Monitoring colonial gulls & terns and waders on the French Mediterranean coast

Protocol based on a document by Nicolas Sadoul (Friends of the Vigueirat Marsh or AMV), 6 May 2011, which was modified by the Tour du Valat (TdV).

1) Method and site bias: at a given moment

Question raised: How many pairs are there in the colony the day I observe it?

a) Remote surveys of incubating birds

Distance surveys of incubating birds are recommended compared to ground surveys. It is strongly advised to not go into the colonies when they are being established (less than 25% of birds nested) or after the first chicks hatch. Distance surveys of incubating birds are preferable to censuses on foot for low-density colonies in habitats with good visibility (limited vegetation, observation point higher than the colony, short distance between observer and colony).

To reduce the biases due to not detecting individuals (significant underestimation, often greater than 50%), the following recommendations should be followed:

- Map the colony to compartmentalize it, and conduct surveys compartment by compartment.
- Use the same observation points so that the surveys will be comparable.
- Try to clearly distinguish between incubating birds and ones that are resting (learning).
- Move closer to the colony, if necessary, by using a hide.

b) Aerial surveys

A lack of visibility and difficult access to the colony site can make both inventory methods (on foot and at a distance) ineffective. This is particularly true of gull colonies established in reed beds. In this case, aerial surveying is the only valid method. The counts are carried out using photos.

Bias in aerial surveys is linked to the difficulty of distinguishing between incubating birds and ones at rest, and also distinguishing between species. Reducing this bias is linked to the quality of the photos, and we recommend to:

- Fly 300 feet above the colony.
- Use a high quality digital camera to be able to count by zooming in on its screen.
- Photograph the colony from the most vertical point of view.
- Conduct survey when the wind is light for a more comfortable flight and to avoid visual obstacles caused by moving vegetation.

2) Method and site bias: entire season

Question raised: How many breeding pairs were there in the colony for the year concerned?

a) Small colonial gulls & terns and waders

It is worth nothing that the total number of pairs having laid eggs remains unknown due to the desynchronized nature of their nesting and the impossibility of distinguishing between the pairs themselves. Likewise, for each counting session, observers can count the number of pairs that laid eggs before the current counting operation and still present, but cannot know the number of pairs that failed before this observation session. Even the individual marking of nests during the first counting session would not enable a distinction to be made between the eggs laid by new pairs that have just nested (and that must be counted) and the replacement clutches of pairs that failed between the two counting sessions at the same colony, which should not be counted.

Consequently, the best method is to count the number of pairs present at the peak laying time.

Small colonial gulls & terns and waders show strong inter-annual, inter-colony (Figure 1), and inter-species phenological variation (Figure 2). In these conditions, it is therefore impossible to know in advance the date of the peak laying time for a particular species in a particular colony. Only periodical monitoring of nesting can enable this peak season to be identified *a posteriori*.

A **weekly survey** would appear to be the best compromise between the need to conduct regular monitoring due to the rapidly increasing numbers of birds in the colonies, the need to reduce the impact of disturbing waterbirds, and the small amount of time that can be invested.

