be useful for burrows where the incubation part is not visible.

The location of each occupied burrow is then noted and mapped.



Inspection of a potential reproduction site (© R. Graille)

#### Census period

These surveys can take place all through the shearwater reproductive season but prove to be more efficient and precise during the incubation phase or when they are feeding their young. Therefore in the periods between mid-March to mid-July for the Yelkouan shearwater and from the end of May to mid-October for the Scopoli's Shearwater.

#### Burrow inventory

Throughout the reproductive period the observation of shearwater droppings, feathers and smells indicate signs of occupation which enable to count the cavities occupied by the shearwater without however confirming that the couple is reproducing.

However, the presence of an egg (or eggshells), of down or of course of an incubating bird (or a chick) in a cavity is indisputable proof that it is being used as a reproduction site.

	March	April	May	June	July	August	Sept.	Oct.
Nocturnal surveys								
Daytime surveys								

Summarising spread sheet of favourable periods for Scopoli's Shearwater surveying

	February	March	April	May	June	July
Nocturnal surveys						
Daytime surveys						

Summarising spread sheet of favourable periods for Yelkouan Shearwater surveying

#### - Mapping and data entry

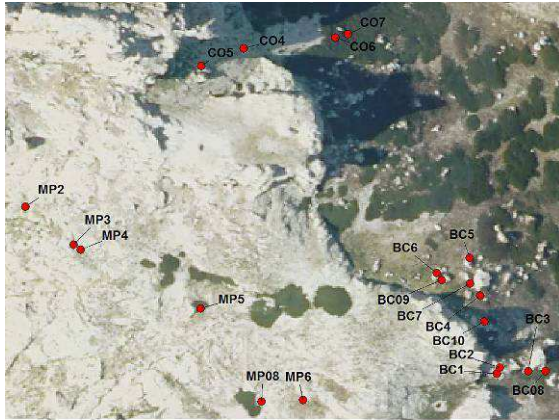
Located burrows are mapped on site with base maps such as aerial photos and integrated in a GIS (Geographical Information System) program. The cartography is then transcribed in a bound folder where all the burrows surveyed since the beginning of the operation are mapped enabling their location on site.

Each colony is named according to local toponymy and the burrows are listed according to precise nomenclature. Each burrow is given a unique code, which can be alphanumeric and contain information relative to its location (archipelago, island, colony, burrow number). For example, the burrow RJGN04 is a burrow located on the Riou (R) archipelago, on the island Jarre (J), on the *Grotte Nord* (GN) colony and it is the 4<sup>th</sup> burrow discovered there (04).

In parallel, a computerised database is created, compiling the information gathered each year on the occupation and reproduction status of each burrow.



Finally, each burrow is marked on site (using the established nomenclature) to allow easy location. The markings can be made with good quality outdoor paint, or with stainless steel signs marked with the burrow number.



GIS mapping of burrows (©CEN PACA)



shearwater burrow marked on site (©CEN PACA)

## Reproduction survey

Reproduction surveys enable the gathering of data to analyse population dynamics and the conditions of population conservation. It enables to follow the change in numbers of nesting birds throughout the years and particularly to assess reproduction success. These numbers are important indicators of the health of the populations. Finally, these kinds of surveys also allow assessing the efficiency of the management measures implemented on these populations.

### - Main objective

The monitoring of reproduction is carried out through nocturnal surveys, called inspections, where all the surveyed and mapped burrows are inspected.

Each known burrow, that has been occupied at least once during a reproductive season, is therefore checked during these inspections.

When the shearwater incubation chamber is visible, the inside of the burrow is inspected with a torch in order to check if reproducing birds are present. Observing signs of presence: droppings, feathers, down, footprints, chicks chirping or adults calling can also give information on whether or not the burrow is occupied if the incubation chamber is not visible.

### - Timeframe, survey implementation and data to be gathered on site

Shearwater reproduction surveys take place in 2 mandatory steps (at minimum) and another optional step, each one related to surveying a reproduction cycle phase of the bird:

#### Laying monitoring (Mandatory step)

Monitoring laying during the incubation period, allows to determine the minimum number of reproducing couples (couples having successfully reproduced and having laid an egg).

This process must be carried out:

- from the end of March to the beginning of April for the Yelkouan Shearwater;
- during the 2<sup>nd</sup> and the 3<sup>rd</sup> weeks of June for the Scopoli's Shearwater.

For each inspected burrow, the data gathered on site has been coded for more efficiency and are as follows:

- **cv** if the presence of an incubating adult is detected;
- **ft** if feather and footsteps are observed
- **mf** if both the male and the female are present (equivalent to « incubating »);
- **w** if a single egg is detected († if the egg is broken or predated);
- **0** if the incubation chamber is completely visible and the burrow is definitely empty;
- **cnv** (non visible chamber) if the incubation chamber is not completely visible and birds cannot be seen.
- **od** if a specific shearwater smell is detected



Scopoli's Shearwater incubating adult (© CEN PACA)



Droppings at the entrance of a Yelkouan Shearwater burrow (© CEN PACA)

### Hatching Monitoring (optional but recommended step)

This survey is to determine the number of chicks produced.

