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Is the yellow-legged gull a superabundant bird species in the Mediterranean? Impact on fauna and flora, conservation measures and research priorities

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In the Mediterranean basin, the yellow-legged gull *Larus cachinnans* has undergone a widespread demographic increase for the past 30 years. Owing to its high ecological adaptability, its aggressive behaviour and its abundance, this gull is often considered to be a pest. The authors review and analyse the impacts of the expansion of the yellow-legged gull on fauna and flora in the Mediterranean area. Despite the relatively limited number of both intensive and general studies, it clearly appears that the population explosion has had a very diverse and severe effect on the ecosystem as a whole (flora, vertebrates, interspecific competition, extinction–colonization processes). The most serious damage has occurred around the largest breeding colonies to the detriment of fragile, rare or very restricted plant and animal species. Thus, from the point of view of fauna and flora conservation, the yellow-legged gull can, for the moment, be considered to be locally superabundant. Control measures are often very onerous and necessitate heavy manpower and material resources. Additional extensive investigations will be necessary to assess the future development of yellow-legged gull populations and their impact on natural environments.

Keywords: *Larus cachinnans*; superabundant species; pest management; large larids.

Introduction

The environmental problems caused by superabundant animal species, particularly 'bird pests' have become increasingly acute during the past decades (Feare, 1991). Gulls are often found to be superabundant due to their adaptable, opportunistic and gregarious nature which makes them highly adapted to living in man-modified habitats (Blokpoel and Spaans, 1991). Several gull species have recently undergone a widespread demographic increase, particularly in Europe (Thomas, 1972; Spaans *et al.* 1991) and in North America (Blokpoel and Scharf, 1991). Six gull species are known for a long time to have become superabundant: the glaucous-winged gull, *Larus glaucescens*, the ring-billed gull, *L. delawarensis*, the silver gull, *L. novaehollandiae*, the black-headed gull, *L. ridibundus*, the herring gull, *L. argentatus*, and the lesser black-backed gull, *L. fuscus* (e.g. Coulson, 1991; Spaans and Blokpoel, 1991). These population explosions have created many problems and many conservation and research organizations are currently alarmed by the damage caused by these birds, including: colonization of coastal towns (Vincent, 1994; Raven and

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Coulson, 1997), predation on wildlife (Swennen, 1989), damage to agriculture (Blokpoel and Struger, 1988), collisions with aircraft (Dolbeer *et al.*, 1993), transmission of diseases (Monaghan *et al.*, 1985), etc.

In the Mediterranean area, another large gull species, the yellow-legged gull *Larus cachinnans* has also undergone a population explosion for the past 30 years, notably on the northern shore (Yésou and Beaubrun, 1995; Thibault *et al.*, 1996). This gull, whose breeding range extends from the Azores to the Aral sea is the most common and widespread larid of the Mediterranean basin and includes at least 120 000 nesting pairs in the Western Mediterranean (Pérennou *et al.*, 1996). Unfortunately, there is no total estimate for this abundant species. The largest western colonies are located on Berlenga island (Portugal), Marseille islands (France) and Balearic archipelago (Guyot and Thibault, 1988; Beaubrun, 1994; Morais *et al.*, 1995; Vidal *et al.*, 1997). The western population is currently estimated to increase at a rate of between 7 and 10% per year (Beaubrun, 1994; Thibault *et al.*, 1996). The demographic increase is due to a combination of three main factors (Beaubrun, 1994; Bosch *et al.*, 1994; Oro *et al.*, 1995): the establishment of a number of peri-urban open-air refuse dumps; the development of industrial fisheries; and the protection of several areas where the species breeds, particularly some islets. Refuse dumps provide abundant food supply, particularly during the inter-breeding period, while discarded fish represent the greatest part of the chick diet. Owing to its large size, its colonial behaviour, its aggressiveness and its ecological adaptability, the yellow-legged gull is now accused of creating many problems. Some control programmes have already been started in the Mediterranean basin, and new ones are currently being investigated.