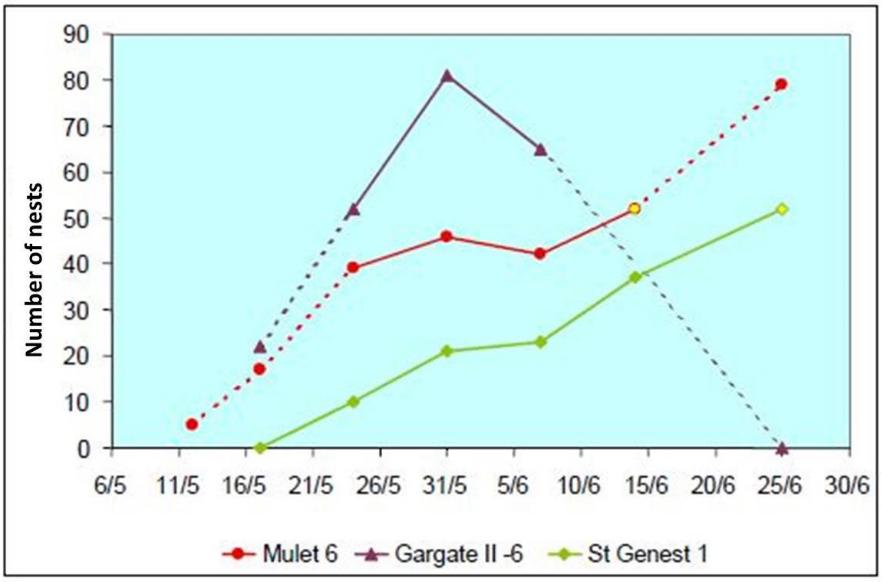


Figure 1. Example of variation in the reproductive phenology of the Common Tern in three colonies in the Salin de Giraud saltworks area (source AMV/TdV).

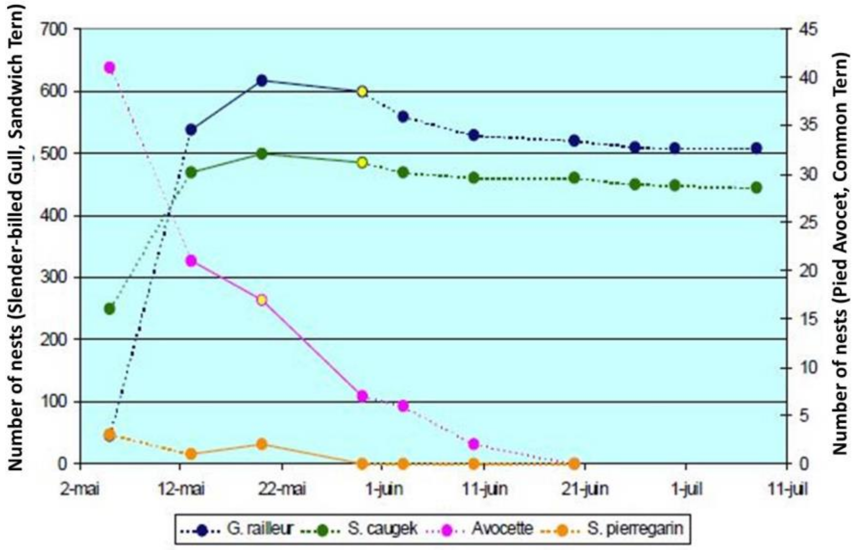


Figure 2. Example of variation in the reproductive phenology of a multi-species colony in the Aigues-Mortes saltpan area (source AMV/TdV).

If the colony fails and abandons the site, the site must be systematically observed to search for any clue that can help identify the causes of the failure: mammal tracks (dog, fox, wild boar...), remains of egg shells (a single well-defined hole = predation by Corvidae, broken eggs = predation by gulls, crushed eggs = predation by mammals) or chicks, signs of flooding. These observations will be entered in the database.

b) Yellow-legged Gull

Inventories of Yellow-legged Gull colonies require the same methodology. However, the large number of colonies to be monitored and their wide geographic range make regular monitoring impossible for practical reasons. Only a one-time count for each colony can be envisaged. Therefore, it is very important to base the observation date on the expected peak egg laying date in order to reduce the bias. The monitoring of a sample of marked nests in two colonies in the Camargue enabled us to show that egg laying is spread over about one month, and that the effect of the monitoring date is key in terms of the number of nests detected: the egg-laying peak occurs when the first chicks begin to hatch, and 81% to 96% of the total number of nests were in fact detected on that date in the two colonies monitored. Six to nine days before that date, the estimated numbers are between 72% and 76%!!

Therefore, a survey conducted during the second week of April, when the first chicks start hatching, would appear to be the best choice.

