LIFE Oxyura Technique Assessment Report 2023

Techniques implemented and results

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Contents

Preface **5**

1 Background **7**

1.1 A conservation issue for the white-headed duck 7

1.2 The ruddy duck in brief 9

2 Management methods **10**

2.1 Management methods adapted to the biological life cycle 10

2.1.1 Insights into the biological life cycle of the ruddy duck in France 10

2.1.2 The winter strategy 12

2.1.3 The summer strategy 14

2.2 Management of the captive population 15

3 Results in their historical context **18**

3.1 Population status in 2023 18

3.2 Detection and culling in 2023 19

4 Discussion and perspectives **22**

4.1 An encouraging trend under threat 22

4.2 A LIFE response adapted to a changing context 22

4.3 Alternative methods that make a difference 24

5 References **26**

A Evidence of moulting in coastal areas? **27**

B Data by department **28**

Preface

This national assessment is carried out in the framework of:

— Recommendation n° 185 of the Berne Convention Permanent Committee, adopted 18 November 2016, on the eradication of the ruddy duck (*Oxyura jamaicensis*) in the Western Palearctic by 2020 (Council of Europe 2016).

— EU regulation n° 1143/2014 concerning the prevention and management of alien invasive species (AIS) introduction and propagation (Council of Europe, 2014).

— The 2015-2025 national plan to eradicate the ruddy duck, validated by the Water and Biodiversity Directorate on 24 June 2016 (Ministère de l'Ecologie du Développement Durable et de l'Energie, 2016).

— The implementation of the EU AIS regulation listing the ruddy duck as a species of concern for the European Union, transcribed into national law by Decree n° 2017-595 of 21 Avril 2017 regarding the control and management of the introduction and propagation of certain animal and plant species, and the Decree of 14 February 2018 regarding the prevention of the introduction and propagation of alien invasive animal species in Metropolitan France.

— The national strategy on AIS, Axis II "Operations for the management of gestion species and restoration of ecosystems", Objective 5 "Control widespread alien invasive species", Action 5.3 "Implement national combat plans".

— The EU project LIFE Oxyura, led by the OFB in partnership with the SNPN, which lasts from October 2018 to December 2023. This financial instrument strengthens past actions in order to achieve two objectives: eradication of the population in the wild by 2025 and control and eradication of the captive population by 2030 (European Commission, 2018).

This assessment report covers the period from the 1th of January to 31 December 2023. The information it contains is derived from the results of censuses, field surveys and destruction operations carried out by the OFB and the SNPN - Grand-Lieu RNN. Concerning observations outside of Grand-Lieu Lake, this assessment report is also based, to a large extent, on information gathered from the naturalist community, in particular through regular consultation of the ornithological data of the Visionature network.

1 Background

1.1 A conservation issue for the white-headed duck

The LIFE Oxyura project responds to a conservation issue of a diving duck species, the white-headed duck - *Oxyura leucocephala* (European Commission, 2018). This species range is subdivided in two geographically isolated populations. One of them, located in the western Mediterranean, is threatened (Green & Hughes, 1996; Hughes et al., 2006). Currently only present in Spain and to a lesser extent in Morocco and Tunisia, it used to nest in Italy and France, the last sedentary pair being observed in Corsica in 1966. In 1977, the population was close to extinction, with 22 individuals recorded in southern Spain. Conservation measures have enabled it to recover, with a fairly stable population of around 2,500 individuals. This increase is associated with occasional sightings of isolated birds in France since the 1980s. (Figure 1).

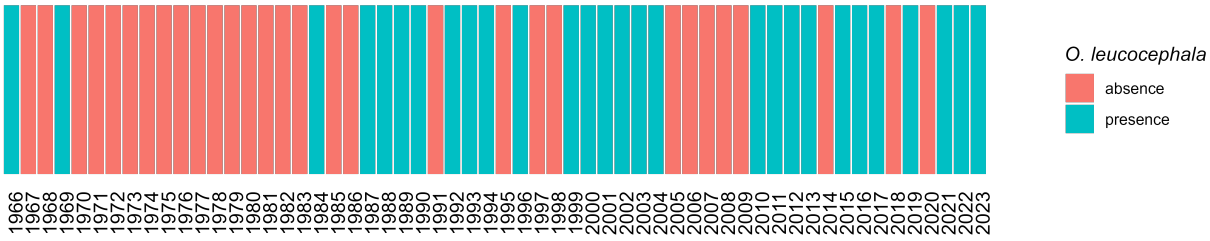

Figure 1: Evolution of the white-headed duck presence in France

The Iberian white-headed duck population faces a new threat since the introduction of a closely-related species, the ruddy duck - *Oxyura jamaicensis* (Gutiérrez-Expósito et al., 2020). This species, native to North America, is a potential competitor for nesting sites and food resources. Although they probably diverged genetically 1-2 million years ago (Muñoz-Fuentes et al., 2007), these two species nevertheless produce fertile hybrids, of which 69 specimens have been observed in Spain since 1991 (Gutiérrez-Expósito et al., 2020). This genetic introgression would likely lead to the extinction of the Iberian white-headed duck population in favour of a hybrid population or a new nucleus of ruddy duck. This transition could be rapid due to the aggressive behaviour of male ruddy ducks during the breeding season, favouring their access to female white-headed ducks (Figure 2) (Gutiérrez-Expósito et al., 2020).

Figure 2: Two males in breeding plumage fighting in Mayenne - France; a ruddy duck to the left, a white-headed duck to the right. © Eric Médard

In view of conserving the white-headed duck, the Spanish authorities carried out a systematic campaign to destroy ruddy ducks and hybrids in their territory until 2007. Since then, a few occasional sightings have been made[1]. Initially introduced in the UK, the threat of the ruddy duck returning to Spain cannot be ruled out as long as the species is still present on the European continent. Under pressure from the white-headed duck conservation issue, the British authorities in association with local ornithological organisations implemented an eradication plan in 2005[2], which reduced the population from 6000 individuals to a dozen individuals from 2019. Breeding in the wild was observed every year between 1953 and 2018, with 2019 marking the end of the population renewal (Henderson, pers. comm.). However, two small nuclei have been established on the continent, one in France remaining at around 200 individuals between 2004 and 2018 thanks to the efforts of the French Biodiversity Agency (OFB) and the French National Nature Protection Society (SNPN), and one in the Netherlands of around 80 individuals [3]. In order to prevent natural breeding in France, the LIFE Oxyura project, led by the OFB, was set up in 2018 to support the 2015-2025 national management plan. In particular, it enabled the hiring of four officers specifically to control the ruddy duck throughout France for five years (European Commission, 2018).

[1]The last three sightings date from 2011, 2014 and 2020, respectively
[2]The plan was set up after a 5-years research phase
[3]Some birds have been observed in Belgium, but are not corresponding to an entire population

1.2 The ruddy duck in brief

The ruddy duck is a small duck with a long tail cocked at 45°, which is characteristic of the *Oxyura* genus (Figure 3).

