



**Bureau Waardenburg bv**  
Adviseurs voor ecologie & milieu

## Ecology and offshore work



### Impact Studies on Marine Benthic Fauna

**Bureau Waardenburg is a specialist in marine hard substrate ecology and in impacts on marine benthic fauna. We have a team of experienced marine biologists that are fully certified professional divers. Our experience extends from North Sea ecology to sub-tropical and tropical marine ecology.**

Where offshore activities occur, impact on marine benthic fauna is inevitable. These impacts, however, are not always negative.

The underwater environment changes when new offshore structures are constructed. In the North Sea this generally means that new hard substrates occur on the previously sandy bottom.

This attracts new benthic communities with species characteristic for hard substrates.

#### Example:

The first Dutch offshore wind farm (OWEZ): Development of underwater flora-and fauna communities on new hard substrates.

NoordzeeWind designed an extensive Monitoring and Evaluation programme to study the effects of the Offshore Wind farm Egmond aan Zee (OWEZ). The execution of this programme was granted to a consortium of IMARES, Bureau Waardenburg and the Royal NIOZ. Monitoring the development of underwater benthic communities was one of the tasks of Bureau Waardenburg.

In the OWEZ, large quantities of shellfish, crustaceans and other organisms, occurred rapidly after construction. This resulted in the development of a benthic community with a high biodiversity. Bureau Waardenburg used video footage and specialist hard-substrate sampling techniques, handled by divers, to document and quantify the species present.



Where offshore activities occur, impact on the marine ecosystem and its inhabitants is inevitable. Bureau Waardenburg is a specialist in offshore impact assessments and monitoring & evaluation programmes. This leaflet will guide you through the different aspects of offshore ecological research in which Bureau Waardenburg is active.

### Offshore Environmental Impact Assessments

Since 1997 Bureau Waardenburg has prepared ecological chapters for several offshore EIAs for a variety of clients, both independently and in collaboration with other institutes and consultancies. These studies state the possible effects of offshore activities for marine wildlife but also migratory terrestrial birds. Effects of offshore activities on marine wildlife are put in the context of the relevant national and international legislation. The findings often result in advice and input in the design and development of compensatory or mitigating measures.

We contribute to species (-group) specific ecological knowledge from specialist research, to effect modelling and risk analyses, to actual EIA contributions. If significant effects cannot be ruled out an Appropriate Assessment is made. In 2009 we, together with several partners, produced 19 offshore Appropriate Assessments for offshore wind farms.

### Qualified Marine Mammal and Bird Observers



Many offshore activities require monitoring of marine wildlife by human observers. Bureau Waardenburg has several experienced specialists that are trained and certified Marine Mammal Observers (MMOs). In addition, these people also hold the other necessary certificates like offshore survival NOGEP A 0.5A, HUET, offshore medical and VOL-VCA.



MMOs record marine wildlife (marine mammals, turtles and birds) before and during offshore operations like seismic surveys, flaring operations and offshore pile-driving to ensure smooth and environmentally safe working conditions. They can guide you through all applicable legislation to minimise the risk of injury and disturbance to marine mammals.

Our marine mammal specialists also conduct research on the distribution and abundance of seals, dolphins and whales and the effects of human activities on their behaviour and distribution.

## Offshore seabird research with bird radars

Ornithologists at Bureau Waardenburg conduct on- and offshore research on seabirds all over the world and with a variety of methods. One of our state of the art methods is the use of radar to track flight movements of birds. In 2007-2010 we participated in a long-term monitoring and evaluation programme to study the effects of the first Dutch offshore wind farm (OWEZ). Numbers of birds, flight altitude and flight routes of local seabirds and migratory birds were recorded 24/7 with an automated bird recording radar system. Currently, a similar set-up is being used to study bird migration on an offshore platform in the North Sea 80 km from the coast.

We generally use radar studies to record flight movements of individual species in location specific studies. One recent example involves sea ducks in a future wind farm location. Radar can also be used to locate and monitor breeding locations of nocturnally active seabirds. We recently carried out such a study in Portugal.

In addition to radar research, seabird specialists at Bureau Waardenburg conduct ship-based and aerial surveys and have experience in many parts of the world. In addition, tracking of seabird movements with GPS loggers is a speciality of Bureau Waardenburg. Bird movements and daily activity can be thus followed throughout the year and linked to environmental factors and human activities. Density maps and population growth models are made from the data using several different (spatial) statistical techniques.