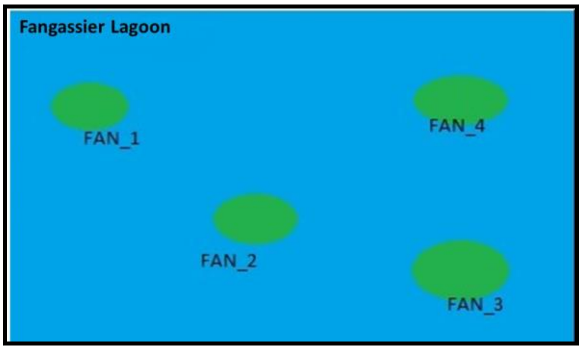
It should be noted, that we are not sure of the degree of inter-annual variation in terms of the first hatchings. Likewise, the laying dates vary to some extent in the different places. Finally, the big colonies in which there are several hundred pairs, as was the case for the two colonies studied, are generally characterized by earlier egg laying than smaller colonies or isolated pairs. Therefore, it seems to be preferable to begin the censuses in the biggest colonies before moving on to the other ones during the third week of April.

3) Method and regional bias*: detecting and naming of colonies*

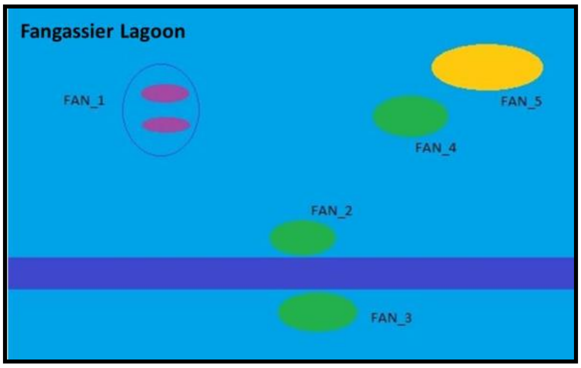
Question raised: How can colonies be detected, named, and managed?

Monitoring colonial gulls & terns and waders is considered to be a long-term project. Therefore, data must be saved in a standardised database that will be understandable to the people in charge of future monitoring. Each nesting site must be located and plotted precisely on a map. Each site receives a unique name, and its geographic coordinates are recorded using a GPS receiver so they can be integrated in a Geographic Information System. We recommend that the name of the lagoon or marsh where the site is located be used as the reference name, and to add a number or letter. For example, four islets occupied in the Fangassier lagoon could be named Fangassier_1, Fangassier_2, Fangassier_3, and Fangassier_4, and encoded as FAN_1, FAN_2, FAN_3, and FAN_4 (be sure that the codes remain unique). We recommend that each site be clearly delimited as a unique physical entity. The idea is to be able to understand trends in colonies in function of these entities:

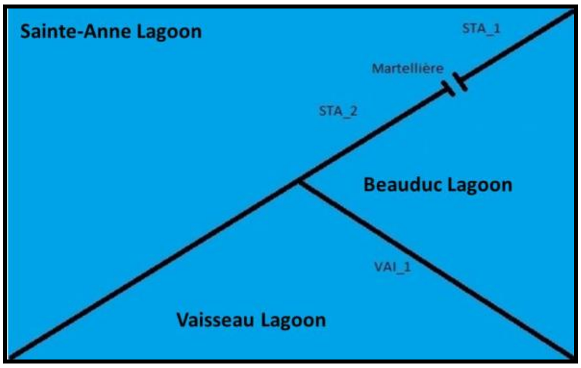
- Example 1. Two distinctly separate islets, each of which represents a different entity and is given its own name.



- Example 2. Two islets only a few meters apart. If the islets feature different vegetation (see FAN 4 and FAN_5 below), it is a good idea to record this information because the breeding success in the colonies might be different. The situation is similar if one of the islets is separated from the shore by a deep channel, while the other is separated from the shore by only shallow water (see FAN_2 and FAN_3 below): these two different situations may lead to two different levels of reproductive success. On the contrary, if two islets are physically similar (see FAN_1 below), they may be given the same name.



