



## **Bat habitats along the Nieuwe Hollandse Waterlinie**

Investigation into present functions for bats, present use,  
bottlenecks and possibilities for sustainable development.

Part 1: Summary

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Department of Regional Affairs (DRZ) – West

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## Contents

1. Introduction.....	4
2. Landscape functions with respect to bats.....	6
3. Bat habitats and the Nieuwe Hollandse Waterlinie.....	12
4. The Flora and Fauna Act and bats.....	17
5. Conclusions.....	21

## 1. Introduction

The Nieuwe Hollandse Waterlinie (NHW) is a national cultural heritage without equal. The line covers a zone of forts, fortresses, defence positions, line dykes and defensive flood zones that runs from North Holland, via Utrecht, Gelderland and South Holland, to North Brabant. The residents of the region and the Dutch in general know little about this monument as a whole: although individual forts and fortified towns are relatively well known, the line as the connection between forts and landscape is much less understood.

To preserve the line, and to increase attention for the forts and the line, a vision was developed as part of the national project the Nieuwe Hollandse Waterlinie, which is currently in a transition phase from vision to reality. In addition to preserving the forts and their cultural historical and natural values, the aim of the NHW project is also to add to the new modern functions such as culture, recreation and education. It is a challenge to develop these new functions without losing the current value and without missing opportunities.

In addition to the cultural historical and recreational value, there are many elements of special natural value present at the various forts and defence positions. That is why for a long time forts and landscapes around the forts have been owned and managed by nature protection organisations such as the Staatsbosbeheer (Dutch National Forestry Service) and the Vereniging Natuurmonumenten ('Nature Reserves Association').

Hibernating bats are present in several NHW buildings. This constitutes one of the forts' known elements of natural value, and has often been the reason why a fort received a natural protection purpose.

At the same time, however, there is insufficient awareness of and insight into the other important and essential functions that red, green and blue elements provide for bats at the forts and in the landscape at and around the forts over the course of the season. Potential functions include winter roosts, summer roosts, maternity roosts, mating roosts, swarming sites, hunting grounds and flyways/connections.

Bats are a highly protected species under the Dutch Flora and Fauna Act. The current use and management of the forts, and certainly the development and changing of that use means that the duty of care under the Flora and Fauna Act should be fulfilled by performing a careful assessment of the impacts of use and development on the bats.

The more we know about how bats use the forts, the better prepared we will be to combine the various fort uses, or consider which interest at which site should (and can) receive priority. Only then can we deliver customised solutions with respect to avoiding, alleviating/mitigating and compensating the impacts on bats during the planning and realisation of developments.

The Zoogdierverseniging VZZ (Society for the Study and Conservation of Mammals) therefore carried out the project 'Bat habitats along the Nieuwe Hollandse Waterlinie' in 2006 at the request of the Ministry of Agriculture, Nature and Food Quality (LNV) and the Nieuwe Hollandse Waterlinie Project Office. A line-wide investigation was also carried out into the functions of the forts and the landscape for bats at and around the forts in preparation for the development and use of forts in a way that both complies with the legislation concerning bats and exploits the opportunities for local development and commercialisation.

More specifically, a systematic bat survey of the Nieuwe Hollandse Waterlinie was performed to obtain information and insight into the presence of bats, how they use the forts and the line, as well as or rather the function(s) that the forts' landscape fulfils for bats, the (possible) impacts of (intended) human activities at the forts, and the formal legal approach of the Flora and Fauna Act.

Finally, the new knowledge and insights were incorporated in a set of rules for handling bats when using and developing forts and the landscape along the line.

The relationship between bats and the landscapes in which they live is extremely complex. And the NHW is an extensive and complicated landscape. The integrated study of the presence of bats at and around the forts and the functions that these forts fulfil for bats could therefore not be realised within the specified timeframe of one year. Due to the magnitude of the underlying problem definition (line-

wide for the NHW and function-wide for the bats) and the available budget and time, the study and the analysis were therefore built up step-by-step over time and space.

Starting from a general and line-wide perspective, the study gradually scaled down to targeted sampling. The forts and the landscape at and around the forts were first analysed and described theoretically on the basis of our knowledge and experience with bats and forts. The various potential functions of the forts and the landscape were then deduced from this analysis. The line-wide analysis based on the available data and expert judgement made it possible to perform a quickscan of the value and sensitivity of forts and objects. Locations requiring further investigation were subsequently sampled and studied further (field survey + deeper analysis).

For the targeted analysis, further data was collected at a select number of forts on the presence of and functions for bats as well as the use of the objects by people. The sampling was based on the geographical location, the landscape at and around the forts, the ecological connection with the surroundings, the building style, the history and the current use of the forts by people, the management regime, etc. Within this sampling, further data was also collected from specific forts where developments are planned for the near future as part of a concrete and targeted analysis and assessment of the impacts of the fort's change in function on bats.

We have nearly a complete picture of the presence of bats and how they use the forts in the winter on the basis of the regular winter counts of bat populations as part of the Ecological Monitoring Network (performed by the Zoogdierverseniging VZZ & CBS, in cooperation with provincial bat working groups) and the additional research from this project. The potential functions available in the summer and autumn phase were investigated and analysed in the targeted sampling. This involved the targeted study and illustration of the occurrence of (potential) functions, what impact these functions have, and when and how these functions should be investigated in the process of developing a fort (rules).

Parallel to the research activities, communication channels were established with an intense exchange of knowledge and experience about the forts and bats between target groups of interested parties: examples include bat experts, bat experts specialised in forts, project leaders from NHW 'envelopes', competent authorities within the framework of the Flora and Fauna Act (Dienst Regelingen and Dienst Landelijk Gebied), and the fort managers.

The communication has several objectives. First, it was about collecting and bringing forward specific knowledge and insight from the experience of the various target groups in the project. The results are ultimately to be used by the target groups and therefore should be geared toward the utilisation by these groups. Second, the communication was intended to make people more aware of the subject of bats and of the specific ecological and legal aspects of the use and development of the forts, and from there develop practical rules for dealing with bats. And third, the results and the project were presented and discussed.