### Some recent projects that Bureau Waardenburg carried out / contributed significantly to:

- ▼ Monitoring and evaluation programme Offshore Wind farm Egmond aan Zee (2007-present)
- ▼ Environmental Impact Assessment OWEZ (2003-2006)
- ▼ Monitoring and evaluation programme Maasvlakte 2 environment compensation (2007-present)
- ▼ Environmental Impact Assessment Maasvlakte 2 (2004-2006)
- ▼ Monitoring and evaluation programme Kustlijnzorg (2009-present)
- ▼ Several Marine Mammal Observer projects for offshore construction work (2010-present), like pile-driving (marine mammals) and flaring operations (birds)
- ▼ Capacity building in Environmental Impact Assessments in Ambon, Indonesia (2010)
- ▼ Several (19) Appropriate Assessments for offshore wind farms



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**Bureau Waardenburg bv**  
Consultants for environment & ecology

# Birds and wind turbines – wind turbines and birds

**Planning a new wind turbine location requires an assessment of potential negative effects on birds. A prerequisite for an adequate assessment of these effects is sound scientific knowledge on flight movements and the influence of turbines on the distribution and flight behaviour of birds.**

Bureau Waardenburg has conducted numerous studies on the effects of wind turbines on birds in both the Netherlands and abroad. Since 1993, a large number of both terrestrial and offshore locations have been studied. In these studies flight movements and behaviour of birds close to turbines or wind farms are systematically recorded both spatially and temporally. The results as well as our practical knowledge and skills are widely distributed in national and international networks. In several projects we have collaborated with universities, institutes and other research consultancies.



Geese flying close to wind turbines

## Risks for bird

Three main types of effects have been identified by research on wind turbines and birds:

1. risk of collision with the rotor blades;
2. disturbance to breeding, resting or foraging birds;
3. deflections of flight paths of flying birds (barrier effects).

When the effects of a specific wind turbine location are sufficiently recorded a risk assessment is made to identify potential long-term conservation concerns.

## Location assessments of small-scale wind farms

Bureau Waardenburg gives advice on the ecological effects in a diverse range of wind farm initiatives for a variety of different clients. The effects on birds and other flora and fauna are put in the context of the relevant national and international legislation during the assessment of a proposed wind turbine location.

The combination of years of experience and thorough knowledge from our own research and the most recent literature guarantees robust ecological advice. Additional fieldwork is conducted to fill-in any gaps in the knowledge.



Linear wind farm along the 'IJsselmeerdijk' (foto ZeelandAir)

## Location assessments of large-scale wind farms

In cases of large-scale wind farm initiatives Bureau Waardenburg works in many different parts of the EIA process. We contribute to species(-group) specific ecological knowledge from specialist research to actual contributions to Environmental Impact Assessments and risk analyses. If significant effects cannot be ruled out an Appropriate Assessment is made.

Bureau Waardenburg has prepared several EIAs independently or in collaboration with other institutes and consultancies. These studies state the possible effects of a wind farm for local and migratory birds. The findings often result in advice and input in the design and development of compensatory or mitigating measures.

## Research methods used for wind turbine studies

Collision risks for birds are highest during dawn, dusk and during the night. Therefore, gathering information on flight paths of local and migrating birds during darkness is essential to get a reliable insight in flight activity at a certain location. This can be achieved by using radar. Bureau Waardenburg has several mobile and platform-based radar set-ups. These radars record spatial patterns of flight activity as well as flux (total number of birds per km per hr) and flight altitude (up to several km).

Our broad experience on analysing radar data and extensive expertise in statistics and Geographic Information Systems (GIS) ensures a sound assessment of the flight activity and spatial patterns of birds at the studied location.

## Offshore research

In 2003-2010 we participated in a long-term monitoring program to study the effects of an offshore wind farm off of the Dutch coast (the OWEZ wind park). Flux, flight altitude and flight paths of local seabirds and migrants were recorded through visual observations, continuous flight call monitoring and automatic flight path recording using continuously operating bird radars. Furthermore, distribution and habitat use were studied using ship-based surveys.

Elsewhere in the North Sea Bureau Waardenburg is involved in research on flight activity of birds and Environmental Impact Assessments of future wind parks. Distribution and habitat use of birds is studied during aerial, platform and ship-based surveys. Here also, radar set-ups are used to monitor flux and flight paths. Density distributions, population estimates and population growth models are made from the data using several different (spatial) statistical techniques.



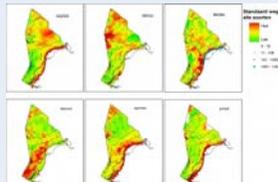
Mobile radar set-up



Radar screen with bird tracks



Offshore wind park OWEZ



Distribution maps of seabirds based on interpolated data



Swift collided with wind turbine

## Monitoring of collision victims

Monitoring the numbers of collisions in a wind farm requires systematic searches for victims in operating wind farms. The total number of collision victims is then calculated from the casualties found, the probability of finding a victim, the disappearance rate (due to scavengers) and the area searched. The results of such research can also be used to improve models for estimating the potential collision victims in our risk assessments of future wind farm initiatives.