- Example 3. The case of a colony established on a dike or the shore of a lagoon. By convention, the section of the dike between two transects is given a unique name. In the long term, the section of the uniquely identified dike can be shortened if there is an easily identifiable topographic point of reference (see STA_1 and STA_2 below).



We recommend keeping a reference map in the office of all of the historical nesting sites, and bringing a copy of it to the field to be able to identify each site occupied during the survey and to locate new sites. The reference map can then be updated at the end of the season. Likewise, a general map of the areas surveyed must be established and updated on a regular basis. In this way, we can determine whether the appearance of a colony on a new site corresponds to the recent colonisation of this site in an area regularly surveyed or to a colonisation that is perhaps much older on a site located in an area that has not yet been surveyed (extension of the surveying zone). Small colonial gulls & terns and waders are very mobile species, and a high level of nest-site change is observed from one year to the next. This explains why the counting of these species requires all of the monitoring area to be surveyed on a weekly basis. To be more certain, at the end of the breeding season, enter a ‘0’ in the ‘numbers’ field in the database for all the historical nesting sites surveyed in the colonies, in which there were no occupants. The detection of colonies varies according to their size and the habitats concerned. An observer can easily miss small colonies in which there are only a few pairs. The only way to reduce the probability of missing colonies is to search for them in a systematic way: each pond, lagoon, and marsh must be thoroughly observed with binoculars, preferably from several observation points so as to avoid the blind spots. This method of surveying must be as standardised as possible in order to reduce the variability in the survey from one year to the next. When it is impossible to verbally transfer this method of surveying from one surveyor to another in the field, it would be ideal to be able to formalize it in writing (map of the routes and observation points).

Finally, be sure to obtain the authorisation needed to access the survey areas before the beginning of the season so that you can survey the entire study area. If access to a given area is impossible, specify this by entering a ‘?’ in the ‘numbers’ field in the database for all the historical nesting sites that could not be surveyed.

4) Method and regional bias*: regional assessment*

Question raised: How many breeding pairs were there in the Region for the year concerned?

A census of breeding pairs in a Region, Department, or local community aims to account for all the pairs present in all the colonies surveyed. When there is synchronised breeding in different colonies, the difference between the numbers at the peak of abundance and the sum of the maximum numbers of each colony is minimal. In the example of the Mediterranean gull (Figure 3), there were 533 pairs at the peak of abundance, while the sum of the all pairs in each colony was 534.

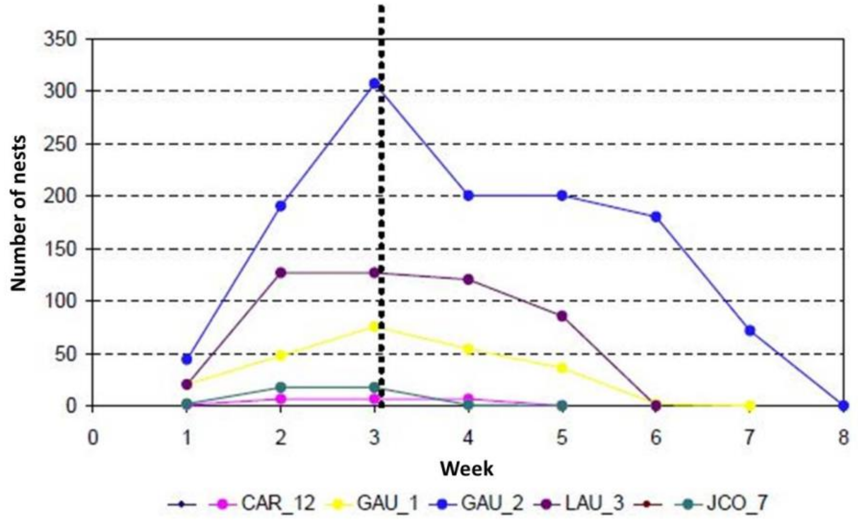


Figure 3. Example of trend in the number of Mediterranean Gull nests in the Camargue (source AMV/TdV)

Meanwhile, when breeding is desynchronized, the difference between the two estimates can be quite important. In the example of the Common Tern (Figure 4), there were 582 pairs at the peak of abundance, whereas the sum of the maximum number of pairs (circled in orange) is 860 pairs!