The results of the project are elaborated in this extended project summary, an extended and detailed study report and an overview of the lessons learned in the form of a set of rules:

Bat habitats along the Nieuwe Hollandse Waterlinie.

Investigation into present functions for bats, present use, bottlenecks and possibilities for sustainable development.

Part 1: Summary (this document).

Part 2: Rules for handling the bat population when developing and using NHW forts (in Dutch)

Part 3: Study report (in Dutch)

## 2. Landscape functions with respect to bats

Chapter 2 presents a theoretical analysis of the functions that a landscape, including the forts and the line, can fulfil.

### 2.1 Functions in theory

A swan is completely different from a swallow. Just like a Daubenton's bat is completely different from a noctule. Bat species are very diverse. Despite these differences, however, we can briefly describe the ecology of bats as a group and deduce from this the model of a network of functions in the landscape.

Bats are nocturnal flying mammals, of which the European species are all insect eaters. In the Netherlands, 22 species have been observed, although some species have not been seen for a long time and are suspected to be extinct from the Netherlands. They are all different. The smallest species, the common pipistrelle, has a wingspan up to 24 cm and weighs up to 8 g. The largest species, the lesser mouse-eared bat, has a wingspan up to 43 cm and weighs up to 40 g. They hunt at night using echolocation to locate flying insects or insects resting on the surfaces of leaves and walls, or to scoop up insects from the water surface with their hind legs. The brown long-eared bat has broad wings, which allow it to fly slowly and nimbly close to, and even through, foliage; it hunts on a small-scale, closed landscape. The noctule has narrow wings, which allow it to quickly fly high through the open air. Daubenton's bats and pond bats often fly just above the water surface.

#### ***colonies and summer roosts***

In the spring, the females gather in groups from a few to sometimes well more than a hundred animals. The young are born in these maternity colonies between June and July. Three to four weeks later, the young bats can already fly by themselves and they begin to learn how to hunt. Depending on the species, bats either live in buildings (for example in attics, between wall spaces, under roof tiles, and behind panels, in underground or ground-covered spaces) or in crevices and holes in trees. There are, however, also species that live in both buildings and trees. Dilapidated sections in and on buildings by their nature can be interpreted as an artificial version of crevices and holes in rocks or trees. The males occupy similar roost sites, but they prefer to live alone or in small groups.

The colony occupies a network of roost sites between which the animals regularly move over the course of the season or from year-to-year. The bats in a particular tree, church attic, or hollow wall are therefore usually only part of the 'colony'. The roost sites are connected via flyways in the landscape. Some species recognise flyways using structures in the landscape, such as hedgerows, wooden fences, riverbank vegetation, etc.; other species fly much more freely and higher above the landscape. Thus, networks of various colonies are located next to each other in the landscape, and depending on the species, these colonies can behave more or less territorially with each other.

There are specific requirements concerning the microclimate in and around the roost site, most importantly that it is warm and dry. This means that roost sites are located particularly in sheltered sites facing southwest in the landscape and in buildings.

#### ***setting off through the landscape***

In principle, bats leave their roost site every night to hunt. Different species choose different hunting grounds ranging from the airspace high above the landscape and large waterbodies, the surface of large waterbodies, ponds and streams, along riverbank vegetation, the edges of forests and forest pathways, to the thick vegetation of shrubs and trees.

Using a set of more or less permanent flyways, which are guided and protected by upward vegetation, bats visit a series of hunting grounds that form a link in the network of roost sites and hunting grounds. The distances between the roosts vary by species, but the distances also depend on food availability and thus the surface area and quality of the hunting grounds. When bats can find enough food nearby, they do not fly far. Often relatively small areas form the core of the actual foraging area. Some species use a series of territorial hunting grounds. Others react in an opportunistic way to the food supply.

In the spring and fall, when they are not caring for young, bats can be lethargic and have no need to leave their roosts every night to hunt. When females are producing milk, however, their body temperature must remain above 37° C. They cannot go dormant and so they must hunt every night. They often choose hunting grounds close to the maternity roosts to reduce their flying time and save energy. At the same time, maternity roosts must also be located near suitable hunting grounds.

### ***mating and swarming phases***

Particularly in the autumn, the males of some species can be heard in fiercely defended courtship territories or mating roosts. From the mating roost in a crack or hole in a tree, bird house, bat box or house, or by just flying around their territory, the males chase away loudly calling competitors and lure the females. Such territories and mating roosts are often not widely spread out, but clustered together in groups. Logically, they are located particularly where many females pass by on their way to their hunting grounds in the autumn or while migrating through Europe.

Such courtship sites are usually located along older avenues, forest plots and parks or fort grounds with several large tree holes, but also city suburbs along the coast and near rivers. These courtship sites are found especially along rivers and near lakes and water-rich areas. This link in the network can be located within the summer habitat, but may also be at a greater distance, and then often on the way to the winter roosts. For example, with the long-distance migrating Nathusius' pipistrelle and noctule species, the traditional courtship sites form stepping stones for the females on their way from north and northeastern Europe to south and southwestern Europe. The networks within the Netherlands are therefore part of a larger network on the European scale.

For other species, the time for courtship and mating is during the swarming phase at the beginning of the hibernation period. Some bats also mate during hibernation, but this is rare. It is mainly the swarming phase in the autumn when large groups of bats swarm again and again for days at the entrances to and inside the winter roosts. Sometimes it looks like a real-live courtship battle. During the swarming phase, bats come together at swarming sites from far away and from different colonies and populations. The winter roost and the surrounding structures offer locations for the actual mating roosts. The swarming sites and winter roosts form an important link in the network.