## Publications

Numerous reports have been written by Bureau Waardenburg staff on the subject of wind turbines and birds. Most of them can be downloaded from our website ([www.buwa.nl](http://www.buwa.nl)). In addition, articles have been published in scientific journals and books, including:

- Dirksen, S., K. Krijgsveld & R. Fijn, 2009. Offshore windenergie: effecten op vogels. *De Levende Natuur* 110(9): 284-286.
- Dirksen, S., A.L. Spaans & J. van der Winden, 2007. Collision risks for diving ducks at semi-offshore wind farms in freshwater lakes: a case study. In: De Lucas et al. (eds) 2007. *Birds and wind farms*. Quercus. Pp 201-218
- Dirksen, S., A.L. Spaans & J. van der Winden, 1996. Nachtelijke trek en vlieghoogtes van steltlopers in het voorjaar over de noordelijke havendam van IJmuiden. *Sula* 10: 129-142.
- Krijgsveld K.L., K. Akershoek, F. Schenk, F. Dijk & S. Dirksen, 2009. Collision risk of birds with modern large wind turbines. *Ardea* 97(3): 357-366.
- Krijgsveld K., M. Poot, S. Dirksen, H. Schekkerman & R. Lensink, 2006. Fluxes and flight altitudes of birds flying over the North Sea. *Journal of Ornithology* 147: Suppl 1 p. 198.
- Meesters, H.W.G., K.L. Krijgsveld, A.F. Zuur, E.N. Ieno & G.M. Smith, 2007. Classification trees and radar detection of birds for North Sea wind farms. In: Zuur, A.F., E.N. Ieno & G.M. Smith. *Analysing Ecological Data*. Springer, New York.
- Poot M., J. van Belle, K. Krijgsveld, H. van Gasteren & S. Dirksen, 2006. Correcting detection loss in observations on bird migration with vertical marine surveillance radar. *Journal of Ornithology* 147: Suppl 1 p. 232.
- Spaans, A.L., L. Van den Bergh, S. Dirksen & J. van der Winden, 1998. Windturbines en vogels: hoe hiermee om te gaan? *De Levende Natuur* 99, 3: 115-121.



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# Birds and electric power lines

Power lines and electricity poles pose a severe mortality risk to birds. Regional characteristics of the electricity structures, the season and the species of bird (including their morphology, age and gender) all have their influence. Birds also use power poles and lines as perching, roosting or nesting sites. In addition to the ecological considerations, birds also form an economic concern to energy supply companies by causing electrical malfunctioning, short-circuits, outages or electrical fires.

Bureau Waardenburg has much in-house knowledge on this subject, including the gathering of field data. Since the beginning of 2007, we have carried out intensive investigations into the effects of (both above and below ground) high-voltage power lines and have advised on possible mitigation measures.

## Risks for birds

Interactions between electric utilities and birds may be categorised in the following way:

1. collisions with the power lines;
2. electrocutions on power lines or poles;
3. disturbance to breeding, resting or foraging birds;
4. positive effects, such as provision of nesting or perching sites.



Grey herons passing power lines

Most power lines carry fatal risks for birds through the collision with power wires or electrocution; when a bird touches two conductors or a conductor and an earthed wire simultaneously. Also, above ground power lines may influence habitat structures and lead to the reduction in breeding, staging and wintering areas for birds.

## Environmental impact assessments (EIAs)

Since 2006, Bureau Waardenburg has been involved in EIAs for new high-voltage power lines in the Netherlands and provides recommendations to the grid administrator for minimising impacts on nature. This includes field research into collision victims, flight behaviour at existing power lines using radar and studying the effectiveness of new types of wire markings as well as carrying out reviews on the issues involved.

## International contacts

Bureau Waardenburg has built up an extensive international network with researchers, NGOs and electricity companies. In this way institutional, as well as scientific aspects can be tackled in the required detail.

This has already been initiated in a symposium, specifically aimed at the interactions between electric utilities and birds, at the 7th European Ornithologists' Union Conference in Zurich in August 2009. The symposium was chaired by Bureau Waardenburg, who invited international specialists to join the discussions into the current status of research into the effects of powerlines and mitigation methods. Bureau Waardenburg is currently undertaking a review for UNEP/AEWA on the conflicts between migratory birds and electricity power grids in the African-Eurasian region. (see [www.buwa.nl/aewareview](http://www.buwa.nl/aewareview)).



Radar study along power lines

## Research methods for interactions between birds and power lines

Collision risks for birds with high-voltage power lines are highest in twilight and at night. Therefore, gathering information on flight paths of local and migrating birds is essential also during this period. In our studies, daytime field observations are combined with radar observations during the night. The mobile radars of Bureau Waardenburg can scan horizontally and vertically, to register the altitudes (up to several km), the flight paths, as well as the flux of birds (total number per km per hr), as well as the alteration of these due to the presence of power lines. Analysis of these data is aided by specialist database and statistical programs, while spatial and trend analyses are carried out using Geographic Information Systems (GIS)

## Monitoring of bird victims along power lines

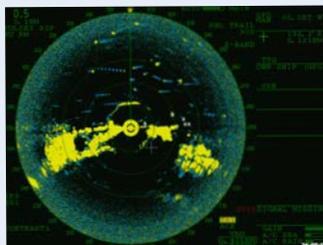
Estimates of the potential number of bird victims can be made prior to construction by carrying out research near existing power lines. Bureau Waardenburg has several years experience on this subject, including fieldwork into collision victims. We have developed standardised search protocols, as well as experiments to correct for the chance of finding a victim (i.e. search efficiency) and loss to scavengers (i.e. disappearance rate).