Superabundance of animal species is a subjective concept (Blokpoel and Spaans, 1991) which depends on the importance attached to the different interactions between the animal population and human interests. To be considered superabundant, a species must fulfil three main conditions (Blockpoel and Spaans, 1991; Feare, 1991; Spaans and Blockpoel, 1991): first, it must demonstrate a strong and sustained demographic (and often geographic) expansion; second, its population level must be higher than that ever previously recorded; and third, it must interfere with the interests of people. Even incomplete, data on the history, dynamics and distribution of yellow-legged gulls in the Mediterranean (e.g. Thibault *et al.*, 1996) clearly show that it fulfils the first two conditions and that the development of yellow-legged gull populations follows the general patterns of superabundant species (Blockpoel and Spaans, 1991). Many human interests are potentially affected by bird pests (Feare, 1991), particularly environmental conservation policies. Thus, one way to assess if a bird species is abounding in too great a quantity is to analyse its impact on natural environments and its interference with conservation programmes.

The aim of this paper is to review and analyse the direct and indirect consequences of yellow-legged gull increase on plant and animal populations and to determine if the yellow-legged gull can be considered as a superabundant species. Although the impact of the expansion of other larids has now been well documented, notably for herring gull in central and northern Europe (e.g. Thomas, 1972; Spaans *et al.*, 1991), those impacts due to yellow-legged gull have not yet been reviewed in detail. This work is based on the largest possible compilation of data and on the analysis of relevant studies on the subject. Some data have been added from less accessible sources whenever methods or results were considered to be reliable.

Impact on flora and vegetation

The effects of the yellow-legged gull on flora and vegetation have occasionally been mentioned (e.g. Beaubrun, 1988; Bocchieri, 1990a, b) but have only been thoroughly studied recently (Paradis and Lorenzoni, 1996; Vidal *et al*., 1998a, b). The actions of gulls greatly affect the vegetation around their nesting sites (Fig. 1). Disturbance caused by gull activity can be analysed based on four main categories: physical disturbances, chemical disturbances, changes in floristic composition and changes in interspecific competition patterns. Removal of plants for nest building can easily be tolerated by local vegetation (Vidal and Bonnet, 1997), but this relatively minor disturbance is heightened by additional destruction caused by boundary disputes (Beaubrun, 1988). Guano deposits also result in an important input of nitrogenous and phosphorus compounds (Sobey and Kenworthy, 1979). Salt deposits caused by droplets off plumage may also be significant (Bioret *et al*., 1991). All these lead to the extinction or regression of indigenous plant species and to the development or establishment of many nitrophilous and halophilous species, such as *Lavatera arborea*, *Allium* div. sp. (Laguna and Jiménez-Pérez, 1995; Vidal *et al*., 1998a) (Fig. 2). Such plant species are sometimes called 'ornithocoprophilous species' (Ornduff, 1965).