### ***hibernation and migration***

There is no clear north–south migration between brooding grounds in the summer and winter foraging grounds in the winter, such as with many insect-eating birds. In the winter, bats hibernate in what we call 'winter roosts'. These roost sites are usually underground, dark, humid, draft-free, relatively undisturbed spaces with a stable temperature a few degrees above freezing. Some species prefer to hibernate in a tree hole, which also sometimes serves as the maternity roost, mating roost and winter roost. Other species hibernate in rock crevices and in similar cavities in buildings.

The strategy is to hang with the body functions in a reduced metabolic state (lethargic) in the winter roost to spare energy and thus wait for the spring. To achieve a stable hibernating state, it is important that the temperature in the winter roost does not rise too high, but also that it does not fall below the freezing point, as this would cost the bats too much energy. Still, hibernating bats wake up once in a while to fly in search of another hibernation spot with a (momentarily) more favourable temperature or to mate.

Some species, such as the common pipistrelle and the brown long-eared bat, do not seem to completely submerge themselves in hibernation. During mild winter weather, they also appear to be active once again. Brown long-eared bats, which are specialised in picking off non-active prey from leaves and walls, hunt hibernating butterflies in attics and in underground structures even in below-freezing temperatures.

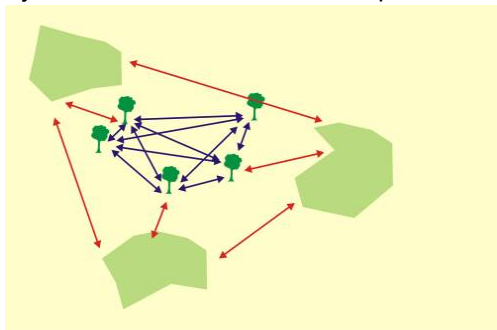
The majority of bat species 'migrate' in the autumn and spring over short to middle distances, in all directions between suitable summer habitats and swarming sites and winter roosts. That is, the migration is not a long-distance event with a clear north–south direction as with many migrating birds. Depending on the availability of suitable winter roosts, bats also hibernate directly in the summer habitat, sometimes even in the same roost site. In fact, they often behave mostly like an indigenous species.

**a network in the landscape**

Bats use a network of partial habitats that fulfil different functions. These include roost sites, flyways and hunting grounds in the landscape. Moreover, they follow a clear seasonal cycle: hibernation, migration, courtship and mating seasons (some species), maternity period, courtship and mating seasons (other species), migration and again hibernation. The periods of migration, courtship and mating overlap and mating can also occur in the winter.

J	F	M	A	M	J	J	A	S	O	N	D
Annual cycle											
			temporary	summer roost site ♀ ♀			temporary roost				
winter roost			roost	(maternity) roost site ♀ ♀			mating roost / territory			winter roost	
hibernation			migration	maternity season			mating season / migration			hibernation	
			swarming phase					swarming phase			
			mating season								

Not surprisingly, bats look for habitats in the landscape that fulfil different functions over the course of the season. Sometimes these areas and functions are physically separated, but it can also involve the same area or object. The functions during the course of the annual cycle from winter to summer to winter again are as follows: winter roost, (spring) swarming roost/mating territory and mating roost, migration route, temporary roost and maternity roost, and then again mating territory and mating roost, migration route, (fall) swarming roost/mating territory and mating roost, and again winter roost. Moreover, the landscape offers hunting grounds used during different phases of the season, flyways used more or less daily between hunting grounds and roost sites, and large-scale connecting routes between habitats used during different phases of the season. A 'bat habitat' is in fact a complex and dynamic network in the landscape.



In the summer, large numbers of females come together to form maternity colonies. A 'bat colony' is a cohesive social group, which uses a network of various roost sites, flyways and hunting grounds over the course of the different seasons (maternity season, mating season, migration and hibernation). In other words, a group of pond bats in an attic represents only a part of the total colony and its habitat. At any given moment, a colony of Daubenton's bats can occupy 12 (maternity) trees simultaneously, and individual bats continually change between trees and subgroups where they are roosting.

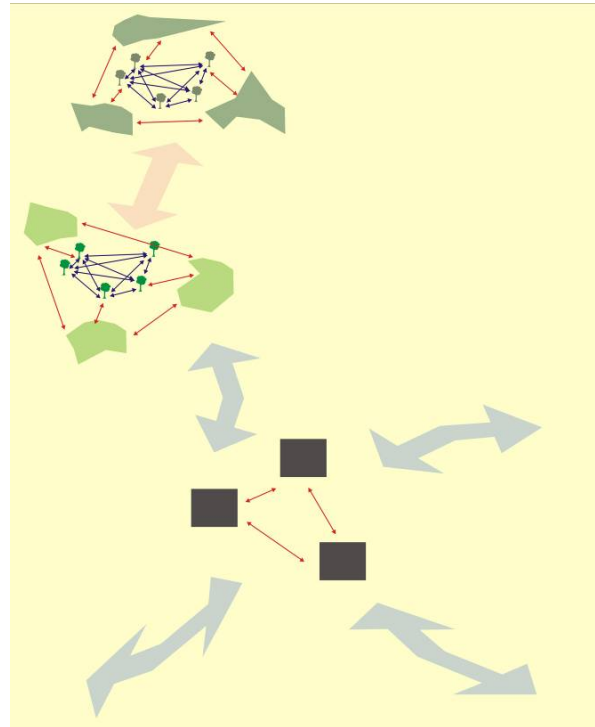
Common pipistrelles almost always occupy several roost sites at the same time, constantly moving so that over the course of a few seasons they can occupy a network of more than 50 different buildings in a town or neighbourhood. Tree-living species such as Daubenton's bats use a network of hollow trees. Sometimes, depending on the species and situation, there may be a central roost site surrounded by satellite sites, while sometimes there is a network of more equivalent roost sites. The different social groups, or colonies, function more or less independently from each other, and at times may even behave territorially. Exchange between the social units takes place particularly via transplanted male bats, or for the entire population during the mating season and/or swarming phase/migration. Exchange of individual females between the colonies takes place only on a limited scale.

