EU Programme "Global Change and Ecosystems"

Contract No. 036891 (GOCE)

RIOS PROJECT– Reducing the Impact of Oil Spills

BACKGROUND DOCUMENT

Research and Development Needs for Reducing Impacts from Oil Spills on Wildlife

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February, 2008

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Foreword

In April 2007 the European project “Reducing the Impact of Oil Spills – RIOS” was started. The RIOS-project is focusing on negative impacts of oil spills on marine wildlife, such as marine and coastal birds, marine mammals and sea turtles, and how these effects can be minimised, e.g. through investments into research and development. The main objective of the project is to develop a European Action Plan for future research and development, and to stimulate contacts and future cooperation between relevant groups and stakeholders such as scientists/researchers, marine wildlife rehabilitators, veterinarians, biologists, NGOs, the oil and maritime industries and governmental organisations.

The present Background Document contains the contributions of four experts who have been asked to provide their personal overview of the state of the art with regards to their field of expertise and to propose a set of priorities for new research. The main areas that have been reviewed in the Background Document include:

- Vulnerability mapping (by Kees Camphuysen);
- Rehabilitation (by Mike Ziccardi and Thierry Jauniaux);
- Post release survival; (by Mark Grantham) and
- Impact assessment (by Kees Camphuysen).

These contributions must be considered as a strong kick off of the discussions that hopefully will take place during the next phase of the project. The RIOS project will accommodate these discussions in two ways, by:

1. Welcoming all stakeholders to provide reactions and new viewpoints. These will be collected by the secretariat in the form of scientific documents, letters or remarks;

2. Holding a two days workshop in Portugal (Algarve, April 17-19), where discussions can take place. Invited speakers will provide an overall overview of the subject of oiled wildlife response and preparedness, after which discussions on new research and development priorities will be held. Contributions from attendants and the wider audience are welcomed in the form of poster presentations.

Annex I provides an overview of the RIOS project. It contains further information on how you can get involved in the discussions and how in the end all the collected information will be used in the European Action plan, the most important delivery of the project.

Claudia Jesus-Rydin, Project Coordinator
On behalf of the RIOS consortium

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Introduction

Hugo Nijkamp, Sea Alarm Foundation, Belgium

The environmental effects of marine oil spills, wherever they happen, may include the effects to wildlife. The immediate impact of an oil spill on marine wildlife such as marine and coastal birds, marine mammals and marine reptiles (e.g. turtles) may be considerable. If in the middle of an area where vulnerable species are abundant, the spill may victimise tens to hundreds or even thousands of animals, especially birds in Europe. The long term impact of an oil spill depends on the proportion of the breeding population of any species that gets affected.

The impact of an oil spill on marine animals can be reduced by taking timely and effective measures as part of the overall oil spill response. At different stages of the response, including a pre-incident phase of contingency planning, there are specific response options that can be considered to prevent wildlife from oiling or to reduce the effects of oiling. An integrated oiled wildlife response requires specific knowledge, strategies and techniques in order to be effective and successful.

Europe has an impressive history of oiled wildlife experiences including incidents that go back as far as 1967 and including e.g. *Torrey Canyon* (UK, 1967), *Amoco Cadiz* (France, 1978), *Braer* (UK, 1993), *Sea Empress* (UK, 1996), *Pallas* (Germany, 1998), *Erika* (France, 1999) and the more recent incidents such as *Prestige* (Spain, 2002), *Tricolor* (France/Belgium, 2003), *Fu Shan Hai* (Denmark, 2003), *Rocknes* (Norway 2004), Glomma river spill (Norway, 2006), *Server* (Norway, 2007), *Duncan Island* (Germany, 2008) and a number of so called mystery spills (Estonia, 2006; Germany, 2001, 2004 and 2008). National authorities in an increasing number of European countries have become interested in exploring the needs and options for oiled wildlife response planning, recently stimulated by a series of three EU workshops in 2006 and the outcome of the related projects (Anon. 2007a). Agreed plans already exist in France, the UK and Belgium. In other countries, e.g. Netherlands, Germany plans are being developed and in a number of other countries national discussions, involving authorities, wildlife responders and sometimes industry, have started. Recently the Baltic Sea States have decided to add oiled wildlife preparedness and response to their programme of international cooperation under the Helsinki Convention (Helcom, 2007a; 2007b).

The emerging field of oiled wildlife preparedness and response in Europe clearly comes with a range of new challenges for many stakeholders. Many of these challenges are best dealt with at an international level, because they are basically the same in any country. Discussions so far have already resulted in the publication of a range of international guidelines on good practice, international strategies and centralised information sources (IPIECA, 2004; Anon., 2007a, 2007b, 2007c, Camphuysen et.al, 2007).

One of the emerging challenges in Europe is the strong demand for best available scientific knowledge in relation to the many disciplines of oiled wildlife response, including e.g. response strategies and techniques, issues of animal welfare, rehabilitation techniques, impact assessment etc. The RIOS project has been developed to identify these fields of research, assess the state of the art in each of them, identify gaps in knowledge and prioritise research needs that may be proposed for future European funding.

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Evaluating the vulnerability of marine areas in terms of sensitivity to oil pollution

Kees (C.J.) Camphuysen, Royal Nioz, Texel, Netherlands

Part I State of the art

Introduction into subject
There has been a long, world-wide history of oil spills and associated mortality of marine wildlife. Some spills have inflicted considerable damage, while others did not seem to affect much wildlife. Several reviews of the effects of oil spills have shown that there is no correlation between the amount of oil spilled and the impact on marine wildlife; it is the place and time that matters most. Clearly, there are spatial and temporal patterns in the sensitivity of sea areas for oil pollution, for as far as marine wildlife such as seabirds and marine mammals are concerned.

Seabird species differ in their vulnerability to oil spills. The scale of vulnerability of individual seabird species depends not only on numbers present, but also on behavioral and other characteristics. Several studies have examined ways of assessing these characteristics and species-specific sensitivities to oil pollution (Oil Vulnerability Indices, OVIs). In most cases, species were graded on the basis of various factors that affect their annual survival and each of these factors was given a score representing respectively no, low, medium or high relevance of that factor indicating sensitivity to oil pollution.

If seabird species with a high OVI score occur in high densities in a particular sea area, that area would naturally classify as a sensitive area with respect to oil pollution and immediate conservation actions would be required in case of a spill. Much less immediate concern would be necessary in areas holding few and only low scoring species. Seabird distribution atlases are a first step to evaluate sea areas in terms of their sensitivity to oil pollution, while the next step should be the transformation of species specific seabird distribution patterns into generalised oil vulnerability maps. Unfortunately, that last transformation has thus far only seldom been undertaken, and even with regard to the baseline information required, most European seas are currently data deficient.

While reviewing Europe's sea areas in these respects, it became clear that (1) there is substantial recent knowledge on seabird distribution and migration patterns, but with large gaps, (2) only few areas have been evaluated in terms of their sensitivity to oil pollution on the basis of marine wildlife and species-specific OVIs, (3) some of the worst recent spills in terms of casualties (i.e. *Erika, Prestige*) occurred in sea areas for which both data sets are lacking or at best incomplete, and (4) in well covered areas, the data are currently ageing and new surveys may be required as updates.

To improve our levels of preparedness regarding oil spills, but also to enhance the possibility to protect the most sensitive sea areas in particular, it is important that data on spatial and temporal patterns of seabird and waterbird distribution are collected and/or updated throughout Europe. As a next step, the collected data should be analysed and generalised to produce oil vulnerability indices for all European sea areas at the smallest possible scale. This information should then be made available in a highly accessible format, for example on the internet, to promote the implementation of the material in conservation measures that could protect our wildlife more effectively from the effects of oil pollution.

Literature review

Oil vulnerability indices of marine birds and waterfowl
A first step towards the evaluation of sea areas in terms of sensitivity to oil pollution, is an inventory of the type of seabirds and waterfowl utilising that area (King & Sanger 1979, Camphuysen 1989, Williams *et al.* 1995). With species specific OVIs, that will vary between areas

because of differences in exposure and behaviour (Speich *et al.* 1991, Begg *et al.* 1997, Anon. 2003, Camphuysen *et al.* 2007), it is not to be recommended to simply adopt OVIs of certain species from other areas within Europe. For each of the major sea areas within Europe, OVIs must be carefully evaluated and peer reviewed according to standards set in studies listed below (see for a summary and comparison Camphuysen 2007).

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Seabird distribution studies within Europe

OVIs are essential as a starting point, but equally important is high quality information on spatial and temporal patterns in seabird and waterfowl distribution. Oil spills may take place at some distances from the nearest shore. In the past, even in very recent years, authorities usually focussed on the protection of coastal areas and overlooked the sensitivity of offshore areas (often in the absence of concrete data that could have helped them with the evaluation of these areas. Systematic seabird offshore distribution studies have been developed in the 1970s (Bourne & Johnston 1971, Bailey & Bourne 1972, Joiris 1972, 1973), but became a common and widespread practice only in the 1980s (Bourne 1982, Blake *et al.* 1984, Bourne 1986, Durinck *et al.* 1987, Tasker *et al.* 1987, Benn *et al.* 1988) and 1990s (Baptist & Wolf 1993, Camphuysen & Leopold 1994, Anon. 1995, Stone *et al.* 1995, Bloor *et al.* 1996).