- Length : 25-43cm
- Female weight : 450-845g
- Male weight : 500-700g

Figure 3: A pair of ruddy ducks in summer. © OFB

The male plumage is predominantly red with a black head and white cheeks (Johnsgard & Carbonell, 1996). The bill is blue in the breeding season. The female has brown plumage with dark brown on the upper parts of the head and darker-striped light brown on the lower parts. The undertail feathers are white. Regardless of sex, the C-shaped bill of the ruddy duck is the main feature distinguishing it from the white-headed duck, whose bill is S-shaped. Juveniles have a similar profile to the female and can be mistaken for young common pochard. In its native range, the ruddy duck winters on large, shallow bodies of water (coastal bays or lowland lakes). Its preferred nesting sites are smaller bodies of water with extensive riparian vegetation consisting of sedges, reeds and willow saplings. The ruddy duck feeds on aquatic plants, molluscs, worms and insects (Sanchez et al., 2000; Woodin & Swanson, 1989). Midge larvae and nymphs (*Tendipedidae*), specifically *Chironomus*, are the primary food sources during the breeding season (Siegfried, 1973).

2 Management methods

2.1 Management methods adapted to the biological life cycle

2.1.1 Insights into the biological life cycle of the ruddy duck in France[4]

A ruddy duck population has been established in France since 1974. At the onset of the first cold weather, most of them gather as from late November on Grand-Lieu Lake, in the Loire-Atlantique department, to spend the winter. They form part of a group of about 20,000 wintering ducks of various species in the central area of the lake (Figure 4). This period is favourable for estimating the size of the French population as almost all the birds are visible at this site.

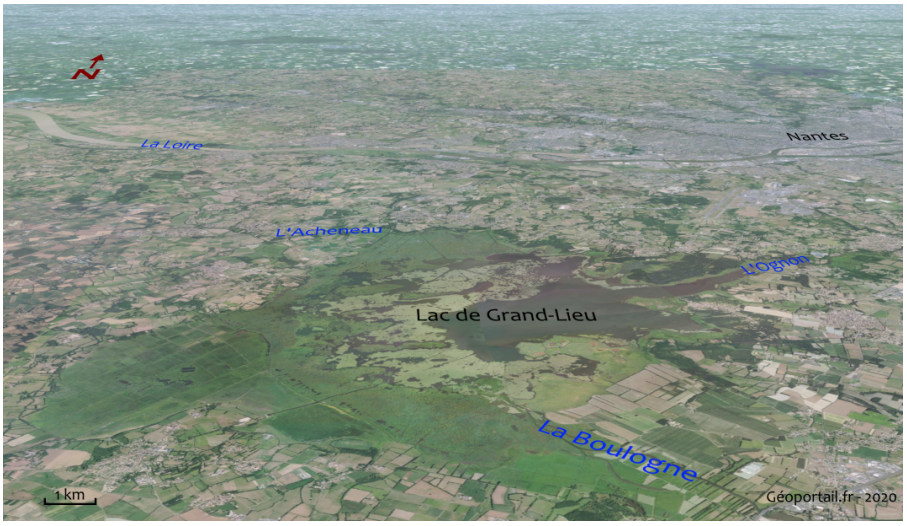

Figure 4: Geography of Grand-Lieu, a lowland lake in western France (47° 05' 45" N, 1° 40' 3" W).The lake has two tributaries, the Boulogne and the Ognon, and flows into the Acheneau which in turn flows into the Loire. The light green areas are water lily beds which disappear in winter. © Geoportail

The ducks move from the east to the west of the central area of the lake, depending on the wind and the disturbance caused by any predators present or the few professional fishermen (Figure 5). Until mid-February, the birds stay away from the edges of the lake and show fleeing behaviour as soon as they are approached within 500m.

[4]The information in Section 2.1.1 is based on observations made by staff from the Grand Lieu SNPN and French Biodiversity Agency, as well as by bird watchers and professional ornithologists.

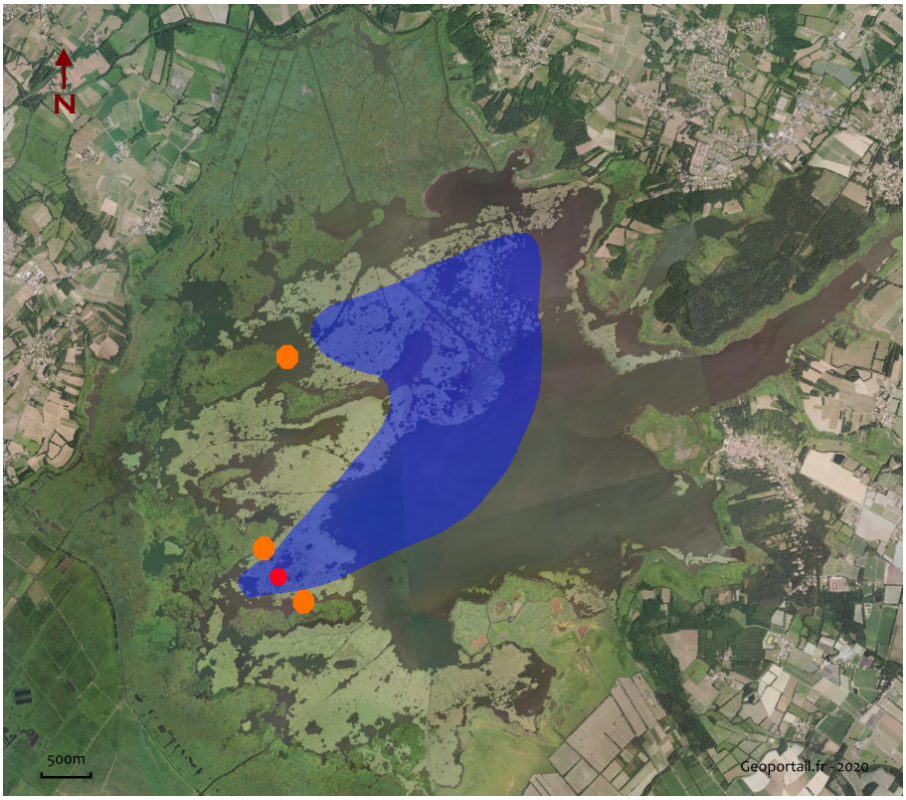

Figure 5: Area where ruddy ducks spend the winter (blue) - Location of hides (orange) - Location of the calling cage (red). © Geoportail

From mid-February onwards, in good weather, the ruddy ducks show the first signs of breeding behaviour. They then move closer to the banks, particularly in the coves beside the riverine woodland to the north of the wintering area and around the islands to the west (Figure 5). The males acquire their breeding plumage in late winter without forming pairs. Only part of the population remains on Grand-Lieu to breed, the rest gradually moving to smaller ponds, mainly in the north-western quarter of France. The maximum dispersal of the birds is unknown[5]. It is therefore not ruled out that there are also connections with the other European populations (notably the Netherlands one).

The first nuptial displays are observed in late winter, when the weather is mild. The male calls throughout the breeding season, which lasts until the end of summer, both day and at night (S. Reeber & A. Laroche, pers. comm.). This call is very characteristic and thus enables the species to be identified. Ruddy ducks make their nests in the vegetation, for example in sedge clumps. They often lay eggs in the nests of other duck species. The first chicks are seen in May at the earliest, but the breeding peak is usually around early July.

The location of the ducks during moulting after breeding has not been clearly identified. On the one hand, the sudden gathering of the population at the wintering site suggests the existence of a potential site where the ducks gather to moult (see analysis in Appendix A). On the other hand, a few individuals located during the same period at very distant sites suggest that the birds moult, camouflaged, close to their nesting site in the vegetation. The moulting behaviour of the native North American population is also poorly identified

[5]In the British island context, maximum dispersal appears to be about 150km, but continental European birds are known to have originated from the founder population in England

(Baldassarre, 2014). Males appear to moult as early as August, after breeding. Some have been seen in large, open areas. The main hypothesis for females is that individuals moult on the nesting sites camouflaged in the vegetation.