The network of roost sites used by a maternity group is mutually connected by flyways and connected with the specific habitats and landscapes used as hunting grounds. The figure opposite shows this system for a species such as the Daubenton's bat, which forms maternity colonies in trees in the summer.

Exchange between neighbouring colonies via female bats is rare. Still, the landscape connection between neighbouring colonies is essential. At a larger scale, the group's network of summer roost sites, hunting grounds, and summer flyways is integrated within a larger network of mating grounds and roosts, swarming sites, winter roosts and the flyways. The Daubenton's bat uses mainly underground cave-like objects, such as forts, as mating grounds, swarming sites and winter roosts.

Within this large-scale network, bats use various routes or landscape connections: the daily flyways between roost sites and between roost site and hunting ground, the routes between summer grounds and mating grounds and hibernation grounds, but also the corridors or connection between colonies or populations.

As a result of the normal course of the season, but also due to factors such as changes in food availability, availability of roost sites, etc., the use of the network is dynamic and variable over the course of the season and from year to year



## 2.2 Potential functions of the NHW for bats

How do bats currently make use of the forts and the landscape along the NHW, or could bats make use of it in theory? On the basis of the analysis and assessment of the landscape at and around the NHW forts, we can potentially expect the following functions: Whether a function at a particular fort is actually under discussion depends on the specific situation and landscape at the fort. Are there accessible underground buildings or ground-covered buildings? Are there buildings above-ground? Are there trees? Do the old trees have crevices or holes?

### *Hibernacula*

Winter roosts are likely to be found in crevices and spaces in underground and ground-covered buildings, in the crevices of outer walls, in above-ground buildings at the fort, and in group shelters at or in the vicinity of the forts, but also in crevices and holes in trees at and around the fort.

### *Swarming site and mating roost at a swarming site*

For the species that typically hibernate underground, swarming locations, swarming roosts and courtship arenas are likely to be found at entrances to spaces in underground or ground-covered buildings, in trees near entrances, in crevices in outer walls, in group shelters at or in the vicinity of the forts. Mating roosts can be found in crevices and spaces in underground or ground-covered sections located near swarming roosts or sites.

Hibernating roosts of species that do not typically hibernate underground are likely to be found in crevices and holes in trees at and around the fort and possibly near the above-ground buildings at the fort.

### *Mating territories, mating roosts and mating grounds*

Mating territories or mating roosts for territorial species are likely to be found in crevices in outer walls, in above-ground buildings at the fort, in group shelters at or in the vicinity of the forts and in crevices and holes of trees at and around the fort.

When several mating roosts and territories are found concentrated together, this can be defined as a 'mating ground'.

### *Maternity roosts and temporary roosts*

Maternity roosts are likely to be found in crevices and spaces in underground or ground-covered buildings, in crevices in outer walls, in above-ground, non-ground-covered buildings at the fort, and in the vicinity of the forts and in crevices and holes in trees at and around the fort. Roosts are classified as simply 'roosts' or 'temporary roosts' when it is not possible to establish that it has to do with a maternity group, or when the bats remain on a temporary basis during the transition phase between different periods of the season.

### *Hunting grounds*

Hunting grounds can be found at the entrances to and in spaces of underground or ground-covered buildings, on the fort grounds, and in trees at and around the fort, above moats, in the immediate vicinity of the fort, and in group shelters in the vicinity of the forts.

### *Flyways and connecting functions*

Flyways can be found on fort grounds, along trees and avenue structures at and around the forts and along the moats. The landscape on the fort grounds and around the fort can fulfil a connecting function on the scale of individual forts or (parts of) the line.

### 2.3 Potential functions per object type

We have divided the landscape on the forts into specific red, green and blue structures. The table below shows which functions can theoretically be expected at a fort, or in the landscape at and in the vicinity of a fort, and what the potential is that a particular function is present in a given structure. The table below also shows the extent and results of the study sampling in 2006.

#### Functions of the red structures

Function	Winter roost	Hunting grounds	Flyway	Summer roost	Swarming site	Mating roost	Connection
Ground-covered building	●	○	-	○	○	○	-
Tower forts and bomb-proof castle towers	●	○	-	○	○	○	-
Wooden sheds	○	○	-	○	○	●	-
'Plofhuisjes' Modern sheds	-	○	-	○	○	●	-
Open barracks/ Fort watchman's quarters	○	○	-	○	○	●	-
Residential homes	○	○	-	●	○	●	-
Small objects on and outside the fort grounds	●	○	○	○	○	○	○ ?

#### Functions of the green structures

Function	Winter roost	Hunting grounds	Flyway	Summer roost	Swarming site	Mating roost	Connection
Trees on and around fort grounds	○	○	○	○	○	○	○/ ○
Trees along line dykes and flood canals	○	○	○	○	○	○	○

#### Functions of the blue structures

Function	Winter roost	Hunting grounds	Flying corridor	Summer roost	Swarming site	Mating roost	Connection
Fort moats and flood canals	-	○	○	-	-	○	○

#### Legend:

- = high potential of presence
- = high potential of presence (in special situations)
- = potentially present
- = absent/not applicable