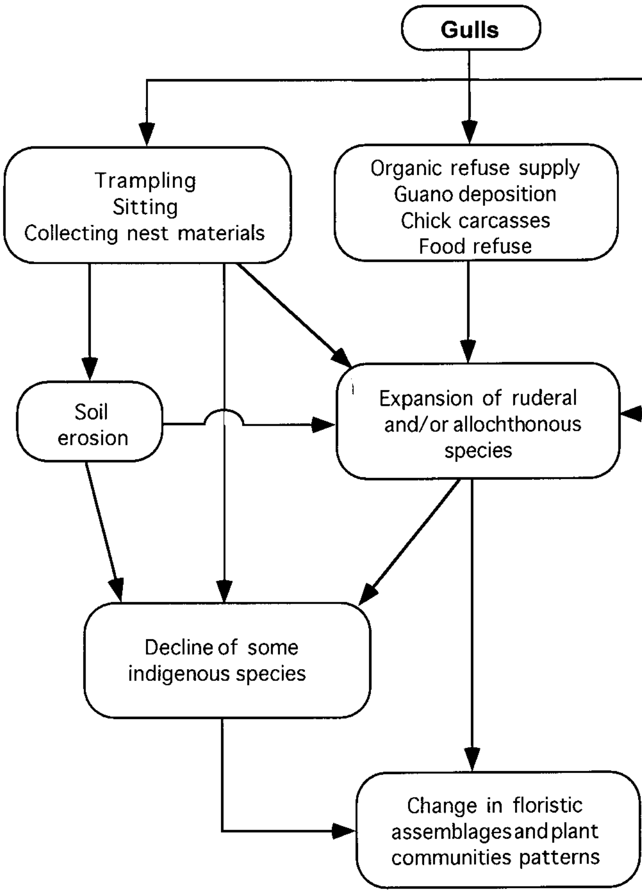

Figure 1. Modes of impact of the yellow-legged gull on flora and vegetation.