2.1.2 The winter strategy

The main difficulty in winter on the Grand-Lieu lake is getting close enough to the birds to have them within shooting range. For this purpose, several complementary tools are used. Investigations have shown that chasing them in boats combined with the use of guns is not very effective and above all counterproductive in terms of disturbing other species that find refuge on the lake in winter. The LIFE programme has enabled the construction of 3 hides positioned on the banks as close as possible to the area occupied in winter (Figure 5 and Figure 6). In windless conditions, these shooting stands are ideal for firing high-precision rifles capable of hitting targets at long distances (300m maximum). The area occupied by the birds during winter shooting campaigns is often far from the stands, so the birds must be moved. An unobtrusive boat can be used to gently bring the birds closer to the shooting stands (Figure 7). From mid-February onwards, playbacks[6] combined with plastic decoys positioned near the shooting stands are used to attract the ducks.

Figure 6: One of the three hides built on Grand-Lieu Lake with funds from the LIFE Oxyura project. © OFB

[6] An audio system to transmit the sound of the males' nuptial calls

Figure 7: Unobtrusive boat with electric motor for gently bringing birds towards the shooting location. © SNPN

An alternative to shooting is capturing ducks with a cage trap. A bird can be lured either with food or by using fellow ruddy ducks. The first option is not selective and may disturb other species. It is also not very effective on ruddy ducks due to their diet, so the use of live decoys is favoured. In partnership with Branféré Zoo[7], the Grand-Lieu SNPN and OFB are developing this approach (Figure 8). The English experience shows that cage traps are time-consuming to use. In order to minimize handling time, the cage developed within the LIFE framework is fitted with an automatic trap door that opens at regular intervals. Photographic traps transmit images by telephone before the trap doors are opened. If a ruddy duck is spotted, the team arrives before it opens to capture the bird.

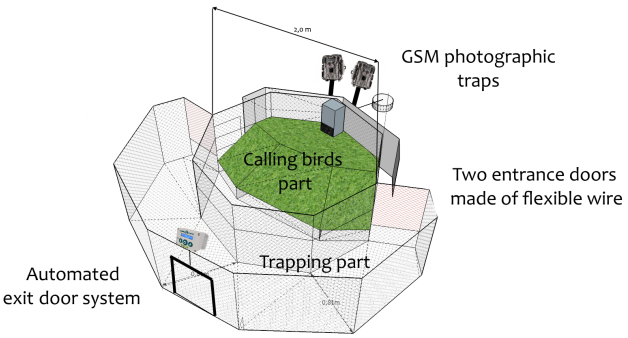

Figure 8: Calling cage under testing at Branféré Zoo. © Diagram: Jean-Marc Gillier, © Photo: Branféré Zoo

[7]Zoo located in Morbihan and member of the French Association of Zoological Parks (AFDPZ)

2.1.3 The summer strategy

Some of the birds nest on Grand-Lieu Lake from spring to the end of summer. The suitable areas vary according to water levels and are not very accessible. The most suitable approach is by boat from the centre of the lake. The males are often found near the nests on the edge of the vegetation and are an indicator of the presence of a female and her nest. Another method is to detect birds calling at night using a sound amplifier. Once the birds have been located, they are shot using a high-precision rifle from a boat stabilised by water lilies. Nests are also occasionally located during surveys in the riverine woodland. In this case, trap cages positioned on the nests are effective for capturing females (Figure 9).

Figure 9: Cage trap system on nests, here an example with a common pochard. © Alain Caizergues

As in winter, an alternative at Grand-Lieu Lake is to attract the birds. The sexual activity of the ducks can be exploited to attract them to the hides which are still situated in the water in spring. The combination of playbacks and ruddy duck-shaped decoys is the most attractive solution. Attempts to shoot with rifles fitted with silencers and night vision equipment are possible under favourable weather conditions (little wind and clear nights). In addition, the use of a calling cage is a solution considered throughout the summer season given the continuous sexual activity during this period.

At the end of winter, some birds leave Grand-Lieu Lake to nest in smaller ponds with suitable riparian vegetation. For this part of the population, the main challenge is locating them. The main detection method is regular surveying of historical sites of ruddy duck presence and potential nesting sites (Figure 10). Bird watchers and professional ornithologists observations are also used and are particularly useful for detecting birds outside the main range of ruddy duck in France. Once located, officers secure the area and adapt their approach to the birds and the shooting solution according to the local configuration.

Figure 10: Boat survey during the breeding season. © Valentin Boniface

2.2 Management of the captive population

The previous study focusing on the captive ruddy ducks in France dates from 2014 with a total of 203 birds counted in 26 departments. Among these individuals, 103 were held by recreational breeders in 21 departments, 80 were detained by 10 zoos in nine departments and 20 were detained by six professional breeders in five departments. The current legislation, notably since the European regulation of the 14 February 2018 on the prevention and management of the introduction and spread of invasive alien species on the metropolitan territory, forbid the detention, transportation, sale or acquisition of the ruddy duck. Except for some zoos authorized to display captive ruddy ducks, breeders who previously detained individuals at this date were authorized to keep their birds until their death, if they declare their birds to the prefecture of their residency place before the 31 December 2019 and if they don't do any breeding (at least eggs destroyed).

In order to monitor the captive population evolution, a survey on the breeders identified in 2014 was conducted at the end of 2022. This survey was conducted among the departmental services of the OFB and among the Departmental Directions on Populations Protection (DDPP) of the departments where captive ruddy ducks were identified in 2014 or were previously unidentified owners were detected. Informations previously collected on ruddy duck detainers were thus actualized in order to conclude on the renewal of the captive population and its threat for the wild population (Figure 11).

We were able to collect information on 27 of the 48 establishements possessing ruddy ducks in 2014, including 16 recreational breeders, three professional breeders and eight zoos. On the other hand, two new recreational breeders were identified in 2022, detaining one and two individuals, respectively. Among those two, the second one did not report its acquisition and thus did not respect the legislation. It is thus likely that captive birds present on the French territory were not identified by this survey, even if they probably represent a low proportion of the total captive population.

The 27 establishments for which data were available for both years of the study represented 117 birds in 2014 for 25 in 2022. The majority of the ruddy ducks still captive in 2022 were detained by zoos for public display and sensibilisation, nine individuals being still detained by recreational breeders, while professional breeders did not possess any bird anymore (Figure 11). The captive population trend is thus strongly decreasing throughout the French territory. These numbers illustrate the overall good respect of the legislation, and the LIFE objective to eradicate the captive ruddy duck population by 2030 is likely reacheable.