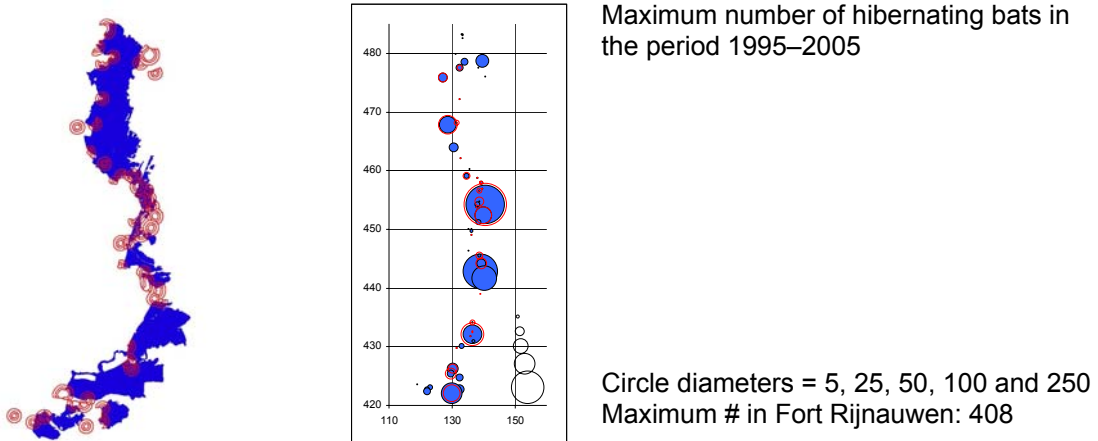
#### State of knowledge in 2005/2006:

- = systematically studied
- = random sampling, several objects on a regional level
- = limited random sampling, only a few objects on a regional level
- = sampled incidentally

### 3. Bat habitats and the Nieuwe Hollandse Waterlinie

#### 3.1 Winter roosts / hibernation in the NHW forts

The number of hibernating bats, and also the number per species, are not evenly spread, but vary from fort to fort. Species concentrate themselves in different forts or regions, indicating the presence of important hibernation hotspots in these places along the NHW.

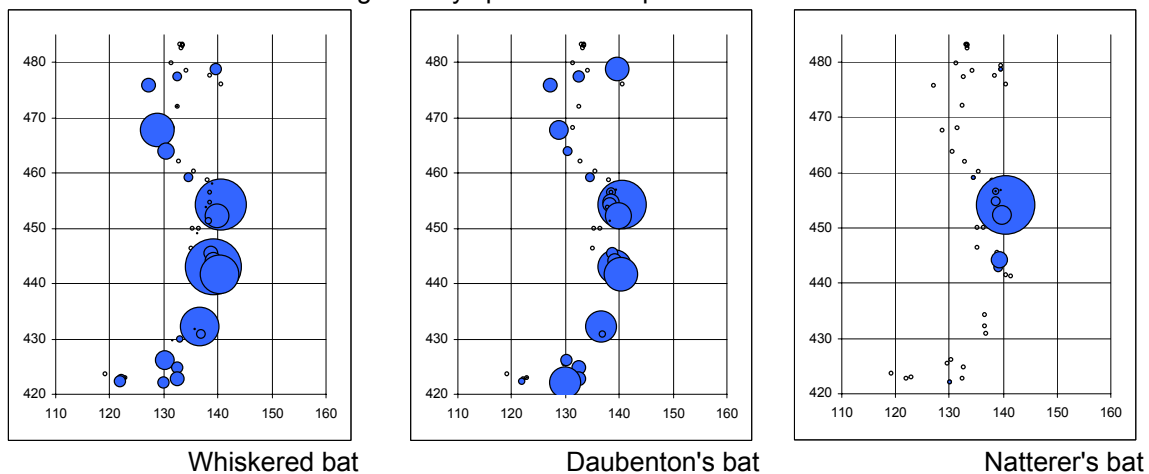


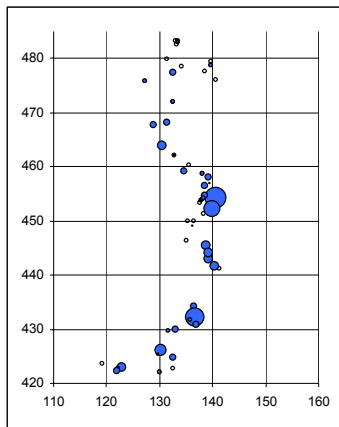
The number of hibernating bats, and also the number per species, are not evenly spread, but vary from fort to fort. Species concentrate themselves in different spots or regions, indicating the presence of important hibernation hotspots along the Nieuwe Hollandse Waterlinie at these forts or regions. It may be evident that these objects should be handled with extra care.

Among the fort grounds investigated, 81% of the forts with ground-covered buildings have buildings or building sections that are used by bats as hibernation roost sites. Of the remaining 19%, there are a number of possible sites that nevertheless shelter a small group of hibernating bats.

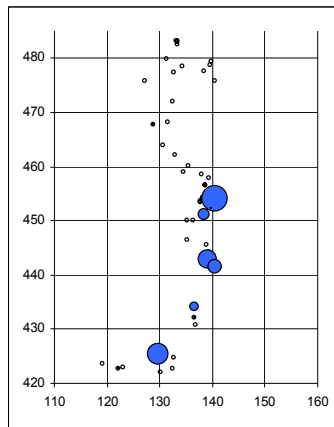
Hibernating bats are regularly found at 29 count locations. This is less than 2% of all the hibernation survey sites in the Netherlands (2005/2006). But within this 2%, nearly 1400 hibernating bats in total are observed annually. The actual number present lies probably between 1700 and 2000 bats.

#### Maximum number of hibernating bats by species in the period 1995-2005.

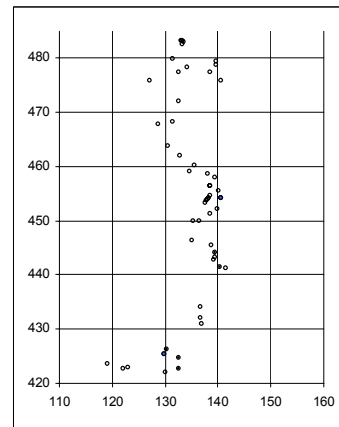




Brown long-eared bat



Common pipistrelle



Serotine

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Number and proportion of hibernating bats along the NWH with regards to the rural population counted. ? = unknown

	In NL (winter)	On NWH	% NL pop	National responsibility	NL Trend	Trend on NWH
Whiskered bat	2600	700	27	!!	(+/-)	Stable
Brandt's bat	<25	>5	?	!!	?	Increasing?
Natterer's bat	1800	236	13	!	++	Strongly increasing
Daubenton's bat	6100	600	9.8	!	-	Slightly increasing
Brown long-eared bat	1000	161	16	!	+	Strongly decreasing
Lesser mouse-eared bat	24	0	0		(+?)	Disappeared after 1960
Pond bat		1-3	0	-	0	A few individuals on an irregular basis
Common pipistrelle	?	>70	0	-	?	Strongly increasing?