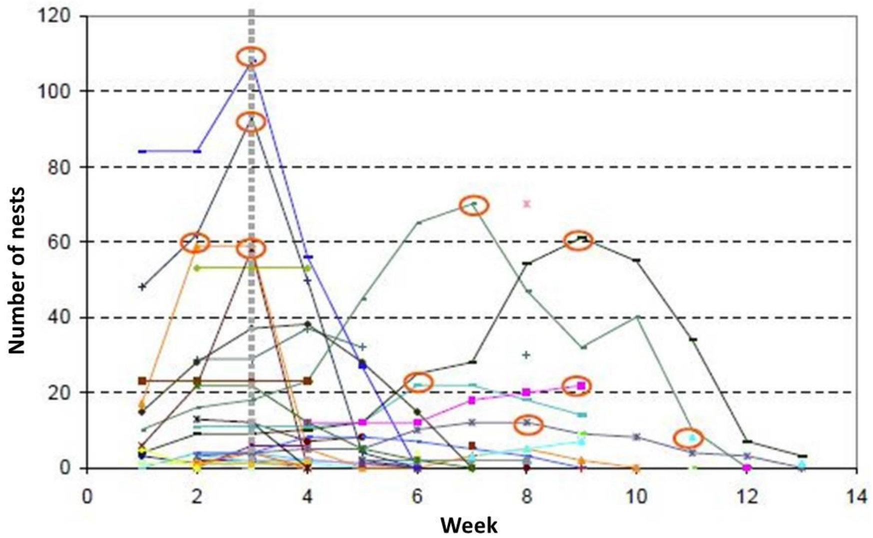


Figure 4. Example of trend in the number of Common tern nests in 2008 in the Camargue (source AMV/TdV)

Which estimate is closest to the actual number of pairs?

The number of pairs at the peak of abundance is an underestimation of the actual number of pairs, because it does not take account of early pairs that failed and did not lay eggs again before the peak, or late pairs that laid eggs after the peak. Not biased by double counting (probability of counting the same pairs twice), this form of estimation can be considered to produce the minimum number of breeding pairs (in the example of the Common tern in Figure 4, we can be sure that there were least 582 pairs, since they were all nesting there at the same time). The major disadvantage of the estimation of numbers based on the sum of the maximum number of pairs in each colony is that it is highly dependent on the rate of renesting in colonies. When there is no renesting, it is the most accurate estimator, because it takes account of early and late breeding, whereas when the renesting rate is significant, all the birds that failed on one site before renesting on another are counted twice. This estimator can be considered to return the maximum number of breeding pairs.
The renesting and redistribution of pairs that failed at the beginning of the season is a frequent phenomenon among small colonial gulls & terns and waders. This phenomenon is to a large extent responsible for desynchronized breeding in different colonies.
The estimation of numbers of pairs at the peak of abundance shows less bias, so it is more appropriate for these species. However, the results can also be presented as a range of values (2008 numbers for the Common tern = 582 to 860 pairs), the actual number would quite certainly fall between these two estimates and closer to the first than to the second.