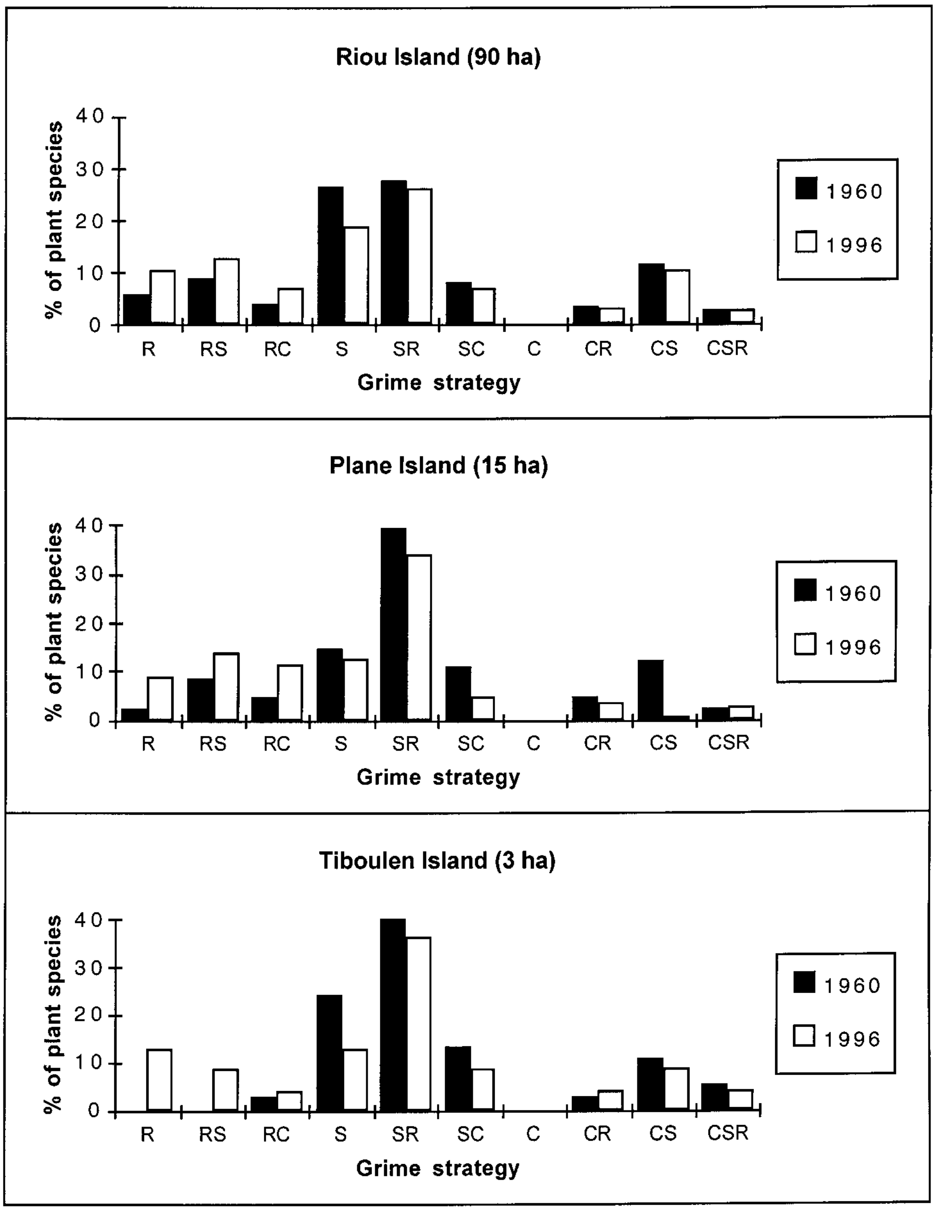

Figure 2. Changes occurring between 1960 and 1996 in Grime strategy distribution within the flora of three islands on the Riou Archipelago (Marseille, France). From Vidal *et al.* (1998b). R, ruderal; S, stress tolerant; C, competitive species; RS, ruderal-stress tolerant; RC, ruderal-competitive; SR, stress tolerant-ruderal; SC, stress tolerant-competitive; CR, competitive-ruderal; CS, competitive-stress tolerant; CSR, medium strategy.

On the Riou archipelago, (Mediterranean coast of France) Vidal *et al.* (1998b) have shown the large extent of floristic changes which have occurred over a 36 year period, due to the severe ecological pressure caused by an increasingly large yellow-legged gull colony.

Small islets have been particularly affected by these changes and some of them now contain more than 50% newly established plant species. Many indigenous species have undergone a severe decline, including some species of special conservation interest. The flora on this studied archipelago has thus undergone a severe ecological transformation. In some places, the vegetation has changed from the original matorrals and coastal phryganic ecosystems to ruderal plant communities, i.e. plants adapted to high disturbance and low stress levels (Grime, 1977). Moreover, on Marseille archipelagos (France), Clauzade and Roux (1975) have shown that intensive guano deposits lead to the development of highly specific ornithocoprophilous lichen communities.

Impact on animal populations

The impact of the yellow-legged gull explosion on vertebrate fauna has been relatively well studied and documented, particularly for birds with conservation interest. Possible interactions between yellow-legged gull and other birds species are triple: predation (on eggs, chicks or adults), kleptoparasitism and competition for nesting places (Table 1).

In the greater flamingo, *Phoenicopterus ruber*, colony in the Rhône delta (France), Salathé (1983) has shown that the predation exerted by gulls on flamingo eggs and chicks represented 11% of total laid eggs. This predation was mainly caused by some highly specialized birds nesting near the flamingo colony. Nevertheless, the predatory pressure seems to have had no serious impact on the demography of the flamingo colony.

Interactions with Audouin's gull, *Larus audouinii*, are particularly well documented as this Mediterranean endemic species is the only category 1 species of European conservation concern breeding in the Mediterranean (Tucker and Heath, 1994). On the Ebro delta (Spain), where 7000 pairs of Audouin's gull (more than 60% of the total world population) nested near 1100 pairs of yellow-legged gull, Oro and Martinez-Vilalta (1994) demonstrated that kleptoparasitism and predation by the yellow-legged gull on Audouin's gull was fairly light and tolerable. This seemed to be due to the abundance of an alternative, easily reached food supply (refuse dumps and fishing vessel discards). However, kleptoparasitism and predation rates were significantly higher during a local fishing moratorium, but how they influence Audouin's gull breeding success is still unknown. In contrast, on the Chafarinas Islands (Spain), the second largest Audouin's gull colony in the world, predation by yellow-legged gull upon eggs and chicks of Audouin's gull partly justified the undertaking of a sustained culling programme (De Juana *et al.*, 1984; Alvarez, 1992; Gonzàlez-Solis *et al.*, 1997). On this site, Bradley (1986) found that 64% of the total Audouin's gull chick mortality was due to the predation by yellow-legged gull. At present, the yellow-legged gull does not seem to constitute a threat to Audouin's gull at least at present population size (Gonzàlez-Solis *et al.*, 1995). On the Asinara island (Italy) (Monbailliu and Torre, 1986), as on the Chafarina Island (Spain) (Varela and de Juana, 1986), the best nesting sites have been colonized by yellow-legged gulls, owing to their earlier breeding. In the Columbretes Island colony (Spain), Castilla (1995) showed experimentally that 78% of artificial Audouin's gull eggs were destroyed by the yellow-legged gull during the first day of her study and 100% the week after. In a Corsican colony, all offspring of nearly 100 Audouin's gull breeding pairs were eaten two years running by a few yellow-legged gull specialists (Thibault *et al.*, 1996).