Numerous studies have been initiated around Britain and workers from the Joint Nature Conservation Committee have played a crucial role in the formation and maintenance of the European Seabirds at Sea Database (ESAS database), currently the largest available dataset on offshore seabird distribution and dispersal in NW Europe. The database holds data from Faeroese waters, the Norwegian Sea, the North Sea, the Baltic, the French Channel, the Bay of Biscay, and Atlantic waters west of Britain, as these were collected following a common standard by research institutes and groups of all North Sea countries.

Camphuysen (2007) evaluated the available data for all sea areas around Europe, and found that large areas are still data deficient or have only been partly surveyed. An important recommendation would therefore be that data deficient areas should be prioritised in near-future research projects and that with the current need to assess marine Important Bird Areas (marine IBAs) in Europe, also the sensitivity to oiling should be evaluated.

The most recent research projects include seaduck monitoring, including aerial surveys, in Iberian coastal waters (e.g. Rufino & Neves 1990), annual surveys to offshore distribution of seabirds by the Spanish Oceanography Institute (Valeiras 2003, 2005, Abad *et al.* 2006), and two BirdLife projects currently under way (SEO and SPEA, data loggers, aerial surveys and ship-based surveys; no results published yet).

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Analysis of spatial patterns in vulnerability to oil pollution within Europe

From seabird distribution studies and OVIs, the next step is the transformation of the material into a format that can be used specifically for the protection of sea areas against the effects of marine oil pollution. It must be realised that decisions on clean-up operations or the displacement of ships in distress have to been taken quickly, based on readily accessible data. When highly sensitive sea areas deserve special protection during major spills, or when offshore operations (for example gas and oil exploration) should be designed such that these areas are respected, there should be very little doubt about their whereabouts. There is some literature about the conservation use of (highly specialised) information on the distribution of seabirds at sea (Tasker 1991). A very important step was the construction of oil vulnerability atlases, where spatial and temporal patterns of species level were transformed into simplified patterns of sensitivity to oil pollution. Basically, seabird densities were multiplied with species specific OVIs, so that concentrations of sensitive species become more prominently visible on sea charts at the expense of concentrations of birds that are usually unaffected from oil pollution. Managers can then instantly compare sea areas with a glance on the chart, without the need to understand the underlying data, let alone the different species of birds and mammals that occur in anyone area. Examples of vulnerability atlases are listed below. In the same review referred to earlier, Camphuysen (2007) made an inventory of oil vulnerability assessments around Europe and data deficient areas were clearly labelled and listed.

It is important not to confuse IBAs inventories with the assessments of the vulnerability of sea areas to oil pollution! Not all highly sensitive seabird species are currently under immediate threat of extinction, and IBAs are often designed to highlight areas with birds under threat. To minimise the effects of oil spills, oil transport and oil exploration, attention should focus rather on species that are normally at the highest risk during spills, even if conservation should be taken into account.

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Forecasting oil spill effects

A more recent development is the involvement in oil spills to assess the risks and possible changes in the sensitivity of affected areas considering migration patterns of vulnerable wildlife. High quality information on the presence of sensitive wildlife should always be checked during accidents and major spills, while oil spill responders should be provided with data on possible radical changes in the sensitivity of affected areas caused by (predictable) shifts in wildlife abundance, for example during migration. The Tricolor spill in the Channel area should not have had the same disastrous environmental impact, had the activities around a non-leaking wreck be postponed a few months (when sensitive seabirds had predictably moved away from that area; Camphuysen 2005). There are currently proposals that describe the type of data that should be collected and address lists of institutes and experts that might be consulted around Europe during spills (Camphuysen *et al.* 2007), but the topic would deserve more attention and standardisation. The development of a European database with online contact information and study results must be considered.

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<u>Existing platforms for cooperation & peer review</u>

Scientific journals that regularly publish on the subject?

- Biol. Conserv.

- Atlantic Seabirds (The Seabird Group & Dutch Seabird Group)
- Marine Ornithology
- Seabird (The Seabird Group)
- Sula (Dutch Seabird Group)
- Seevögel
- British Birds
- Journal of Ornithology

Existing conference series that should be interested in papers on the subject

- International Seabird Group Conference (Europe)
- Pacific Seabird Group Conference (N America)

Research groups that might be interested in submitting proposals

Europe:

- Partners of the European Seabirds at Sea database
- BirdLife partners

North America:

- Canadian Wildlife Service
- US Fish & Wildlife Service

Part II Selected research topics (priority fields) for European research funding

1.
Title
Mapping offshore seabird concentrations
Brief description Spatial and temporal patterns in seabird distribution in European waters are still incompletely known. Important data deficient areas, or areas where the available information is incomplete, are arctic waters, the Norwegian Sea, Bay of Biscay, the Mediterranean and the Black Sea. Some areas suffer from ageing data and that includes a greater portion of the otherwise well studied North Sea. Evaluating the sensitivity of sea areas is impossible in the absence of high-quality information of offshore seabird distribution patterns and this must be considered an issue of the highest priority.
Long term objectives A re-evaluation protection needs of sea areas with emphasis on the vulnerability to oil pollution, possibly even a new design of specially protected areas under MARPOL Annex I.
Examples of projects or programmes towards these objectives European Seabirds at Sea database and associated groups and institutes, programmes to designate marine IBAs (but see text above)
Opportunities

- From a European perspective
- From an international perspective (e.g. cooperation EU-US)

2.
Title
Oil vulnerability indices of marine birds and waterfowl
Brief description Evaluating the sensitivity of sea areas (oil vulnerability atlases), in particular of areas that are currently data deficient (Camphuysen 2007) is an issue of high priority. For several sea areas, species specific OVIs should be assessed following techniques that have been published.

Long term objectives A re-evaluation protection needs of sea areas with emphasis on the vulnerability to oil pollution, possibly even a new design of specially protected areas under MARPOL Annex I.
Examples of projects or programmes towards these objectives European Seabirds at Sea database and associated groups and institutes

3.
Title
Forecasting oil spill effects
Brief description Techniques of “on the spot” area vulnerability assessments should be evaluated and standardised, with the aim of providing technical oil spill responders with high quality advice regarding the priorities of clean-up operations or the particular risks of certain offshore activities during spills in the light of sensitive wildlife. Recommendations should be made available on techniques to transform data on migration patterns in clear predictions of shifts in area sensitivity, and on techniques to combine data of a variety of sources (wildfowl counts, point transect counts, line-transect counts, aerial surveys, ship-based surveys, assessments of breeding distribution) into information to forecast the variability in patterns of area sensitivity on a small scale.
Long term objectives Practical guidelines to be followed in case of oil spills to rapidly update existing information on area sensitivity and to inform technical responders during oil incidents about possibilities to minimise further damage to oiled wildlife.
Examples of projects or programmes towards these objectives EC funded project “Impact of Oil Spills on Seabirds”, development of Handbook Oil Impact Assessment
Opportunities

- From a European perspective
- From an international perspective (e.g. cooperation EU-US)

4.
Title **Evaluating the impact of oil spills**
Brief description The impact of oil spills has been evaluated partly or fully, but usually on an individual basis. A
Long term objectives
Examples of projects or programmes towards these objectives
Opportunities

- From a European perspective
- From an international perspective (e.g. cooperation EU-US)

Reducing the effects of oil spills on wildlife: avian rehabilitation methods

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Part I State of the art

Introduction to the subject

Large-scale impacts of oil spills to wildlife (primarily bird species) have been reported in the past century, causing widespread morbidity and mortality in affected animals both at individual-, as well as a population-, levels. More recently, large-scale wildlife responses (particularly in European countries) have been mounted by professional animal care organizations, leading to opportunities to provide input into developing improvements in the knowledge and understanding of the effects of oil on wildlife, as well as methods to better care for affected animals. Research to date has focused on a number of different fronts, primarily focused at understanding the effects of oil on wildlife at a physiological level, but has been limited thus far on the development of better rehabilitation methods to care for oil-affected wildlife. Therefore, the purpose of this document is to review these advances in rehabilitation techniques of oiled birds to better identify knowledge gaps for directing future research. Because of the space limitations to this document, only those aspects directly related to avian rehabilitation will be included – other topics such as the moderate-term and chronic effects of oil on bird species, field operations, and logistical/facility issues will not be addressed.