Search for bird victims along power lines



Mobile radar set-up with vertical and horizontal radar



Radar screen with bird tracks



Spoonbill as a collision victim



Observing bird movements in Italy

## Risk assessment studies

For future power lines risk assessments can be conducted beforehand. This is carried out in the search areas of the power lines based on research on flight movements (by radar and visual observations) and determined relationships of bird collisions and flight movements. The results of such studies are also used to improve our models for estimating the potential collision victims in future initiatives.

## Publications

A number of studies have been carried out by Bureau Waardenburg staff on the subject of power lines and birds. Most of them can be downloaded from our website ([www.buwa.nl](http://www.buwa.nl)). The results of our studies were also presented at national and international conferences.

- Gyimesi, A., R.R. Smits & H.A.M. Prinsen, 2010. Radar study of diurnal and nocturnal bird migration in Calabria, Southern Italy. Monitoring bird passages over a planned 380 kV power line location in spring 2010. Report 10-110.
- Gyimesi, A., R.R. Smits & H.A.M. Prinsen, 2010. Flight movements of geese, ducks and waders in the search area of the high-voltage power grid ZW380. Radar study in the eastern part of the Oosterschelde in the winter of 2009/2010. Report 10-084 (in Dutch).
- Hartman, J.C., A. Gyimesi & H.A.M. Prinsen, 2010. Monitoring the efficiency of wire markers. Field study on bird victims and flight behaviour at a marked transect of a 150 kV power line. Report 10-082 (in Dutch).
- Prinsen, H.A.M., R.R. Smits, F.L.A. Brekelmans, L.S.A. Anema, D. Emond & S. Dirksen, 2009. Background nature study of the Environmental Impact Assessment of the Southern Ring Randstad380. Report 08-003 (in Dutch).
- Smits, R.R., J.C. Hartman, A. Gyimesi, M.P. Collier & H.A.M. Prinsen, 2010. Flight movements of spoonbills, waders and nightjars in the search area of the high-voltage power grid ZW380. Radar study in the eastern part of the Oosterschelde and the Brabantse Wal in the summer half-year of 2010. Report 10-169 (in Dutch).
- Smits, R.R., R.G. Verbeek, H.A.M. Prinsen & J. van der Winden, 2009. Flight movements of colonial birds in the search area of the high-voltage power grid NW380. A study on spoonbills in the province of Flevoland and on purple herons and black storks in North-Holland and Friesland. Report 09-139 (in Dutch).
- Verbeek, R.G. & H.A.M. Prinsen, 2008. Collision victims at the high-voltage power grid Southern Ring Randstad380. Accompanying note (in Dutch).



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Bureau Waardenburg has developed a high standard in applied ornithological research. A broad field of subjects is covered in research or advisory projects. Examples can be found in the relation between birds and large infrastructure works, the effect of persistent contaminants on birds and studies on feeding ecology as a basis for a better understanding of changing ecosystems.

## Birds and airplanes – airplanes and birds

### Birds and flight safety

Birds are an important risk for flight safety. Due to bird hits the civil sector in air transport has an estimated \$ 2-5 billion yearly damage; sometimes accompanied by human casualties. Bureau Waardenburg has knowledge on bird behaviour (in general and in relation to airports) as well as environmental planning and management. Both are essential for advising on active and passive bird control on airports. Bureau Waardenburg has carried out research on the densities of flying birds in the lower air layers above airports. This information is a useful source in risk analysis.

#### Projects

- ▼ Densities of birds in the lower air layers; a study on Eindhoven airport 1998-1999.
- ▼ The attractiveness for birds of waters around Eindhoven airport, bird movements of risk species in relation to a possible new lake in Meerhoven and the possibilities for bird control on these waters.

#### Related projects

- ▼ Possible bird mortality by high radio towers.
- ▼ Gulls and road traffic on Neeltje Jans (large dam in estuary)
- ▼ The effects of wind turbines on birds in relation to different EIA studies: on land and offshore.



### Birds and airports

The building of airports and the accompanying air traffic could have a large impact on nature. Another important factor is flight safety. Bureau Waardenburg is able to describe and evaluate all effects of air traffic on nature values. We also advise on lay out plans and management alternatives, all based on our own research and/or knowledge.

#### Projects

- ▼ The effects of a possible airport in Lake Markermeer on the natural environment
- ▼ waterbirds on a possible artificial lake in Meerhoven in the vicinity of Eindhoven airport: current research, predictions, scenario's for management, bird control as well as monitoring
- ▼ Alternatives for Meerwater; a short description of the bird community in relation to Eindhoven airport.
- ▼ Research on disturbance of fauna and recreation by the small civil air traffic: towards a future policy.
- ▼ Effects of airports on birds: a contribution in the EIA Amsterdam Airport (Schiphol) 2003.



## A new airport island in the North Sea?

For the future building an island in the North Sea might be an option to accommodate further growth of air traffic in the Netherlands. Here, the two subjects mentioned before are connected. However, in this case birds and flight safety and birds and airports do have a different scale and dimension. Bureau Waardenburg is involved in both subjects. Currently, Bureau Waardenburg is partner in a large research project on the impact of an airport island on marine ecology and marine morphology.