In the Salines of the Rhône delta, yellow-legged gulls take over the best nesting sites (i.e. the ones protected from terrestrial predators and flooding) to the detriment of the other

Table 1. Actual impact of the yellow-legged gull on vertebrates in the Mediterranean (–: not specified)

		Impact						
		Predation			Klepto-parasi-tism	Competition for nesting sites		
Species	Site	Eggs	Chicks	Adults			Results	Ref.
Reptiles								
Podarcis sp.	Balearic Islands (SP) Berlenga Island (P)			Yes (general)			Threat	1
Birds								
Phoenicopterus ruber	Rhône delta (F)	Yes	Yes	–	–	–	Tolerable	2
Larus audouini	Ebro delta (SP)	Yes	Yes	Yes	Yes	–	Tolerable	3, 7
	Chafarinas Island (SP)	Yes	Yes	Yes	Yes	Yes	Threat?	4–8
	Columbretes Islands (SP)	Yes	–	–	–	–	?	9
	Asinara Island (I)	Yes	–	–	–	Yes	Threat	10
	Balearic Islands (SP)	Yes	Yes	–	Yes	Yes	Threat	16
	Corsica (F)	–	Yes	–	–	–	Threat	17
Hydrobates pelagicus	Fifla Island (M)	–	Yes	Yes	–	–	Extinction	11
	Plane Island (F)	–			–	–	Threat	12
Stema sp., *Larus genei*	Rhône delta (F)	–	–	–	–	Yes	Threat	13, 14
Apus apus	Mediterranean coast (F)	–	–	Yes	No	No	Threat?	15

F, France; I, Italy; M, Malta; P, Portugal; SP, Spain.

References: 1. Beaubrun, 1994; 2. Salathé, 1983; 3. Oro and Martinez-Vilalta, 1994; 4. Varela and De Juana, 1986; 5. Bradley, 1986; 6. De Juana *et al*., 1984; 7. Gonzàlez-Solis *et al*., 1995; 8. Gonzàlez-Solis *et al*., 1997; 9. Castilla, 1995; 10. Monbailliu and Torre, 1986; 11. Borg *et al*., 1995; 12. Walmsley, 1986; 13. Sadoul, 1996; 14. Sadoul *et al*., 1996; 15. Gory and André, 1997; 16. De Juana, 1984; 17. Thibault *et al*., 1996.

colonial charadriiforms (notably terns, *Sterna* sp., and slender-billed gull, *Larus genei*) which are thus compelled to nest in poorer quality areas. These birds show a very low breeding success, which is insufficient for population renewal (Sadoul, 1996; Sadoul *et al.*, 1996). A recent census has shown that 63.7% of 1720 yellow-legged gull nesting pairs were established on places previously occupied by other charadriiforms (Sadoul, 1996).

The storm petrel, *Hydrobates pelagicus*, is also suffering from yellow-legged gull predation; in the Mediterranean, breeding populations are small and confined to just a few islands (Massa and Sultana, 1991). On Filfla Island (Malta), 48 pellets contained 32 remains of storm petrel adults and chicks (Borg *et al.*, 1995). The authors partly attributed the petrel colony decline to the increase in gulls. On Plane Island (France), a small storm petrel colony has disappeared because of predation by gulls (Walmsley, 1986). According to Zotier *et al.* (1992), predation by the yellow-legged gull upon the storm petrel commonly occurs on coastal Mediterranean islets. Nevertheless, no global assessment of the extent of the phenomenon is available for the Mediterranean area. Moreover, predation on the common swift, *Apus apus*, seems to extend to the French Mediterranean coastline (Gory and André, 1997).