- Biomedical Issues: General health diagnostics, general therapeutics, disease issues (animal and human-health issues)
- Husbandry Issues: Captivity stress, nutrition, housing
- Wildlife Cleaning Issues: Techniques, water requirements, products, methods

Birds coated with oil can present with a variety of biomedical issues both directly and indirectly related to oil exposure (reviewed in (Leighton 1990; Jessup and Leighton 1996). Much work has gone into conducting and evaluating routine medical diagnostic procedures (primarily blood work) to determine "cut-off" values that predict whether animals will survive a certain stage of rehabilitation, or survive after release (Leighton, Lee et al. 1985; Leighton 1986; White and Sharp 1994; Newman 1995; Newman, Anderson et al. 2000; Golet, Seiser et al. 2002; Newman, Golightly et al. 2004; Alonso-Alvarez, Munilla et al. 2007). As a whole, complete blood counts (CBCs) and plasma chemistry analyses have proven less informative than simple assessment of packed cell volumes (PCV) and total plasma protein (TP) levels using rapid, simple manual assessment techniques (Ziccardi, Tseng et al. 1997; Tseng 1999; Newman, Anderson et al. 2000; Mazet, Newman et al. 2002; Newman, Ziccardi et al. 2003). More recent studies evaluating additional blood values (acute phase proteins such as fibrinogen, and hemoglobin) using more advanced methodologies (e.g., protein electrophoresis) may prove to be more accurate in predicting survival than those previously used (Mazet, Gardner et al. 2000; Newman, Golightly et al. 2004; Johnson 2007; Massey 2007). General avian therapeutics is another area of focused concern for oil spill research, with particular interest in rehydration methods, addressing anemia and hypoproteinemia, and enteric coating agents. Oiled birds more often than not present with moderate to severe dehydration, due to being out of the aquatic environment and with decreased access to water sources (directly via water or through food sources) (Crocker, Cronshaw et al. 1975; Croxall 1975; Miller, Peakall et al. 1978; Lee, Leighton et al. 1985; Balseiro, Esp¡ et al. 2005; Massey 2006). These findings are also often coupled with anemias and low blood proteins – the former likely due to chronic stress reducing blood production and, possibly, an increase in destruction from the direct effects of petroleum exposure (Leighton, Peakall et al. 1983; Leighton, Lee et al. 1985; Leighton 1986; Burger and Fry 1993; Yamato, Goto et al. 1996; Balseiro, Esp¡ et al. 2005), the latter from anorexia and gastrointestinal impacts (Tseng 1999; Newman, Anderson et al. 2000; Mazet, Newman et al. 2002; Alonso-Alvarez, Munilla et al. 2007). Different rehydration techniques and solutions have been evaluated fairly extensively (Newman; Newman, Tseng et al. 2000), with oral rehydration using balanced electrolyte solutions often being the primary method used (due to the logistical limitations of the other techniques). Newer, more specific parenteral products (such as colloids) may have great value coupled with oral techniques, especially immediately upon intake, to rapidly eliminate fluid deficits and address hyproteinemia (Antinoff 2003). Gastrointestinal agents (used to protect the gut as well as "adsorb" petroleum) are also regularly used immediately upon presentation at oiled bird facilities (Anon. 1990; Miller and Welte 1999; Tseng 1999; Newman, Tseng et al. 2000), as maldigestion and malabsorption of nutrition and fluids is a common finding in oiled animals (Miller and Welte 1999). However, there is little research evaluating the effectiveness of the different available products, or if those that include activated charcoal effectively adsorb petroleum. Another area of biomedical emphasis is the rapid diagnosis of infectious disease within oil-affected birds, both for the affected animal's sake as well as the human worker's safety. The disease of primary concern in oiled bird responses is aspergillosis, a fungal infection thought to be the primary cause of mortality in oiled animals (aside from the consequences of hypothermia) (Haebler, Borsay et al. 1997; Daoust, Conboy et al. 1998; Carrasco, Lima et al. 2001; Balseiro, Esp¡ et al. 2005; Skerratt, Franson et al. 2005). Much research has been done to develop an accurate diagnostic test and treatment modality for this disease in bird populations, with limited success (Tseng 1995; Risi 2003; Burco 2007). Currently, prophylactic administration of antifungal medications, maximizing ventilation within facilities, and minimizing stressors appears to be the only way to address this infection in a herd-health environment such as an oil spill (Tseng 1995; Newman, Tseng et al. 2000; Tell 2007). Zoonotic disease agents are also a concern during spills because of the close contact of humans to their patients and the potential for high concentrations of environmental exposure (large animal numbers, confined space, less-than-ideal biosecurity and stressed individuals – thereby possibly shedding more organisms) (McOrist and Lenghaus 1992; Miller 2007). At the present time, the most pressing example of this is Highly Pathogenic Avian Influenza (or HPAI) H5N1 (Guberti and Newman 2007; Merivee and Ojaste 2007). Unlike aspergillosis, diagnostic testing for this disease exists; however, rapid differentiation of high versus low pathogenic strains of this organism has not yet been established (Cattoli and Capua 2007). Many researchers are currently investigating this area (including the development of rapid field diagnostics), and evaluation of affected animals should be planned for during wildlife response to ensure risks to staff and volunteers are minimized. In addition, concerns over nosocomial (versus environmentally-acquired) infections regularly arise during oil spills, as the risk of reintroducing rehabilitated but diseased animals into a naïve population regularly concerns wildlife managers (Stone and White 1997; Steele, Brown et al. 2005; Jijon, Wetzel et al. 2007). Broad-based disease surveillance during non-spill periods for zoonotic and important population-level disease agents should be done if at all possible to better interpret the results of disease testing during oil spills.

Husbandry Issues: There is a great deal of information available related to development of improved rehabilitation methods and techniques related to the husbandry of oiled birds, however, much of these data exist in the "grey" literature, in the proceedings of rehabilitation conferences, or within individual organization's documents. Underlying many of these modifications and improvements to husbandry methods are changes to minimize the number and/or impact of stressors to animals while in captivity. Several studies have evaluated the contributions of captivity versus petroleum exposure in pathological findings, as well as the detection of stress hormone levels (blood and fecal) and behavioural changes in birds in differing husbandry environments (Gorsline and Holmes 1981; Leighton 1986; Fry and Addiego 1988; Newman, Takekawa et al. 1997; Romero and Wikelski 2002; Trendler 2003; Balseiro, Esp¡ et al. 2005). Unfortunately, it is extremely difficult to differentiate the effects of oil versus rehabilitation methods without controlled studies. Another area of research is the development of adequate nutritional diets and methods for oiled birds while in a captive setting (Donoghue 1990; Oka and Okuyama 2000). Most rehabilitation organizations provide nutritive slurries via gavage tubes while birds are within a facility to ensure each animal is receiving adequate caloric levels (Tseng 1999; Massey 2006), the recipes of which have been derived under consultation with avian nutritionists (Donoghue 1990; Holcomb 2003). Newer enteric formulas developed for the critical care of pet birds, however, have entered the market over the past ten years, and may provide better overall support of such birds (Donoghue and Stahl 1997; Harper and Skinner 1998; MacLeod and Perlman 2001; Perlman and MacLeod 2003). Additionally, after birds have been cleaned and are in a pre-release conditioning phase of the rehabilitation process, the reliance on lower-fat fish for aquatic birds is currently necessary to ensure fish oils are minimized within the water column of the pool and/or preened onto the feathers of the recovering bird (Miller and Welte 1999; Tseng 1999; Newman, Tseng et al. 2000). Such fish are not nutritionally optimal, though, as the fish oils can provide excellent caloric density for the diet (Bryan, Soupir et al. 1996). Additional research into better pool filtration is currently underway by several researchers in order to allow higher nutritive fish to be provided. Animal enclosure design and construction, both pre-cleaning as well as pre-release, is another area of extensive scrutiny within the oiled wildlife arena. The development of net-bottomed pens, as well as the use of protective coverings over bird's bony protuberances, has helped reduce the number and severity of pressure wounds developing within non-aquatic housing types (Holcomb 1988; Goodfriend 1997). The use of non-wood materials to construct these pens (e.g., plastic, rubberized cloth) is currently being evaluated to further reduce secondary lesions associated with wounds from striking the sides of the enclosures (Ballard 2007). Pool design has also been an area of extreme interest by oiled bird rehabilitation groups. Warm water pools have been developed to allow birds to be placed into an aquatic environment more quickly and for longer periods after cleaning without having to be as concerned about hypothermia (Goodfriend 1997; Tseng 1999). By use of these methods, birds can begin to regain waterproofing more quickly and with a lower risk of succumbing to secondary problems associated with remaining in indoor pens.