### Projects

- ▼ Review of risk species and risk behaviour of birds on a possible airport island in the North Sea
- ▼ Falls of migrant birds; an analysis of current knowledge.
- ▼ Designing shores for a potential airport island; natural values versus birds strike risks
- ▼ Participant in workshops on island related problems

Researchsituation Eindhoven Airport  
(drawing J. Brandjes)



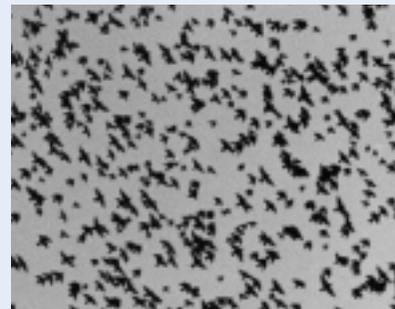
Research on bird flight movements by means of our own radar equipment.  
(photo Martijn de Jonge)

## Development of research methods

As part of effect studies Bureau Waardenburg carries out large-scale research on bird flight movements. In these studies the temporal and spatial aspects of movements are studied. The field methods for these studies are highly standardised and laid down in protocols. We also have our own radar equipment to gather data on movements during dawn, night and dusk. Both data types can be analysed in GIS and can be applied in all sorts of effect studies.

### Projects

- ▼ Methods and protocols for a visual method to measure bird densities in the lower air layers and validation of the method by radar measurements
- ▼ Standardised mapping of birds and bird movements in order to compile the Atlas of Bird Concentrations and Bird Movements in SW-Netherlands.
- ▼ Measuring the altitude of nocturnal movements of birds in a national research program on effects of wind turbines on birds
- ▼ Mapping and analysis of bird movements of sea ducks in the Kattegat (Denmark) in the vicinity of a wind farm



(photo Martijn de Jonge)



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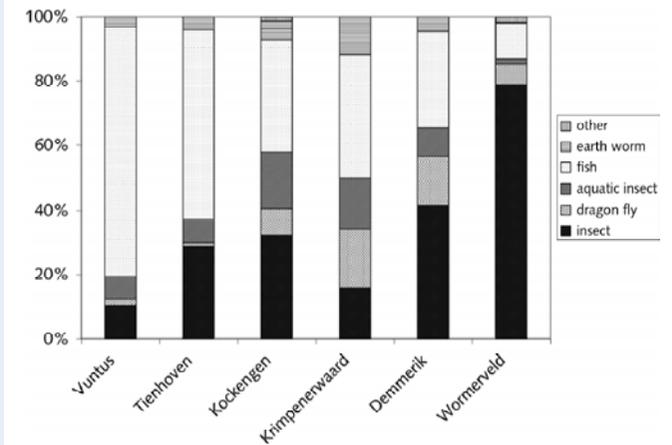


purple heron with a European weather loach  
photo: W. Jongejan.

A number of the bird species that breed in marshlands forage, to a greater or lesser extent along the polder ditches for fish. This is certainly true for a number of colony breeding species such as cormorant, spoonbill, grey heron, purple heron and black tern. The ditches along polders have a number of characteristics that make it easy for birds to forage. These ditches are of the right depth and mud-type for wading species such as spoonbill and have a relatively long edge for species that forage from the bank, such as purple heron. In addition to marshland habitats, polders with ditches have specific fish communities. For breeding marshland birds, these fish communities are very attractive since they are readily available and have enough variation during the breeding season. Three examples are given that illustrate the integration of fish- and bird ecology and how this contributes to the management of these areas.

## Fish as food for birds

*Figure 1.* Composition of the diet of young black terns, in colonies in the western Netherlands. In some area fish were the main component of the diet, while in other areas fewer fish were eaten. In Wormerveld too few fish were available to enable a stable reproductive population.



Black Tern

### 'Zouweboezem'

The 'Zouweboezem' and surrounding area in South Holland is a very good example of the ideal marshland habitat where specific marshland birds breed and enclosed ditches act as a foraging habitat. Here, black terns and purple herons are an important measure of the seasonal availability of food from the ditches. Fish species of importance for both species are: perch, pike, European weather loach, spined loach, stickleback, tench, roach and bream. The spawning and growth of young fish, without disturbance or obstructions, are crucial for a sustainable fish population within these marshlands.

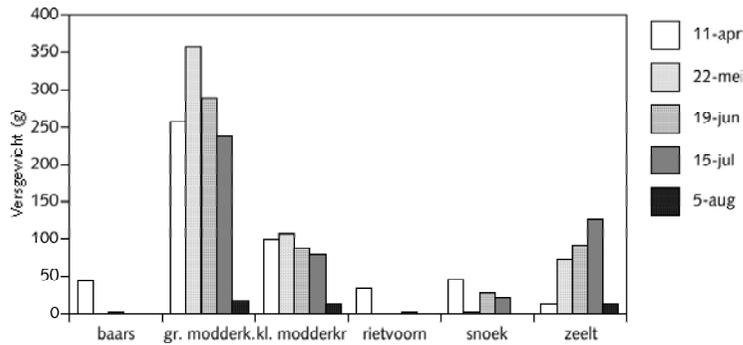


Figure 2. Calculated fish biomass from three sample points in the shallow bank zone of 'De Boezem', April-August 2002. European weather loach dominated the fish community in this area.