Beaubrun (1994) has indicated that the yellow-legged gull frequently kills endemic lizards, such as *Podarcis lilfordi* and *Podarcis pityusensis* on the Balearic islands (Spain) or *Podarcis bocagei berlengensis* on Berlenga Island (Portugal). The last species now appears to be nearly extinct in some areas of Berlenga Island.

Even if some mammals are occasionally consumed by yellow-legged gulls (Beaubrun, 1988, 1994), no mammal population seems to be currently threatened. However, waste and chick carcasses may provide additional food sources for some opportunistic mammals (such as roof rats *Rattus rattus* introduced on to the Marseille islands) and may greatly increase their density in some areas (Vidal *et al.*, 1997).

Discussion

Is the yellow-legged gull a superabundant species?

The consequences of the yellow-legged gull population explosion for natural environments are consistent with the general patterns of disturbance caused by superabundance of large larids, notably the herring gull (Thomas, 1972; Spaans *et al.*, 1991), which is very similar from a taxonomic, ecological and behavioural point of view (Yésou, 1991). The expansion of the yellow-legged gull creates disturbances which seem to affect all the ecosystem processes (interspecific competition, soil dynamics, colonization–extinction processes). Most of the serious damage has been recorded in the large nesting sites where the ecological pressure exerted by the birds is the most severe and constant (Fig. 3).

As for the impact on the vertebrate fauna, which is the most frequently mentioned, serious damage results in severe changes in the dynamics and often in the decline of the target population. Beaubrun (1994) lists more than 40 vertebrate species which have been predated by the yellow-legged gull, but very few of these seem to suffer from gull expansion. Nevertheless, disturbances due to the gull population explosion have to be taken seriously, particularly when target species are weak or have a very limited range. Competition with other colonial charadriiforms for breeding sites, particularly terns, is really worrying even if some site management techniques seem to be effective and encouraging (Sadoul, 1996; Pérennou *et al.*, 1996). Other worrying situations concern endemic lizard species (*Podarcis* sp.), and to a lesser extent, Mediterranean endemic Audouin's gull and