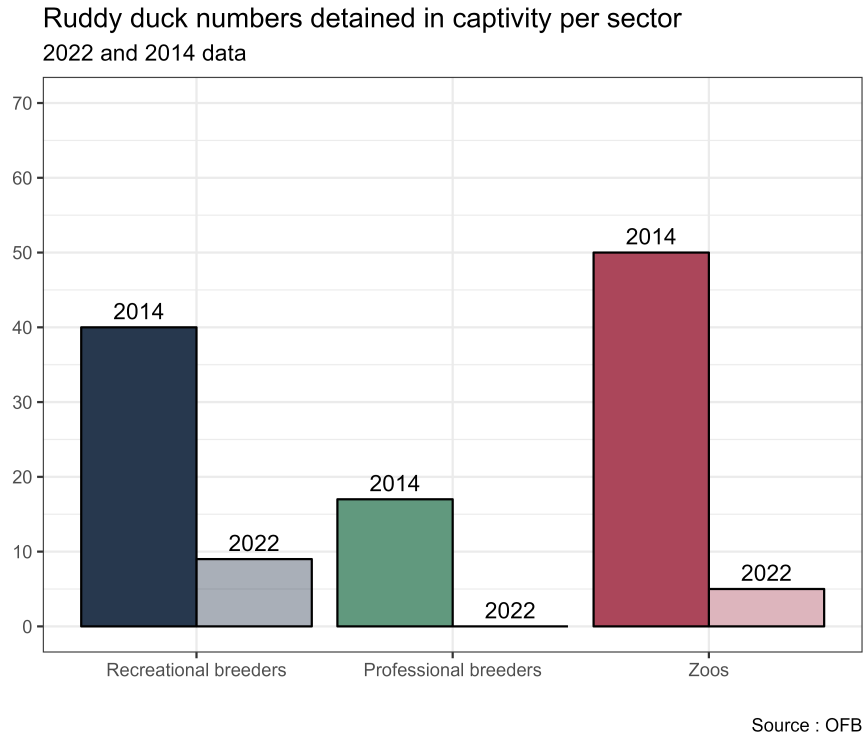

Figure 11: Ruddy duck numbers detained in captivity per sector

On the other hand, the new legislation may led recreational breeders of diving ducks to turn to another species of the *Oxyura* genus. The lake duck, also called Argentine ruddy duck (*Oxyura vittata*), native from South America, may also hybridizes with other *Oxyura* species, and notably the white-headed duck. To date, it is difficult to estimate the number of captive lake ducks in France, but if some of them escape into the wild, they are likely to provoke, as the ruddy duck before, the same issues of genetic introgression in the white-headed duck. It is thus paramount to prevent this species introduction into the wild, notably by promoting new legislation or preventive actions.

Figure 12: Argentine ruddy duck, *Oxyura vittata*, male

3 Results in their historical context

3.1 Population status in 2023

At the beginning of 2023, the number of ruddy ducks reached 28 individuals on Lake Grand Lieu[8]. The trend is a decrease of 53% compared to the previous winter. We have to go back to 1995 to find similar numbers (Figure 13).

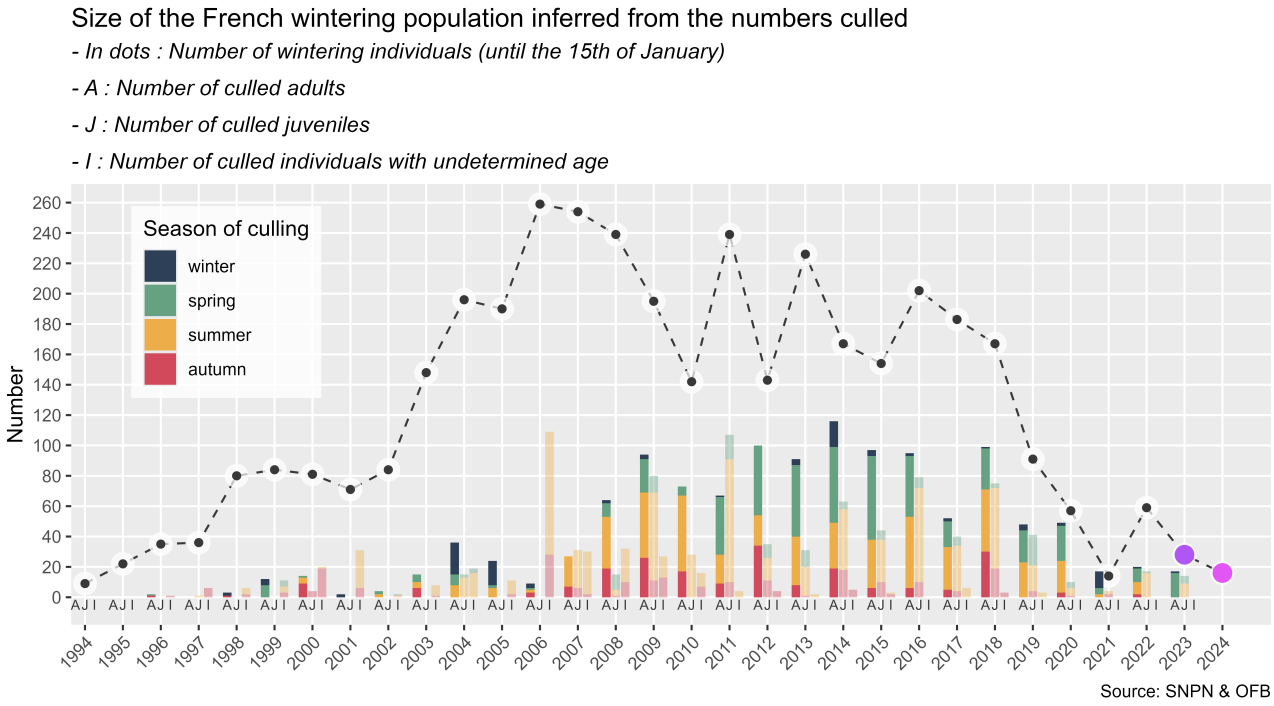

Figure 13: Numbers of the French wintering population with respect to the numbers culled. Numbers before culling in mid-January 2023 in purple, and numbers of the resulting population in mid-January 2024 in pink.

After the 2022-2023 wintering period, ruddy ducks were observed at 22 sites, 8 less than the previous year (Figure 14). This result is coherent with the wintering numbers trend. These sites are located in the same areas as in previous years (See details per department in Appendix B).

[8] A few isolated individuals can be observed elsewhere in France, but they do not necessarily belong to the French population and are therefore not taken into account here