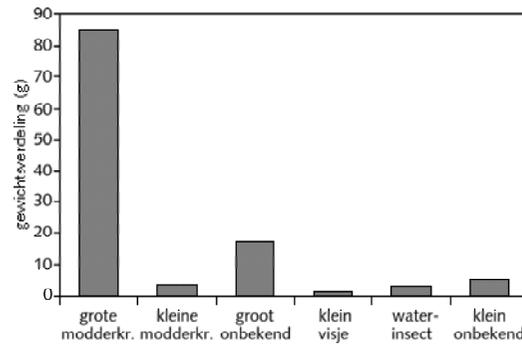


Figure 3. Calculated quantities (number\*mass) of different prey types taken by purple herons in 'De Boezem' May-June 2002. Data were based on observations of foraging birds.

## The turbid waters of 'Wormerveld' and 'Jisperveld'

In North Holland above the North Sea canal, the black tern has shown a more marked decrease than elsewhere in the Netherlands. During exploratory research in 2001 it appeared that almost no fish were being caught in this area. This was in stark contrast to other areas in the western Netherlands (figure 1.).

The terns tried to compensate for this lack of fish with other prey items, but failed and consequently raised very few young. The area has a range of habitats with large areas of open water and a variety of broad and narrow ditches, however, the ditches are very shallow with thick layers of mud and are very turbid. It was this poor water quality (with few fish) that resulted in the poor breeding success of the black terns. In 2003 measures were taken to improve the situation of surrounding areas.

## Isolation can be favourable

Following the 'Protection Plan for Marshland Birds 2000-2004', a study was carried out on the importance of water quality in the foraging habitats of purple herons. In one area close to Ameide (South Holland), exceptionally high densities of foraging purple herons were found. In this area the fish community was dominated by European weather loach (figure 2.) and purple herons from a neighbouring colony were found to be making use of this (figure 3.). The isolated position and semi-natural fluctuations of the water-level seemed to ensure that other fish species could not compete in the marsh, however, European weather loach can occur under such conditions in very high densities. Due to this research, the area is now designated and protected under the Habitats Directive for European weather loach and similar plans for dynamic marshes are planned in future policies.



Nature reserve 'De Boezem'



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# Fish

## for people, nature, ecology and the environment

Fish form part of the aquatic ecosystem. They live in all types of water and can strongly influence aquatic communities. Fish are of important value in nature, as indicators of the quality of eco-systems and for both sport and commercial fisheries.

### Fish communities

Fish communities can change due to a number of reasons, the most important factors being water quality, hydrological management and land-use development. These influence the functions of the water for fish populations such as breeding and migration possibilities.

Fish communities in the Netherlands also change because of new species, such as Asp, and the return of formerly extinct species such as salmon and houting. Nevertheless, in small polder ditches as well as in large rivers, lakes and estuaries the diversity of fish has declined over the last century.



European Weather Loach

### Monitoring

Both in national waterways as well as in regional waterways fish populations have been monitored for some decades. Since the start of the Water Framework Directive (WFD), the need for fish monitoring has increased further. Bureau Waardenburg conducts regular monitoring projects, such as in the Naardermeer, where fish populations are monitored over a five year period. This monitoring is carried out as part of a restoration project, aimed at improving fish communities in the Naardermeer. Bureau Waardenburg also conducts short-term fish research, especially as part of WFD assessments. The monitoring of fish stocks adds to our current knowledge about the rapid changes that can occur in aquatic ecosystems. Good examples of projects undertaken by Bureau Waardenburg in this area include: "Fish monitoring on the river Eem" (2008), "Fish monitoring in the Waterschap Brabantse Delta" (2007) and "Fish monitoring in the Stichtse Rijnlanden" (2006).

### Fish migration

Migration possibilities for fish are a prerequisite for the presence of healthy populations.

In water systems all kinds of barriers can exist that can prevent fish from reaching the areas necessary for breeding or wintering.

In the coastal zone important improvements for the fish community can be made through the creation of gradients between fresh and salt water as well as sufficient possibilities for fish to move between these habitats. Several fish species, such as rare migratory fish and typical estuary species can settle and extend their populations far upstream thus enriching fish communities in these areas.

Also in polder areas and streams a lack of migration possibilities can cause problems for the fish stock. Bureau Waardenburg has undertaken many projects on this subject.