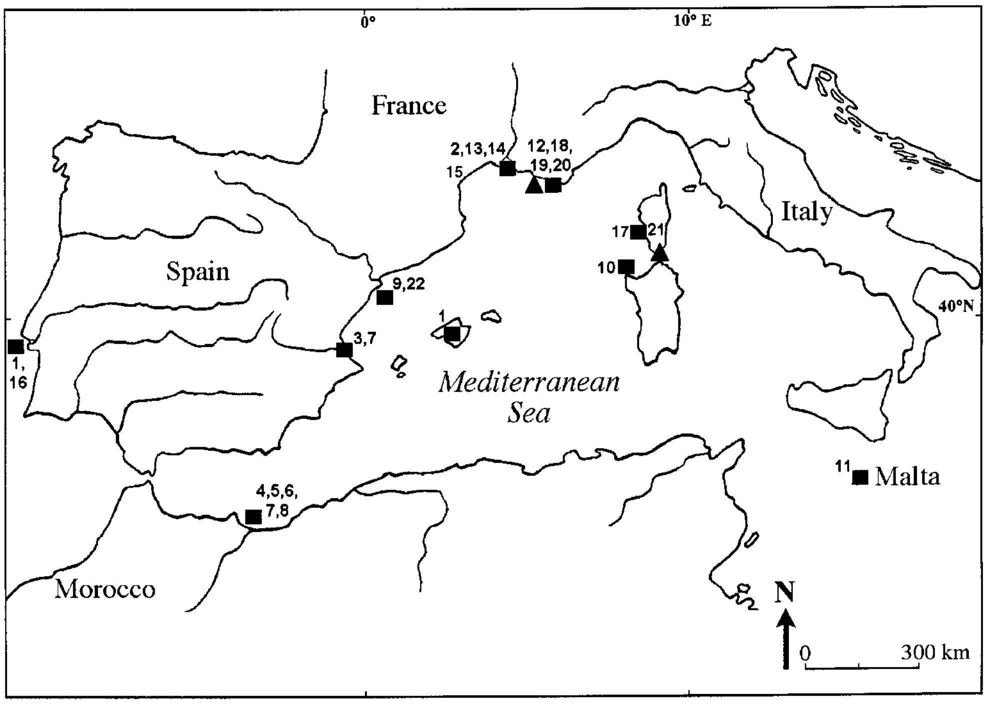

Figure 3. Location of well-founded and detailed impacts of the yellow-legged gull on natural environments in the Mediterranean basin. ▲, Impact on flora and vegetation; ■, Impact on fauna. References: 1. Beaubrun, 1994; 2. Salathé, 1983; 3. Oro and Martinez-Vilalta, 1994; 4. Varela and De Juana, 1986; 5. Bradley, 1986; 6. De Juana *et al.*, 1984; 7. Gonzàlez-Solis *et al.*, 1995; 8. Gonzàlez-Solis *et al.*, 1997; 9. Castilla, 1995; 10. Monbailliu and Torre, 1986; 11. Borg *et al.*, 1995; 12. Walmsley, 1986; 13. Sadoul, 1996; 14. Sadoul *et al.*, 1996; 15. Gory and André, 1997; 16. De Juana, 1984; 17. Thibault *et al.*, 1996; 18. Vidal *et al.*, 1997; 19. Vidal *et al.*, 1998a; 20. Vidal *et al.*, 1998b; 21. Paradis and Lorenzoni, 1996; 22. Laguna and Jiménez-Pérez, 1995.

storm petrel. However, the limited number of local intensive studies and the lack of general investigations, may mask the seriousness and the extent of this phenomenon.

The impact on flora and vegetation in the nesting sites seems to be extremely severe and posssibly irreversible in the largest colonies (Vidal *et al.*, 1998b). According to Gillham (1961), the specificity of the Mediterranean climate enhances the effects of disturbances caused by gull activities; drought and evaporation increase the guano concentration in soil. The establishment and the expansion of gull colonies seems generally to result in severe denaturation of indigenous phytocoenosis, and damage to 'islet specialist' plant communities (Höner and Greuter, 1988) may often be very prejudicial. The ecological drift of island flora, due to the extension of ruderal and/or allochthonous plants and the regression of native species is extremely preoccupying. In fact, the flora of the Mediterranean islands and islets represents an important element in Mediterranean plant diversity, with a rate of endemism between 7 and 13% (Médail and Quézel, 1997). Contrary to what some authors have reported for other biogeographic zones (Ornduff, 1965; Norton *et al.*, 1997), the Mediterranean littoral flora seems not to have 'co-evolved' along with sea-bird and seal colonies and its presence does not depend on disturbance by rookeries. Nevertheless, some rare plant species (*Senecio leucanthemifolius*, *Stachys brachyclada*) seem to survive within the disturbance patches created by gull activities (unpublished data).

Thus, from the point of view of disturbances on 'desirable' plants and animals, this review shows that the yellow-legged gull locally fulfils the third requirement for consideration as a superabundant species. Nevertheless, the effects of yellow-legged gull expansion on natural environments overall have not yet been closely studied. This is very infortunate as in Europe and notably in France, there is a popular outcry for the regulation of some of the abundant bird species which are considered to be pests (cormorants, herons, gulls, corvids). These demands often come from very influential hunters, fishermen or fish-farmer groups. Due to the lack of precise studies, the scientific authorities involved in nature management are often at a loss to provide them with convincing counter arguments. For example, no extensive study has yet been conducted on the consequences of the yellow-legged gull for farms, game or fish. Nevertheless, some hunters' organizations, notably in France, have already obtained the right to perform some one-off culling operations to protect gamebirds. This review highlights the gap existing between the deficiency of intensive and global studies and the evidence produced by the rare studies which have been done. The yellow-legged gull population seems to increase at a rate of 10% per year, but our knowledge of colony size, colony location and population dynamics is only fragmentary given that phenomenon resembles the well-documented herring gull demographic explosion.