Wildlife Cleaning Issues: Probably the area which has engendered the most interest from researchers actively involved in oiled bird response is the development of new and innovative cleaning equipment, supplies and techniques to remove the oil from bird's feathers. Most frequently, oiled birds are cleaned using water and a cleaning product (e.g., soap or detergent) (Odham 1971; Berkner, Smith et al. 1977; Kerley and Erasmus 1987; Jessup and Leighton 1996; Tseng 1999; Newman, Tseng et al. 2000; Massey 2006; Tibazarwa, Williams et al. 2007). However, recent work on the use of iron powder and magnetic removal of the contaminant has garnered interest in its use either as a primary cleaning technology or a pre-washing step (Williams 1999; Orbell, Ngeh et al. 2004; Orbell, Van Dao et al. 2005; Dao, Maher et al. 2006). Significant levels of work has been done to identify the ideal water parameters and requirements (e.g. temperature, hardness, volume, and pressure,) necessary to not only remove the product from the feathers, but to eliminate any residual secondary contamination from soap, minerals in the water, or other compounds added to improve the effectiveness of cleaning (Anon. 1990; Clumpner 1990; Newman, Tseng et al. 2000). Each parameter is important for different reasons: appropriate temperature to provide the best cleansing action for the product as well as to keep the bird from becoming hypo- or hyperthermic, hardness of approximately 3 grains to ensure soap is removed completely without allowing mineral deposits from remaining on the feather structure, adequate volumes to allow for all birds to be cleaned, and sufficient pressure to ensure feathers are completely cleaned down to the skin. This being said, however, several spills where water was present with sub-optimal characteristics was used extremely effectively by mitigating the subsequent problems through knowledge of the overall cleaning mechanics (Kerley and Erasmus 1987; Holdsworth and Bryant 1997; Callahan 2001; Merivee and Ojaste 2007). Research into the products used to remove oil have been fairly numerous and well designed. A number of different studies have evaluated the efficacy of using different "pre-cleaning" agents to emulsify or mobilize weathered oil, with the most success being those in the oleate family (methyl- or ethyl-) (Miller, Bryndza et al. 2000; Tegtmeier and Miller 2007). Additionally, several studies have examined the effectiveness of cleaning agents in the removal of oil from feathers (Berkner, Smith et al. 1977; Jenssen and Ekker 1989; Bryndza, Foster et al. 1990; Basseres, Verschuere et al. 1994; Bryndza, Foster et al. 1995; Miller, Bryndza et al. 2000; Monfils, Gilbert et al. 2000; Miller, Keller et al. 2005; Tibazarwa, Williams et al. 2007). It has been repeatedly seen that liquid dishwashing detergents provide the best cleaning action while minimizing the damage to individually-oiled feathers – a finding supported by live bird observations during actual spill responses. Lastly, the mechanics of removing oil from feathers has also been evaluated fairly extensively, comparing manual cleaning techniques to those of machines designed to remove product (Cooke 1997; Westerhof, Berreyoets et al. 1997; Lamy, Jacques et al. 2000). The preliminary results using machines to remove oil from birds appear to indicate that it can be done more quickly and efficiently, however, a variety of opinions exist within the oiled bird rehabilitation field about the effectiveness and potential injuries associated with such technologies. Extensive, live-animal testing in a controlled environment comparing the two different methods has yet to be conducted to address these concerns.

Existing platforms for cooperation & peer review

Journals: Journal of Wildlife Disease, Marine Pollution Bulletin, Journal of Avian Medicine and Surgery, J. Of Environmental research, J. Of Wildlife Rehabilitation, J. Of Zoo and Wildlife Medicine, Marine Ornithology, Wildlife Society Bulletin, J. Environmental Toxicology & Chemistry
Conferences: Effects of Oil on Wildlife, Wildlife Disease Association, SETAC

Research groups that might be interested in submitting proposals

Universities (any with environmental toxicology and/or wildlife rehabilitation/health programs), rehabilitation organizations (particularly larger oil-spill specific organizations such as IBRRC and TSBRR), animal welfare groups (such as IFAW, RSPCA, WWF), and other scientific research organizations (BirdLife International, PRBO).

Part II Selected research topics (priority fields) for European research funding

1.
Title
Baseline Health Assessment of Wildlife in Rehabilitation Organizations
Brief description
Fund the diagnostic assessment of at-risk wildlife species (both live and dead) that present at wildlife rehabilitation organizations, including ante- and post-mortem evaluation.
Long term objectives
To better understand baseline health in these populations so that "controls" (or a comparison group) can be used to assess the impact of oil on these species.
Examples of projects or programmes towards these objectives
Establishment of a centralized diagnostic center, collaborations between Universities and rehabilitation organizations, development of a tissue/sample bank for advanced diagnostics
Opportunities
- From a European perspective: Good-Excellent
- From an international perspective (e.g. cooperation EU-US): Good

2.
Title
Data Management Systems for Oiled Wildlife Response
Brief description
Development of a centralized data management system for organizing and analyzing data distilled from oiled wildlife responses
Long term objectives
Include data with post-release survival projects, specific clinical research, and/or beachcast wildlife programs to provide a more robust understanding of the effects of oil on wildlife
Examples of projects or programmes towards these objectives: Develop an integrated medical management database, blend clinical research findings with other data sources form other collaborators
Opportunities
- From a European perspective: Good
- From an international perspective (e.g. cooperation EU-US): Good-Excellent

3.
Title
Identification of the Most Sensitive Biomedical Parameters for Development of Triage Criteria in Oiled Seabirds
Brief description
Analysis of biomedical findings from clinical diagnostic evaluations that predict success or failure of rehabilitation (both to release as well as after release).
Long term objectives
To better assess the success and/or failure of protocols to improve the “success” of oiled bird responses.
Examples of projects or programmes towards these objectives
Analysis of biomedical findings and compare results to ability of birds to successfully progress through rehabilitation, to release, and extent of post-release survival.
Opportunities
- From a European perspective: Excellent
- From an international perspective (e.g. cooperation EU-US): Excellent

4.
Title
Development of Better Housing Methods to Care for Oiled Birds in Captivity
Brief description
To develop and evaluate newer indoor and outdoor enclosures and pools to reduce secondary impacts of keeping oiled birds in captivity.
Long term objectives
To implement changes in husbandry techniques to reduce avoidable injuries of holding birds in captivity for the length of time necessary to repair the damage of oiling.
Examples of projects or programmes towards these objectives
Evaluation of pool filtration systems to provide closed-circuit filtration, development of simple yet robust indoor holding pens for seabirds, assessment of ventilation parameters to reduce infectious disease
Opportunities
- From a European perspective: Excellent
- From an international perspective (e.g. cooperation EU-US): Excellent

5.
Title
Evaluation of the Efficacy of Washing Techniques to Clean Oiled Birds
Brief description
To scientifically evaluate the advantages, disadvantages, successes and failures of different methods and technologies for removing oil from birds.
Long term objectives
To determine if a single technique can be determined to be the most advantageous to use during most spill events involving oiled birds.
Examples of projects or programmes towards these objectives
Evaluate iron powder vs. “machines” vs. hand-washing in a controlled environment, evaluating impacts to feather quality, cleanliness, bird behaviour, stress, logistical issues and survival.
Opportunities
- From a European perspective: Excellent
- From an international perspective (e.g. cooperation EU-US): Excellent

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Reducing the effects of oil spills on Marine Mammals

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Part I State of the art

Introduction into subject

- Marine mammals exposed to same threats such as oil spill that seabirds;
- Marine mammals less vulnerable;
- Impacts of oil and its evaluation different following species;
- Cetaceans: no impact described but biomarkers for chronic exposure;
- Seals: some animals oiled during spills in European waters but no long term impacts known;
- Otters: frequent victims of oil by fur impregnation, ingestion, and inhalation, cases described in Europe;
- Marine mammals stranding network may help in the evaluation of the impact
- Gaps in knowledge: experimentally, impacts demonstrated on animal models but should be demonstrated on marine mammals; no systematic necropsy and samplings of dead animals

Literature review

Marine mammals and seabirds are sharing the same aquatic environment and are exposed to similar environmental threat, but former are less vulnerable to oil than latter. The situation is quite different following species. Cetaceans and seals spend most on their time under the sea surface and their insulation is ensured by a thick blubber layer. In addition, the skin of cetaceans is naked (not stuck by oil) while pinnipeds have a tick fur. Nevertheless, otters are more affected because they are staying longer at the sea surface for grooming (as preening for seabirds) and their insulation is ensured by the fur entrapping air (similarly of the birds feathers). Considering previous items, impact of oil on marine mammals and its evaluation should be considered differently for cetaceans, seals and otters. Along most of the European coastlines, networks evaluated the evolution of stranding and causes of marine mammals death. If an impact occurred, it can be estimated by the post-mortem investigations. Oil can affect directly by inhalation (volatile compounds), ingestion and accumulation and fur impregnation, and indirectly by modification of preys availability and bioaccumulation of trace elements.

Impact on cetaceans
Even if cetaceans have been observed swimming and feeding in oil spill, they seem to be not affected by it (Geraci, 1990). In Europe, no cetacean's death was reported during the *Braer* oil spill and even if effects were suspected for the *Prestige* spill, nothing was documented. No effect of the *Erika* spill could be detected on cetaceans using different indicators of exposure but, high level of vanadium was measured in common dolphins (*Delphinus delphis*) from the Bay of Biscay and could reveal a chronic oil exposure in the area (Ridoux *et al.,*2004).

Impact on seals
The impact on seals is not clearly understood but considered as minor (St. Aubin, 1990). It was considered that 302 harbour seals (*Phoca vitulina riichardsi*) were killed by the *Exxon Valdez* oil spill in 1989, but a recent reassessment evaluated a lower impact as only 14 seals were found dead and their cause of death was ascertained (Hoover-Miller *et al.,* 2001). For other oil spills, some seals were found dead, fouled with oil but necropsies were not performed and it is impossible to link oil and death (St. Aubin, 1990). Grey seals (*Halichoerus grypus*) moulting in Shetland during the time of the *Braer* oil spill may have been acutely affected by exposure to hydrocarbons, but it is difficult to determine the proportion attributable to other causes (Hall *et al.,*

1996). After the *Braer* spill, 31 seals were rehabilitated mostly with respiratory and intestinal problems and two died of the complications induced by the oil exposure (Wijnberg D. *et al.*, 1993). As for cetaceans, no effect was detected on seals after the *Prestige* and *Erika* oil spills (Ridoux *et al.,* 2004).