**Bureau Waardenburg bv**  
Adviseurs voor ecologie & milieu

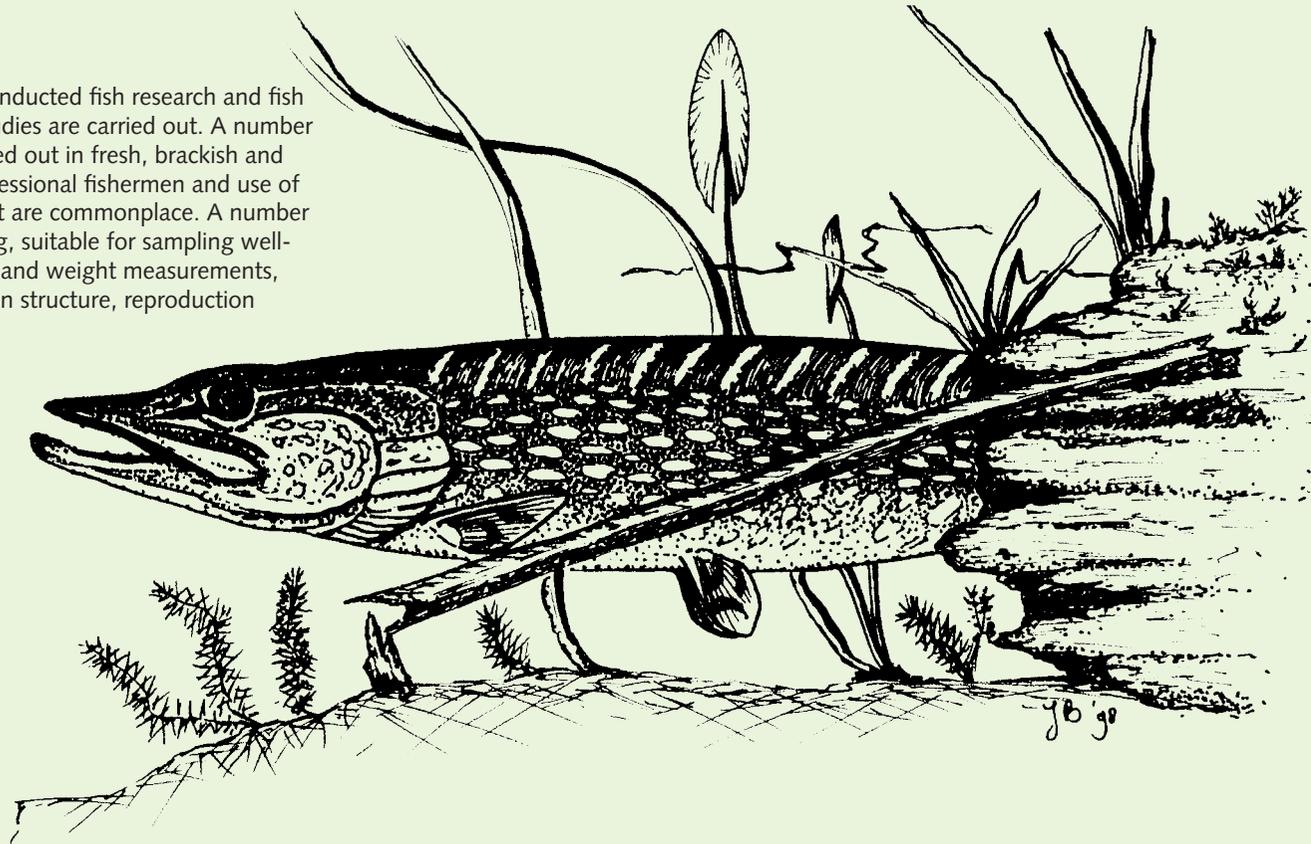


## Fish management

Sustainable management of fish stocks are important for the natural environment and both sport and commercial fisheries, therefore, fish management plans can be desirable. Such fish management plans are obligatory for national waterways. Active biological management, where fish (notably bream) are removed from water bodies, is one form of management. However, integrated water management and land-use development of the water system is generally more sustainable for improving fish populations. Bureau Waardenburg develops fish population management plans where all aspects of the fish fauna are considered.

## Bureau Waardenburg

Since its start in 1979, Bureau Waardenburg has conducted fish research and fish ecology studies. Both field studies and literature studies are carried out. A number of long-term monitoring programs have been carried out in fresh, brackish and salt water habitats. Frequent cooperation with professional fishermen and use of all kinds of (custom made) fish sampling equipment are commonplace. A number of project workers are experienced in electro-fishing, suitable for sampling well-vegetated banks and other obstacles. Using length and weight measurements, fish populations are described in terms of population structure, reproduction success and the condition of the fish community.



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# Twenty years of ecological restoration in the IJsselmeer District

Results of an evaluation of ecological restoration in the largest lake district in The Netherlands, The IJsselmeer district. This project was carried out by order of the Departement IJsselmeer area of the Dutch Ministry of Water Management.

## History

The IJsselmeer was formed in 1932 after construction of a dam. This dam, the 'Afsluitdijk' of 32 km, separates Lake IJsselmeer from the Dutch Waddensea. In 1976 another dam was built (the "Houtribdijk") which divided the large lake into two compartments: the present lakes Markermeer and IJsselmeer. Despite several plans no further land reclamation has taken place since then.