5) Data compilation

The results from each count are compiled in an Excel file named "Gulls & terns and waders census". Each line corresponds to the count of a species in a colony on a given date. The following columns (presented here in a line) are to be filled in:

Location - Date - Species	Place	Name of place: Salins de Giraud, Tour du Valat
	Lagoon	Name of lagoon: Launes Lagoon, Fangassier Lagon
	Colony	Colony code: LAU_1
	Date	Date of count
	Week	Week of count
	Species	Chroicocephalus genei - CHRGEN
		Chroicocephalus ridibundus - CHRRID
		Larus melanocephalus - LARMEL
		Sterna hirundo - STEHIR
		Sterna sandvicensis - STESAN
		Sterna nilotica - STENIL
		Sternula albifrons - STEALB
		Recurvirostra avosetta - RECAVO
Counts	P1	Number of nests with 1 chick
	P2	Number of nests with 2 chicks
	P3	Number of nests with 3 chicks
	P4	Number of nests with 4 chicks
	P5	Number of nests with 5 chicks
	Nest	Number of nests occupied, but no indications on the number of chicks
	Total	Sum of columns (P1-P2-P3-P4-P5-Nest)
Remarks	Any information useful in terms of monitoring, predation, causes of abandonment, etc.	
Observers	Name(s) of observer(s)	

This file is used to compile the data gathered to estimate the number of pairs of each species in a particular Region.

Site	Week19	Week20	Week21	Week22	Week23	Week24	Week25	Week26	Week27	Week28	Week29	MAX
CAR_0				0	1	0						1
CAR_25			0	2	0							2
ESQ_4	0	12	0									12
JNO_23	0	2	0									2
MAI_5				0	14	0						14
MAR_1			0	1	1	0						1
MAR_3		0	22	17	1	0						22
PAL_4		47	70	81	69	57	29	0	0	0		81
PAV_29	0		0	1	0							1
PRA_2		1	0	20	0							20
QUA2_0						0	11	0				11
QUA2_1				0	3	1	0					3
QUA2_3				0	5	0						5
QUA2_6				0	1	0						1
QUA3_3			0	9	29	58	61	18	2	0		61
RAS_1					0	1	0					1
RAS_13		0	1	0								1
RAS_4					0	1	0					1
REM_9	4	4	5	4	3	0						5
VAC_20	24	52	47	47	41	13	9	4	4	0	0	52
GAU_1	35	35	45	45								45
Total	63	153	190	227	168	131	110	22	6	0	0	342

(yellow)	First chicks hatch
Blue	Distance estimations
Red	Estimate
Green	Aerial count

For the colonies that are not surveyed one week (in red in the table above), numbers are estimated as the average of the number in the previous week and the subsequent week. When no monitoring figures are available for the previous week, it is the number from the following week alone that is reported.

Notice how important it is to indicate that there is no colony (number = 0) for counting the total number of pairs. When this is not done, it is necessary to make an estimate based on the number of pairs from the previous or subsequent week.
Reminder: following the abandonment of a colony, the site is visited on foot to look for any clues enabling the causes of the failure to be identified.

6) Monitoring breeding productivity (number of fledged chicks)

The variation in the number of chicks depends on a whole set of local and external factors, and is not a sufficiently adequate indicator of the condition of a local population. In addition to the fact that a drop in the local numbers can occur several years after the events having caused problems locally, the movement of individuals between colonies can prevent us from detecting conservation issues. For example, a high level of immigration can result in a strong increase in the number of breeding pairs in a particular place, at a particular time, but the colonies present locally cannot alone produce enough chicks to maintain the local population.

That explains in part why breeding success is a parameter of primary interest, because it is highly dependent on local factors, such as food and predation, and is immediately affected by any changes.