Impact on otters

Oil spills are considered as being a serious threat for otters (Geraci & Lounsbury, 2005). It is estimated that the Exxon Valdez killed between1000 (Geraci & Williams, 1990) and 5500 (Geraci & Lounsbury, 2002) sea otters (*Enhydra lutris*). Experimentally, it was demonstrated that the metabolic rate increases twofold when 20% of the fur is fouled with crude oil (Costa & Kooyman, 1982). Long-term effects (decreased survival rate, high levels of cytochrome P450 1A) have been demonstrated for sea otter population after the *Exxon Valdez* oil spill, up to nine years after (Monson *et al.*, 2000). Experimental studies using minks (*Mustela vison*) as model for sea otters demonstrated that chronic exposure at low concentrations can have effects on the immune system (Schwartz *et al.*, 2004a), on the adrenal gland (Mohr *et al.*, 2007), on haematological parameters (Schwartz *et al.,* 2004b), on the reproduction success (Mazet *et al.,* 2001).
In Europe, six Eurasian otters (*Lutra lutra*) were found dead during the *Braer* spill and of these, the cause of death was considered has being linked with oil for only two. Modification in the concentration of porphyrins -biomarkers of contaminants present in the oil- was detected in Eurasian otters after the *Erika* oil spill but no deleterious effects were reported.

Conclusions

In Europe, most effects should be expected on Eurasian otters, few on seals and cetaceans. Eurasian otters are considered as being abundant in northern Britain especially Shetland and Norway and less frequent or extinct in others areas. Even if impacts of oil exposure have been demonstrated experimentally, the main gap in the knowledge for the reduction of effects of oil spills on marine mammals is the demonstration of similar impacts on wild animals during rehabilitation (short term) and after rehabilitation (long term) as well as on stranded marine mammals. In addition, for ethic reasons and animal welfare, similar experimental models could not be developed on captive marine mammals. Only animals kept in rehabilitation or dead stranded should be investigated for the evaluation of the oil impacts. For the monitoring of the potential impacts of oil, target species to investigate are, by decreasing order of relevance : otters, pinnipeds and cetaceans. Another gap is the lack of necropsy of animals dying during such oil spill to insure that the death is linked with the oil or not. Stranding networks can achieve and help in the impact evaluation with background data and tissues collections, and different biomarkers can be used to compare historic data and spill impacts assessment data (Bowen *et al.,* 2007, Mazet *et al.,* 2001; Mohr *et al.,* 2007; Ridoux *et al.,* 2004; Schwartz *et al.,* 2004a, b).

<u>Existing platforms for cooperation & peer review</u>

Scientific journals that regularly publish on the subject include

- Marine Mammal Sciences
- Journal of Wildlife Diseases
- Veterinary Immunology and Immunopathology
- Archives of Environmental Contamination and Toxicology
- Science of the total environment

Existing conference series that would be interested in papers on the subject include

- European Cetacean Society
- Biennial conference on the Biology of Marine Mammals
- International effects of oil on wildlife conference

<u>Research groups that might be interested in submitting proposals</u>

In Europe, interested research units and strandings networks may include: MARIN (Belgium), Centre de Recherche sur les mammifères marins, La Rochelle (France), IMARES, Texel (the Netherlands), Sea Mammals Research Unit (United Kingdom).

Interested marine mammals rehabilitation centres may include Sea Life Blankenberghe (Belgium), Oceanopolis (France), Ecomare Texel (Netherlands); Zeehonden Creche Pieterburen (the Netherlands).

Part II Selected research topics (priority fields) for European research funding

1.
Title: Metabolites of oil in faeces and blood of marine mammals during rehabilitation procedure
Brief description: During rehabilitation of marine mammals, faeces and blood can be easily collected to detect presence of specific metabolites or biomarkers linked with a specific oil exposure. Such as porphyrins and vanadium will indicate the internal exposition and potential effects.
Long term objectives: Development of specific indicators of the level of contamination on live animals
Examples of projects or programmes towards these objectives
- The impact of the «*Erika* » oil spill on pelagic and coastal marine mammals
Opportunities
p.m.

2.
Title: Detection of biomarkers specific for deleterious effects
Brief description: Experimental studies using animal model have shown that the chronic exposure even at low concentrations can have effects on the immune system, on the endocrine system, on haematological parameters... Similar biomarkers of exposition can be detected in the blood of marine mammals during rehabilitation process or in tissues if animals are dying during the procedure
Long term objectives: if similar effects are detected, specific medical treatment could be developed to limit them
Examples of projects or programmes towards these objectives
Opportunities
p.m.

3.
Title: Comparison of specific biomarkers on dead stranded marine mammals
Brief description: collection of marine mammals tissues are existing for most European countries. Scientific teams of stranding networks are dissecting marine mammals and are collecting samples for most organs. Such samples are integrated in national tissues banks for long term studies. Such collections can help to identify and compare specific modifications before and after an oil spill or to highlight the potential impact of chronic exposure. As impairment of reproduction has been suspected, such impact is relevant in term of marine mammals conservation.
Long term objectives: If long term studies demonstrated any impacts correlated with oil exposition, oil impact should be also considered in term of marine mammals conservation and specific “answer” can be developed.
Examples of projects or programmes towards these objectives
Monitoring of marine mammals deaths programmes are existing in Europe (Belgium, France, Germany, Spain, UK) and have established tissues banks.
Opportunities
p.m.

4.
Title: Satellite tagging of seals and otters after rehabilitation

Brief description: After rehabilitation following oil spill, animals should be tagged using satellite tags to follow them during the weeks and months after the release. Tags have been developed by Sea Mammals Research Unit (SMRU, UK). Such study can help to know if animals are going back to their initial area or if they prefer to avoid it. There are different programme in Europe to tag wild seals or after rehabilitation. Such studies help to understand their ecology and the behaviour.

Long term objectives: if animals are going directly to their initial area, the release should postponed up to the area is completely oil-free. If animals are released in the initial area, such study will help to understand how animals are using their habitat and highlight some indirect effects such as food availability.

Examples of projects or programmes towards these objectives:

p.m.

Opportunities

p.m.

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Monitoring Post-release survival of rehabilitated birds

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Part I State of the art

Introduction into subject

Most seabirds have very high annual survival rates but low annual productivity. This strategy is adaptive in a usually stable environment, but stochastic events, such as oil spills, can potentially have a serious impact on these birds, both at the individual and the population level. Many oil spills are associated with large-scale mortality of birds through acute oiling and stress, but beyond this, survival chances of individual birds may be compromised with even relatively low levels of oil contamination. Protocols for post-incident rehabilitation care have been developed, and, in some cases, this can greatly increase an individual's chance of survival post-release. Clearly, if a sufficient number of individuals have reduced survival, then there is the potential for an impact at the population level (*e.g.* Esler *et al.* 2002). However, these impacts of will depend on the number and nature (age, sex, breeding location *etc.*) of individuals affected. In many seabird populations the number of adult breeding birds is rather stable, with a variable (but possibly substantial) number of non-breeding individuals; these are mostly younger birds. So impacts at the population level are greater when adult birds are affected, particularly because breeding success tends to increase with age.

In a European context, oil spills will primarily affect two main groups of birds: seabirds, particularly auks and divers, and waterfowl (seaducks). Seabirds tend to be affected in greatest numbers during and immediately after major spills, whereas waterfowl tend to be more affected by chronic oil exposure. The species most affected in European oil spills is the Guillemot *Uria aalge*, and studies often show very low post-release survival (Sharp 1996; Wernham *et al.* 1997). Recent large spills, primarily involving Guillemots, have either been in the vicinity of colonies but outside of the breeding season (e.g. *Braer* in Shetland and *Sea Empress* in Pembrokeshire) or have affected wintering populations, primarily young birds (e.g. *Erika* in Brittany and *Prestige* in Galicia). More serious though are spills in close proximity of a colony in the breeding season or one primarily affecting adults (e.g. the *Tricolor* spill in the southern North Sea).

Europe holds internationally important populations of several seabird species, and many of these are located in inaccessible breeding colonies, where the impacts of oil spills and other events can be difficult to measure, even though they can have demonstrable impacts (Votier *et al.* 2005). Many seabirds present in the North Atlantic during the non-breeding (winter) season will be from breeding colonies spread over a very wide geographic area, potentially extending the influence of a winter oil spill far beyond European boundaries. Wider and closer co-operation across the whole of the North Atlantic breeding range is essential in much of the suggested work here, and this will be a key output of the recommendations.

There are thus two key considerations in monitoring post-release survival. Firstly, if short-term survival rates are low, what are the welfare issues in relation to rehabilitating these birds rather then humanely euthanasing them? It is only ethical to attempt rehabilitation if the suffering the bird must endure is alleviated and it will have a reasonable quality of life after release. Secondly, what is the long-term survival rate of rehabilitated birds, and do they successfully re-enter the breeding population? In essence, rehabilitation has not been successful if the individual bird doesn't re-enter the wild population and have a similar chance of surviving and breeding as non-rehabilitated birds. Key to this is an understanding of distribution and behaviour in the non-breeding season (when oil spills are most frequent) and the demographic processes in each population, *i.e.* how important is survival in determining population trend.