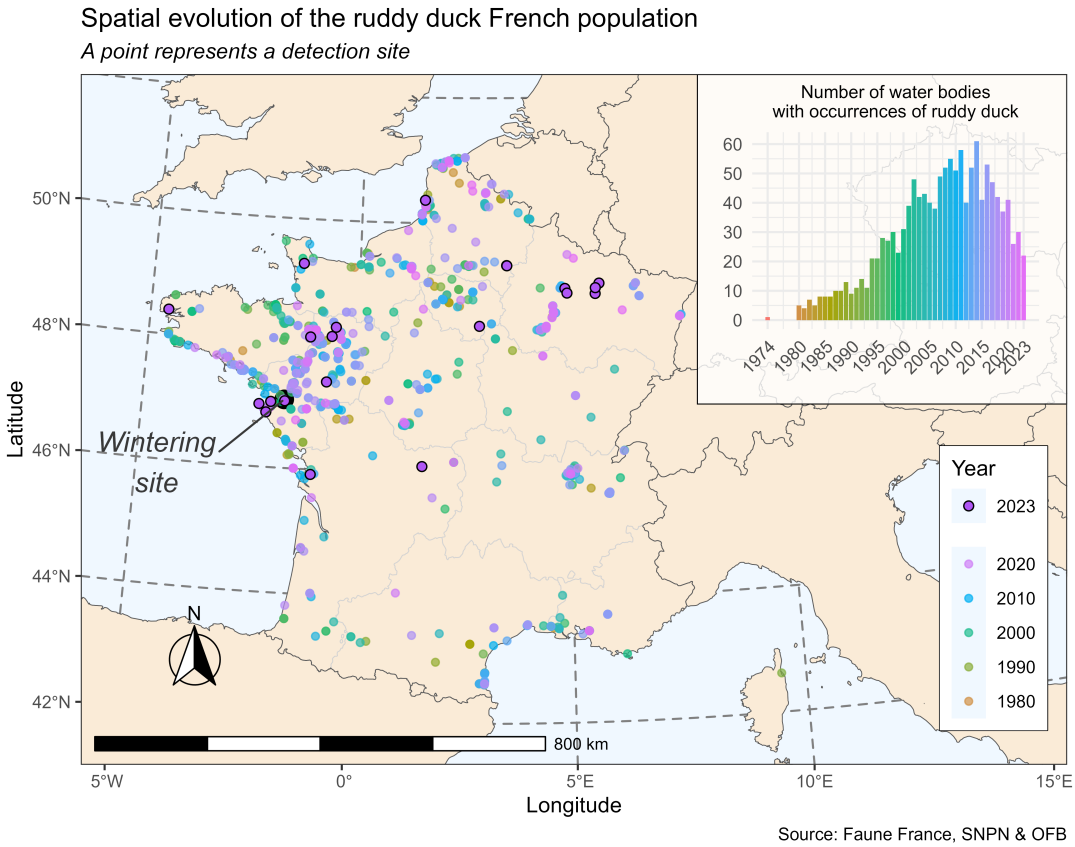

Figure 14: Trends in spatial range of ruddy ducks - See the **interactive map** for the historical details of the sites.

3.2 Detection and culling in 2023

Continuous work is carried out by the LIFE project field officers who survey potential bird habitats throughout the year. Online ornithology platforms[9] are also routinely consulted to detect part of the birds. This partnership is essential because the birdwatching community covers the whole of France and allows for the rapid recognition of new areas. Finally, the officers from the OFB's departmental units assist this detection work by transmitting information during their field missions.

Surveys by LIFE officers were divided as follows: 2/3 monitoring of historical sites of ruddy duck presence, 1/3 exploration of sites with high presence potential. This year, LIFE officers made 389 visits to 55 sites (Figure 15).

[9]http://www.faune-france.org - http://www.observation.org - BDBiodiv

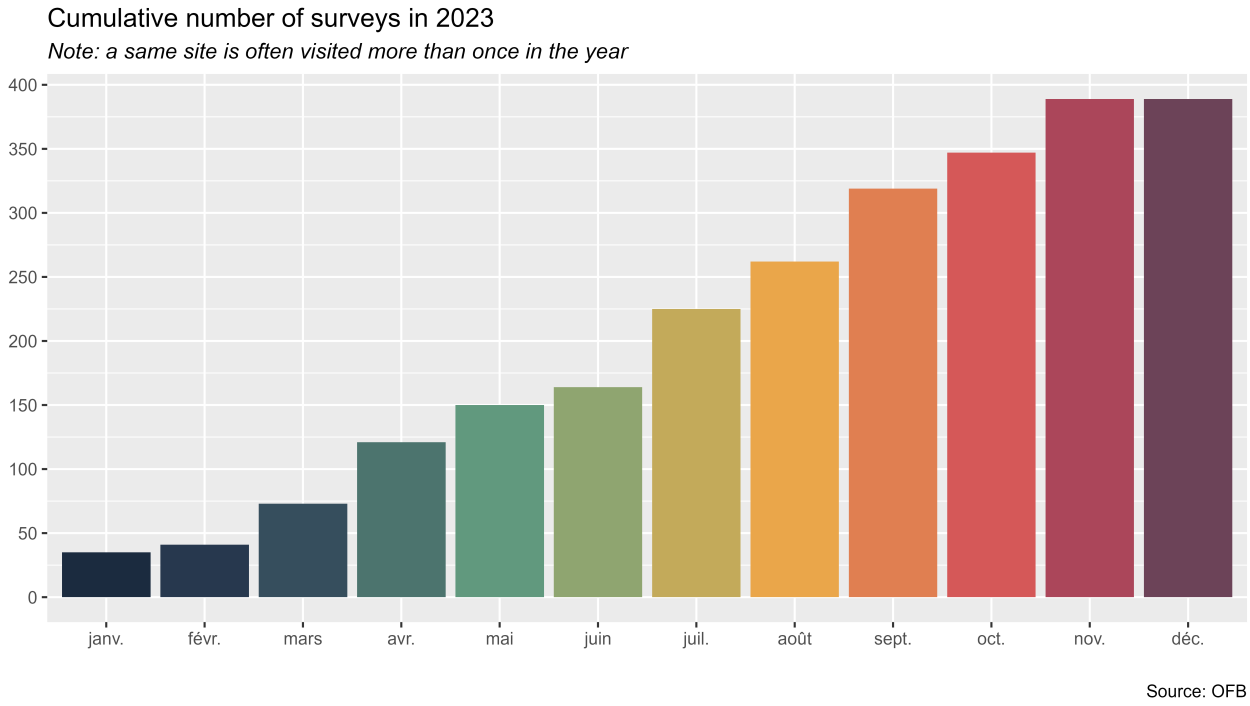

Figure 15: Cumulative number of surveys in 2023.

From the observation data derived from the various sources available, the number of birds actually detected without the breeding period is looked for[10]. To make this estimation, we assume that two successive observations of a ruddy duck [11] on the same site correspond to two different individuals if over one month has elapsed between observations. Naturally, major sources of error[12] result in an uncertain estimation. However, this approach remains the best indicator of bird detectability outside the wintering period.

Using the method described above, we estimate that 35 different individuals were detected. Among these, 12 adults of which 8 males and 4 females. The remaining 23 individuals were juveniles or individuals of undetermined age. The wintering population consisted of 28 individuals. The detection rate for adults that wintered in France is thus 43%[13].

In parallel with detection, the culls performed by SNPN and OFB officers eliminated 31 individuals[14], of which 17 were adults: 14 males and 3 females. The remaining 14 individuals were juveniles[15]. The culling rate for adults that wintered in France is 61%[16] & [17].

[10] A ruddy duck may be observed repeatedly at a site by one or more bird watchers or professional ornithologists

[11] Observations are considered to be potentially of one single individual only if the age and sex characteristics are identical

[12] There are two sources of error in this estimation of the number of birds detected: i) the time interval between two observations for which individuals are considered different, and ii) individuals that have travelled between several sites and are therefore counted as many times as they are detected

[13] A detection rate over 100% is not necessarily an error as it is likely that birds from a population not wintering in France are detected.

[14] During the autumn-winter period, juvenile birds are of adult size but with female plumage. Birds culled during this period are systematically sexed and aged by dissection

[15] Very few individuals are not retrieved and could be adults

[16] We cannot estimate the effectiveness for juveniles because we do not have the number of young produced during the year

[17] The sampling rate on adults detected amounts to 142%; this rate can sometimes be greater than 100% because the method of calculating the number of birds detected prevents us from differentiating between two birds passing the same site over a short time

An interesting indicator is the proportion of adults culled before they have reproduced. Indeed, by definition, they have not had time to produce young and therefore contribute to population renewal, which has a significant impact on the decline in numbers the following winter. This rate of culling before reproduction amounts to 61%.

In order to make comparisons from year to year, the detailed culling time series is presented in Figure 13. Historical detection and culling efficiencies are presented in Figure 16.