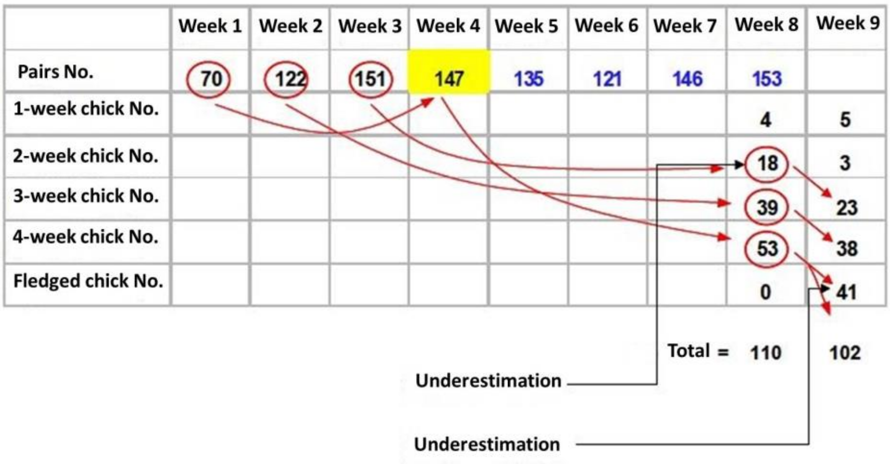
Using marked nests, breeding success is expressed as of the number of chicks that succeed in leaving their nest. This scientific approach requires a major time investment and a set up in the field (marking of chicks in the nest, construction of a barrier around each nest), which is often incompatible with the colony’s need to not be disturbed. Another, less precise approach consists in comparing the total number of chicks before fledging and the total number of pairs estimated during the initial count. This method is not very precise in terms of breeding productivity, and it does not enable small differences between colonies to be identified. However, it does enable us to ascertain if breeding was mediocre or rather good in a colony, and if no breeding occurred. This level of precision seems to be adequate in terms of meeting the initial conservation objectives. The aim here is not to count the maximum number of flight capable chicks, bred in a colony, rather the number of flight capable chicks bred by the pairs counted at a given time. Most often, this moment corresponds to the time at which:

The number of breeding pairs is the highest in a week close to the hatching (week 3 in the example below). All the chicks from pairs that nested after this week must not be counted. As it takes time for chicks to grow, they are only counted 3 to 4 weeks after the first chicks hatch (week 8 below), i.e., just when the first chicks that hatched (in week 4) are four weeks old, and close to fledging. As its chicks develop more rapidly, for the Little tern, the first count should be made 3 weeks after the first chicks hatch.

To optimise the quality of the chick counts, colony monitoring from a distance often requires a portable blind to be able to approach it. Chicks often hide in vegetation, so you should take time when counting and observe feeding by the parents (the chicks come out of the vegetation to eat). The chicks are counted by one-week age groups based on the following criteria:

Week 1: downy plumage
Week 2: moult of the body (appearance of feathers on the body)
Week 3: moult of the head
Week 4: full plumage (or nearly)

In the following example, the aim is to estimate the number of flight-capable chicks produced by the 151 pairs counted in week 3. These 151 pairs include the birds that laid eggs in weeks 1, 2, and 3. During week 8, the 1- to 4-week old chicks are observed. The 4-week old chicks are the ones that hatched in week 4, from the eggs laid by the 70 pairs that nested in week 1. The 3-week old chicks are those from eggs laid in week 2, and so on. The total number of these chicks counted in week 8 is 110.



However, the number of 2-week old chicks is highly underestimated. Because of their age, they are often not very mobile, and hidden in the vegetation.
To complete this count, a second count was conducted one week later. The chicks that were 2 weeks old in week 8 were 3 weeks old in week 9. But the chicks that were 4 weeks old in week 8 could fly in week 9, and their occasional flights away from the colony means that their numbers were underestimated in this count. The final count was thus the total number of chicks that were 3 and 4 weeks old in week 9, plus the chicks that were 4 weeks old in week 8: 53 + 38 + 23 = 114 chicks. Therefore, productivity in the colony is 114/151 = 0.75 chicks per pair. It is worth noting that the 8 chicks that were 1 and 2 weeks old in week 9 are not counted, because they hatched from eggs laid after week 3. Due to the lack of precision in distance surveys, the number of chicks is generally underestimated. That explains why it is preferable to express productivity as a range of values:

Productivity 0: no flight-capable chicks
Productivity 1: 0< Productivity ≤ 0.1 chicks per pair
Productivity 2: 0.1 < Productivity ≤ 0.5 chicks per pair
Productivity 3: 0.5 < Productivity ≤ 1 chick per pair
Productivity 4: Productivity > 1 chick per pair.