Literature review

Although much effort has been expended on rehabilitating birds following an oil spill, there are surprisingly few studies critically assessing the efficacy of this (*e.g.* Whittington 1996; Anderson et al. 1999; Newman et al. 2003; Joys et al. 2003). Post-release survival of rehabilitated birds is highly dependent on species and the particular circumstances surrounding the spill. Factors such as how much time the species spends on water, feather structure and grooming behaviour can all affect how well species respond to rehabilitation. Groups shown to have responded well to rehabilitation include waterfowl (ducks, geese, swans) and particularly penguins, with survival rates in African Penguins *Spheniscus demersus* similar to non-oiled birds (Randall *et al.* 1980; Whittington 1999). However, there are fundamental differences in the plumage of auks and penguins, and also in grooming behaviour (time spent grooming will have an obvious impact on the amount of oil ingested), which may go part way to explaining the differences.

Ideally, one would monitor survival rates of birds post-release by fitting radio or satellite transmitters so a sample of oiled and un-oiled birds, so that all individuals have a known fate (e.g. Anderson et al. 1999) and length of time post-release can be assessed. However, for most species this is not possible, since transmitters with sufficient power and longevity would not be light enough to attach to birds without adversely affecting their behaviour. Consequently, most studies of post-release survival have involved marking a sample of oiled birds with metal bands or tags, and analysing the pattern of subsequent recoveries.

There have been three main studies of post-release survival in Guillemots using ring recovery data: Sharp (1996), Wernham *et al.* (1997) and Joys et al (2003). The first focussed on oiled birds in North America, with the latter two using UK data; Wernham focussed on oiled Guillemots, while Joys et al covered a range of rehabilitated species. Wernham *et al.* (1997) showed that 70% of recoveries of rehabilitated guillemots occurred with 14 days of release (with a median survival time post-release of only 7 days). This equates to a monthly survival rate of 17% during the first month following release, rising to 86% in subsequent months, and 0.6% over the first year, i.e. of 1000 birds released following an oil spill only 6 are predicted to survive longer than 12 months. This compares with a survival rate of 94-99% for unoiled birds; survival rates increase as birds get older.

Sharp (1996) found similarly low survival in Guillemots on the Pacific coast of the USA, with most recoveries of birds occurring within a few days or weeks of release (94% of Guillemots within 60 days of release) and with only two out of 78 birds (2.6%) surviving more than one year. For Guillemots in this study, the mean life expectancy was just 9.6 days, with long-term recovery rates (of Guillemots surviving more than one year after release) being only 10-20% those of non-oiled birds. They quoted many examples of rehabilitated birds re-entering the wild population, but these were still considered exceptions, and didn't influence the median number of days survived by birds. These will also not contribute markedly to the wild population. More generally, the number of days survived by oiled birds of all species was 5-100 times lower than that for non-oiled birds.

More recently, Joys *et al.* (2003) analysed the survival rates of a variety of species, comparing survival rates of rehabilitated birds with wild birds. These were not restricted to oiled birds, though most recoveries of the seabirds (Guillemot, Gannet *Morus bassanus* and Common Scoter *Melanitta nigra*) would have been oil spill casualties. Their main conclusions were that though many species responded well to rehabilitation, those faring worst were the seabirds. For both Guillemot and Gannet (which had suitably large datasets), most recoveries of rehabilitated birds were within two months of release, with the median time (and distance) between release and recovery being 7 days (11km) for Guillemot, 17 days (42.5km) for Gannet and 8 days (4km) for Common Scoter. They suggested that there may be differences between the success of rehabilitation of chronically oiled birds (where some of the lighter hydrocarbons have evaporated) and those from oil spill incidents.

Currently, the main limitations of with survival studies include inadequate recording of rehabilitation methods, small sample sizes of ringed birds (both wild and rehabilitated), lack of representative data from a ringed wild population, data analysis methodology and lack of understanding of behaviour of rehabilitated birds. Solutions for some of these problems may include co-ordinated ringing (and colour-ringing) of rehabilitated birds throughout Europe, though not all countries are currently ringing rehabilitated birds, and many will not have the ability to ring large numbers of auks. There is also much scope for technological advances in understanding exactly how birds react to rehabilitation, and how they behave post-release.

There is reasonable evidence to show though that implantation of transmitters is not suitable, as this leads to increased post-release mortality, even in wild birds. In many cases, the external attachment of a transmitter may be suitable, though the energetic costs for diving species must be minimised. Some authors have found that the attachment of a transmitter to the back of a bird may not be suitable, as this may affect the breeding performance of a bird.

Existing platforms for cooperation & peer review

The literature on the subject of post release survival is scattered, but journals including such studies within their remit include *Atlantic Seabirds*, *Environmental Pollution*, *Marine Ecology progress Series*, *Marine Ornithology*, *Marine Pollution Bulletin*. The subject is broached during conferences, though suitable outlets include the *Effects of Oil on Wildlife* series and meetings of The Seabird Group, or targeted sessions in more general ornithological or ecological conferences, such as those of the European Ornithologists' Union.

Research groups that might be interested in submitting proposals

- British Trust for Ornithology, Thetford, Norfolk, UK (http://www.bto.org/). The BTO conducts impartial research in field ornithology, providing scientific evidence and advice on priority issues in bird conservation. This is based on a partnership between amateurs and professionals.
- Edward Grey Institute of Field Ornithology, Oxford University, UK (http://www.zoo.ox.ac.uk/egi/). The EGI conducts research into the behaviour, ecology, evolution and conservation of birds, with a strong emphasis on understanding organisms in their natural environments.
- Centre for Ecology and Hydrology, UK (http://www.ceh.ac.uk/). CEH maintains a seabird research group in Scotland.
- European Union for Bird Ringing (http://www.euring.org/). EURING is the coordinating body for bird ringing schemes throughout Europe. EURING supports cooperation between schemes and promotes scientific studies of birds at the European level.
- Royal Society for the Prevention of Cruelty to Animals, UK (http://www.rspca.org.uk/). The RSPCA is on of the UK's major animal welfare charities, and is responsible for oiled wildlife response and rehabilitation of live wildlife.
- Marine Biology and Ecology Research Centre, UK (http://innovatecentre.co.uk/mberc/)
- Sea Alarm Foundation, Belgium (http://www.sea-alarm.org/)
- Oiled Wildlife Care Network, USA (http://www.vetmed.ucdavis.edu/owcn/)

Part II Selected research topics (priority fields) for European research funding

1.
Title
Short-term behavioural monitoring of rehabilitated seabirds.

Brief description
The few days or weeks immediately after release appear to be key to the success of rehabilitation of seabirds. It is vital to understand how the behaviour of birds in this key period may differ from that of un-oiled birds, and how factors pre-release, such as type of care, affect this.
Long term objectives
To identify the possible failings of rehabilitation in returning birds to the wild that are capable of behaving in a normal manner and increasing long-term survival rates post-release.
Examples of projects or programmes towards these objectives
The key components are to adequately describe the normal behaviour of seabirds at sea and to closely monitor released birds. We need to improve our understanding of how body condition and environmental factors affect bird behaviour, particularly away from the breeding colonies, which can be used as a baseline against which to guide protocols on where and when to release birds, and to monitor post-release survival. Such information can be gathered using a variety of data logger-based approaches, however, for species such as the Guillemot, further development of data logger technology will be required to ensure that use of loggers does not adversely affect bird condition or behaviour.
Opportunities
Once appropriate technology has been developed, developments in this area have the potential to inform other areas, for example in helping the identification of 'at risk' areas in the wider marine environment. The development of suitable technology will also be immediately transferable to other studies and other sea areas.

2.
Title
Use of ring-recovery analysis and colour ringing as a means of estimating survival rates.
Brief description
At a European level, there is a need to co-ordinate the ringing and colour ringing of all rehabilitated seabirds (primarily Guillemots). Complementary to this is the co-ordination of regular monitoring of seabird colonies throughout the range to locate and identify rehabilitated birds.
Long term objectives
A system will need to be in place such that in the event of a large-scale oil spill incident, the necessary logistics are in place to ensure all rehabilitated birds are dealt with correctly and efficiently. Oiled birds are continually being rehabilitated due to chronic oiling, and ongoing ringing training will slowly feed birds into the population for ongoing monitoring. This will also lead to a trained network of ringers to respond to larger incidents.
Examples of projects or programmes towards these objectives
Coordination of the manufacture and storage of metal rings and colour rings as part of a single European scheme and establishment of a co-ordinated ringing training programme for rehabilitators in key countries. This will also involve the setting up of a Europe-wide colour-ringing protocol for rehabilitated birds, both from chronic oiling and following a large incident and increased coordination of a network of colony recorders looking for colour-ringed birds and assessing their breeding performance, and also managing feedback to and from these recorders.
Opportunities
There are currently structures in place to coordinate such a programme, and this would ensure best ringing practice in European countries. Currently, management of seabird ringing data is spread across Europe, and this is an opportunity to pull this data together for a more coherent response to an incident. This is also such a specialist area, that large scale coordination is essential, and the opportunity to promote this should be taken.