Control measures and scientific priorities

Damage caused by superabundant larids on fauna around the world has led to the implementation of some routine or one-off control measures, mainly by culling breeding adults or destroying clutches (e.g. Thomas, 1972, Wanless *et al*., 1996; Harris and Wanless, 1997). On very small gull colonies, some alternative solutions are sometimes tested, through the installation of exclosures and the removal of nests (Blockpoel *et al*., 1997). To have a real impact on long-lived species like gulls, control campaigns need to be sustained over a very long time period. Thus, intensive control measures are often very onerous and necessitate heavy manpower and material resources (notably when colonies are inaccessible). Moreover, severe and repeated culling programmes often result in undesirable secondary effects such as the moving or the splitting of the treated colony and a density-dependent response compensating for the mortality due to culling (Duncan, 1978; Coulson *et al*., 1982; Coulson, 1991).

In the case of the yellow-legged gull, some control programmes are documented in the literature (for a review, see Beaubrun, 1994), notably in the Rhône delta (Blondel, 1963; Sadoul, 1996), Chafarinas Islands (Alvarez, 1992) and Berlenga Island (Morais *et al*., 1995). Two main techniques are used to control the yellow-legged gull population: narcotizing adults and sterilization of eggs. In Camargue (Rhône delta), the yellow-legged gull population continues to increase in spite of more than 30 years of culling of a minimum of 10% of the nesting population each year (Sadoul, 1996). On the Frioul Islands (bay of Marseille), the yearly sterilization of a thousand clutches (1/3 of the nesting population) since 1993 has not been sufficient to check the population explosion (Vidal *et al*., 1997). In these two cases, the relative failure of the culling programmes is partly imputed to the intensive immigration from Riou archipelago (ca 15 000 nesting pairs) (Sadoul, 1996; Defos du Rau *et al*., 1997).

In fact, the superabundance of the yellow-legged gull is probably currently considered to be worrying based on its potential future impact rather than on its actual impact on natural environments. Even if closing down the open-air refuse dumps by 2002, as ordered by the European Community, is probably the only efficient means of reducing the yellow-legged gull population, a severe and sudden drop in food availability may induce some temporary but serious problems. Some people are afraid that the gull flock will initially fall back on alternative food sources, such as waterfowl, gamebirds, town refuse and farms. Thus, it may be wise to take some local precautions to avoid future depredation.

Currently, there are three main scientific priorities. First, a better knowledge of colony sizes, colony locations and population dynamics, particularly in the eastern and south Mediterranean, along with a better understanding of population exchanges between colonies. Second, the prediction and modelling of the future development of the yellow-legged gull population dynamics. This necessitates demographic data for parameterizing population models. Data such as productivity and age of first breeding are available (Beaubrun, 1988; Defos du Rau, 1995), but, for the moment, survival rates are still unknown despite the fact that such information is available for the herring gull (e.g. Pons and Migot, 1995). Obtaining such data is undoubtely part of the first and main scientific priority. Third, the drawing up of an inventory, as complete and precise as possible, of yellow-legged gull depredations on natural environments, particularly those concerning bird species suspected to be potentially at risk such as the storm petrel, cory's shearwater, *Calonectris diomedea*, and the Mediterranean shearwater, *Puffinus yelkouan* (e.g. Thibault *et al.*, 1996). This inventory is necessary to measure precisely the effects of changes in the dynamics of yellow-legged gull colonies. Insular systems are well suited to these investigations as ecological processes are simpler and easier to understand on an island than on the mainland and insular ecosystems are more sensitive to changes in disturbance patterns (Vitousek *et al.*, 1995).

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