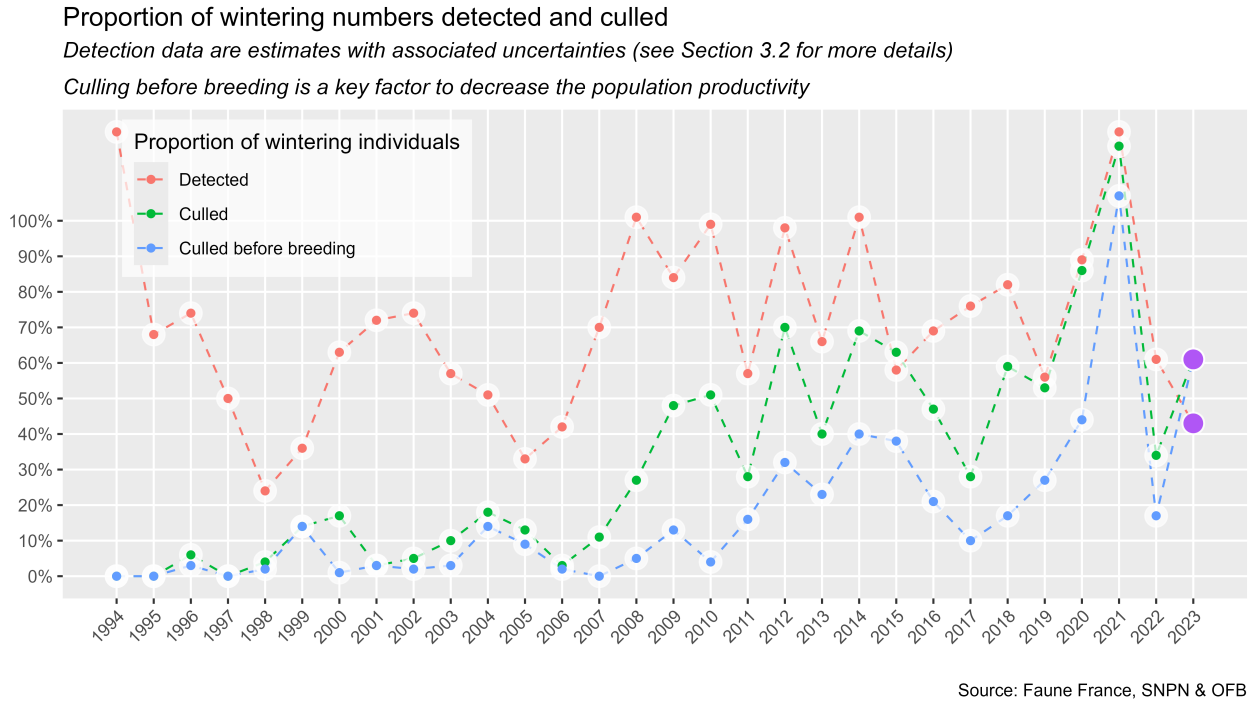

Figure 16: Proportion of wintering numbers detected and culled. Please note that these figures are only estimates and therefore uncertain.

interval

4 Discussion and perspectives

4.1 An encouraging trend under threat

The control pressure made before LIFE made it possible to stabilise the French population of ruddy ducks at around 190 individuals over the period 2004-2017. Over the LIFE period (2018-2024), the population of ruddy ducks decreased by 90%, from 167 individuals in winter 2017-2018 to 16 individuals in winter 2023-2024. With the exception of 2022, the population has decreased by an average of 50% in each year, demonstrating the effectiveness of the control intensity in France. The population wintering at Grand Lieu Lake counted at its lowest six individuals in early December 2021. While the LIFE objective was practically achieved[18], counts increased by more than 50 individuals on Grand Lieu Lake from mid-December 2021, representing an increase by a factor of three between 2021 and 2022. This event raises questions about the dynamics of this species.

This population rebound in a context of strong harvest pressure is due either to exceptional reproduction or to the arrival of individuals from another population. The first hypothesis states that it is unlikely to control/eradicate this population because, even at low numbers, it would be able to regain a considerable size with a few episodes of good reproduction; a control prioritised before reproduction would still make it possible to buffer the effects of exceptional production of youngs. If the explanation for the population rebound corresponds to the second hypothesis, then the French population is not isolated but at least temporarily connected to other populations. In this case, only a synchronised control effort throughout the range of the connected populations would allow the control of the ruddy duck.

4.2 A LIFE response adapted to a changing context

The detection rate of adults is no higher during the LIFE period than before the LIFE period, which illustrates the limited contribution of the surveys carried out by LIFE officers. However, these surveys still allowed the detection of young birds in early autumn in sites that are not accessible to ornithologists. The main contribution of LIFE is the improved culling efficiency of adult birds compared to the pre-LIFE period, and in particular the greater proportion of birds collected before/during reproduction[19]. These efforts have resulted in the number of birds decreasing by about 50% per year, with the exception of 2022.

Maintaining this high harvest rate while the population size has declined significantly is very positive for several reasons. It is a priori more difficult to detect birds when their density is lower because the groups are less detectable. However, this point must be put into perspective, because the reduction in numbers seems to be associated with a reduction in the occupied area around the wintering area, which favours prospecting and therefore detection. However, after the sampling attempts of recent years, the agents are confronted with more suspicious adult birds. In the long term, the strong selection pressure created by this level of harvest favours the survival of the most inconspicuous birds or those that best avoid being shot, thus allowing the spread of the relevant genes.

The high rate of removal of adult birds before reproduction has undoubtedly reduced the production of young birds and contributed to the decline of the population. On Grand Lieu Lake, the main observers also noted poor reproduction of the common pochard, a species whose ecology is close to that of the ruddy duck, in 2020 and 2021 (A. Caizergues & S. Reeber, pers. com.) [20]. The decline in the reproductive success of diving ducks was probably due to a combination of poor environmental conditions (J.-M. Gillier, pers. com.). There was a rapid decline in water levels in April and May and a small late flood in mid-June. However, too rapid

[18] Taking into account pre-LIFE data, the objective was to reach a population consisting of dispersed and therefore non-breeding individuals by the end of 2023

[19] In 2023, for example, all birds were culled during the reproductive period

[20] 190 female pochards with chicks were counted in spring 2020, compared to 385 on average over the previous five springs and 480 over 10 years

fluctuations in water levels at the time of reproduction were responsible for the failure of many broods. In addition, the palustrine vegetation[21] of Grand Lieu Lake was observed to have growth retardation and general decline in spring, which was another unfavourable factor for breeding success. Population size may also have reached a critical threshold that reduces the population's ability to efficiently produce numerous offspring. This phenomenon is known as the Allee effect (Kuparinen & Uusi-Heikkilä, 2020) and may be due, for example, to the difficulty of finding a mate when bird density is low.

The investigation, which aimed to identify the causes of the rebound in numbers observed in winter 2021-2022, consisted of two parallel approaches. One concerned the analysis of the consistency of this change in numbers with the maximum reproductive and survival capacity in order to test the hypothesis of exceptional reproduction. The other involved analysing the change in the genetic structure of the population to test the hypothesis of an exceptional migration event. In case of a change in genetic structure, a comparison with the population genetics of the Netherlands, the geographically closest population, would allow testing the connectivity between these two populations.