3.
Title
Linking survival/mortality to rehabilitation protocols and identification of causes of post-release mortality.
Brief description
This experimental approach to the survival of birds will identify which parameters at release can predict the short-term and long-term survivability of birds, and which rehabilitation methodologies

are most likely to lead to a successful long-term outcome.
Long term objectives
To identify the rehabilitation methodologies and release criteria that are most likely to ensure long-term survival.
Examples of projects or programmes towards these objectives
Establishment of an integrated database containing details of all rehabilitation methods and release criteria for every bird. This will also require the adoption of standardised, comprehensive data entry forms at rehabilitation centres. This should link back to release centres, such that any birds being found dead soon after release can be returned to the centre for complete post-mortem examination. Colony-based studies could improve our understanding of how intrinsic factors (such as body reserves, muscle condition, blood parameters) affect survival, particularly during the winter period when most spills occur.
Opportunities
This is an opportunity to identify any failings of rehabilitation, and to highlight the immediate causes of short-term mortality. This will feed back into rehabilitation methodology and increase its effectiveness. Any improvement in rehabilitation protocols in Europe will obviously be highly relevant to similar situations in North America.

4.
Title
Towards a better understanding of seabird movements in Europe.
Brief description
Seabird populations tend to be highly structured in terms of movement patterns, with birds from specific colonies and age or sex tending to winter in the same location. Impact of oil spills will vary depending on location of the spill and consequently the birds affected. There is a need to understand these movement patterns in order that the potential impact of spills in a given location can be identified.
Long term objectives
To ensure that during a spill response, birds from different populations are treated appropriately. This may require different treatment protocols and will also drive where and when birds should be released, and in what condition.
Examples of projects or programmes towards these objectives
There are several factors that are key to understanding population movements, and these should all be addressed:
Movements away from breeding colonies vary greatly by age, sex and population. A more formal analysis of ring recoveries across Europe will aid in identifying these differences.
More specific information on movements will only come from following individual birds, and these should be representative of different populations, ages and sexes (all throughout the annual cycle). This could be achieved through the use of data loggers or transmitters, though the latter would require some engineering input to produce.
Opportunities
A better understanding of seabird movements has many uses, not only those mentioned above, but also in more accurate vulnerability mapping of sea areas. Most previous work on seabird distributions has used ring recovery information, and this is also an opportunity to assess the suitability of such analyses in monitoring seabird movements.

5.
Title
Establishment of a North Atlantic Beached Bird Survey network.
Brief description
Many European countries do not currently maintain regular, standardised beach bird surveys. There are several reasons why this should be a priority action, some of which have much wider ranging outputs than just for oil spill response.
Long term objectives

In many cases, long-term monitoring of survival rates relies on the finding and reporting of ringed birds. In many coastal areas, standardised Beached Bird Surveys would improve the data collected and enable a much better understanding of the scale of the problem.

Examples of projects or programmes towards these objectives

Coordination of suitable organisations within Europe to work towards a common survey methodology. Funding will always be an issue for such a survey, as by its nature will need to be an ongoing project.

Opportunities

This is a perfect opportunity to engage large numbers of people in survey work, and will not only improve the level of ring recoveries during spills, but also serve as a useful monitoring tool for the more general state of the marine environment.

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Assessing the impact of accidental oil spills and chronic oil pollution

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Part I State of the art

Introduction into subject

Oil spills, both accidental spills and most forms of chronic oil pollution, can cause considerable environmental damage in the marine environment and usually involve seabird casualties. Mass mortality in oil spills can impact seabirds negatively at the population level. Demonstrating effects on seabird populations of even major oil spills has not been easy, and few case studies have been able to do so convincingly. One important reason for the scarcity of convincing evidence is the fact that wintering populations are usually affected, while it is unclear which breeding populations should then be examined and monitored. Most species are protected in Europe, and countries have a duty of care and legal obligation during the part of the year these common resources are in their territory. To assess the damage inflicted during a spill or as a result of chronic pollution, four basic questions need to be answered: (a) what has been killed, (b) how many, (c) where did they come from, and (d) can any effect be detected at the population level?

For the impact assessment, the main task during a spill is thus to establish a reliable count of the casualties (both dead and live), to identify them to species, examine them for characteristics or markers that might indicate their breeding origins, and to age and sex them as far as possible. These procedures should be generic to any major oil spill, as part of the spill response and are essential to understanding the impact on seabird populations. This understanding is necessary for two reasons. First, by reliably assessing the contribution of oil-spill related mortality in comparison with other unnaturally caused reductions in the annual survival of seabirds we enhance our understanding of factors underlying specific population trends and increase the possibilities for proper protective measures. Secondly, by carefully and routinely assessing the damage of oil spills using standardised techniques, we can evaluate more precisely how different the immediate effects of even rather small oil spills in particular sea areas and/or in particular times of the year actually are. With that knowledge, protective measures can be steered more directly and precisely to those sea areas where the most substantial damage from oil pollution can be expected from experience.

Within Europe, there is a long history with oil pollution. Oil impact assessments have been conducted on a regular basis in only relatively few countries and sea areas, producing highly biased information regarding the scale and possible impact of different spills within Europe. It would be a misunderstanding to think that in the absence of a study report a spill has probably not affected any wildlife. Yet, in some sea areas, known to hold highly sensitive populations of seabirds and waterfowl, known also to experience both chronic oil pollution and accidental spills, impact assessments have never been conducted.

Much of the above is relevant in particular to accidental oil spills, while arguably, chronic oil pollution is a more persistent and perhaps even a more important threat to seabirds. In recent decades, the amounts of mineral oil released into the marine environment have fallen substantially, but even today there are still at least thousands of illegal spills detected per annum in European waters (Joint Research Centre, European Commission). The impact of chronic oil pollution should be assessed just as well as the effects of accidental spills and this work should be promoted in areas where regular monitoring programmes of stranded seabirds are currently missing (large parts of the Baltic, arctic regions, most of the Mediterranean region and all of the Black Sea, much of the Atlantic seaboard and Macaronesian islands).

A most significant step in combating chronic oil pollution today would be research into the types of pollutants currently causing most damage in the marine environment and whether legislative measures could be designed to improve the current situation. A monitoring programme is required in which the chemical analysis of samples from contaminated seabird feathers and beaches is included, to evaluate and quantify the main sources of chronic oil pollution in the present day situation.

In recent years, the effects of other lipophilic substances (non-mineral oil) on marine wildlife (some listed under MARPOL Annex 2) have become more prominent than ever before. This could be the result from an increase in discharges of these substances. Our understanding of the relative contributions of the different substances affecting marine wildlife, how frequently each of these are discharged, the exact chemical composition of these substances and the cleaning agents used to discharge them into the marine environment, as well as the impact on seabirds and other wildlife is incomplete. The chemical analysis of samples from contaminated seabird feathers and beaches suggested above should therefore include the analysis of non-mineral oils and other fatty substances.

Literature review

Impact assessments of oil spills (some examples)

To assess the damage inflicted during a spill or as a result of chronic pollution, the basic questions that need to be answered are (a) what species have been killed, (b) how many perished, (c) where did they originate from (breeding areas), and (d) can any effect be detected at the population level? For the impact assessment, the main tasks during a spill include reliable counts of the casualties (both dead and live), the identification of affected seabirds to (sub-) species level, and a careful examination af all possible cues, characteristics (e.g. biometrics) or markers that might indicate their breeding origins. The affected birds must be aged and sexed for as far as possible, to investigate if the affected population is biased in anyone direction. These procedures should be generic to any major oil spill, as part of the spill response and are essential to understanding the impact on seabird populations. Most examples of recent oil spills include impact assessments that just evaluated the numbers killed, sometimes including large numbers of unidentified casualties. In some studies, the impact assessment was more thorough, and includes careful evaluations of the possible origin of the birds (Jones *et al.* 1978, 1982, Cadiou *et al.* 2004, Grantham 2004, Camphuysen & Leopold 2005 among others). Evaluating the various impact assessments and their follow-up in terms of population monitoring has highlighted the need for standardisation. A significant development was the production of the Handbook Oil Impact Assessment (Camphuysen *et al.* 2007), but there is more work needed to get these protocols tested, completed and refined where needed and to get them implemented in future spills within Europe.

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Assessing numbers affected: beached bird surveys and drift experiments

Apart from counting stranded casualties, a reliable estimate has to be provided as how many casualties may have gone undetected, or, worse, how many would never have reached the shore. Only if these figures are well known, may a proper estimated of total numbers affected be broadcasted. It is unfortunate, that for many spills, highly inflated numbers have been published, many of which are based on very slender factual data. Drift experiments are the appropriate tool to address the issue of corpses lost while adrift at sea. Any item afloat at the surface will drift basically steered by the wind, but with some influence of surface currents that needs investigation and modeling (Ebbesmeyer 2004). For a proper drift experiment, either corpses of birds (e.g. Bibby 1981, Keijl & Camphuysen 1992, Colombé *et al.* 1996), or drift blocks mimicking the drift of bird corpses may be used (Hlady & Burger 1993, Wiese & Jones 2001). Both methods have advantages as well as disadvantages. Camphuysen & Heubeck (2001) highlighted the need for site-specific drift experiments, because historical data clearly suggest that the outcomes of drift experiments are very different between areas.