In the example above, the productivity estimated to be 0.75 chicks per pair corresponds to productivity code 3, and the number of flight-capable chicks must be between 77 (151 * 0.51 = 77) and 151 (151*1 = 151).
The results of each count are entered in the Excel file named “Gulls & terns and waders census”, in the Productivity spreadsheet. Each line corresponds to the Productivity results of a single species in a colony on a specific date. The following columns (presented as a line here) are filled in:

Place	Name of place
Lagoon	Name of lagoon
Colony	Colony code name
Species	Species code name
Date	Date of count
Year	Year of count
Number of pairs	Number of pairs taken into account: 151
Hatched	No = 0; Yes = 1; ? = 9
No. chicks observed	Number of chicks counted in 2 visits: 114
Productivity	Productivity code: 3
No. juveniles min.	Min. no. juveniles calculated based on productivity code: 77
No. juveniles max.	Max. no. juveniles calculated based on productivity code: 151

It seems to be unrealistic to pretend to estimate the breeding success of all colonies, even if it is estimated for some of them during the pair monitoring operations: **in fact, all the chicks that failed before fledging must be taken into account.**
A choice must often be made among the colonies that bring the chicks to an age at which they are able to fly. Of course, productivity will not be estimated in the colonies where it is impossible to count the chicks. If you cannot make this estimation in the other colonies, due to a lack of time, priority should be given to:

- colonies nesting on islets where facilities were created, in order to measure how pertinent these facilities are,
- the largest colonies, which could contribute the most significantly to the total production of chicks,
- the colonies in which productivity was calculated the previous year, in order to be able to measure inter-annual variation in productivity.

7) Monitoring environmental parameters

Many parameters used to describe nesting sites can explain the trends observed in terms of increasing or decreasing numbers, the maintenance or abandonment of colonies, and breeding success. Only a considerable investment would enable them to be measured and monitored in the long term.

At present, it is not possible and you should not feel obligated to monitor all of these parameters. If possible, a small number can be covered in a rapid field survey. In the future, we will see if this monitoring can be extended.
An ideal site for nesting is one that is isolated from terrestrial predation and features surface cover (substrate, vegetation) suitable for protecting eggs and chicks (Little terns are an exception because of their shorter breeding time, which allows them to adopt a riskier strategy).
Parameters you can monitor (these parameters can be entered in the “Gulls & terns and waders census” Excel file:

a) *Factors describing how nesting sites are isolated against terrestrial predation.*

The **distance from the site to the closest shore**. This can be measured in the field, using an IGN (French National Geographic Institute) map or GPS coordinates. The distance is 0 for a dike.
The **maximum depth for accessing an islet** concerns the maximum depth of water a predator has to cross to reach the islet. It should be measured during the nesting season during ground surveys. The depth is 0 for a dike.
Note: the **changing water levels in lagoons** is a parameter that should be taken into account, but that would require monitoring during the entire period in which colonies are present. Check to see if the site managers can gather this information.

b) *Factors describing the site*

Nature of the nesting site: islet, beach, dike, *sansouïre* (halophilous steppes).
Plant cover: measured approximately in 4 categories (bare clayey soil, loose bare soil (sand, shell debris, gravel, gypsum), *Salicornia-Salsola-Atriplex*, other plants (graminaceae, ruderal plants, etc.)) in the following ranges: 0-25%, 26-50%, 51- 75%, and 76-100%. For example,

an islet can be covered 0-25% by loose bare soil, and 76-100% by *Salicornia-Salsola-Atriplex*.

c) *Other parameters*

Nature of management: water levels checked or not checked.
Number of visitors to site: few visitors, many visitors.
Type of land: private or public property.