There are hotspots along the NWH, particularly for the whiskered bat and the Natterer's bat, and a large part of the rural population hibernates along the NWH.

### Object sections

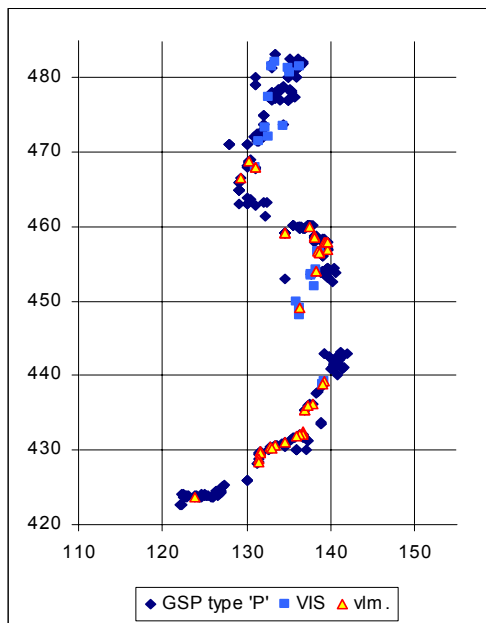
The number of rooms available for bats and the number of continuous years that a fort is managed in a bat-friendly way determines to a large extent whether a fort or fort buildings are an important hibernating site. Especially the underground levels of forts and large above-ground buildings house larger numbers of hibernating bats. The various species use in part different sections of the buildings. This reflects differences in requirements for a hibernation location. But large numbers of deep and shallow crevices in masonry appear to be one of the most important qualities for winter roosts.

The current management at forts with large numbers of hibernating bats is considered to be relatively good to very good. Management at fort grounds or buildings with smaller numbers is often considered average to very poor, with rules regularly being violated.

### 3.2 Winter roosts in small objects

Around 500 small objects at and around the forts have been mapped (with GPS coordinates). More than 370 objects in total were checked. About 50% of these objects were bricked up and inspections were not possible. Those objects that were accessible were examined for hibernating bats. Vandalism and disturbances very often take place in these types of objects.

Hibernating bats were found in 32 of the type P open group shelters (GSP), in 9 of the VIS bunkers, in 4 of the type 1902 depots and 2 of the type 1860 group shelters. In these objects, brown long-eared bats are mostly encountered (from a few individuals to small groups), although whiskered bats are also present, including two possible Brandt's bats along the Zuider Lingedijk. Daubenton's bats are also encountered in VIS bunkers located deeper underground. In one object, a group of 9–12 Daubenton's bats are counted annually. Evidence of use by bats during their active season has also been found at a few locations. These were dry, ideally located GSPs which are never or hardly ever visited by people.



The location of the '1908' depots, the 'P' group shelters and the VIS bunkers along the NWH and their use by bats as winter roost sites.

Small objects can accommodate bat populations, but because most objects are open and accessible for people, hibernating bats are relatively quickly disturbed and/or the interior climate is disturbed by digging up/breaking open objects or clearing of surrounding vegetation.

For bats, the most important features of small objects are the closure of the periscope hole, the existence of extra crawl spaces in the object, and a location beneath trees. This situation is common with small objects located on various fort grounds and clusters of group shelters in forested areas and rural estates. Small groups of objects are locally present in poplar forests.

### 3.3 Spring and summer

Because there is little or no data on the summer use of these grounds, various fort grounds, fortresses and defence positions were examined in the spring, summer and fall. A sample of forts and defence positions were examined in the spring (30 objects) and summer (15 objects).

The species composition of bats hunting on the fort grounds appear to reflect the bat populations present in the vicinity of the fort in the summer. In the spring and fall, these species are supplemented by species that also hibernate in the forts. Relatively high densities of bats were encountered hunting on and around the fort grounds. This is the case in the spring, particularly at and around the forts bordering urban areas, and in the fall particularly at forts near large open bodies of water, such as Vesting Naarden.

The layout of the grounds strongly determines which species are present on the grounds. 'Barren' is the worst layout for the summer; and furthermore this has a negative effect on the use of the grounds as a winter roost.

A few modern buildings on and near fort grounds are used as maternity roosts by common pipistrelles and serotines: Naarden, Muiden, Lunetten 1-2, Diefdijk, Fort Honswijk, Woudrichem.

In a few barracks and a few other ground-covered buildings, small groups (1–5 exx) of brown long-eared bats and Daubenton's bats, common pipistrelles and whiskered bats are present in the summer. This is the case, for example, at Ruigenhoek, Rijnauwen, Honswijk, Everdingen and Bakkerskil. Surprisingly, there are a large number of summer colonies of Daubenton's bats, including maternity colonies, in nearly all tower forts not under intensive use, such as at Uitermeer, Nieuwersluis, Honswijk and Everdingen! There was a group present at Asperen, but it is not known whether this group is still holding out. There is (still) no targeted management or attention for these colonies. These summer groups were also sometimes encountered in other types of two-level ground-covered buildings, such as bomb-proof barracks, guard rooms and ammunition depots.

Although a few fort managers have observed bats at their fort, the presence of bats is not taken into account and no accommodation is made for them during events, restoration work and reuse.