The distinction between male and female individuals during the census conducted in winter 2021-2022 (59 individuals) at Grand Lieu Lake allowed an indirect estimation of the proportion of young in the population (see Tableau et al. (2024) for details on the method). By combining this information with the change in numbers compared to the previous year, we can then distinguish the contributions of juvenile recruitment/immigration and adult survival/immigration to population rebound. In winter 2021-2022, the wintering population was estimated to consist of about 25% juveniles (*i.e.* ~15) and 75% adults (*i.e.* ~44). As the population comprised 14 individuals in winter 2020-2021, the apparent recruitment in 2022 is approximately one recruit per adult and the apparent adult survival rate is 300%. This apparent recruitment rate is about twice as high as in previous years, but does not rule out exceptional breeding success. As the maximum survival rate for a closed population is 100%, the apparent survival rate of 300% indicates that at least 30 adult individuals have immigrated. This is consistent with a potential arrival of juveniles, which would have added to a more traditional production of juveniles in the order of 1/2 young per adult. The increase in the population in winter 2021-2022 was therefore not due to exceptional reproduction, but to the arrival of individuals from another population. In France, it seems unlikely that such a population could go unnoticed and overwinter only this year on Grand Lieu Lake. Of the known European populations, only the Dutch population could produce so many individuals, given its geographical proximity, its size and its dynamics in terms of reproduction.

The development of a panel of genetic single nucleotide polymorphism (SNP) markers has now been finalised[22]. The results show that the genetic structure of the French population did not change significantly between the period before winter 2021-2022 and the subsequent period. This conclusion is not incompatible with an exceptional migration episode if the individuals of the external population have an identical genetic structure or if the individuals have returned to their area of origin to reproduce, i.e. the period in which the samples were taken. Furthermore, under the hypothesis of an exceptional migration episode, the resulting population must have an intermediate genetic signature between the two source populations, which makes the analysis complex. The results also show that the genetic structuring between the French and Dutch populations before winter 2021-2022 is weak[23], so there is no clear spatial structuring. The genetic proximity between these populations tends to support that these populations are historically connected, which prevents an assessment of the impact of a possible recent flow of individuals. This connectivity is consistent with the hypothesis that all European ruddy ducks originate from a single source population, originally consisting of seven individuals introduced to the UK in the 1950s. The genetic structure between the French and Dutch populations is still slightly closer after winter 2021-2022, but this convergence is only due to four individuals out of 16 adults sampled in spring 2022. This is therefore not sufficient to conclude an exceptional migration of Dutch individuals. However, the

[21] Marsh vegetation mainly aquatic or herbaceous.

[22] This work made it possible to develop 291 SNPs to study the diversity of ruddy ducks; 194 French and 7 Dutch individuals were successfully analysed

[23] This distinction between populations may only be an artefact and underlines that the Dutch sample may not be representative of the whole population as it includes a few individuals mainly originating from the same site (only 7 individuals)

small Dutch sample (seven individuals) limits the possibility of definitively confirming these conclusions. The samples now taken in the Netherlands are a good opportunity to complete this genetic analysis.

The reproductive behaviour of the new individuals, which originated from a different population, was a question in 2022. Would these individuals return to their original territory or would they occupy nesting sites on French territory and thus contribute to the renewal of the French population in the long term? The harvest rate of wintering birds was around 30% in 2022, while it was always above 50% in the other years of the LIFE project. So it seems that at least some of the birds have returned to their original area, as the harvest effort remained constant during the LIFE project. If we look at the resulting population, i.e. based on the counts in winter 2022-2023, we see that it is half as low as in the previous winter (28 *vs* 59 individuals). Considering the low harvest rate (~30%) of adults compared to other years, this significant decrease supports the hypothesis that certain individuals have returned to their original area.

The historical spread of the English ruddy duck population on the European continent is probably due to one or more migration events. The LIFE project *Oxyura against Oxyura* had therefore anticipated the possibility of migration flows and therefore supported an initiative by the English government aimed at sensitising the Dutch government to the importance of controlling their ruddy ducks from 2020. In response to this request, a meeting was held in the Netherlands in June 2022 between the English managers, some of the French LIFE agents and the Dutch managers and decision-makers. The aim of this meeting was to identify which management methods were effective in France and the UK and could be replicated in the Netherlands. Following this meeting, national coordination was set up in the Netherlands. This international co-operation is maintained thanks to the Bern Convention working group on the management of ruddy ducks in Europe. The final LIFE Oxyura seminar, which took place in October 2023, made it possible to extend this collaboration to the countries where the white-headed duck is present and to share locally the control methods that have proven successful in Spain, the United Kingdom, Belgium or France.

4.3 Alternative methods that make a difference

Even on a small scale, improving pre-reproduction harvest rates can have a significant impact on the population's ability to renew itself. For this reason, the LIFE project has made considerable efforts to test alternative methods, particularly in winter (section 2.1.2).

The use of watchtowers was tested in winter 2019-2020 and made it possible to kill two females in February 2020. However, this method remained very random as it was difficult to get the birds to approach the watchtowers. No birds were killed using this method in winters 2020-2021 and 2021-2022. In March 2021, the ducks moved closer to the edges of Grand Lieu Lake, and occupied coves lined with willows. Thanks to this behaviour, which was observed for the first time in 2021, the shooting operations were successful[24]. However, this behaviour was no longer observed in the subsequent years.

The development of a trapping method using calling birds (also known as decoys) has been repeatedly delayed. The prototype of the trapwas completed at the end of 2020, but the procedure for obtaining a licence to keep ruddy ducks was not completed until June 2021[25]. Through the collaboration with Aviornis, captive ruddy ducks were collected from summer 2021 and were thus available as decoys. The outbreak of avian influenza in France due to the H5N8 virus since autumn 2020 prevented the start of this experiment, as the movement of birds was very controlled in this context. In spring 2023, this method was successfully tested[26] as nine adult birds were caught in the trap (eight males and one female) and two other males were caught by shooting nearby thanks to the attractiveness of the decoys. Only four more adult males and two females were shot outside this

[24]Four operations were organised, during which six of the 16 individuals discovered in the previous months were culled
[25]Capacity certificate and opening authorisation
[26]The test was carried out between the end of March 2023 and the end of June 2023, the captures were made between 19 April 2023 and 5 June 2023

equipment in 2023, proving the effectiveness of trapping with decoy traps. The sample taken with the cage corresponded to 40% of the adults counted in winter 2022-2023, making it a very efficient and complementary tool for shooting. This tool also has the advantage that it can be used for populations where culling by shooting is more difficult due to the urbanisation of occupied areas.

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A Evidence of moulting in coastal areas?

The moulting season of ducks is a vulnerable period that is propitious for capturing them. If, as with other species, ruddy ducks gather together in this period of the year, it would therefore be efficient to identify the moulting sites. This aspect of ruddy duck ecology is poorly known within its natural range. The low number of sightings during this period shows that the birds are more wary at this time.

Throughout the year, ruddy ducks in France are mainly observed in areas less than 100 km from the coast (Figure 17). This could reflect the potential species' dependence on coastal habitats, notably during the moulting season. Analysis of the positions of the sites where the ruddy ducks are observed shows that the birds sighted during the moulting season[27] are more numerous in coastal areas than during the rest of the year. This could be evidence that some of the population moults in coastal areas. Unfortunately, this result is not significant enough to conclude that the moult occurs in coastal areas, and therefore to consider carrying out specific surveys to identify a potential moulting site. A plausible hypothesis concerning the presence of ruddy ducks in this area in autumn is the utilization of the wastewater treatment lagoons of seaside resorts as a food source and refuge area during the hunting season.