This process must be carried out:

- from the end of May to early June for the Yelkouan Shearwater;
- during the two last weeks of July Scopoli's Shearwater.

For each inspected burrow, the data to be gathered is as follows:

- **p** if a single chick is detected († if dead);
- **w** if a single egg is detected († if the egg is broken or predated). In which case there was a failure during the incubation period;
- **0** if the incubation chamber is completely visible and the burrow is definitely empty;
- **cnv** if the incubation chamber is not completely visible and birds cannot be seen. In which case the presence of shearwater droppings (**ft**), of feather (**pl**) and smell is detected (**od**)

Caution: the inspection of incubation chambers can be quite difficult. Indeed, young chicks are very small and can easily be hidden and seem to not be present in the burrows. So beware not to conclude that burrows are empty too quickly...



Young Scopoli's Shearwater chick (© CEN PACA)



Single Yelkouan Shearwater egg (© CEN PACA)

### Fledging Monitoring (mandatory step)

A final survey is done a few weeks before fledging in order to determine the number of young to take flight:

- from the end of June to early July for the Yelkouan Shearwater;
- from the end of September to early October for the Scopoli's Shearwater.

Chicks that reach this age are considered ready for flight and as a product of successful reproduction.

For each surveyed burrow, the data to be gathered is as follows:

- **p** if a single chick is detected († if dead);
- **w** if a single egg is detected († if the egg is broken or predated). In which case there was a failure during the incubation period;
- **0** if the incubation chamber is completely visible and the burrow is definitely empty;
- **cnv** if the incubation chamber is not completely visible and birds cannot be seen. In which case the presence of shearwater droppings (**ft**), of feather (**pl**) and smell is detected (**od**)

The abundant presence of chick down around a nest, during fledging monitoring, can be considered as proof of successful reproduction and as an indicator of the near fledging of the young Shearwater.



Young Scopoli's Shearwater a few days before fledging (© CEN PACA)

	March	April	May	June	July	August	Sept.	Oct.
Yelkouan								
Scopoli's								

Laying monitoring
 Hatching Monitoring
 Fledging Monitoring

### Summarising spread sheet of reproduction survey periods for both species

#### - Data entry

The observations made during the reproduction season are recorded on field form gathering all the information necessary for the survey.

This field form must contain the following information:

- The date and the name of the person carrying out the survey ;
- The name of the island, the colony and the burrow ;
- The species present in the burrow : CALDIO (Scopoli's Shearwater) or PUFYEL (Yelkouan Shearwater) ;
- The observations made at the burrow: see codes above.

#### Bordereau Suivi repro CALDIO/PUFYEL

Date : 11 / 06 / 2012

Observateur(s) : JPD

Fiche n° 1 sur 1

Nom terrier	Obs terrier	Sp.	Remarques	Nom terrier	Obs terrier	Sp.	Remarques
RRSF01	cv	CD					
RRSF02	cv	CD					
RRSF03	0	CD					
RRSF04	cnv	CD	ft / od				
RRSF05	cv	CD					
RRSF06	w	CD	Seul, non prédaté				

An example of a field form that can be used for shearwater

The data is then compiled in a computerised database to archive all the information gathered about the shearwater populations.