The fortresses and defence positions often play an important role as flyways to and from the hunting grounds in an often otherwise open area. Important flyways are located, for example, at Vesting Naarden, Vesting Muiden, Fort Blauwkapel, Fort de Bilt, Fort Lunetten 2, and Liniedijk Poederloijen. At the same time, progressive damage to the structures used as corridors is visible at several places. More attention and targeted management are still required.

At some forts, roost sites were found in trees which were used as a summer roost and a mating roost by noctules (Fort Rijnauwen) and as mating roosts by Nathusius' pipistrelles (e.g., Nieuwersluis, Rijnauwen). Indications of roosts were found at a number of other forts (Naarden, Ronduit, Liniedijk Brakel, Giessen). This phenomenon also still receives too little attention. Various mating roosts were felled during the most vulnerable period (autumn) and without a preliminary investigation (Uppelsedijk, Liniedijk Poederloijen, Klopvaart, Muiden, Naarden).

### 3.4 Swarming

From the end of August to the beginning of October, various forts serve as swarming sites. The number of bats found swarming at night depended on the fort and ranged from 1–2 to 60 bats. The actual number of individuals that visit a fort on a given night is 3 to 7 times greater than observed. On the different nights this takes place, different groups of bats come. Each species knows its own period. Bats are completely light intolerant during this period, and during the day, there are few or no bats present in the fort.

The swarms make use of both a bit of outdoor space as well as a number of rooms. The swarming activity was regularly concentrated at the most important hibernating spots and at several of the neighbouring warmer rooms. All the swarming zones found so far were completely unlit and located in protected areas.

Due to unfamiliarity with the presence of this function, swarming sites are often not taken into account when hosting events, conducting restoration activities and developing new forms of use for the forts.

## 4. The Flora and Fauna Act and bats

### 4.1 The Flora and Fauna Act.

The protection of indigenous (naturally occurring in the Netherlands) animals species living in the wild is regulated by the Flora and Fauna Act. This law, which came into effect on 1 April 2002, replaced the Bird Act, Hunting Act and part of the Nature Protection Act. The Flora and Fauna Act translates the European Habitat Directive into Dutch national legislation. The duty of care forms the core of the Flora and Fauna Act, as described in article 2. In addition, there are various prohibitive clauses for indigenous species such as bats.

#### *Article 2*

- 1. Everyone shall take sufficient care for animals and plants living in the wild, as well as for their immediate habitat.*
- 2. The 'care' referred to in the first paragraph implies that anyone who knows or can reasonably suspect that his/her action or lack thereof can have adverse consequences for flora or fauna is required to refrain from such handling in so far as can be reasonably demanded, or to take all measures that can be reasonably be required in order to prevent the consequences, or in so far that the consequences cannot be prevented, to limit or undo these as much as possible.*

The Flora and Fauna Act assumes the 'not unless' principle. Protection stands first and foremost; interference is an exception. The law recognises the intrinsic value of animals living in the wild. In terms of the law, this means that all animals are of irreplaceable value and that people may not treat them in a careless manner. This 'duty of care' implies that everyone should take 'sufficient care' for all wild animals and their habitat. This should be realised, for example, through a careful assessment of the impacts of use and development of forts and the landscape at and around the forts on bats.

#### *Article 9*

*It is forbidden to kill, wound, capture or intentionally track animals belonging to a protected indigenous species.*

#### *Article 10*

*It is forbidden to intentionally disturb animals belonging to a protected indigenous species.*

Also, if an intervention is not meant to kill bats or intentionally disturb bats, there can be mention of a 'conditional intent' when the person that is responsible for the intervention knows or can reasonably suspect that their action can result in killing or disturbing bats.

When using and developing forts and the landscape at and around the forts (demolition, renovation, heating buildings, felling trees) it should therefore be determined whether bats can be (unintentionally) killed or disturbed.

*Article 11*

*It is forbidden to destroy, remove, take away or disturb nests, holes or other reproductive or permanent resting places or roost sites of animals belonging to a protected indigenous species.*

Roost sites that are not used continually, but regularly and repeatedly (winter roosts, swarming sites, summer roosts, mating roosts) count as permanent resting places or roost sites, even when the bats are not present.

Roost sites used by bats as winter roosts, swarming sites, summer roosts and mating roosts are defined as roost sites in the narrow sense. The European Hall of Justice, however, declares that damaging or destroying breeding and permanent resting places and roost sites should also be understood to include all acts that alter, harm or counteract in an adverse way the functioning of the reproductive and permanent resting places and roost sites. Hunting grounds, flyways and connecting routes are therefore interpreted as part of the permanent resting and/or roost site in the broader sense if they are essential for the functioning of the permanent resting and/or roost site in the narrow sense.

All bats are protected under the Flora and Fauna Act (Table 3 – species listed in Appendix IV of the EU Habitat Directive). An exemption request can be submitted for these species. A comprehensive test is applicable here. Exemptions can be granted in the following cases:

- there is no alternative, i.e., other satisfactory solutions, and
- there is mention of compelling reasons for the greater public good, including reasons of social or economic nature, and there are beneficial consequences for the environment, and
- there is no harm done to the favourable conservation status of the species

The duty of care and the prohibitions require us to assess the impacts of fort use and development as well as the changing landscape use on bats by analysing the consequences for the entire network of roost sites, hunting grounds, swarming sites, and flyways. For interventions granted under an exemption, the duty of care requires the intervening party to take all possible measures to prevent, mitigate or compensate the impacts. Mitigating and compensating measures should be operational by the time the intervention is carried out and the original habitat affected.

Species populations in their natural habitats are referred to when, according to the European Birds and Habitat Directive, the species is able to favourably maintain itself. The measures are therefore not concerned with (populations of) species on the abstract national or European scale, but rather, for example, with local populations in a winter roost, at a swarming site, in a summer roost, on a flyways, etc.

#### 4.2 Legislation and the functions of the NHW forts

When developing and managing the forts and the landscape at and around the forts, the impacts on the functions that the forts and the landscape have on bats must be investigated, as required under the Flora and Fauna Act.