## Species

Large areas of the IJsselmeer lakes and its shores are protected under national nature legislation. Important nature values consist of large numbers of water birds like ducks (e.g. Tufted Duck) which use the lakes mainly for resting and foraging in winter. Bare ground breeders (like Common Tern) use the natural sand- and shellbanks in summer season. The extensive reed zones along the shores of the mainland in summer form suitable breeding habitat for wetland birds (e.g. Great Reed Warbler). Especially in the shallow Borderlakes large areas of submerged macrophytes (like Chara- & Potamogeton-species and Horned pondweed) form habitat for aquatic invertebrates and fish. In the deeper parts of the Borderlakes and in Lakes IJsselmeer and Markermeer Zebra mussels (*Dreissena polymorpha*) and other fresh water mussels are an important food resource for diving ducks and other bird species that forage on macrozoobenthic organisms.

## Problems

### Water quality:

Eutrophication (dominance of bluegreen alga / bream)  
Hypoxia  
Turbidity

### Hydromorphological:

Land reclamation (habitat loss)  
Unnatural waterlevel regime  
Abrupt land-water transitions



Lessons learned and contribution towards achieving WFD- and Natura 2000 goals.

## Restoration projects

### 19 projects: islands, sandbanks, basalt dams

To mitigate the effects of hydromorphological changes, 19 ecological restoration projects were carried out in this region between 1990 & 2008. Most projects aimed initially at an increase of bird numbers by providing resting, foraging and breeding habitat. Later on also aquatic ecology (macrophytes, helophytes, fish etc.) became part of the project goals. The main method of ecological restoration was to create different types of islands and sandbanks. Another method was the construction of dams to create sheltered water between the dam and the mainland.

## Assessment original project goals

In this study we assessed the achievement of the original project goals and new goals (WFD and Natura 2000)

### Most original goals achieved:

- habitat for birds species breeding on bare ground (e.g. Terns) and wetland birds;
- resting & foraging habitat for water birds (shallow water);
- protection of natural sand- en shellbanks.

### Some effects appear to be temporary:

- without intensive management islands and sandbanks turn out unsuitable for bare ground breeders
- without shore protection constructed islands and sand banks disappear by erosion

### Some goals are difficult to achieve:

- development of helophyte vegetation is limited by unnatural water level regime.

### Example contribution to WFD

**The Abbert in lake Drontermeer:** 120 isles with a diameter of 5/20 m, total area 15 ha, construction in 1994/1995, main goal was resting, foraging and breeding habitat for water and wetland birds.

**Lake Vossemeer:** Comparable to The Abbert, 80 islands surrounded by sand banks, constructed in 1997/2000, same goals. Big difference with The Abbert is the loss of hydrodynamics because of the sandbanks. This prevents the development of reed vegetation.

#### Success:

The shallow sheltered water around isles, sandbanks and dams often becomes clearer, because sediments settle on the bottom. As a result of higher transparency, submerged vegetation develops (mainly Potamogeton & Chara species). Together with the vegetation development macrofauna and fish appear, which use the submerged macrophytes for shelter, foraging, reproduction etc.

#### But:

A few projects developed algae problems (floating layers of blue-algae, oxygen-shortage). This occurred especially at spots with little water circulation. So too much shelter can also work out negatively. This is an important factor to keep in mind at the design and construction of nature islands and dams.

### Example contribution to Natura 2000 goals

**The Kreupel in Lake IJsselmeer:** Sandbanks and islands surrounded by shallow water, with a total area of 70 ha, construction 2003/2004. Main goals are resting, foraging habitat for winter guests like diving ducks and breeding habitat for bare ground breeders like Common Tern-Visdief, Little Tern/Dwergstern. In the large and relatively deep Lake IJsselmeer this habitat type is rare.

#### Success:

Past years thousands of breeding pairs of Common Tern were spotted. Also Little Tern and plovers. In 2006 large parts of the islands were covered with bare ground breeders. Also lots of duck, geese and gull species use the islands as breeding place. At the central island there is a large breeding colony of Great Cormorant. In winter season it is an important resting place for Black Tern.



The Abbert



Vossemeer



The Kreupel



#### But:

Construction of islands and dams can cause loss of hydrodynamics (wind and wave action) in the existing reed zones along the mainland. This phenomenon occurs at the shores of the northern Borderlakes. This resulted in degeneration of the existing (water) reed zones (accumulation of organic material) and a decrease of breeding pairs of the Great Reed Warbler (N2000-species). This is an important aspect that should be taken into mind when designing new nature development plans.

### Matching WFD to Natura 2000

#### Match:

- creation of shallow zones (macrophytes, water birds)
- creation of natural banks (helophytes, wetland birds)

#### Conflict:

- decrease of nutrients --> increase of transparency --> development of submerged macrophytes (+ KRW)
- decrease of nutrients --> decrease of fish biomass --> decrease of waterfowl numbers (- N2000)

### Lessons learned

#### Success factors:

- Vegetation management of islands is important (bare ground breeders);
- Hydrodynamics (wave and wind action, water circulation) around islands and dams are important to prevent proliferation of algae and reed degeneration;
- Shore protection of islands and sandbanks is important to prevent erosion.

#### Limiting factors:

- Relatively high nutrient concentrations;
- Unnatural waterlevel regime.



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