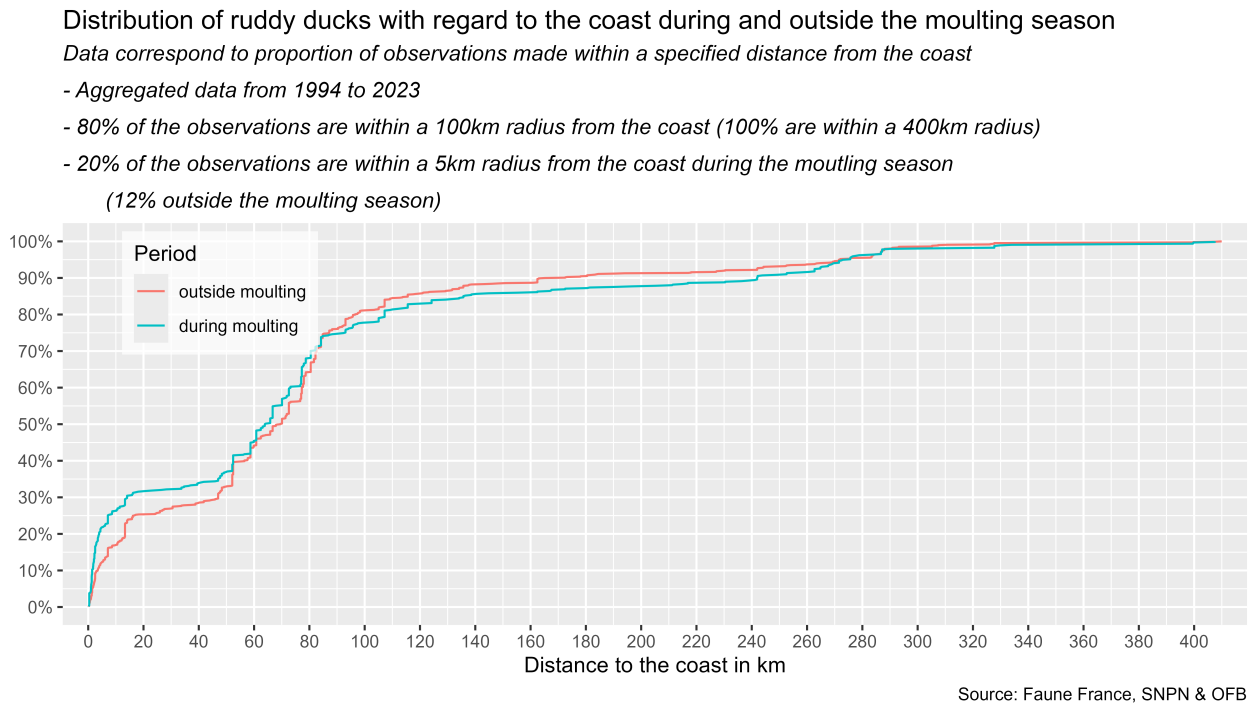

Figure 17: Distribution of ruddy ducks with regard to the coast during and outside the moulting season.

[27]This period is defined in the analysis as between the 1th of August and the 1th of December, from the evidence provided by Baldassarre (2014)

B Data by department

For the detail of the historical observation sites, see the **interactive map online**.

Table 1: Table of individuals culled and number of sites occupied by department

Department	Year	Numbers culled by category				Total	Number of sites
		Female	Male	Young	Under-temined age		
44-Loire-Atlantique	**2023**	3	12	13	0	28	3
	2022	5	6	11	0	22	2
	2021	4	7	0	0	11	1
	< 2021	205	325	380	100	1010	35
53-Mayenne	**2023**	0	1	0	0	1	2
	2022	0	0	0	0	0	2
	2021	1	0	1	0	2	3
	< 2021	141	134	192	47	514	46
85-Vendée	**2023**	0	0	1	0	1	2
	2022	1	1	1	0	3	5
	2021	0	0	0	0	0	0
	< 2021	48	38	65	86	237	22
35-Ille-et-Vilaine	**2023**	0	0	0	0	0	1
	2022	0	0	0	0	0	1
	2021	0	0	0	0	0	1
	< 2021	81	43	11	66	201	19
49-Maine-et-Loire	**2023**	0	1	0	0	1	1
	2022	1	0	0	0	1	3
	2021	0	1	2	0	3	3
	< 2021	18	31	26	11	86	23
80-Somme	**2023**	0	0	0	0	0	1
	2022	0	0	0	0	0	0
	2021	0	0	1	0	1	1
	< 2021	12	19	4	13	48	17
56-Morbihan	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	0
	2021	0	0	0	0	0	0
	< 2021	9	9	6	2	26	18

Department	Year	Numbers culled by category				Total	Number of sites
		Female	Male	Young	Under-temined age		
72-Sarthe	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	0
	2021	0	0	0	0	0	0
	< 2021	4	4	4	12	24	12
17-Charente-Maritime	**2023**	0	0	0	0	0	1
	2022	0	0	5	0	5	2
	2021	0	0	0	0	0	1
	< 2021	8	4	6	4	22	14
79-Deux-Sèvres	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	0
	2021	0	0	0	0	0	0
	< 2021	1	6	0	8	15	10
37-Indre-et-Loire	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	0
	2021	0	0	0	0	0	0
	< 2021	3	4	0	0	7	3
41-Loir-et-Cher	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	0
	2021	0	0	0	0	0	0
	< 2021	1	0	4	0	5	7
50-Manche	**2023**	0	0	0	0	0	1
	2022	0	0	0	0	0	1
	2021	0	0	0	0	0	0
	< 2021	0	3	0	1	4	13
13-Bouches-du-Rhône	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	1
	2021	0	0	0	0	0	1
	< 2021	1	1	0	1	3	18
59-Nord	**2023**	0	0	0	0	0	0
	2022	1	1	0	0	2	2
	2021	0	0	0	0	0	2
	< 2021	1	1	1	0	3	18

Department	Year	Numbers culled by category				Total	Number of sites
		Female	Male	Young	Under-temined age		
27-Eure	**2023**	0	0	0	0	0	0
	2022	0	3	0	0	3	2
	2021	0	0	0	0	0	0
	< 2021	1	1	0	0	2	7
61-Orne	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	0
	2021	0	0	0	0	0	0
	< 2021	1	2	0	0	3	4
62-Pas-de-Calais	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	2
	2021	0	1	0	0	1	1
	< 2021	0	0	0	2	2	11
51-Marne	**2023**	0	0	0	0	0	1
	2022	0	0	0	0	0	1
	2021	0	1	0	0	1	5
	< 2021	0	1	0	1	2	10
33-Gironde	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	0
	2021	0	0	0	0	0	0
	< 2021	0	0	0	2	2	6
34-Hérault	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	0
	2021	0	0	0	0	0	0
	< 2021	0	1	0	1	2	6
36-Indre	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	1
	2021	0	0	0	0	0	0
	< 2021	0	0	0	1	1	10
77-Seine-et-Marne	**2023**	0	0	0	0	0	1
	2022	0	0	0	0	0	0
	2021	0	0	0	0	0	0
	< 2021	0	1	0	0	1	6

Department	Year	Numbers culled by category				Total	Number of sites
		Female	Male	Young	Under-temined age		
89-Yonne	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	0
	2021	0	0	0	0	0	0
	< 2021	0	1	0	0	1	2
19-Corrèze	**2023**	0	0	0	0	0	0
	2022	0	0	0	0	0	0
	2021	0	0	0	0	0	0
	< 2021	0	1	0	0	1	1