At locations where species listed under Appendix II of the European Birds and Habitat Directive (e.g., bats) are present, an investigation must also take place within the framework of an appropriate Birds and Habitat Directive assessment. This concerns the external impacts of projects and developments on the conservation status of a species designated area or object.

Negative impacts should be avoided and mitigated and remaining impacts or damage should be compensated.

A primary question is therefore which bat species are found and what functions the fort and the landscape at and around the forts provide for bats.

On the basis of the landscape at and around NHW forts, we can expect the following functions. Whether the function at an actual fort is under discussion, depends, of course, on the specific landscape at the fort: Are there accessible underground buildings? Are there buildings above ground? Are there trees? Do the old trees have crevices and holes?

When a development or an event is prepared and planned at a fort, the functions that are likely to be present should be verified, along with the data that is already available about the functions and whether this is current and complete. Data that is missing or too old should be collected prior to conducting the impact assessment.

The decision process is displayed in the flowchart below.

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<p><b>1</b> What information is known about the planned area? Species/landscape use, resolution/detail and current information</p>	<p>Data files, available reports.</p>
<p>↓</p>	
<p><b>2</b> Which species and which landscape use may be expected? What functions will the landscape provide?</p>	<p>Interpretation of available information, landscape assessment → <i>informed expert judgement</i></p>

**1 + 2 Information for :**

<p><b>3</b> Interim conflict analysis Interim assessment of possible consequences of intervention From construction phase, object and user phase on Species / landscape use / landscape functions</p>	<p>Opinion / analysis ← expert judgement</p>
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**3 Information for :**

<p><b>4</b> Assessment if sufficient information is available, or that further examination is necessary for Conflict Analysis, impact assessment, Planning mitigation and compensation</p>	<p>Opinion / analysis ← expert judgement</p>
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**3 + 4 Decision to and information for:**

<p><b>5</b> Development and formulation proposal/request and plan of approach What (additional) information is necessary? Which methods, periods? What intensity?</p>	<p>Analysis / Advice ← expert judgement</p>
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**3, 4 + 5 Information for :**

<p><b>6</b> Fieldwork /information collection</p>	<p>Expert application of correct methods, during correct periods, with sufficient intensity</p>
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**3 + 6 Information for:**

<p><b>7</b> Conflict analysis Assessment of expected consequences of intervention from construction phase, object, user phase and maintenance and management on Species / landscape use / landscape functions - valued species and landscape use - assessment of what impacts are to be expected - assessment of impact significance</p>	<p>Analysis ← expert judgement</p>
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**6 + 7 Information for :**

<p><b>8</b> Development and planning of avoidance, mitigation and compensation</p>	<p>Analysis / advice ← expert judgement by specialists in consultation / workshops with developers</p>
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## 5. Conclusions

Bats are mammalian species that use the landscape in a complex way. We encounter them hibernating in the underground sections of forts, hunting above moats and along trees, nursing in maternity colonies in church attics and trees, and courting from roof edges and crevices in poplars. Connecting structures serve as flyways between these elements. To provide insight into the importance of forts for bats, we describe how bats use a landscape starting from a network model. Bats use a network of landscape elements that fulfil a variety of functions. A summer colony consists of a network of maternity roost sites, which are connected together by means of flyways. The roost sites are connected to hunting grounds via daily routes. In the autumn and early winter, the summer habitats are connected to mating roosts, swarming sites and winter roosts via migration routes. Ultimately, the winter roosts complete the network of actively used roost sites.

The NWH forts have long been recognized as winter roosts for bats. The forts and the landscape at and around the forts, however, fulfil much more important functions for bats!



The project 'Bat habitats along the Nieuwe Hollandse Waterlinie' carried out by the Zoogdierverseniging VZZ in 2006 investigates and describes the presence of bats at and around the forts and the functions these forts fulfil for bats. This, however, is not a definitive investigation. The picture is rather complete for the winter season on the basis of regular winter counts as part of the Ecological Monitoring Network and the additional research from this project. For the summer season and the autumn phase, a targeted sampling was included in the study.

With this approach, a lot of factual information was collected for a strategic selection of forts, with the aim of creating a set of rules for handling bats during planning or implementation of developments at the level of the entire line, a specific fort, or a (single) event.

The set of rules ask the following series of questions: What functions are expected? What data is already available? What possible (negative) impacts are to be expected from a development or (single) event? What additional research is necessary? What can and should be done to prevent, mitigate or compensate the impacts? What can and should be done to enable an exemption from the Flora and Fauna Act?

It should be verified whether data is known about the object in question. If there is no data, this function should be investigated during the function-relevant season. If the use of the fort, the individual objects, or the above-ground buildings and trees at and around the fort is known to fulfil a particular function for bats, disturbance or damage to these roosts should be prevented or avoided, or any negative impacts alleviated (mitigation) during development, use and management. Moreover, the killing of bats should always be prevented during activities such as felling, demolition, or renovation.

There is still relatively little known about how to compensate for negative impacts that remain after avoidance and compensation measures have been performed. Experiments and research, among other tools, should be used to investigate effective possibilities for compensation. In the third part of the report, a number of suggestions are made for concrete mitigating and compensating measures concerning changing use, temporary use for events, etc.

The resulting rules will help to implement a sustainable use of the Nieuwe Hollandse Waterlinie by bats and people. We propose that this is certainly possible, provided that the annual cycle of the bat is incorporated in the planning, planning processes and planning of user forms in space and time.

The more information is known, the simpler the planning and any requests for the necessary exemptions will be, and how much wider the spectrum of mitigation or compensation possibilities there will be. Bat-friendly management, however, will continue to require customised solutions!

It is advisable to formulate a protocol as a working framework for carrying out activities that affect bats in and around the Nieuwe Hollandse Waterlinie forts and group shelters. This protocol can serve as a basis for granting a long-term exemption under article 75 of the Flora and Fauna Act.