1	Espece	lie	Colonie	Terrier	Date	obs terrier	remarques	Nature du terrier	Heure	observateur(s)
7948	CALDIO	Riou	Grotte yelkouans	RRGY10	31/05/2011	cv		arg	jour	JPD / CEP
7949	CALDIO	Riou	Grotte Yelkouans	RRGY02	31/05/2011	cv		nat	jour	JPD / CEP
7950	CALDIO	Riou	Grotte yelkouans	RRGY11	31/05/2011	cv		nat	jour	JPD / CEP
7951	CALDIO	Riou	Grotte yelkouans	RRGY12	31/05/2011	crw	ft++	nat	jour	JPD / CEP
8306	PUFYEL	Riou	Grotte yelkouans	RRGY09	28/06/2011	pmf	Pas de duvet	arg	jour	JPD / CEP / NIB / MAI
8307	PUFYEL	Riou	Grotte yelkouans	RRGY09	28/06/2011	pmf		arg	jour	JPD / CEP / NIB / MAI
8308	PUFYEL	Riou	Grotte yelkouans	RRGY09	28/06/2011	pmf		arg	jour	JPD / CEP / NIB / MAI
8309	PUFYEL	Riou	Grotte yelkouans	RRGY05	28/06/2011	p	Duvet tête	arg	nuit	JPD / CEP / NIB / MAI
8310	PUFYEL	Riou	Grotte yelkouans	RRGY06	28/06/2011	p	Duvet tête	arg	nuit	JPD / CEP / NIB / MAI
8311	PUFYEL	Riou	Grotte Yelkouans	RRGY13	28/06/2011	pa		arg	nuit	JPD / CEP / NIB / MAI
8312	PUFYEL	Riou	Grotte Yelkouans	RRGY13	28/06/2011	p		arg	nuit	JPD / CEP / NIB / MAI
8313	PUFYEL	Riou	Grotte Yelkouans	RRGY14	28/06/2011	p		nat	nuit	JPD / CEP / NIB / MAI
8333	CALDIO	Riou	Grotte yelkouans	RRGY11	28/06/2011	cv		nat	jour	JPD / CEP / NIB / MAI
8334	PUFYEL	Riou	Grotte Yelkouans	RRGY01	28/06/2011	0		nat	jour	JPD / CEP / NIB / MAI
8335	PUFYEL	Riou	Grotte yelkouans	RRGY04	28/06/2011	0		nat	jour	JPD / CEP / NIB / MAI
8360	CALDIO	Riou	Grotte yelkouans	RRGY10	02/08/2011	-		arg	jour	JPD / NIB / CEP
8426	CALDIO	Riou	Grotte yelkouans	RRGY10	03/08/2011	p		arg	jour	JPD / NIB / CEP
8427	CALDIO	Riou	Grotte Yelkouans	RRGY02	03/08/2011	crw	ft+	nat	jour	JPD / NIB / CEP
8428	CALDIO	Riou	Grotte yelkouans	RRGY11	03/08/2011	crw	ft	nat	jour	JPD / NIB / CEP
8429	CALDIO	Riou	Grotte yelkouans	RRGY12	03/08/2011	crw		nat	jour	JPD / NIB / CEP
8686	CALDIO	Riou	Grotte yelkouans	RRGY12	05/08/2011	pmf		nat	nuit	JPD / CEP
8905	CALDIO	Riou	Grotte yelkouans	RRGY10	28/09/2011	p		arg	jour	JPD / CEP
8942	CALDIO	Riou	Grotte Yelkouans	RRGY02	28/09/2011	crw		nat	jour	JPD / CEP
8943	CALDIO	Riou	Grotte yelkouans	RRGY11	28/09/2011	crw		nat	jour	JPD / CEP
8944	CALDIO	Riou	Grotte yelkouans	RRGY12	28/09/2011	crw	ft	nat	jour	JPD / CEP
10548										
10549										

An example of a Database gathering breeding monitoring information

A second, more synthetic file is also produced each year with the information on the various phases of the reproductive cycle for each burrow as well as the reproductive failures. This file is used to make calculations relative to the reproduction surveys.

- **Banding operations**

Bird banding allows to gain biological and ecological knowledge of a species. It allows to identify individual birds and to improve knowledge on the species demography. Ringing quantify recruitment and the exchanges between different colonies, it helps to estimate the birds' longevity and age of sexual maturity and it helps to obtain data on the birds' behaviours such as philopatry.

Banding consist of putting a metallic ring engraved with a unique number around the bird's tarsus.

Biometric measurements (weight, beak length, height of the beak nostrils and hook...) are also recorded during these operations.

In order not to disturb reproduction and risking the destruction of the eggs, adult banding must take place outside of incubation periods. These operations can therefore be carried out during two periods, preferably on moonless nights or the nights just before or just after:

- during pre-laying periods, namely during colony prospection or mating periods ;
- when the birds are raising their young, however, after the chicks are at least 15 days old.

Banding the young, however, takes place about 15 days before fledging, day or night.

**Note that these delicate operations can turn out to be relatively dangerous for the birds if they are not carried out correctly. That is why the capture of shearwaters must only be done by qualified people holding valid permits.**

As banding operations require specific training, we will not list here the favourable banding periods nor the recording, entry and analysis of the data.



**Banding of a young Yelkouan Shearwater before fledging (© CEN PACA)  
PACA)**



**Biometric measurements of a young Scopoli's Shearwater (© CEN**

## Knowledge of the environment

When the agents are on site, it is important that they are aware of the different signs of shearwater presence. Very often, new nesting sites are found during on-site excursions for other motives. Agents should not hesitate to inspect cavities that seem favourable and that have droppings at the entrance. Furthermore, the shearwater smell being rather strong and specific could be an indication that would lead to searching for a burrow in a certain place.

Note that shearwaters can use a very wide range of habitats, and therefore no types of habitat should be neglected for inspection: rocky areas, landslides, canopy, loose ground, artificial constructions... Also, shearwaters can nest a few meters from the sea, as well as inland or at the top of the island.

As the shearwaters are sensitive to disruption, it is best to avoid revealing the exact location of the nesting sites to people not involved in their management.