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Demonstrating effects on seabird populations of even major oil spills has not been easy, and few case studies have been able to do so convincingly (e.g. Votier *et al.* 2005). One important reason for the scarcity of convincing evidence is the fact that wintering populations are usually affected, while it is unclear which breeding populations should then be monitored to evaluate the impact on population level. It is no point simple to report a number of casualties that died, without any information on species and age composition and in the absence of any data on the breeding origin of the casualties. Oil spills affecting mostly young birds will have rather little and certainly a delayed effect on (future) breeding populations, while spills that kill concentrations of adult breeding birds may have immediate and rather clear effects. Wintering birds may by highly site faithful, however, and for some the breeding origin is not all that clear. Some studies have demonstrated prolonged effects of oil spills on wintering populations (Heubeck 1997a), and the monitoring of these is equally important, in particular of species where breeding distribution is diffuse, and where breeding habitats are located far inland.

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Sources of (chronic) pollution

Accidental spills are a very important source of pollution, but chronic oiling is a more persistent threat. Within Europe, there is a long history with chronic oil pollution, and recent evaluations have shown that our oceans are far from clean today (Camphuysen 2007). Oil impact assessments of the constant threat of chronic oiling have been conducted on a regular basis in only relatively few countries and sea areas, producing highly biased information regarding the scale and possible impact within Europe. Just as with oil spills, it would be a misunderstanding to think that chronic oiling has no affected on wildlife in the absence of a monitoring programme and study reports. Yet, in large sea areas, some known to hold highly sensitive populations of seabirds and waterfowl, known also to experience both chronic oil pollution and accidental spills, even the baseline data facilitating an impact assessment have never been collected.

In recent decades, the amounts of mineral oil released into the marine environment have fallen substantially, but even today there are still at least thousands of illegal spills detected per annum in European waters (Joint Research Centre, European Commission; Camphuysen 2007). While the source of oil spills is often known, there are numerous uncertainties regarding the source of chronic oiling. There is little doubt, given the distribution of detected oil slicks in relation to shipping lanes and offshore installations, that shipping is a major source of pollution. Unfortunately, there are very few monitoring programmes studying the source of (chronic) oil pollution in a systematic manner (Dahlmann 1984, 1991). The elimination of oil pollution starts with a proper understanding of the source(s) of pollution and the need of a routine sampling programme, studying beach samples, slick samples and oiled-feather samples in a systematic manner is very important. While the techniques and benefits are well described and perfectly known (Dahlmann et al. 1994, Camphuysen & Dahlmann 1995), it must have been the cost of the work that has prevented the development of a large scale monitoring programme. In the absence of data, however, it is difficult to advice on new steps to further reduce marine pollution.

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The effects of other (lipophilic) substances

In recent years, the effects of other lipophilic substances (non-mineral oil) on marine wildlife (some listed under MARPOL Annex 2) have become more prominent than ever before (Hak 2003). This could be the result from an increase in discharges of these substances. Our understanding of the relative contributions of the different substances affecting marine wildlife, how frequently each of these are discharged, the exact chemical composition of these substances and the cleaning agents used to discharge them into the marine environment, as well as the impact on seabirds and other wildlife is not well understood. The effects on wildlife of many of these substances (either pure, or mixed with cleaning agents) are often even more dramatic than mineral oil pollution, inflicting considerable and unnecessary suffering of large numbers of animals (Peakall *et al.* 1987, Zoun *et al*. 1991, Camphuysen *et al.* 1999). As with (chronic) oil pollution, a most significant step in combating marine pollution today would be systematic research into the types of pollutants currently causing most damage in the marine environment and whether legislative measures could be designed to improve the current situation.

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Existing platforms for cooperation & peer review

Scientific journals that regularly publish on the subject

- Mar. Poll. Bull.
- Env. Poll.
- Biol. Conserv.
- Env. Sci. Technol.
- Env. Conservation
- Mar. Env. Res.
- Atlantic Seabirds (The Seabird Group & Dutch Seabird Group)
- Marine Ornithology
- Seabird (The Seabird Group)
- Sula (Dutch Seabird Group)
- Seevögel
- Arch. Environm. Contam. Toxicol.

Existing conference series that should be interested in papers on the subject

- International Seabird Group Conference (Europe)
- Pacific Seabird Group Conference (N America)

Part II Selected research topics (priority fields) for European research funding

1. **Standardisation of impact assessment protocols**

Brief description Impact assessments should be generic to any major oil spill, as part of the spill response and are essential to understanding the impact on seabird populations. Impact assessments include an estimate of total numbers affected and killed, including careful evaluations of the species, age and possible origin of the birds. The need for the standardisation of impact assessments has been identified before and led to the drafting of the Handbook Oil Impact Assessment (Camphuysen *et al.* 2007). There is more work needed to get these protocols tested, completed and refined and to have them implemented in future spills within Europe.

Long term objectives A careful and thorough evaluation of population level effects of oil pollution on seabird populations

Examples of projects or programmes towards these objectives EC Project "The impact of oil spills on seabirds: towards an effective impact assessment" (DG Environment, 2006-2007)

2. **Corpse drift experiments: towards a standard protocol and issues of preparedness**

Brief description To provide reliable estimates on numbers of casualties affected, the fraction that may have gone undetected or missing at sea must be assessed. Drift experiments are the appropriate tool to address the issue of corpses lost while adrift at sea, but few spills in Europe have been studied in a way that drift experiments could be conducted. There are several methods to perform drift experiments, but there are no clear recommendations. The methods currently practiced have advantages as well as disadvantages. The need for site-specific drift experiments is obvious from previous studies and methods will need to be developed so that oil spill responders can prepare themselves for drift experiments.

Long term objectives Better estimates of affected numbers of wildlife, higher quality impact assessment, development of directed measures to improve seabird conservation

Examples of projects or programmes towards these objectives Canadian studies have been developing wooden drift blocks that can be prepared and kept in stock as mimics of carcasses set afloat during a spill. Similar techniques could be developed for Europe, focusing on "typical" casualties in European waters (drift blocks must be made of the appropriate size and mass to mimic a particular species).

3. **Studying bird populations: the possibility of assessing breeding origin**

Brief description Most spills affect wintering concentrations of seabirds, and it is often very difficult to identify the breeding origin. Ringing programmes should be stimulated, also in rather remote breeding areas, so that a higher proportion of affected birds will be ringed in future spills. In addition to this, workers in breeding areas should be stimulated to collect biometrical data and tissue samples allowing molecular techniques to be developed to describe characteristics and markers for specific populations. The material should be made available for comparisons between affected birds and birds from known breeding sites.

Long term objectives Better estimates of population level effects, higher quality impact assessment, development of directed measures to improve seabird conservation

Examples of projects or programmes towards these objectives Numerous programmes, partially connected, need for co-ordination and database management

4. **Studying sources of marine (oil) pollution, including non-mineral oil and other substances**

Brief description Levels of marine oil pollution have gone down, while the frequency of pollution resulting from discharges of non-mineral oils and other "fatty" substances has either stabilised or even increased. There is an urgent need for deeper insight into the sources of pollution and the effects of substances on marine wildlife. Therefore, a large scale and systematic monitoring programme is urgently required. When monitoring programmes are developed on a national basis, the laboratories involved should team up internationally, to enhance the detection techniques and to improve institutional skills to identify substances and oils.

Long term objectives A better understanding of sources of pollution; development of counter measures to (further) reduce pollution levels in Europe

Examples of projects or programmes towards these objectives Historical: Dahlmann *et al.* (1994); joint project in Denmark, Germany and The Netherlands (EC funding)

Annex

The European project Reducing the Impact of Oil Spills (RIOS) is focusing on negative impacts that oil spills can have on marine wildlife, such as marine and coastal birds, marine mammals and sea turtles, and how these effects can be minimised, e.g. through investments into research and development. The main objective of the project is to develop a European Action Plan for future research and development, and to stimulate contacts and future cooperation between relevant groups and stakeholders such as scientists/researchers, marine wildlife rehabilitators, veterinarians, biologists, NGOs, the oil and maritime industries and governmental organisations.

The RIOS-project offers a platform for all stakeholders to discuss the need for research and development in the field of oiled wildlife response and preparedness, The European Action Plan that will be written on the basis of these discussions may lead to the inclusion of oiled wildlife response and preparedness as one of the priority fields in future Framework Programmes of the European Commission. This would create an important and considerable source of European funding for future projects and activities.

The stronger the European Action Plan can be formulated, the better it can be used to convince the European Commission that oiled wildlife response and preparedness is an emerging field of research and development and worth to benefit from future financial resources.

The RIOS project has duration of 18 months and is run by a consortium of Nordeconsult (Sweden), Sea Alarm (Belgium) and Zoomarine (Portugal) with the assistance of four contracted experts. The work is divided into clearly defined work packages, including:

- Providing a state-of-the-art overview and the identification of research priorities with the help of the expert group
- Inviting the input of stakeholders before, during and after a 2-day workshop in Algarve, Portugal;
- Review and assessment of project results
- Development of a European Action Plan (main deliverable)
- Dissemination of results

All stakeholders can get involved in the project. Stakeholders can write their views to the publication of the Background Document, complementing the views of this Document, or bringing new views to the table and/or proposing new fields of research and development. These reactions will be discussed at the RIOS workshop and taken into consideration in the development of the European Action Plan.

Contributions can be made by email (rios@nordeconsult.com) and/or by participation in the discussions at the RIOS-workshop at Zoomarine, in Albufeira, on the 17-19th April 2008.