It is also interesting to be able to identify different signs of shearwater predators. The main shearwater predators are the Black Rat (for the eggs and the young chicks), the feral cat (for the adults) and the European Grand-duc (mainly for the adults and the young fledglings). There have also been descriptions of cases of Peregrine Falcons specialised in catching Yelkouan Shearwater, and in rarer cases Scopoli's Shearwater, at the entrance of their burrows.

On colonies where big snakes are present, monitor to see if a larger number of reproduction failures are recorded.

European rabbits can come into competition with the shearwaters over territory when the birds nest in the rabbits' burrows. They can cause disruptions, crush the eggs, or cause the collapse of the cavities used by the shearwaters

In case of reproduction failure, it is interesting to look out for possible signs near the burrow that could explain the reason of the failure.

Some characteristic examples of shearwater predation:

- Usually, the European Eagle-Owl rips its prey's head and wings off.



© JP. Durand, CEN PACA)



Scopoli's Shearwater's head and wings ripped off by the European Eagle-Owl (©CEN PACA)



European Eagle-Owl pellets containing a Scopoli's Shearwater band (©CEN PACA)

- Predation cases on the Yelkouan Shearwater show that the Peregrine Falcon operates in the same way.



**Yelkouan Shearwater corpses predated by a Peregrine Falcon (© JP. Durand, CEN PACA)**

- The contents of the eggs predated by rats are consumed and the shells show signs of predation, generally holes or teeth-marks.



**Broken egg not predated by a rat (©CEN PACA)**



**Egg showing signs of predation by a rat (© CEN PACA)**



## Data analysis (reproduction parameter calculations)

Surveying reproduction allows to obtain data providing important information about the health of populations, about their conservation status and to identify certain on site disruptions.

It at least provides data on:

- the number of occupied burrows: burrows where birds are directly observed or significant signs of occupation are present;
- the number of reproducing couples: burrows where an egg, an incubating adult, a chick or down are identified ;
- the number of young produced: the number of young birds identified before fledging.

This data, gathered during surveys several times a year, allows to know if a population is expanding and provides the first elements to study the population's health and the evolution of the number of nesters.

Reproduction surveys also allow to know the number of couples having successfully reproduced and laid an egg and the number of fully fledged young.

### Breeding success

The breeding Success (BS) will be calculated as follows:

The baseline is the number of breeding pairs (A) => determined at the first monitoring step: All the incubating adults and the intact eggs observed. The second important number (B) is determined at the 3<sup>rd</sup> step: all the chicks observed or heard during the survey.

$$BS = B/A$$

**When calculating the Breeding Success and to avoid an overestimation, it is important to only take in account burrows for which information has been recorded since the first monitoring step**

For example, for a specific burrow, if the incubation chamber is not visible during the incubation survey and the young bird is then identified during the fledging phase, the couple will not be taken into account in the reproductive success calculations because the adult was not identified when incubating. The fledgling however may be taken into account into the number of fully fledged young.

Reproductive success is an essential parameter that enables to measure the health of a population.

Large variations in the reproductive success numbers show the existence of disruptive factors that have an impact on reproduction and the demographic dynamic of the Shearwater populations. Furthermore, a reproductive success rate below 0.5 young / couple shows that the population cannot be maintained without recruiting.

Example of spread sheet summarising the results of the annual reproduction site surveys and the number of mating birds of a species of Shearwater:

Island	Surveyed Burrows	Inspected Burrows	Occupied Burrows	Number of mating birds
Petit Congloué	10	10	8	8
Grand Congloué	18	18	18	15
Plane	8	7	7	6
Jarre	30	30	20	17
Riou	324	311	255	217
<b>Total Riou archipelago</b>	<b>391</b>	<b>377</b>	<b>308</b>	<b>263</b>

Surveyed burrows = number of burrows occupied at least once by mating couples.

Inspected burrows = number of burrows having been inspected at least once during the reproduction period

Occupied burrows = number of burrows where the presence of birds is certain (droppings, feathers, down, smells)

Number of mating birds = number of burrows where the presence of eggs or chicks is certain

Example of spread sheet summarising the results of the annual reproductive success surveys of a species of shearwater:

Island	Number of incubating couples <sup>(1)</sup>	Number of eggs hatched	Number of fully fledged young	Reproductive success <sup>(2)</sup>
Petit Congloué	8	7	7	0,88
Grand Congloué	12	11	11	0,92
Plane	5	4	4	0,80
Jarre	13	11	10	0,77
Riou	149	129	130	0,87
<b>Riou archipelago</b>	<b>187</b>	<b>162</b>	<b>162</b>	<b>0,87</b>

<sup>(1)</sup> couples with completely reliable laying and fledging surveys

<sup>(2)</sup> number of fully fledged young / number of incubating couples